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FIELD GUIDE

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NBRI BOTANICAL GARDEN, LUCKNOW: A TREASURE TROVE OF PLANT VEGETATION, ITS HISTORY AND ECOLOGY

Poonam Verma, Shreya Mishra and Suman Sarkar



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Field Guide Book

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NBRI Botanical Garden, Lucknow: A treasure trove of plant vegetation, its history and ecology

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Team Leaders



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Shreya Mishra is a palaeopalynologist and her research spans Palaeozoic to Cenozoic palynology, with specialized expertise in biostratigraphy, palaeoecology, and the reconstruction of ancient vegetation, climates, and environments. A core area of her work focuses on terrestrial floral transitions during major Earth history events, including mass extinction horizons, climatic perturbations, volcanic activity, and the tectonic evolution of the Indian Plate. Her key contributions include refining Permian–Mesozoic Gondwana palynostratigraphy, assessing vegetation shifts tied to Deccan volcanism, and detailing Cretaceous angiosperm diversification.



Dr. Suman Sarkar

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Dr. Suman Sarkar is a specialist in Paleogene and Neogene coralline algae and benthic foraminifera. He has worked extensively on the palaeogeography of multiple Palaeocene-Eocene coralline algal taxa from the Tethyan domains with special emphasis on their taxonomy and ecology. His research interests include analysing the climate change impacts of hyperthermal events like the Paleocene-Eocene Thermal Maximum (PETM) and Middle Eocene Climate Optimum (MECO) on the larger benthic foraminifera and coralline algae.

Abstract

The National Botanical Research Institute (NBRI) Botanical Garden represents a unique amalgamation of geological setting, historical evolution, architectural excellence, and biodiversity conservation in the heart of Lucknow. Located on the banks of the Gomti River, these sites illustrate the intimate relationship between the Quaternary alluvial landscape of the Central Ganga Plain and the development of Nawabi architecture, characterised by planned, picturesque botanical landscapes. The NBRI Botanical Garden, established on the historic Sikandar Bagh estate, serves as one of India's premier centers for plant research and ex situ conservation. This excursion will provide participants with insights into the geological evolution of the Gomti floodplain, the historical transformation of the landscape, urban biodiversity, and heritage conservation.

Preamble

The NBRI Botanical Garden complex occupies a historically and scientifically significant landscape along the Gomti River in central Lucknow. The area has evolved through the interaction of natural fluvial processes and human intervention over the last several centuries. The fertile alluvial deposits of the Gomti River supported the establishment of royal gardens and palaces during the Nawabi regime, creating a landscape that continues to combine historical monuments with botanical diversity. Today, NBRI Botanical Garden functions as a nationally important center for botanical research, conservation, and environmental education.

Research problem

Across the world, historic urban landscapes face increasing pressures from rapid urbanization, environmental degradation, climate change, and loss of biodiversity. Botanical gardens are becoming increasingly important as centers for ex situ conservation, climate adaptation, and public awareness. The NBRI field transect is unique because it integrates geological heritage, historical architecture, riverine geomorphology, and botanical conservation within a single urban landscape. It demonstrates how Quaternary floodplain evolution influenced the establishment of royal gardens and monumental architecture, while providing an exceptional opportunity to study the sustainable management of cultural and ecological heritage in tandem.

The NBRI Botanic Garden: Botanical, Ecological and Heritage Significance

Location

The CSIR–National Botanical Research Institute (NBRI) is situated in the historic Sikandar Bagh area in the heart of Lucknow, the capital city of Uttar Pradesh, India (approximately 26°52′ N latitude and 80°57′ E longitude). Spread over nearly 65 acres, the institute occupies a strategic location on the southern bank of the Gomti River, within the Central Ganga Alluvial Plain, one of the world's largest Quaternary sedimentary basins. The garden lies in an intensely urbanized landscape but continues to function as an important green space, conserving rich biodiversity within the city.

Historical Evolution

The CSIR–National Botanical Research Institute (NBRI), Lucknow, traces its origin to the historic Sikandar Bagh, a royal garden established in 1789 CE by Nawab Saadat Ali Khan in honor of his queen, Sikandar Mahal Begum. Designed as an elegant pleasure garden in the Awadhi style, Sikandar Bagh later became a prominent landmark in Lucknow and is historically significant as one of the major sites of the Siege of Lucknow during the First War of Indian Independence in 1857.

During the British regime, the royal garden was transformed into a Government Horticultural Garden, where emphasis shifted from ornamental landscaping to the cultivation, introduction, and acclimatization of economically important and exotic plant species. Recognizing its scientific potential, the Government of Uttar Pradesh established the National Botanic Gardens (NBG) in 1948, marking its transition from a historic garden to a national institution dedicated to botanical research, plant conservation, and horticultural development.

A major milestone in the institute's history was the appointment of Prof. Kailas Nath Kaul, the founding Director, whose visionary leadership laid the foundation for modern botanical research in India. He expanded the living plant collections and initiated programs in taxonomy, floriculture, horticulture, and conservation. In 1953, the National Botanic Gardens were brought under the Council of Scientific and Industrial Research (CSIR), enabling the expansion of multidisciplinary research in plant sciences. Under the leadership of Prof. T. N. Khoshoo, research activities were further strengthened, particularly in biodiversity conservation, ecology, ornamental horticulture, and environmental sciences. Reflecting its

expanded scientific mandate, the institute was renamed the National Botanical Research Institute (NBRI) in 1978. Today, NBRI is recognized as one of India's leading centers for plant science research, biodiversity conservation, and botanical education, while preserving the rich historical and cultural legacy of the historic Sikandar Bagh.

Botanical Diversity and Living Collections

The CSIR–National Botanical Research Institute (NBRI) Botanic Garden is one of India's most important living repositories of plant diversity, representing over two centuries of botanical exploration, plant introduction, and conservation. Situated within the historic Sikandar Bagh in the heart of Lucknow, the 65-acre garden combines historical significance with scientific excellence and serves as a national center for ex situ conservation, plant research, education, and public outreach. Owing to its rich biological wealth and scientific infrastructure, the garden has evolved into a unique interface between biodiversity conservation and botanical research.

