

THE INDIAN OCEAN

INTRODUCTION:

The World's Oceans are the greatest bodies of water covering more than 70% of the earth's surface.

The continents divide these water bodies into 5 major oceans as the Pacific, the Atlantic, the Indian, the Arctic and the Antarctic Oceans.

The Pacific ocean occupies 30.5%,
the Atlantic ocean occupies 20.8%,
the Indian ocean 14.4%,
the Southern ocean 4.0 %, and
the Arctic ocean occupies 2.8% of the total area of all the oceans of the world.

The Southern Hemisphere consists of 80% of the oceanic waters in area when compared to the northern hemisphere.

Among these, the Indian Ocean is the third largest ocean in the world. It is next to the Pacific and Atlantic Oceans. This ocean is named after the close geographic proximity to India.

The Indian Ocean covers about 14% of the Earth's Surface.

It is enclosed on all the three sides by the landmasses of Africa, Asia and Australia.

Understanding of the geographic setting, oceanographic conditions and the natural resources of the Indian Ocean is necessary while studying Geography, Marine Geology and Oceanography.

In this episode, the following modules are highlighted:

1. Geography of Indian Ocean
2. Climate and Oceanographic Conditions
3. Natural Resources of Indian Ocean
4. Indian Ocean Bottom Relief
5. Environmental issues of Indian Ocean

1. GEOGRAPHY OF INDIAN OCEAN

The Indian Ocean covers about 74.93 million sq km on the surface of the earth. It is delineated from the Atlantic Ocean by the 20° east meridian running south from Cape Agulhas, and from the Pacific by the meridian of 146°55' east. In 2000, the IHO redefined the Indian Ocean, moving its southern limit to 60°S, with the waters south of that line identified as the Southern Ocean.

The waters of the Indian Ocean include the Red sea, the Oil rich Persian or Arabian gulf, the Arabian sea, the Andaman sea, and the Bay of Bengal.

The equator passes through the northern parts. A major part of this ocean lies in the southern hemisphere.

The Indian Ocean is 9,980 km wide between the southern points of Africa and Australia.

It's north-south length is 9,880 km extending from Pakistan to Antarctica.
The Indian ocean contains about 292.31 thousand cubic km of water.

The average depth of water column in this ocean is 3,890 meters. Its deepest point is Diamantina Deep in Diamantina Trench, at 8,047 m deep, also sometimes considered is Sunda Trench, at 7,258–7,725 m deep.

When compared to the Pacific and the Atlantic Oceans, the Indian ocean has less number of islands.

The Madagascar and the Sri Lanka are the biggest and the most prominent islands of Indian Ocean.

The smaller islands are:

- a) The Socotra
- b) The Zanzibar
- c) The Comoro
- d) The Seychelles
- e) The Andaman and Nicobar islands
- f) The Lakshadweep Islands
- g) The Maldivian Islands
- h) The Mauritius islands
- i) The Reunion islands.
- j) The Cocos and
- k) The Christmas islands.

The Sunda Islands of Indonesia separate the Indian and the Pacific Oceans. The Atlantic and Indian oceans meet off the southern tip of Africa.

North of the equator, the Indian Ocean is divided into two water bodies as the Arabian sea on the left and the Bay of Bengal on the right of India and Sri Lanka.

The Bay of Bengal is a very Unique water mass in the Indian Ocean

The Bay of Bengal is the largest bay in the world. It forms the northeastern part of the Indian Ocean.

It resembles like a triangle in shape, and is bordered by

- a) Bangladesh and the Indian state of West Bengal down to the state of Tamil Nadu in India and Sri Lanka to the west and
- b) Burma (Myanmar) and the Andaman and Nicobar Islands to the east.

The Bay of Bengal occupies an area of 2.172 million square Km.

A number of large rivers like

- a) the Padma (a distributary of the Ganges),
- b) Meghna (a distributary of the Brahmaputra),
- c) Jamuna (a branch of the Brahmaputra),
- d) Ayeyarwady, Godavari, Mahanadi, Krishna and Kaveri (Peninsular River) – all flow into the Bay of Bengal.

