



Date - 14 July 2023

## MOON'S SOUTH POLE

This article covers "Daily Current Affairs" and the topic details "Moon's South Pole". The topic "Moon's South Pole" has relevance in the "Science and Technology" section of the UPSC CSE exam.

### For Prelims:

What are the different features of Moon's South Pole?

### For Mains:

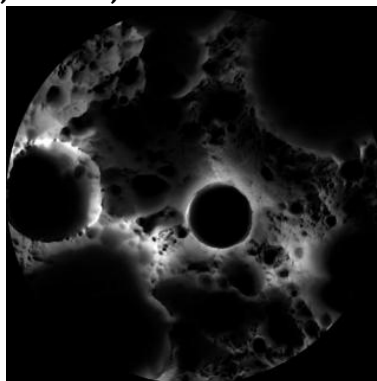
GS3: Significance of Lunar Exploration

### Why in the news?

ISRO's Chandrayaan-3 is likely to land near the south pole of the moon at 70 degrees latitude after its launch on July 14, 2023.

### Moon's South Pole

- The lunar South Pole is one of the most compelling places in the entire Solar System. **The lunar south pole is located at the southern end of the Moon's axis of rotation.**
- Known for its **permanently shadowed craters**, the lunar south pole also contains other **volatiles, such as hydrogen, methane, and carbon dioxide.**
- The region surrounding the south pole of the Moon exhibits various notable geological features, including craters, basins, and mountains.
- Among these features, the **South Pole-Aitken basin** stands out as one of the most prominent and significant characteristics of the Moon.
- Additionally, the area is home to impressive **mountains, with Epsilon Peak** reaching a height of 9.050 km, surpassing any mountain found on Earth.
- In terms of craters, **Shackleton Crater** holds the rotational axis of the Moon within its boundaries. Other notable craters in close proximity to the lunar south pole include **De Gerlache, Sverdrup, Shoemaker, Faustini, Haworth, Nobile, and Cabeus.**



### **Why were previous landings not on the South Pole?**

- Landing in the vicinity of the equator is preferable due to various factors that make it more **suitable and secure**.
- The **terrain is smoother and more accommodating for extended instrument operations, with minimal steep slopes, hills, or craters**.
- **Abundant sunlight is available**, particularly on the side facing the Earth, ensuring a consistent energy supply for solar-powered instruments.
- On the other hand, the **polar regions of the Moon present a starkly contrasting and challenging environment**.
- Many areas are situated in perpetual darkness, **devoid of sunlight, and subject to extremely frigid temperatures** that can plummet to as low as -230 degrees Celsius. These conditions pose significant obstacles to instrument functionality.
- Moreover, the **presence of numerous large craters**, varying in size from small centimeters to vast stretches spanning thousands of kilometers, further complicates matters.

### **Exploration of South Pole**

#### **Existence of Water:**

- The harsh and challenging conditions of the Moon's polar regions have deterred exploration efforts, but recent Orbiter missions have uncovered compelling evidence that makes these areas highly intriguing for further investigation.
- Notably, the presence of significant quantities of ice molecules in the deep craters has been suggested by findings from missions like India's Chandrayaan-1 in 2008. This mission employed two instruments that helped confirm the existence of water on the lunar surface.

#### **Insights into the Solar System**

- The extreme cold prevailing in these regions has the advantage of preserving substances in a frozen state, maintaining them largely unchanged over time.
- Consequently, the rocks and soil found in the north and south poles of the Moon possess the potential to provide valuable insights into the early stages of the Solar System. These frozen remnants could serve as invaluable clues for scientific research and exploration endeavours.

#### **Scientific research**

- The lunar south pole is a unique and challenging environment, and it offers a wealth of opportunities for scientific research.
- Scientists are interested in studying the geology, mineralogy, and geochemistry of the lunar south pole, as well as the history of water and volatiles on the Moon.

#### **Lunar resources**

- The lunar south pole is a potential source of resources for future space exploration. In addition to water ice, the south pole may also contain other resources, such as metals and minerals.
- These resources could be used to support future human missions to the Moon, as well as to launch missions to other destinations in the Solar System.

### **Permanently Shadowed Regions**

- In contrast to Earth, where the spin axis is inclined by 23.5 degrees relative to the plane of its solar orbit, the Moon's axis exhibits a mere tilt of 1.5 degrees.
- This distinctive geometric arrangement results in an intriguing phenomenon: certain craters situated near the lunar north and south poles remain untouched by sunlight. These specific regions are commonly referred to as Permanently Shadowed Regions (PSRs).
- Permanently Shadowed Regions are of great scientific interest because they are thought to contain frozen volatiles such as water ice, as well as other organic compounds.

- These substances are believed to have been delivered by comets and asteroids or created through various processes on the Moon.
- Understanding the composition and properties of these PSRs is crucial for future lunar exploration and potential resource utilisation, as they could provide valuable resources for sustained human presence on the Moon.