The garden conserves more than 6,000 species, cultivars, and varieties of native and exotic plants collected from diverse phytogeographical regions of India and abroad. These living collections represent a broad spectrum of taxonomic diversity, ecological adaptations, and economic importance. The campus supports a mosaic of habitats comprising ornamental landscapes, arboreta, thematic gardens, aquatic ecosystems, lawns, dense tree plantations, shrubbery, climbers, and specialized plant houses. Such habitat heterogeneity creates favorable microenvironments that support not only diverse plant communities but also numerous insects, butterflies, pollinators, reptiles, and resident and migratory birds, making the Botanical Garden an important urban biodiversity hotspot within the city of Lucknow.

Unlike conventional public parks, the NBRI Botanic Garden functions as a scientifically curated living museum, where every plant accession is systematically documented, labelled, and maintained for research, conservation, education, and germplasm preservation. The collections are periodically enriched through botanical explorations, exchange programs with national and international botanical institutions, and scientific expeditions across various ecological regions. This dynamic approach ensures continuous enhancement of the garden's genetic diversity and strengthens its role in safeguarding valuable plant resources for future generations.

Overall Plant Diversity

The remarkable diversity maintained within the Botanical Garden encompasses representatives of almost all major groups of terrestrial plants, ranging from primitive non-flowering plants to highly evolved angiosperms. The collections include annual and perennial herbs, shrubs, climbers, woody trees, aquatic plants, medicinal species, ornamentals, palms, cycads, bamboos, succulents, ferns, bryophytes, orchids, and numerous economically important taxa. Plants representing tropical, subtropical, semi-arid, wetland, and xerophytic ecosystems are successfully cultivated under carefully managed environmental conditions.

Particular emphasis has been placed on conserving economically important, rare, threatened, endemic, and ornamental species. Native Indian flora is displayed alongside exotic introductions from Asia, Africa, Europe, Australia, and the Americas, enabling

comparative studies in taxonomy, ecology, adaptation, and horticulture. Such diversity provides invaluable opportunities for scientific investigations on plant morphology, reproductive biology, physiology, phenology, environmental adaptation, and climate resilience.

Beyond their scientific value, the collections demonstrate the immense aesthetic and educational potential of plant diversity. Seasonal flowering displays, ornamental landscapes, and specialized thematic gardens attract researchers, students, horticulturists, and visitors throughout the year, contributing to environmental awareness and appreciation of botanical heritage.

Living Collections

The principal strength of the NBRI Botanic Garden lies in its extensive living collections, which constitute one of the largest and most systematically maintained assemblages of plants in India. Unlike preserved herbarium specimens, living collections allow continuous observation of plant growth, flowering, fruiting, phenology, physiology, and ecological interactions. These collections provide indispensable material for taxonomic verification, breeding programs, conservation biology, biotechnology, teaching, and public education.

Each accession is maintained with scientific documentation that includes botanical identity, accession number, collection source, geographical origin, ecological characteristics, and propagation history. Such meticulous record-keeping ensures traceability of germplasm and facilitates long-term scientific studies. The living collections also serve as reference material for species identification and support national and international collaborations involving plant exchange and conservation.

The collections encompass ornamental species, medicinal plants, economically useful taxa, indigenous trees, aquatic plants, palms, cycads, orchids, ferns, succulents, and numerous wild relatives of cultivated plants. These resources provide an invaluable genetic reservoir for future research in plant breeding, climate adaptation, restoration ecology, and sustainable utilization of plant resources.

The living collections of the CSIR–NBRI Botanic Garden constitute far more than an assemblage of ornamental plants; they represent an invaluable scientific resource supporting research, conservation, education, and sustainable utilization of plant diversity. The integration of extensive germplasm collections, specialized conservatories, thematic gardens, and arboreta provides unique opportunities for multidisciplinary investigations in taxonomy, systematics, ecology, horticulture, biotechnology, conservation biology, environmental sciences, and climate-change research.

Germplasm Collections

One of the defining features of the NBRI Botanic Garden is its nationally important germplasm collections, representing decades of systematic exploration, introduction, evaluation, and conservation of plant genetic resources. Germplasm conservation forms the foundation of crop improvement, ornamental breeding, and biodiversity preservation by safeguarding genetic variability that may otherwise be lost due to habitat degradation, climate change, urbanization, or overexploitation.

The institute maintains one of India's richest collections of ornamental plants. Particularly noteworthy are approximately 202 cultivars of Bougainvillaea, making it one of the largest documented collections in the country. Equally impressive are the collections of about 200 Chrysanthemum, 115 Gladiolus, 125 Rose, and 45 Canna cultivars, which have served as valuable genetic resources for breeding programs and varietal improvement.

The aquatic plant collections include numerous accessions of Nelumbo nucifera (lotus) and Nymphaea species (water lilies), representing diverse flower colours, leaf morphology, and ecological adaptations. These collections support research in taxonomy, ornamental horticulture, aquatic ecology, and conservation biology while enhancing the visual appeal of the Botanical Garden.

In addition to ornamental crops, the germplasm collections encompass medicinal plants, aromatic species, indigenous trees, climbers, shrubs, palms, cycads, orchids, ferns, succulents, cacti, bamboo, and several threatened taxa. The broad taxonomic representation enables comparative research on genetic diversity, reproductive biology, stress tolerance, and adaptive evolution under varying environmental conditions.

The germplasm repositories also serve as an important source of propagules for multiplication, exchange, restoration programs, and scientific experimentation. Through systematic characterization, documentation, and evaluation, these collections contribute significantly to national efforts aimed at conserving plant genetic diversity and ensuring sustainable utilization of valuable biological resources.

Arboretum

The Arboretum constitutes one of the most distinctive components of the NBRI Botanic Garden and serves as a living archive of woody plant diversity. Covering a substantial portion of the campus, it conserves nearly 400 species of trees and shrubs representing diverse climatic regions and phytogeographical provinces of India and the world. The arboretum provides an invaluable resource for studies on dendrology, systematics, ecology, silviculture, and landscape planning.