Among the important ports located in the Bay of bengal are Cuddalore, Ennore, Chennai, Karaikal, Pondicherry, Tuticorin, Kakinada, Machilipatnam, Vishakhapatnam, Paradip, Kolkata , Mongla, Chittagong and Yangon.

The shortest classified river which drains into the Bay of Bengal is the Cooum River at 64 km located in Chennai, the then Madras.

Brahmaputra is the 28th longest River in the World with its length upto 2,948 km , and it discharges into the 'Bay of Bengal' and travels through mainly Bangladesh and China, also India.

The Major international sea port located in Bangladesh is the Port of Chittagong and Yangon is an important port in the bay, belonging to Myanmar.

Major Indian ports on the bay include Kakinada, Chennai, Pondicherry and Vishakapatnam.

Only 37 of the 572 islands and islets of the Andaman and Nicobar Islands are inhabited, or 6.5%.

The Andaman and Nicobar Islands have unique features like Colorful Coral Reefs, Marine life, Habitations, mud volcanoes and tribal population.

The Arabian Sea is an attractive water mass.

The Arabian Sea is a region of the Indian Ocean bounded on the east by India, on the north by Pakistan and Iran, on the west by the Arabian Peninsula, on the south.

In the ancient period, the Arabian Sea was called as *Sindhu Sagar* (meaning "Sea of Sindh" in Sanskrit) and Erythraean Sea.

The Arabian Sea's surface area is about 3.862 million Square Km. The maximum width of the Arabian Sea is approximately 2,400 km , and its maximum depth is 4,652 metres.

The largest river flowing into the Arabian Sea is the Indus River and the others include the Netravathi, Sharavathi, Narmada, Tapti, Mahi, and the rivers of Kerala.

The Arabian Sea coast of central India is known as the Konkan Coast, and that of southern India is known as the Malabar Coast.

The Arabian Sea has two important branches —

- a) the Gulf of Aden in the southwest, connecting with the Red Sea through the strait of Bab-el-Mandeb; and
- b) the Gulf of Oman to the northwest, connecting with the Persian Gulf.

There are also the gulfs of Cambay and Kutch on the Indian coast.

The countries with coastlines on the Arabian Sea are Somalia, Djibouti, Yemen, Oman, Iran, Pakistan, India and the Maldives.

The Arabian Sea is an important route of water transportaion within India and serves as the base of the fishing industry on the west-coast.

The Arabian Sea has long been an important trade route between India and the West; its chief ports are Aden, Yemen; Karachi, Pakistan; and Mumbai, India.

The Andaman Sea

The Andaman Sea refers to the body of water in the northeastern corner of the Indian Ocean.

It stretches about 650 km from west to east and 1200 km from north to south.

It is connected with the Australasian Mediterranean Sea via the Malacca Strait between Thailand and Sumatra.

The Great Andaman is the main archipelago or island group of Islands in the Bay of Bengal and Ritchie's Archipelago consists of smaller islands.

The temperature of the surface waters fluctuates mildly from a monthly average of about 30°C in the summer months to one of about 27.5 in the winter months.

The surface salinities exhibit strong seasonal variations due to an extremely large freshwater influx from the Irrawaddy and Salween rivers during monsoon season.

In the northern part the salinities range from about 20 during the monsoon months from June to November to about 32 from December to May.

2. CLIMATE AND OCEANOGRAPHIC CONDITIONS

Indian Ocean experiences a typical Climate due to its geographic location surrounded by various continents on all sides.

The Climate of the Indian ocean includes

- a) northeast monsoon (December to April), and
- b) southwest monsoon (June to October).

The central and northern regions of Indian ocean have a tropical climate.

This regions experience regular tropical cyclones during May/June and October/November in the northern Indian Ocean and January/February in the southern Indian Ocean.

The seasons and the distance from the equator decide the temperatures at the surface of the sea. But the temperature does not reach extremes in any way as seen in other major oceans.

In January, the surface temperature in Northern hemisphere ranges from 21° to 27° c and in Southern hemisphere from 27° to 29° c.

Dramatic advances in satellite technology have led to the recent discovery of an El-Niño-like oscillation in the equatorial Indian Ocean.

