



Unveiling Ancient Climate Secrets with Ladakh

For Prelims: [Deglaciation](#), [Monsoon](#), [Inter Tropical Convergence Zone \(ITCZ\)](#), [El Nino](#), [Himalayan region](#), [Climate change](#), Climate Evolution.

For Mains: Significance of Ladakh in Climate Research.

Why in News?

Scientists have made significant strides in **understanding [climate variations](#) during the transition from the last [deglaciation period](#)**, approximately 19.6 to 6.1 thousand years ago.

- By studying sediment deposits from **ancient lakes in the [Indus River valley](#) in Ladakh**, they have reconstructed climate records and shed light on the region's climate history.

What are the Major Findings of the Research?

- **Research Methodology:**
 - Scientists sampled sediment deposits from an 18-meter-thick sequence found along the **Indus River** at an altitude of 3287 metres.
 - The researchers conducted meticulous laboratory analyses on the samples, examining physical characteristics such as **colour, texture, grain size, grain composition, total organic carbon, and magnetic parameters**.
 - These parameters were used to extract information about past climate conditions from the **palaeolake sedimentary archive**.
- **Major Findings Related to Climate Evolution:**
 - Between 19.6 and 11.1 thousand years ago, a **cold arid climate dominated the region** due to the influence of [westerly circulation](#).
 - From 11.1 to 7.5 thousand years ago, [monsoon](#) forcings became the **primary driver of climate**, leading to a period of strong monsoons.
 - Afterward, **orbitally controlled solar insolation** played a crucial role in shaping the climate by influencing the position of the [Inter Tropical Convergence Zone \(ITCZ\)](#) and the variability of atmospheric circulations.
 - During the mid-Holocene (7.5 to 6.1 thousand years ago), the westerlies regained strength, coinciding with decreasing insolation, **a weakening monsoon, and enhanced [El Nino activities](#)**.
 - The study also demonstrates the **potential of using multiple physical parameters of sediments to reconstruct paleoclimate variations** (changes in Earth's climate that occurred in the geological past) with high resolution and accuracy.

What is the Significance of Ladakh in Climate Research?

- **High-altitude Environment:** Ladakh region, located in the Trans-Himalaya, serves as an environmental boundary between **North Atlantic and monsoon forces**.

- This region is characterised by **extreme temperatures, low oxygen levels, and arid conditions.**
- Studying the climate dynamics and changes in such high-altitude environments helps scientists **better understand the impacts of climate change on similar regions worldwide.**
- **Ideal to Study Atmospheric Circulation:** Its **geographical position makes it ideal for studying variations in atmospheric circulations**, including the westerly winds and the Indian summer monsoon.
 - Understanding the variability of these atmospheric circulations is crucial in the context of [global warming](#) and its implications for regional climate patterns.
- **Sedimentary Archives:** Among the **various sedimentary archives that exist in Ladakh**, the sediment deposits in lakes are useful in **attesting both short and long-term climatic changes.**
 - This is because **lakes have continuous sedimentation rates and preserve physical and chemical characteristics** of the sediments that reflect past environmental conditions.
- **Glacial Retreat:** The [Himalayan region](#), including Ladakh, is home to numerous glaciers that act as a crucial source of freshwater for rivers like the [Indus](#), [Ganges](#), and Brahmaputra.
 - [Climate change](#) has accelerated the retreat of these glaciers, leading to concerns about water security, changes in river flow patterns, and potential impacts on local ecosystems and communities.
 - **Ladakh provides an important location to monitor glacial changes** and study the consequences of glacial retreat.
 - Also, the **transition from a glacial to interglacial climate period** entails large-scale climate reorganisation. Understanding the dynamics during this transitional phase is crucial for **comprehending climate evolution.**
 - Mountainous regions like **Ladakh are particularly susceptible to these changes due to their unique geomorphological characteristics.**

Westerly Circulation

- It refers to the **predominant west-to-east flow of winds in the mid-latitudes of both hemispheres.**
- It is caused by the **rotation of the Earth and the temperature differences between the equator and the poles.** The westerlies play a crucial role in weather patterns and the transport of heat, moisture, and pollutants across regions.

Orbitally Controlled Solar Insolation

- It refers to the **variations in the amount of solar radiation received on Earth due to changes in Earth's orbit around the sun.**
- These orbital variations occur over long periods, such as tens of thousands of years, and can impact climate patterns.

Intertropical Convergence Zone

- The **ITCZ is a low-pressure zone near the equator** where trade winds from the northern and southern hemispheres converge.
- It is **characterised by abundant rainfall and is responsible for the formation of tropical rainforests and monsoon systems.**
 - The **ITCZ migrates north and south with the changing seasons**, following the sun's zenith position.

El Nino Activities

- **El Nino is a climate phenomenon that occurs in the tropical Pacific Ocean.** It involves the **warming of sea surface temperatures**, disrupting the normal patterns of atmospheric circulation and weather systems.

- During El Nino events, the **trade winds weaken, and warm waters from the western pacific flow eastward, altering rainfall patterns globally**. El Niño has significant impacts on weather, agriculture, fisheries, and ecosystems.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. 1 With reference to 'Indian Ocean Dipole (IOD)' sometimes mentioned in the news while forecasting Indian monsoon, which of the following statements is/are correct? (2017)

1. IOD phenomenon is characterised by a difference in sea surface temperature between tropical Western Indian Ocean and tropical Eastern Pacific Ocean.
2. An IOD phenomenon can influence an El Nino's impact on the monsoon.

Select the correct answer using the code given below:

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Ans: (b)

Q.2 Consider the following pairs (2019)

	Glacier	River
1.	Bandarpunch	Yamuna
2.	Bara Shigri	Chenab
3.	Milam	Mandakini
4.	Siachen	Nubra
5.	Zemu	Manas

Which of the pairs given above are correctly matched?

- (a) 1, 2 and 4
- (b) 1, 3 and 4
- (c) 2 and 5
- (d) 3 and 5

Ans: (a)

Exp:

- An important glacier of the Yamuna river basin is Bandarpunch glacier in the Garhwal division of the Himalayas. It is situated on the Northern slopes of Bandarpunch West, Khatling peak and Bandarpunch peak. The glacier is formed by three cirque glaciers and then joins the river Yamuna. Hence, pair 1 is correctly matched.
- Bara Shigri is the largest glacier located in the Lahaul Spiti region in Chandra Valley, Himachal Pradesh. It is a 30 km long glacier, the second longest glacier in the Himalayas after Gangotri. It flows northwards and feeds the Chenab river. **Hence, pair 2 is correctly matched.**
- Milam glacier in Munsiyari, Pithoragarh district, Uttarakhand is the source of Gori Ganga river. Gori Ganga is an important tributary of Kali River. **Hence, pair 3 is not correctly matched.**
- Siachen glacier in Ladakh is located at an altitude of roughly 5,400 meters. It is the source of the Nubra river, a tributary of the Indus river flowing into Pakistan and the Arabian Sea. **Hence, pair 4**

is correctly matched.

- Zemu glacier is the largest in the Eastern Himalayas in Sikkim. It is at the base of the Kanchendzonga and is one of the sources of the Teesta river. Teesta river is one of the tributary of the Brahmaputra river. **Hence, pair 5 is not correctly matched.**
- **Therefore, option (a) is the correct answer.**

Mains

Q. Briefly mention the alignment of major mountain ranges of the world and explain their impact on local weather conditions, with examples. **(2021)**

Q. Most of the unusual climatic happenings are explained as an outcome of the El-Nino effect. Do you agree? **(2014)**

Source: PIB

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