The tree collections include numerous indigenous species characteristic of the Indo-Gangetic Plains alongside economically important timber trees, fruit-bearing species, medicinal trees, ornamental taxa, palms, and several rare or threatened species. Mature specimens of banyan (Ficus benghalensis), peepal (Ficus religiosa), neem (Azadirachta indica), arjun (Terminalia arjuna), mahogany (Swietenia mahagoni), and many other species create a structurally complex canopy that supports diverse birdlife, insects, and epiphytic flora.

From a scientific perspective, the arboretum functions as a long-term experimental resource for monitoring tree growth, phenology, carbon sequestration, and responses to changing environmental conditions. It also serves as an important reference collection for taxonomic identification and provides plant material for ecological and physiological studies. Mature tree cover significantly enhances the Botanical Garden's microclimate by moderating temperatures, increasing humidity, improving air quality, and supporting urban biodiversity.

Conservatories and Specialized Plant Houses

A distinctive feature of the CSIR-NBRI Botanic Garden is its well-developed network of conservatories and specialized plant houses, designed to cultivate and conserve plant groups requiring specific environmental conditions. These facilities simulate natural habitats by regulating temperature, humidity, light, and irrigation, thereby enabling the successful maintenance of species that cannot be grown under open-field conditions. Besides serving as display units, the conservatories function as living laboratories for research in taxonomy, plant physiology, propagation, conservation biology, and horticultural sciences.

The Tropical and Subtropical Conservatory houses nearly 300 species and cultivars representing a wide range of ornamental and economically important plants adapted to warm and humid climates. These collections provide valuable material for studies on plant adaptation, growth behaviour, reproductive biology, and environmental responses under controlled conditions.

The Cactus and Succulent House conserves approximately 350 species and varieties of xerophytic plants from arid and semi-arid regions worldwide. The collection demonstrates remarkable structural and physiological adaptations to drought stress, including succulent stems, reduced leaves, specialized water-storage tissues, and Crassulacean Acid Metabolism (CAM) photosynthesis. These plants provide excellent examples for understanding ecological adaptation to water-limited environments.

The Palm House maintains more than 50 species of palms, representing diverse ecological habitats from tropical rainforests to coastal ecosystems. Palms constitute an important component of tropical biodiversity and possess considerable economic, ornamental, and ecological significance. Their collection facilitates comparative studies on taxonomy, morphology, and landscape utilization.

The Cycad House conserves nearly 70 cycad species, one of the oldest surviving lineages of seed plants. Often referred to as "living fossils," cycads originated during the Mesozoic Era and provide valuable insights into plant evolution, palaeobotany, and conservation biology. Their inclusion is particularly relevant to palaeoscientists and Quaternary researchers, highlighting the evolutionary continuity of ancient plant lineages.

The Orchidarium, containing approximately 120 orchid species, represents one of the most diverse collections within the garden. Orchids are internationally recognized for their extraordinary floral diversity, specialized pollination mechanisms, and ecological sensitivity. The collection supports research on orchid conservation, micropropagation, and reproductive biology.

Additional specialized facilities include the Fern House, preserving nearly 100 species of ferns and fern allies, and the Moss House, which maintains representative bryophyte diversity. These lower plant groups play important ecological roles in nutrient cycling, moisture retention, and habitat formation while also serving as useful indicators of environmental quality. Other facilities, including the Gerbera House, propagation units, mist chambers, nurseries, and experimental plots, provide essential infrastructure for plant multiplication, varietal improvement, and conservation research.

Thematic Gardens

In addition to its taxonomic collections, the NBRI Botanic Garden has established several thematic gardens that integrate scientific interpretation with environmental education and visitor engagement. These gardens are designed to illustrate specific aspects of plant diversity, conservation, and human–plant relationships in an accessible manner. Among the most innovative facilities is the Touch and Smell Garden, developed specifically for visually impaired visitors. The garden incorporates aromatic, textured, and medicinal plants accompanied by Braille labels and audio support, enabling visitors to explore plant diversity through touch and fragrance. This inclusive initiative represents an excellent example of accessible botanical education.

The Know Your Plants section introduces visitors, particularly school children, to economically important plants encountered in daily life. Food crops, spices, medicinal plants, fibre-yielding species, ornamentals, and useful trees are displayed with interpretative information highlighting their economic and cultural importance. This section promotes awareness of human society's dependence on plant resources and encourages appreciation of biodiversity. The garden has also established thematic collections such as the State Plants of India Garden and the Threatened Plants of India Garden, showcasing representative species from different Indian states and highlighting taxa facing varying degrees of extinction risk. These gardens serve as important platforms for raising conservation awareness and demonstrate national efforts to safeguard India's floristic wealth.

Aquatic gardens featuring lotus (Nelumbo nucifera) and water lilies (Nymphaea spp.), ornamental landscapes, seasonal flowering beds, medicinal plant sections, and avenue plantations further enrich the Botanical Garden's educational value. Together, these thematic displays provide visitors with an integrated understanding of plant diversity, ecological adaptation, conservation priorities, and sustainable utilization.

Living National Repository

The exceptional diversity maintained by the NBRI Botanic Garden has led to its recognition as a Living National Repository by the National Biodiversity Authority (NBA), Chennai. This prestigious designation acknowledges the garden's vital role in conserving India's plant genetic resources and maintaining authenticated living collections of national importance. As a Living National Repository, the Botanical Garden is entrusted with the long-term maintenance, documentation, propagation, and scientific management of valuable germplasm representing diverse taxonomic groups. The collections support taxonomic research, species authentication, conservation planning, plant breeding, ecological restoration, and educational programs. They also provide authenticated reference material for researchers, students, government agencies, and conservation organizations.

The repository contributes significantly to national biodiversity conservation strategies by preserving threatened, rare, endemic, medicinal, ornamental, and economically important plant species outside their natural habitats. Such ex situ conservation complements in situ conservation efforts and provides an insurance mechanism against habitat degradation, invasive species, climate change, and anthropogenic disturbances. The systematic documentation of plant accessions, periodic enrichment of collections, and application of

modern conservation techniques ensure that the repository remains a dynamic scientific resource supporting both national and international botanical research.