### **Missions to Lunar South Pole**

- **Chandrayaan- 3:**

- As per Isro officials, Chandrayaan-3 is projected to enter the lunar orbit approximately one month after its launch. The anticipated landing date for its lander, Vikram, and rover, Pragyaan, is August 23.
- It is worth mentioning that the landing location for this upcoming mission closely resembles that of Chandrayaan-2, situated near the moon's south pole at a latitude of 70 degrees.
- Chandrayaan-3 will secure the distinction of being the first mission worldwide to achieve a soft landing in close proximity to the lunar south pole.

- **Chang'e 4:**

- The Chang'e 4 mission was launched by the China National Space Administration (CNSA) in December 2018.
- It was the first mission to land on the far side of the Moon, and it also landed near the 45-degree latitude in the lunar south pole region at the South Pole Aitken Basin.
- The Chang'e 4 lander and rover have been exploring the region since January 2019, and they have made a number of important scientific discoveries.

- **LCROSS:**

- The Lunar Crater Observation and Sensing Satellite (LCROSS) was a NASA mission that was launched in 2008.
- The LCROSS spacecraft crashed into the Cabeus crater near the lunar south pole in October 2009.
- The impact created a plume of debris that was analysed by the LCROSS spacecraft and other orbiting spacecraft. The analysis of the debris revealed the presence of water ice in the Cabeus crater.

- **Chandrayaan-1:**

- The Chandrayaan-1 mission was launched by the Indian Space Research Organisation (ISRO) in 2008.
- The Chandrayaan-1 spacecraft carried a number of instruments that were used to study the lunar south pole region.
- The spacecraft's Moon Impact Probe (MIP) crashed into the Shackleton crater near the lunar south pole in November 2008. The impact of the MIP created a crater that was about 10 metres in diameter.

### **Sources:**

Chandrayaan-3 mission: Why ISRO wants to explore the Moon's south pole |  
Explained News, The Indian Express  
Image Credits: NASA/GSFC/Arizona State University

### **Q1. With reference to Lunar Geography, consider the following statements:**

1. Moon's axis tilt is greater than the Earth's, leading to creation of Permanently Shadow Region.
2. China's Change -4 landed near the South Pole Aitken Basin of the Moon.
3. Abundant sunlight is available on the Southern Pole of the Moon.

### **Which of the statements given above is/are NOT correct?**

- (a) 1 and 2 only

- (b) 2 and 3 only
- (c) 1 and 3 only
- (d) 1, 2 and 3

**Answer: (c)**

**Q2. Consider the following pairs**

**Mission Agency/Country**

1. LCROSS – France’s CNES
2. Chang’e – Japan’s JAXA
3. SMART-1 – European Space Agency
4. Surveyor 7 – USA’s NASA

**How many of the above mentioned pairs are correctly matched ?**

- (a) Only one
- (b) Only two
- (c) Only three
- (d) All Four

**Answer: (b)**

**Q3. Explain the significance of exploring the lunar south pole in the broader context of lunar exploration.**

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## MARINE HEATWAVE

*This article covers “Daily Current Affairs” and the topic details “Marine Heatwave”. The topic “Marine Heatwave” has relevance in the Environment section of the UPSC CSE exam.*

**For Prelims:**

*About Marine Heatwaves?*

**For Mains:**

*GS 3: Environment*

*How does Marine Heatwave Impact Rainfall in Northwest India?*

*What are the other Impacts of Marine Heatwaves?*

**Why in the news?**

The northern Bay of Bengal has been experiencing an intense marine heatwave since June 28, 2023. This has led to India’s usually arid northwest receiving extreme rainfall

**What is Marine Heatwave?**

- Marine Heatwaves are prolonged periods of anomalously high Sea Surface Temperature (SST).
- These events are linked to coral bleaching, seagrass destruction, and loss of kelp forests, affecting the fisheries sector adversely.
- The most common drivers of marine heatwaves include ocean currents which can build up areas of warm water and air-sea heat flux or warming through the ocean surface from the atmosphere.
- Winds can enhance or suppress the warming in a marine heatwave, and climate modes like El Niño can change the likelihood of events occurring in certain regions.



## How does Marine Heatwave Impact Rainfall in Northwest India?

- The marine heatwave in the Bay of Bengal increased sea surface temperatures, causing higher evaporation rates and a greater moisture supply in the atmosphere. This surplus of moisture contributed to above-average rainfall in northwest India.
- The marine heatwave likely influenced the formation and behavior of depressions in the Bay of Bengal, which may have contributed to an increase in the frequency and intensity of depressions, particularly on faster timescales (3-10 days).
- Depressions, which are low-pressure systems, play a significant role in the monsoon and rainfall patterns.
- The marine heatwave, along with changing timescales of depressions, affected the path and trajectory of these weather systems. Depressions tended to move more towards northwest India rather than north-central India, causing a higher concentration of rainfall in the northwest region, leading to above-average rainfall in that area.

## What are the other Impacts of Marine Heatwaves?

**Affect Ecosystem Structure:** Marine heat waves affect ecosystem structure, by supporting certain species and suppressing others. It has been associated with the mass mortality of marine invertebrates and may force species to change behaviour in a way that puts wildlife at increased risk of harm.

