Shrinking Caspian Sea – Causes and Consequences

Mains: *GS I – World Geography*

Why in News?

The Caspian Sea is undergoing rapid shrinkage due to the combined effects of climate change and human interventions.

What is the Caspian Sea?

- **Location –** Bordered by five countries: Russia and Azerbaijan to the west, Kazakhstan and Turkmenistan to the east, and Iran to the south.

- **Size and Volume –** It covers a surface area of about 371,000 square kilometers (143,000 square miles) with a volume of approximately 78,200 cubic kilometers.
- **Water Composition –** Its water is brackish, meaning it is less salty than the ocean

(about one-third as salty).
- It gets almost 80% of its freshwater inflow from Europe's longest river, the Volga.
- **Depth –** Depths vary wildly, from a shallow 5 to 6 meters in the northern basin to over 1,000 meters in the southern basin.
- Although known as a sea, the Caspian is technically the **world's largest landlocked lake**.
- Unlike oceans, it has no natural outlet, and its water balance depends on river inflows and evaporation.
- The Caspian receives inflow from nearly **130 rivers**, with the **Volga River** contributing almost **80% of the total freshwater inflow**.

What is the ecological importance of the Caspian Sea?

- **Centre of Endemism –** Nearly **80% of its aquatic species are endemic**, meaning they are found nowhere else on Earth.
- Notable endemic species include:
  - Caspian Seal
  - Several species of sturgeon
  - Numerous endemic fish and invertebrates
- **Global Centre for Sturgeon and Caviar –** The Caspian has historically produced nearly **90% of the world's black caviar**, obtained from various species of sturgeon.
- The endangered **Beluga Sturgeon** depends on freshwater rivers connected to the Caspian for spawning.
- **Important Wetland Ecosystem –** The shallow northern Caspian functions as, a major breeding ground for fish, an important spawning habitat and a critical stopover for migratory birds travelling between Europe, Asia and Africa.
- **Climate Regulation –** As a large enclosed water body, the Caspian influences, regional humidity, local temperature regulation, precipitation patterns, and microclimatic stability.
- **Economic and Geostrategic Importance**
  - **Energy Resources –** The region possesses, vast oil reserves, significant natural gas deposits and extensive offshore energy infrastructure.
  - **Trade and Connectivity –** The Caspian serves as an important transport corridor connecting, Russia, Central Asia, Iran, Europe, and China.
- It also supports strategic connectivity initiatives such as, **China's Belt and Road Initiative (BRI) and India's International North-South Transport Corridor (INSTC)**
- Thus, environmental degradation of the Caspian has implications extending far beyond regional ecology.

Why is the Caspian Sea Shrinking?

- **Declining Freshwater Inflow –** The primary cause is the reduced inflow from the **Volga River**, which supplies nearly four-fifths of the seas freshwater.
- Human activities responsible include, construction of dams, reservoir development, diversion of river water, excessive irrigation withdrawals, and upstream water regulation.

- These interventions have significantly reduced freshwater reaching the Caspian.
- **Climate Change and Increased Evaporation –** Climate change has intensified water loss through evaporation.
- Between **1979 and 2015,** Surface air temperatures increased by approximately **1°C**.
- Wind patterns changed considerably and evaporation rates increased substantially.
- Unlike oceans, which experience sea-level rise due to global warming, enclosed inland water bodies like the Caspian lose water because evaporation exceeds river inflows.

*Since the mid-1990s, the Caspian Sea has lost approximately **5.5% of its surface area**, equivalent to nearly **630 cubic kilometres of water**.*

What are the consequences?