Botanic Gardens Conservation International (BGCI) Network

The NBRI Botanic Garden is an active member of Botanic Gardens Conservation International (BGCI), the world's largest network of botanical gardens dedicated to plant conservation and sustainable development. Through this global partnership, the institute collaborates with botanical gardens, research organizations, universities, and conservation agencies across the world in the exchange of plant germplasm, scientific knowledge, and best practices.

Membership of BGCI facilitates participation in international initiatives addressing biodiversity conservation, restoration ecology, threatened species recovery, climate change adaptation, and capacity building. It also strengthens NBRI's role in implementing the objectives of the Global Strategy for Plant Conservation (GSPC) under the Convention on Biological Diversity (CBD).

International collaboration has enabled the Botanical Garden to enhance its living collections, improve documentation standards, adopt modern conservation methodologies, and strengthen scientific exchange programs. Such partnerships have significantly expanded the institute's contribution to global plant conservation while simultaneously promoting India's botanical heritage on the international stage.

Research Infrastructure and Scientific Contributions

Since its establishment under the Council of Scientific and Industrial Research (CSIR), the CSIR–National Botanical Research Institute (NBRI), Lucknow, has emerged as one of India's leading centers for multidisciplinary plant science research. The institute integrates classical botanical disciplines with modern biological sciences to address fundamental and applied problems related to biodiversity conservation, sustainable utilization of plant resources, environmental management, and agricultural improvement.

A major strength of NBRI lies in its long-standing contributions to plant taxonomy and systematics. Extensive taxonomic investigations, floristic surveys, and systematic revisions have significantly improved the understanding of India's plant diversity. These studies are supported by the internationally recognized LWG Herbarium, which houses more than 200,000 authenticated herbarium specimens representing diverse floristic regions of the country. The herbarium serves as an invaluable reference collection for plant identification, nomenclature, biodiversity assessment, and taxonomic research.

NBRI has played a pivotal role in biodiversity documentation through botanical explorations, species inventories, floristic assessments, and conservation studies. Its living collections and herbarium resources provide baseline information for monitoring plant diversity, evaluating threatened species, and supporting national conservation programs.

The institute has earned international recognition for its research in horticulture and floriculture, particularly in the development and improvement of ornamental crops such as Bougainvillaea, Gladiolus, Chrysanthemum, Canna, and Rose. These programs have resulted in the release of several improved cultivars that contribute to landscape horticulture,

commercial floriculture, and urban greening initiatives.

Research in plant biotechnology has expanded NBRI's capabilities in crop improvement, molecular biology, genetic transformation, stress physiology, and functional genomics. Complementary work in plant tissue culture has facilitated rapid multiplication, conservation of elite germplasm, micropropagation of economically important species, and propagation of rare and threatened plants.

Another major research focus is medicinal and aromatic plants, encompassing phytochemical investigations, isolation of bioactive compounds, herbal product development, and validation of traditional medicinal knowledge. These studies have contributed to the development of value-added phytopharmaceuticals and natural products with potential pharmaceutical and industrial applications.

To modernize botanical information management, NBRI has recently introduced DRONA (Digital Recognition and Organization of NBRI Herbarium using Artificial Intelligence), an AI-assisted digital herbarium platform. DRONA enables efficient digitization, automated specimen recognition, metadata management, and rapid retrieval of herbarium records, thereby enhancing accessibility for researchers and facilitating national and international collaboration in plant taxonomy and biodiversity informatics.

Collectively, these multidisciplinary research programs have established NBRI as a nationally important institution supporting plant taxonomy, biodiversity conservation, horticultural innovation, biotechnology, and sustainable utilization of plant genetic resources.

National Recognition and Conservation Programmes

The CSIR–National Botanical Research Institute (NBRI), Lucknow, is nationally recognised for its significant contributions to plant conservation, germplasm management, and sustainable utilization of plant genetic resources. Through its extensive living collections and multidisciplinary research programs, the institute has emerged as one of India's foremost centers for ex situ plant conservation and biodiversity management.

A major recognition of the institute's conservation efforts is its designation as a Living National Repository by the National Biodiversity Authority (NBA), Chennai. This status acknowledges the scientific value of NBRI's authenticated living collections, which include more than 6,000 plant species, cultivars, and varieties representing native, endemic, threatened, economically important, and exotic taxa. These collections serve as national reference material for taxonomy, conservation biology, ecological restoration, plant breeding, and biodiversity research while supporting the objectives of the Biological Diversity Act, 2002.

The NBRI Botanic Garden has also been identified as one of the Lead Botanic Gardens under the Assistance to Botanic Gardens (ABG) Scheme of the Ministry of Environment, Forest and Climate Change (MoEFCC), Government of India. Under this programme, the institute undertakes conservation of threatened and endemic plant species, restoration of valuable germplasm, capacity building, and public awareness initiatives. The programme has strengthened NBRI's role in developing scientific protocols for plant propagation,

reintroduction, and long-term conservation of vulnerable plant resources.

Another important national responsibility entrusted to NBRI is its recognition as a DUS (Distinctness, Uniformity and Stability) Centre for Bougainvillea, Gladiolus, and Canna under the Protection of Plant Varieties and Farmers' Rights Authority (PPV&FRA), Ministry of Agriculture and Farmers Welfare, Government of India. The institute conducts characterization and evaluation of new ornamental varieties to support plant variety registration and the protection of breeders' rights, thereby promoting innovation in ornamental horticulture.

Conservation of threatened plant species forms an integral component of the institute's research and conservation strategy. Rare, endangered, and endemic taxa are maintained under carefully managed conditions in specialized conservatories, thematic gardens, nurseries, and field collections. Scientific propagation techniques, including seed-based multiplication, vegetative propagation, and tissue culture, are employed to enhance survival and facilitate future restoration programs.

