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Q14

Explain the factors responsible for the origin of ocean currents. How do they influence regional climates, fishing and navigation?

UPSC Civil Services Mains 2015 · GS I · 12 marks · Geophysical Phenomena

Important Geophysical phenomena such as earthquakes, tsunami, volcanic activity, cyclone etc., geographical features and their location-changes in critical geographical features (including water-bodies and ice-caps) and in flora and fauna and the effects of such changes.

Core demand of the question

- Explain the factors that start and steer ocean currents
- Then show how currents shape regional climates, fishing grounds, and navigation

Revision summary

Winds, unequal heating and salinity, Coriolis force, and continent shape originate ocean currents.

The north Indian Ocean also reverses with the monsoon winds.

Warm currents milder high-latitude west coasts; cold currents cool and dry some west coasts.

Upwelling currents support the richest fisheries.

Navigators still use gyres and monsoon flows and must watch fog and ice on cold-current shores.

Introduction

Ocean currents are large, fairly steady flows of seawater. They begin because the sun, wind, and Earth's rotation heat and push the sea unevenly, and because continents block the water. Those flows then move heat, nutrients, and ships, so they are a climate, food, and trade factor, not only a map colour.

Body

Factors responsible for origin and pattern

- Planetary winds, especially the trade winds and westerlies, drag the surface and start the great gyres in each ocean basin.
- **Unequal heating of equator and poles creates density differences:** warm, lighter water and cold, denser water that sink and rise in a slow conveyor.
- Salinity changes from evaporation, rainfall, ice melt, and river input also change density and help drive deep and surface flows.
- The **Coriolis effect**, from Earth's rotation, turns currents to the right in the northern hemisphere and to the left in the southern, which shapes gyres and western boundary currents.
- Shape of continents, narrow straits, and the mid-ocean ridges steer, split, or speed the flow, as at the Cape of Good Hope or the Florida Strait.

- In the north Indian Ocean, the reversing monsoon winds reverse surface currents seasonally, which is a special case of wind drive.
- Tides and local coastal winds add smaller currents, but the main origin story is wind plus density plus rotation plus basin shape.

Influence on regional climates

- Warm currents such as the Gulf Stream and North Atlantic Drift keep northwest Europe milder and wetter than other places at the same latitude.
- Cold currents such as the Humboldt (Peru), Benguela, and California currents cool west coasts, raise fog and aridity, and help make coastal deserts.
- The Kuroshio warms Japan's east; the Labrador Current cools eastern Canada and feeds fog on the Grand Banks where it meets warmer water.
- El Niño is a breakdown of the usual Pacific cold upwelling pattern and shows how current and wind shifts can change rainfall far inland, including the Indian monsoon in some years.

Fishing

- Upwelling along Peru, California, and Benguela brings nutrients to the surface and supports huge fisheries, until El Niño or overfishing cuts the catch.
- Mixing zones on banks and at current edges concentrate plankton and fish, which is why some of the world's great fisheries sit on current maps.
- Warm, nutrient-poor tropical **gyre** centres are poorer in fish than cold upwelling coasts.

Navigation

- **Sail and steam both used or fought known currents:** the Gulf Stream for the North Atlantic crossing, and **monsoon currents** in the Arabian Sea and Bay of Bengal for historic Indian Ocean trade.
- Today, routing still saves fuel by riding currents and avoiding adverse flow; ice and fog on cold-current coasts remain hazards.
- Oil spills and plastic also follow current paths, which is a modern navigation and disaster fact.

Way forward for the answer

- List wind, density, Coriolis, and continents first, then one climate, one fishery, and one shipping example each.

Flow diagram

Winds heat salt -> Ocean currents
Coriolis continents -> Ocean currents
Ocean currents -> Regional climate
Ocean currents -> Upwelling fisheries
Ocean currents -> Shipping routes hazards

Conclusion

Ocean currents start from wind drag, heat and salt density, Earth's spin, and the walls of the continents. They milden or dry coasts, feed upwelling fisheries, and still guide ships. To know a region's climate and fish, one must know the current at its shore.

Facts & figures

Gyre

A large circular surface current system in an ocean basin, driven mainly by winds and Coriolis force.

Gulf Stream / North Atlantic Drift

Warm current system that helps keep northwest Europe milder than its latitude suggests.

Humboldt or Peru Current

Cold eastern-boundary current with strong upwelling and a major fishery, sensitive to El Niño.

Coriolis effect

Deflection of moving water because of Earth's rotation, essential to gyre direction.

Monsoon currents

Seasonally reversing surface flows in the north Indian Ocean tied to reversing winds.

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