It has been called as the Indian Ocean Dipole Mode. Under normal conditions, the band of warm waters in the western Pacific extends across the north Indian Ocean .

The eastern equatorial Indian Ocean is usually warmer than its western counterpart .

Recent research suggests that the dipole has a significant influence on the rainfall over India.

The Arabian Sea and the Bay of Bengal also exercise a profound influence on the regional climate.

Scientists have determined that the Indian Ocean Dipole (IOD), an oscillation of sea surface temperatures in the Indian Ocean, is occurring more frequently because of global warming.

In July, the surface temperature of Antarctica may fall upto -1°C .

When the monsoon winds change, cyclones sometimes strike the shores of the Arabian Sea and the Bay of Bengal. The Indian Ocean is the warmest ocean in the world.

The Indian Ocean has three belts of wind

1. Monsoons
2. Southeast trade winds
3. Prevailing westerly winds.

The North east (or dry) Monsoon blows from Asia across India to East Africa from November to March.

The southeast (or west) monsoon blows from the Arabian sea and the Bay of Bengal across India and south east Asia, picking up moisture from the ocean.

The south west monsoon blows from April to October.

The southeast trade winds originate in the southern hemisphere and blow towards the equator.

In the Arabian Sea the violent Monsoon brings rain to the Indian subcontinent.

Currents and Tides are typical in this ocean. The Indian Ocean has asymmetric ocean circulation.

The winds govern the movements of currents in the Indian ocean. The currents vary with the season. Depending on monsoon, the currents may flow North to the equator either eastward or westward.

In the southern hemisphere, the south equatorial current, a warm water current, flows westward along the equator driven by the trade winds towards Africa and south along the African coast. Then it turns east and follows the westerly winds to Australia.

The west wind drift a cold-water current driven by Antarctica winds, flows northward to Australia, where it turns to east.

The Indian Ocean is identified with moderate tidal variation due to its enclosure by four continents.

The highest and lowest tides occur along the western coast of Australia. The tide rises 11 meters at Collier by near Durby and 3 centimeters at Geraldton and near Burnbury, Australia.

Deep water circulation is controlled primarily by inflows from the Atlantic Ocean, the Red Sea, and Antarctic currents.

3. NATURAL RESOURCES OF INDIAN OCEAN

The Indian Ocean provides major sea routes connecting the Middle East, Africa, and East Asia with Europe and the Americas.

It carries a particularly heavy traffic of petroleum and petroleum products from the oil fields of the Persian Gulf and Indonesia.

Large reserves of hydrocarbons are being tapped in the offshore areas of Saudi Arabia, Iran, India, and Western Australia.

An estimated 40% of the world's offshore oil production comes from the Indian Ocean. Beach sands rich in heavy minerals, and offshore placer deposits are actively exploited by bordering countries, particularly India, South Africa, Indonesia, Sri Lanka, and Thailand.

Indian ocean is the adobe of wide variety of marine animal species. Phytoplankton is the key microscopic organism for direct or indirect survival of these species.

Phytoplankton are abundant near northern India and Persian Gulf.

Most rare species like dugong - a plant eating marine mammal is also found in this ocean.

Indian Ocean is also home to Dolphin and many variety of fishes.

The Fishes of the Indian Ocean are of great importance to the bordering countries for domestic consumption and export.

The Indian Ocean provides about 7% of the world's fish catch. That amounts to 7 million metric tons. The most fishing activity takes place near west coast of India.

Fishing fleets from Russia, Japan, South Korea, and Taiwan also exploit the Indian Ocean, mainly for shrimp and tuna.

Endangered marine species include the dugong, seals, turtles, and whales.

Bay of Bengal

The Bay of Bengal is one of the World's 64 largest marine ecosystems. It is full of biological diversity.

The coral reefs, estuaries, fish spawning and nursery areas, and the mangroves are favorable zones for fisheries.

Kerilia jerdonii is a sea snake of the Bay of Bengal. Glory of Bengal Cone (*Conus bengalensis*) is just one of the seashells which can be photographed along beaches of the Bay of Bengal.

An endangered species, the Olive Ridley - sea turtle can survive because of the nesting grounds made available at the Gahirmatha Marine Wildlife Sanctuary, Gahirmatha Beach, Orissa, in India.