The Botanical Garden serves as a major centre for ex situ conservation, preserving plant diversity outside natural habitats while safeguarding valuable genetic resources against habitat degradation, urbanization, invasive species, and climate change. Continuous germplasm enrichment through botanical explorations, plant exchange programs, and scientific introductions further strengthens the genetic diversity of the collections and supports research in taxonomy, breeding, conservation biology, and climate resilience.

Collectively, these national recognitions underscore the importance of NBRI as a premier institution for plant conservation and biodiversity management. By integrating scientific research with conservation, education, and sustainable utilization of plant resources, the institute makes a significant contribution to India's national biodiversity goals while supporting global efforts towards the conservation of plant diversity.

Education, Outreach and Public Engagement

In addition to its research and conservation activities, the CSIR–National Botanical Research Institute (NBRI), Lucknow plays a vital role in botanical education, environmental awareness, and public engagement. As one of India's leading botanic gardens, NBRI bridges scientific research and society by promoting appreciation of plant diversity, sustainable utilization of biological resources, and biodiversity conservation through a range of educational and outreach programs.

One of the most distinctive educational facilities within the Botanic Garden is the Touch and Smell Garden, developed specifically for visually impaired visitors. The garden contains aromatic, medicinal, and textured plant species that can be explored through touch and fragrance. Plant labels in Braille, together with audio-assisted interpretation, enable visitors to identify and appreciate different plant species independently. This innovative initiative promotes inclusive environmental education and demonstrates NBRI's commitment to making botanical knowledge accessible to all sections of society.

Another important attraction is the Know Your Plants section, which is designed primarily for schoolchildren and the general public. This thematic garden showcases plants of everyday importance, including food crops, spices, medicinal plants, fibre-yielding species,

beverages, ornamentals, and economically useful trees. Informative displays explain their botanical identity, uses, and ecological significance, helping visitors understand the close relationship between plants and human well-being. The section serves as an effective platform for promoting plant literacy and biodiversity awareness among younger generations.

The institute is widely known for organizing its Annual Flower Shows and the popular Bougainvillaea Festival, which attract thousands of visitors, horticulturists, researchers, students, and gardening enthusiasts each year. These exhibitions display a remarkable diversity of ornamental plants, improved cultivars, landscaping techniques, and innovative horticultural practices. The events also provide opportunities for interaction between scientists, commercial growers, nurseries, and the public, facilitating the dissemination of scientific knowledge and recent advances in ornamental horticulture.

NBRI regularly conducts training programs, workshops, and demonstration courses in ornamental horticulture, nursery management, plant propagation, landscaping, bonsai cultivation, and floriculture for students, researchers, gardeners, entrepreneurs, government officials, and members of the public. These capacity-building initiatives promote scientific cultivation practices and encourage the adoption of environmentally sustainable horticultural technologies.

The Plant Sales Section of the Botanic Garden further strengthens public participation by making high-quality saplings and planting material of ornamental, medicinal, aromatic, and indigenous plant species available to visitors. This initiative encourages urban greening, home gardening, and the conservation of useful plant species while extending the institute's conservation efforts beyond the garden itself.

Through guided visits, educational displays, botanical exhibitions, awareness campaigns, publications, and digital outreach, NBRI continues to foster public appreciation of India's rich plant heritage. By integrating scientific research with education and community participation, the institute has established itself as a leading center for environmental awareness and biodiversity conservation. These outreach initiatives complement the institute's research mission and reinforce the role of botanical gardens as important institutions for conservation, education, and sustainable development.





Glimpses of NBRI-Botanical Garden, Lucknow





Nursery of NBRI-Botanical Garden, Lucknow







Entrance of NBRI-Botanical Garden, Lucknow

Regional Geology

Lucknow is located in the Central Ganga Alluvial Plain, within the Ghaghara–Ganga interfluve, and lies along the middle course of the Gomti River. The Gomti is a groundwater-fed meandering river that originates in the Terai region of Pilibhit district and flows southeastward to join the Ganga at Ghazipur. The river drains thick Quaternary alluvial deposits and has played a dominant role in shaping the geomorphology of the Lucknow region. Its locally distorted meander pattern and asymmetric valley morphology have been interpreted as evidence of late Quaternary neotectonic activity.

The Quaternary landscape around Lucknow comprises three geomorphic surfaces representing successive stages of fluvial evolution:

(i) Upland Terrace Surface (T_2 or Older Alluvium/Bangar):

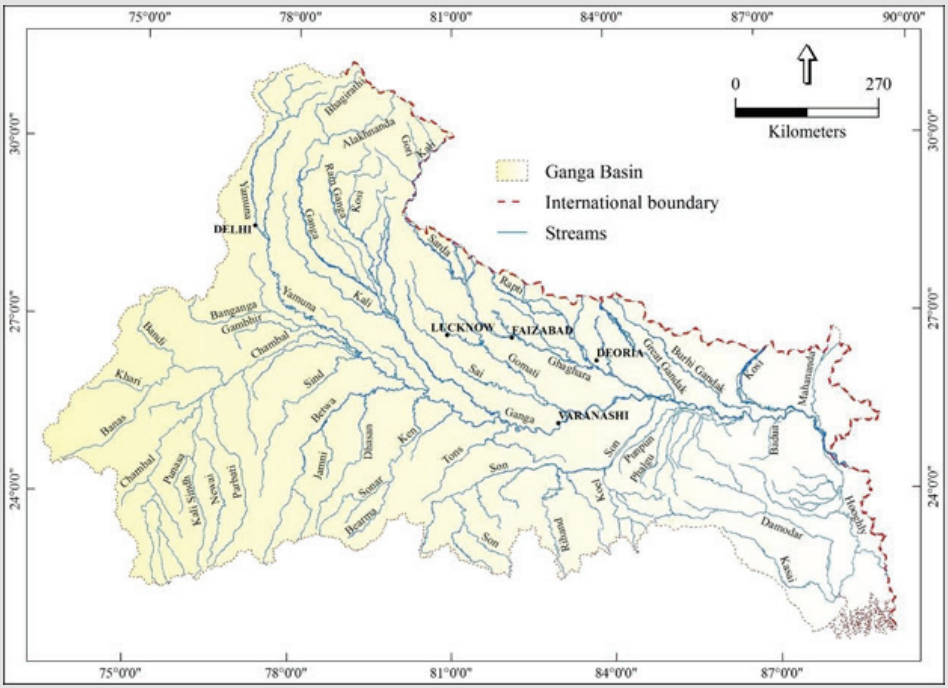
This is the oldest and highest geomorphic surface, standing approximately 15–20 m above the younger river terrace (T_1). It consists predominantly of oxidized sand, silt, and clay with multiple calcrete (kankar) horizons, indicating prolonged subaerial exposure and pedogenesis. Characteristic landforms include abandoned palaeochannels, bhur sand ridges, shallow depressions, ponds, lakes, and patches of alkaline soils. These geomorphic features developed mainly during the Early to Middle Holocene and preserve valuable records of palaeohydrology, palaeoclimate, and landscape evolution.

