

Monsoon Fluctuation Footprints

Prelims: Current events of national and international importance | Geography

Why in News?

A recent study published in the *Journal of Asian Earth Sciences* reconstructs approximately 4,600 years of climate and environmental history in the Central Ganga Plain.

KARELA LAKE, HULAS KHERA

A vital freshwater lake near Lucknow with ecological, scientific and archaeological significance

Location
Hulas Khera, Mohanlal Ganj, near Lucknow, Uttar Pradesh.

Physiographic region
Central Ganga Plain

Lake type
Oxbow lake

Significance
Its sediments preserve evidence of long-term environmental and climatic changes.

Archaeological relevance
The nearby Hulas Khera archaeological site provides an opportunity to investigate interactions between ancient settlements, agriculture and climate.

- **Sediments analysed from** - Karela Lake (Hulas Khera), an oxbow lake near Lucknow, Uttar Pradesh.
- **Aim** - To investigate the impact of Indian Summer Monsoon variability on ecosystems and early agricultural communities.
- **Conducted by** - Birbal Sahni Institute of Palaeosciences (BSIP), an autonomous institute under the Department of Science and Technology (DST).
- **Key Findings**
 - Monsoon variability significantly affected lake water conditions and associated hydrological processes.
 - Variations in rainfall altered sediment transport, including changes in grain size and patterns of deposition.
 - Climatic fluctuations drove transitions between **C₃** and **C₄** vegetation types.

C3 and C4 plants use different biochemical pathways to fix carbon dioxide during photosynthesis.

- Monsoon variability influenced both the composition and deposition of sedimentary organic matter.
- Alterations in environmental conditions affected microbial activity within lake sediments.
- Climatic changes influenced agricultural adaptation, including the adoption of manure-based farming practices.
- Moisture records linked to westerly winds offered evidence for flooding events during the colder phase of the **Little Ice Age (LIA)**.

Little Ice Age (LIA) refers to a period from the fourteenth to the nineteenth century characterised by regional cooling of varying intensity, influenced by changes in temperature, precipitation, and atmospheric circulation.

- **Major Climatic Events Identified** - The study identified four major environmental phases associated with climatic events, including the following:

Climatic event	Key point
4.2 ka arid event	A major period of climatic aridity around 4,200 years ago
Roman Warm Period	A relatively warm climatic interval during the Roman era
Little Ice Age (LIA)	A prolonged period of relative cooling, particularly from the late medieval period into the 19th century
Other environmental phase	Reconstructed through lake sediments and multiple environmental proxies

Note - The 4.2 ka event refers to approximately 4,200 years before present; “ka” means kilo-annum, or thousand years.

- **Scientific Methods Used**

Method / Proxy	Purpose
AMS-based radiocarbon chronology	Establishes the age of organic samples and helps date sediment records
Stable carbon and nitrogen isotopes	Provide information about vegetation, organic matter sources and environmental conditions
Grain-size analysis	Helps reconstruct sediment transport and depositional conditions
End-member modelling	Identifies and separates sediment populations associated with different transport or depositional processes
Palynology	Study of pollen and spores to reconstruct past vegetation and environmental conditions

Archaeological records	Help understand human settlement and agricultural adaptations
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- **Significance** - These datasets strengthen climate modelling and explain human-environment interactions, supporting resilience, conservation, and future adaptation planning.

Reference

[PIB | Climate History Finds Monsoon Fluctuation Footprints from Sediment Transport to Farming Adaptations](#)