- **Loss of Biodiversity –** Shrinking water levels threaten several endangered species.
  - **Sturgeon –** Reduced river flow and pollution interfere with spawning migrations, pushing several sturgeon species closer to extinction.
  - **Caspian Seal –** The endangered Caspian Seal is losing critical coastal habitats due to the disappearance of shallow waters.
- **Algal Blooms and Water Quality Decline –** Scientists have observed increasing concentrations of **chlorophyll-a**, indicating, greater algal growth, nutrient enrichment and rising risk of harmful algal blooms.
- These developments reduce water quality and disturb aquatic ecosystems.
- **Wetland Degradation –** Shrinking shorelines threaten, coastal wetlands, fish nurseries, and migratory bird habitats.
- Loss of these ecosystems reduces regional biodiversity and weakens ecosystem services.
- **Socio-Economic Consequences**
  - **Impact on Fisheries –** Fishing communities across the five littoral states depend heavily on the Caspian.
  - Declining fish populations affect, food security, employment, traditional livelihoods, and local economies.
  - **Navigation and Trade –** lower water levels reduce navigability.
- This leads to difficulty in operating commercial ports, reduced shipping efficiency and increased transport costs.
- Disruptions to regional trade routes connecting Europe and Asia.
- **Emerging Public Health Risks –** If water levels decline by approximately **5 metres**, nearly **20% of the seabed** could become exposed.
- This may result in, toxic salt storms, dust pollution, air quality deterioration and respiratory health hazards.
- The situation resembles environmental disasters observed in the shrinking **Aral Sea**.

What are the measures adopted to conserve Caspian Sea?

- **The Tehran Convention –** Recognising the ecological significance of the Caspian Sea, the five coastal states adopted the **Framework Convention for the Protection of the Marine Environment of the Caspian Sea (Tehran Convention)** in **2003**.

- It remains the only legally binding regional agreement dedicated to protecting the Caspian Sea.
- **Guiding Principles**
  - Precautionary Principle.
  - Polluter Pays Principle.
  - Information sharing and transparency.
  - Regional cooperation.
- **Other Major Protocols –** The Convention is supported by four protocols:
  - **Aktau Protocol** – Oil pollution preparedness and response.
  - **Moscow Protocol** – Control of land-based pollution.
  - **Ashgabat Protocol** – Biodiversity conservation.
  - **Environmental Impact Assessment Protocol** – Environmental safeguards for development projects.
- However, these agreements were negotiated primarily to address pollution and did not adequately anticipate climate-induced water level decline.
- **COP29 Declaration –** Recognising climate change as the principal driver of shrinking water levels, the five littoral countries adopted the **Declaration on Strengthening Cooperation to Address the Caspian Sea Water Level Decline** at **COP29 (2024).**
- The declaration emphasizes, joint scientific research, coordinated environmental monitoring, regional working groups, better understanding of climate impacts and enhanced cooperation among coastal states.
- This represents an important shift from pollution control towards climate adaptation.

What could be done?

- Strengthening implementation of the Tehran Convention.
- Establishing a comprehensive transboundary monitoring system.
- Sharing hydrological and climate data among all littoral states.
- Coordinating management of the Volga River basin.
- Regulating dam construction and excessive upstream water withdrawals.
- Restoring wetlands and degraded coastal habitats.
- Conserving endangered species through sustainable fisheries management.
- Integrating climate adaptation into regional environmental governance.
- Promoting ecosystem-based management and scientific cooperation.
- Long-term success depends upon translating political declarations into concrete institutional action.

What lies ahead?

- The shrinking Caspian Sea represents one of the clearest examples of the combined impacts of climate change and unsustainable human interventions on inland water ecosystems.
- Beyond biodiversity loss, it threatens regional climate regulation, fisheries, public health, trade and energy security.
- While initiatives such as the **Tehran Convention** and the **COP29 Declaration** demonstrate growing regional awareness, effective conservation requires stronger legal cooperation, coordinated river basin management and sustained climate action.

- The Caspian crisis also offers an important global lesson: protecting transboundary ecosystems demands collective responsibility, scientific collaboration and long-term environmental governance to ensure ecological sustainability for future generations.

Reference

The Indian Express| Caspian Sea