(ii) River Valley Terrace Surface (T_1):

The T_1 terrace forms an intermediate geomorphic level approximately 5–10 m above the active floodplain (T_0). It comprises relatively younger alluvial deposits laid down during later phases of river migration. The terrace exhibits nearly level topography, well-drained, fertile alluvial soils, and is a stable geomorphic surface suitable for vegetation and urban development. Natural levees and abandoned channels associated with this terrace are commonly observed along the Gomti valley.

(iii) Active Floodplain Surface (T_0):

The youngest geomorphic unit consists of the present Gomti River channel, point bars, channel bars, levees, and seasonally inundated floodplain deposits. These sediments are composed of unconsolidated sand, silt, and clay that continue to accumulate during annual flooding. The active floodplain provides an excellent example of ongoing fluvial processes, including lateral channel migration, sediment transport, overbank deposition, and floodplain aggradation.



Fluvial architecture of the Ganga Basin

Flora, Fauna and Climate, weather conditions during field excursion

Flora

CSIR-National Botanical Research Institute (NBRI), Lucknow, maintains one of India's most important living plant collections and botanical gardens. The collections are arranged in specialized sections such as the arboretum, palm house, cactus and succulent house, fern house, aquatic garden, bonsai section, and climber collections. The arboretum contains hundreds of native and exotic tree species, including members of Ficus, Polyalthia, Eucalyptus, Delonix, Cassia/Senna, and Azadirachta. The palm collections include genera such as Areca, Phoenix, Livistona, and Washingtonia, while the cactus house preserves diverse xerophytic plants including Opuntia, Mammillaria, Echinocactus, Aloe, and Agave.

NBRI is particularly renowned for its rich ornamental flora, with extensive collections of Rosa, Bougainvillea, Chrysanthemum, Gladiolus, Canna, Hibiscus, Ixora, and numerous

seasonal flowering plants. The aquatic garden maintains species such as Nymphaea (water lilies) and Nelumbo nucifera (lotus), and the institute has developed the lotus cultivar Namoh 108. The fern house conserves several fern species and other shade-loving plants, whereas the climber section contains a large diversity of ornamental vines and creepers. In addition, NBRI maintains fruit plants, economically important species, and a substantial collection of medicinal and aromatic plants including Bacopa monnieri, Withania somnifera, Ocimum, Aloe vera, and Catharanthus roseus. Recent conservation initiatives include the State Plants of India Garden and the Threatened Plants of India Garden, which display rare, endemic, and threatened taxa from different regions of the country. The institute also houses the LWG Herbarium with over two lakh preserved plant specimens, making NBRI a major center for plant conservation, taxonomy, floriculture, education, and botanical research in India.

Climate of Lucknow

The climate of Lucknow district is classified as humid subtropical (Köppen Cwa), characterized by hot summers, a pronounced monsoon season, and cool winters. Located in the central Ganga Plain, the district experiences a strong seasonal influence of the Indian Summer Monsoon (ISM).

Summer extends from March to June and is the hottest period of the year. Maximum temperatures commonly range between 38–42°C, and during heat-wave conditions they may exceed 45°C. Relative humidity is generally low before the onset of the monsoon, and hot, dry winds locally known as loo frequently occur during May and June.

The southwest monsoon usually arrives in late June and continues until September. This season contributes nearly 80–85% of the annual rainfall, with an average annual precipitation of approximately 900–1,000 mm. July and August are typically the wettest months. High humidity, cloud cover, and frequent rainfall characterize this period, and temporary waterlogging may occur in low-lying areas.

Post-monsoon conditions prevail during October and November, when rainfall decreases sharply and temperatures become moderate. **Winter extends from December to February and is generally cool and dry. Mean minimum temperatures range from 7–10°C, although cold-wave events may occasionally lower temperatures to around 3–5°C.** Fog is common during December and January and can affect visibility for several days.

Thus, Lucknow exhibits a climate with marked seasonal contrasts in temperature and precipitation, controlled primarily by monsoonal circulation and continentality. These climatic conditions strongly influence agriculture, vegetation, hydrology, and sedimentary processes across the district.

Fauna

The fauna of Lucknow district is representative of the Middle Ganga Plain and includes a mixture of urban, agricultural, wetland, and riverine species. The district supports diverse mammalian, avian, reptilian, amphibian, and aquatic fauna associated with the Gomti River, marshes, ponds, agricultural fields, and remnant woodland patches.

Among mammals, commonly recorded species include the golden jackal (Canis aureus), Indian grey mongoose (Urva edwardsii), small Indian mongoose (Urva auropunctatus), Indian hare (Lepus nigricollis), five-striped palm squirrel (Funambulus pennantii), Indian flying fox (Pteropus giganteus), and several species of rats and mice adapted to rural and urban habitats. Occasional sightings of nilgai (Boselaphus tragocamelus) occur in the peri-urban and agricultural fringes of the district.

Bird diversity is particularly high in wetlands and along the Gomti floodplain. Common resident birds include the Indian peafowl (Pavo cristatus), red-vented bulbul (Pycnonotus cafer), house sparrow (Passer domesticus), common myna (Acridotheres tristis), rose-ringed parakeet (Psittacula krameri), black kite (Milvus migrans), cattle egret (Bubulcus ibis), and white-throated kingfisher (Halcyon smyrnensis). Winter wetlands attract migratory waterfowl such as northern pintail (Anas acuta), common teal (Anas crecca), gadwall (Mareca strepera), and other ducks, geese, and waders.