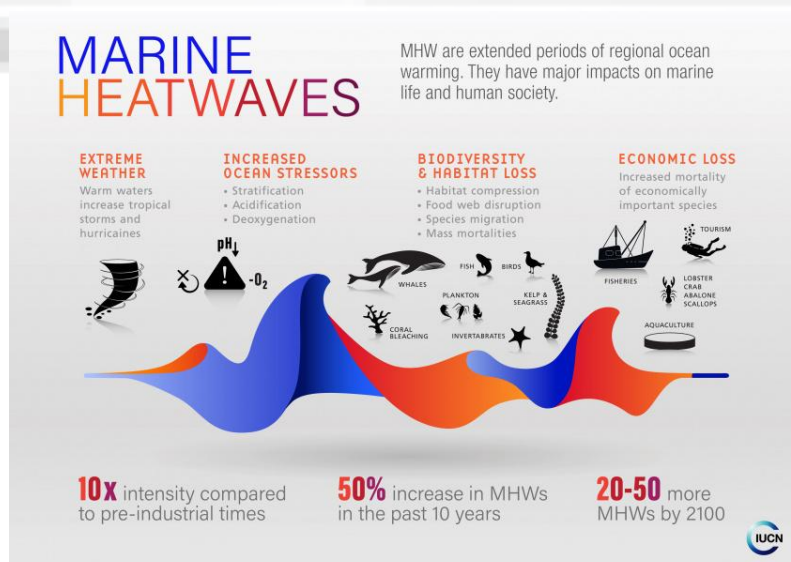
**Change Habitat Ranges of Certain Species:** Marine heatwaves can change the habitat ranges of certain species, such as the spiny sea urchin off southeastern Australia which has been expanding southward into Tasmania at the expense of kelp forests which it feeds upon.

**Economic Losses:** Marine heatwaves can cause economic losses through impacts on fisheries and aquaculture.

**Affect Biodiversity:** A study from 2020 (Genesis and Trends in Marine Heatwaves Over the Tropical Indian Ocean and Their Interaction With the Indian Summer Monsoon) reveals that a previous marine heatwave led to bleaching of 85% of corals in the Gulf of Mannar near the Tamil Nadu coast.

## Increase the Risk of Deoxygenation and Acidification:

- Often, they occur alongside other stressors such as ocean acidification, deoxygenation, and overfishing.
- In such cases, MHWs not only further damage habitats, but also increase the risk of deoxygenation and acidification.



## How does the Bay of Bengal Impact Monsoon?

### Moisture Source:

The warm and humid air mass over the Bay of Bengal provides the necessary moisture that is carried by the monsoon winds towards the Indian subcontinent.

### Heat Exchange:

The Bay of Bengal has warm sea surface temperatures, especially in its northern part. During the monsoon season, the landmass of the Indian subcontinent gets heated up, creating a low-pressure area. The warm air rises, and cooler air from the Bay of Bengal rushes in to replace it, causing a pressure gradient. This pressure gradient helps draw in moisture-laden winds from the Bay of Bengal, contributing to the monsoon rainfall.

### U-Turn of Monsoon Currents:

- The monsoon winds blowing from the southwest over the Arabian Sea cross over into the Bay of Bengal. When they reach the Bay of Bengal, they make a U-turn and start moving towards the northeast, eventually bringing rainfall to different parts of India.
- The warm temperatures in the Bay of Bengal facilitate this U-turn and the transport of moisture to the Indian subcontinent.

### Low-Level Jet Stream:

- The Bay of Bengal also influences the formation and intensity of the low-level jet stream, known as the Somali Jet.
- This jet stream plays a significant role in transporting moisture from the equatorial Indian Ocean to the Indian subcontinent, contributing to the monsoon rainfall patterns.
- The warm sea surface temperatures in the Bay of Bengal contribute to the strengthening of this low-level jet, enhancing the moisture supply during the monsoon season.

### SOURCE:

<https://www.downtoearth.org.in/news/climate-change/warming-bay-an-ongoing-heatwave-in-india-s-eastern-sea-is-causing-extreme-rain-in-its-northwest-say-experts-90481>

### Q.1 Which of the following statements regarding marine heatwaves in India is/are correct?

1. Marine heatwaves have no impact on the formation and behavior of depressions in the Bay of Bengal.
2. The warm sea surface temperatures in the Bay of Bengal facilitate the U-turn of monsoon currents and enhance the moisture supply to the Indian subcontinent.

### Choose the correct option:

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) None of the above

**ANSWER: B**

**Q.2 Which of the following statements regarding marine heatwaves and their impacts is/are correct?**

1. Marine heatwaves are primarily caused by ocean currents and have no relation to atmospheric conditions.
2. Marine heatwaves can result in economic losses by affecting the fisheries and aquaculture industries.

**Choose the correct option:**

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) None of the above

**ANSWER:B**

**Q.3 Discuss the impact of marine heatwaves on marine ecosystems and their consequences for fisheries and aquaculture industries. Examine the factors contributing to the occurrence and intensity of marine heatwaves and suggest measures to mitigate their effects on marine biodiversity and economic activities.**

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Rishabh