Reptiles commonly include the Indian rat snake (Ptyas mucosa), checkered keelback (Fowlea piscator), spectacled cobra (Naja naja), common krait (Bungarus caeruleus), garden lizard (Calotes versicolor), and freshwater turtles in suitable aquatic habitats. Amphibians such as the Indian bullfrog (Hoplobatrachus tigerinus), skittering frog (Euphlyctis cyanophlyctis), and common Indian toad (Duttaphrynus melanostictus) are abundant during the monsoon season.

The aquatic fauna of the Gomti River includes fishes such as rohu (Labeo rohita), catla (Catla catla), mrigal (Cirrhinus mrigala), common carp (Cyprinus carpio), and several catfish species, together with freshwater molluscs, crustaceans, and aquatic insects.

The fauna of Lucknow district reflects the ecological mosaic of the central Gangetic plains, where riverine wetlands, agricultural landscapes, and urban green spaces collectively sustain significant biodiversity despite increasing urbanization and habitat modification.

Literature review

The literature highlights NBRI's significant contributions to plant taxonomy, floristics, biodiversity documentation, and herbarium science, supported by the internationally recognized LWG Herbarium containing over 200,000 preserved specimens. Research has also focused on ornamental horticulture, plant biotechnology, tissue culture, medicinal plants, phytochemistry, and the development of improved ornamental cultivars. Recent studies emphasize conservation initiatives through thematic gardens, ex situ germplasm conservation, AI-assisted herbarium digitization using the DRONA platform, and the institute's role in public outreach through flower festivals and botanical education.

Overall, published research demonstrates that NBRI has established itself as a nationally important institution integrating scientific research, biodiversity conservation, horticultural innovation, and environmental education. Future research opportunities include climate

change biology, urban biodiversity, conservation genomics, ecological restoration, and geospatial biodiversity assessment, which will further strengthen the institute's role in advancing contemporary plant sciences.

Field Transect

Distance: ~2.0 km

Travel Time: 10–15 minutes by bus (25–30 minutes on foot)

Mode: Bus/Walking

Stop	Location	Major Observations
1	Birbal Sahni Institute of Palaeosciences (BSIP) [26.5339°N; 80.9389°E]	Introduction to the Mid-INQUA Field Excursion. Overview of Quaternary geology, palynology, palaeobotany, and palaeoclimate research in the Middle Ganga Plain.
2	Birbal Sahni Marg [26.8626°N; 80.9480°E]	Observe the gently undulating urban landscape developed on Quaternary alluvial deposits of the Gomati River valley. Discuss the geomorphic setting of central Lucknow and the River Terrace (T2).
3	National Botanical Research Institute (NBRI) Gate – Sikandar Bagh [26.8581°N; 80.9506°E]	Historical introduction to Sikandar Bagh (1789 CE), Nawabi landscape planning, and its location on the Quaternary river terrace.
4	Inside NBRI Botanical Garden [26.8556°N; 80.9524°E]	Study the relationship between alluvial soils, groundwater conditions, and botanical diversity. Visit thematic gardens, arboretum, conservatories, medicinal plant collections, and discuss ex situ plant conservation.

Map of Location



Map of NBRI-Botanical Garden, Lucknow



Satellite imagery of NBRI-Botanical Garden, Lucknow

Geomorphological features

The NBRI Botanical Garden is situated on the River Valley Terrace (T2) along the southern bank of the Gomti River. The site is underlain by Quaternary alluvial sediments consisting predominantly of fine- to medium-grained sand, silt, and clay deposited by the ancestral Gomati River system. The relatively elevated terrace position protects the area from frequent flooding while maintaining a shallow groundwater table that supports luxuriant vegetation.

From a geological perspective, the Botanical Garden offers an excellent opportunity to study the relationship between geomorphology, alluvial sedimentation, soils, hydrology, and vegetation. The terrace surface illustrates the transition from the older Bangar uplands to the active floodplain and provides insight into the Late Quaternary evolution of the Gomti valley. The fertile alluvial soils and geomorphic stability of the T2 terrace explain the historical establishment of gardens and scientific institutions in this part of Lucknow. The influence of fluvial geomorphology on groundwater availability, vegetation distribution, and historical land use.

History, Culture, Cuisine and Geoheritage

Lucknow, the capital of Uttar Pradesh, is one of India's most distinguished heritage cities, renowned for its unique blend of geological setting, architectural grandeur, cultural refinement, and culinary traditions. Situated on the banks of the Gomti River within the Central Ganga Alluvial Plain, the city's evolution has been profoundly influenced by its geomorphological setting, which provided a stable foundation for human settlement and urban development since antiquity. Archaeological discoveries indicate that the Lucknow region has been inhabited since the Early Iron Age. Excavations at Lakshman Tila (Tile Wali Masjid) have yielded Painted Grey Ware (PGW), dating to approximately 1200–600 BCE, while the nearby archaeological site of Hulaskheda preserves evidence of settlements dating back nearly 3000 years BP. These findings demonstrate the continuity of human occupation along the fertile alluvial plains of the Gomati River and underscore the geoarchaeological significance of the region.

According to tradition, Lucknow derives its name from Lakshmana, the brother of Lord Rama, and the ancient mound of Lakshman Tila is believed to mark one of the earliest settlement sites. The elevated alluvial terraces bordering the Gomati River provided naturally flood-safe locations that favored the establishment of early settlements, forts, gardens, and later the magnificent monuments of the Nawabi period.

The city's cultural identity flourished during the eighteenth and nineteenth centuries under the Nawabs of Awadh, who transformed Lucknow into a centre of architecture, literature, music, dance, craftsmanship, and etiquette, giving rise to the celebrated Ganga-Jamuni

Tehzeeb that is a unique tradition of communal harmony and cultural syncretism. This composite culture continues to define the social fabric of Lucknow and is reflected in its festivals, language, performing arts, and traditional crafts such as Chikankari embroidery and Zardozi work, both recognized internationally for their craftsmanship. Lucknow is equally celebrated for its monumental architectural heritage. Iconic structures such as Bara Imambara, Chota Imambara, Rumi Darwaza, Chattar Manzil, Residency Complex, Dilkusha Kothi, and Sikandar Bagh represent outstanding examples of Indo-Islamic and Nawabi architecture. The historical core of Lucknow has been included in India's UNESCO Tentative List as the "City of Nawabs", recognizing its exceptional cultural landscape, architectural heritage, and urban character.

The city is internationally acclaimed for its rich culinary heritage, especially the renowned Awadhi cuisine developed in the royal kitchens of the Nawabs. This cuisine features the refined dum-pukht slow-cooking method. Popular dishes such as Galouti Kebabs, Kakori Kebabs, Shami Kebabs, Biryani, Sheermal, Kulcha-Nahari, and traditional sweets draw visitors worldwide, making gastronomy a key element of Lucknow's cultural identity. A recent milestone is its designation as a UNESCO Creative City of Gastronomy (2025), acknowledging the city's global reputation for Awadhi cuisine and its sophisticated culinary techniques.

From a geoheritage perspective, Lucknow illustrates the close relationship between geology, geomorphology, and civilization. The Quaternary alluvial terraces of the Gomati River provided fertile soils, reliable groundwater, and protection from seasonal flooding, facilitating continuous human occupation for over three millennia. The distribution of archaeological sites, historic gardens, palaces, and scientific institutions, including the National Botanical Research Institute (NBRI) at Sikandar Bagh, reflects the influence of the region's geomorphic framework on settlement patterns and landscape evolution.

Local conveniences

1. Hospitals and Medical Facilities

The NBRI Botanical Garden is located in the central part of Lucknow, where several government and private hospitals are available within a short driving distance.

- Balrampur Hospital – One of the oldest government tertiary-care hospitals in Lucknow, approximately 2 km from the Botanical Garden.
- Dr. Ram Manohar Lohia Institute of Medical Sciences – Major government super-specialty institute (about 6–7 km).
- Dr. KNS Memorial Hospital – Multi-specialty hospital with 24-hour emergency services.
- Medanta Lucknow – Advanced tertiary-care hospital for specialized medical emergencies.

Assistance for Lost or Stolen Passport

International visitors who lose their passport should first lodge a report at the nearest police station and then contact their country's Embassy or High Commission in New Delhi. Passport-related assistance in Lucknow is available at:

- Passport Seva Kendra, Lalbagh – Located on Vidhan Sabha Marg, about 1 km from NBRI, providing passport-related services and guidance.
- Regional Passport Office, Lucknow – Located at Vipin Khand, Gomti Nagar, handling passport administration for the region.

Shopping Areas and Bazaars

Several traditional and modern shopping areas are located close to the Botanical Garden.

- Hazratganj Market (0.5–1 km) – Lucknow's historic commercial district with bookstores, handicrafts, restaurants, banks, pharmacies, and cafés.
- Janpath Market – Popular for garments, handicrafts, souvenirs, and local shopping.
- Aminabad Market (about 3 km) – One of the city's oldest bazaars, famous for Chikankari embroidery, textiles, footwear, jewellery, and traditional Awadhi cuisine.
- Chowk Market – Renowned for traditional crafts, perfumes (ittar), zardozi work, sweets, and authentic Awadhi food.

These facilities make the NBRI Botanical Garden an excellent base for field excursions, with easy access to emergency medical care, administrative services, shopping, dining, and visitor amenities.

Useful emergency numbers:

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

Banking, ATMs, and Daily Needs

Area is well served by:

- Multiple ATM networks (SBI, HDFC, ICICI, Axis, PNB, etc.)
- Pharmacies and medical stores
- Grocery and convenience stores
- Ride-hailing services (Uber, Ola, Rapido)
- Metro connectivity through Hazratganj Metro Station

Duration & Cost

Mid-INQUA field Excursion: 31 January 2027 (1 day)

Cost: €50 per person

Concluding Remarks

The CSIR–National Botanical Research Institute (NBRI), Lucknow, represents a unique confluence of historical heritage, botanical diversity, scientific excellence, and environmental conservation. Established on the historic grounds of Sikandar Bagh, the institute has evolved from an eighteenth-century royal garden into one of India's foremost centers for plant science research and biodiversity conservation. Its remarkable transformation reflects the successful integration of cultural heritage with modern scientific advancement. The NBRI Botanic Garden conserves an exceptional diversity of native and exotic plant species through its extensive living collections, specialized conservatories, arboretum, and thematic gardens. These resources support a wide range of research in taxonomy, systematics, horticulture, biotechnology, medicinal plants, and conservation biology, while also serving as an important national repository of plant genetic resources. The institute's recognition as a Living National Repository, a Lead Botanic Garden, and a DUS Centre underscores its pivotal role in plant conservation, germplasm management, and sustainable utilization of biodiversity. Beyond research, NBRI has established itself as a major center for botanical education and public engagement through innovative initiatives such as the Touch and Smell Garden, Know Your Plants exhibits, annual flower shows, training programs, and environmental awareness activities. These programs strengthen the connection between scientific knowledge and society while promoting appreciation of India's rich botanical heritage.

From the perspective of the INQUA-2027 Mid-Field Excursion, the NBRI Botanic Garden provides an ideal introduction to the interaction between Quaternary geomorphology, fertile alluvial landscapes, groundwater resources, urban ecology, and biodiversity conservation in the Middle Ganga Plain. Although primarily a botanical institution, its location on the Quaternary river terrace of the Gomti River demonstrates how geological and geomorphological processes have influenced vegetation patterns, land use, and the historical development of Lucknow. The garden therefore serves as an outstanding example of the close relationship between Earth's surface processes, biological diversity, and human stewardship of natural resources, making it a scientifically significant and educationally valuable stop on the Mid-INQUA field excursion.

Acknowledgements

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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

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