Marlin, barracuda, skipjack tuna, (*Katsuwonus pelamis*), yellowfin tuna, Indo-Pacific humpbacked dolphin (*Sousa chinensis*), and Bryde's whale (*Balaenoptera edeni*) are a few of the marine animals.

Bay of Bengal Hogfish (*Bodianus neilli*) is a type of Wrass which live in turbid lagoon reefs or shallow coastal reefs.

Schools of dolphins can be seen including bottle nose dolphin (Tursiops truncatus), Pantropical spotted dolphin (Stenella attenuata) or the spinner dolphin (Stenella longirostris).

Tuna and dolphins are usually residing in the same waters.

In shallower and warmer coastal waters the Irrawaddy Dolphins (Orcaella brevirostris) can be found.

The Great Nicobar Biosphere Reserve provides sanctuary to many animals some of which include the saltwater crocodile (Crocodylus porosus) , giant Leatherback Sea Turtle (Dermochelys coriacea) , and Malayan box turtle (Cuora amboinensis kamaroma) to name a few.

Marine Life in Maldives are yet another feature of **the Indian ocean**.

The waters in and around Maldives is best described as "a treasure trove of marine life".

The abundance of marine life in the Maldives can be mainly attributed to the ideal growing conditions for the coral reefs.

Thousands of fishes and other marine life flourish in and around the underwater gardens of corals.

In Maldives, the coral reefs of about 70 different species and in almost every color adorn the waters surrounding these islands.

The clear waters and abundance of various species of fishes and beautiful aquatic plants has made Maldives popular as a diving destination with divers from all around the world.

More than 700 species of 'fishes' have found their home among the reefs in Maldives.

4. INDIAN OCEAN BOTTOM RELIEF

According to the theory of plate tectonics, scientists believe that the Indian ocean started to form about 200 million years ago.

India broke away from Antarctica and Australia as early as 130 years ago and moved northward about 45 million years ago.

India's northward movement produced numerous scars and ridges on the ocean floor.

New crustal rock is being formed along the Mid-India Ridge.

The continental shelf stretches for up to 200 kilometres in some parts of the Indian Ocean.

Around Africa, Asia, and Australia, it slopes gently to an average depth of 140 metres.

Around Antarctica, it reaches a depth of 300 to 500 metres. Between Australia and New Guinea Island, the shelf is 960km wide.

The Continental shelves are characterized by a large number of canyons and valleys. The Shelf is relatively broader in the vicinity of Madagascar.

Beyond the continental shelf, the ocean floor becomes rugged, consisting of mountain ranges, broad plateaus, and deep basins or trenches.

A mountain range called the Mid-Indian Ridge runs north-south through the centre of the Indian Ocean.

The ridge begins in the Gulf of Aden and separates into two parts at about 25° south latitude. Plateaus in the Indian Ocean may rise more than 3,050 metres above the ocean floor.

The other ridges of the ocean are:

- a) The ninety east ridge
- b) The Investigator ridge
- c) The Mentawai ridge
- d) The Chain Ridge
- e) The Amirante Ridge
- f) The Davie Ridge
- g) The Murray Ridge
- h) The Broken Ridge
- i) The Hartog Ridge
- j) The East Indiamon Ridge
- k) The Bengal Ridge
- l) The Carlsberg Ridge
- m) The Diego Garcia Ridge
- n) The Mascarene Ridge
- o) The Crozet Ridge.

About 50% of the bottom of the Indian ocean is in the form of broad, flat deep-sea plains. Their depth range from 4000 to 6000m.

The deepest trench is the Java Trench, which is at least 7,100 metres below sea level.

The other trenches of the Indian ocean are:

- a) The Sunda trench
- b) The Nicobar Trench
- c) The Amirante trench
- d) The Timor trough
- e) The New Guinea trench
- f) The Ob trench.

The diamantine deep is yet another deepest point of the Indian Ocean located in the ob trench.

Scientists from many countries are collaborating on the Ocean Drilling Programme.

The aim of this programme, begun in 1987, is to improve knowledge of the Indian Ocean floor.

Seamounts are notable features of ocean bottoms. The seamounts of the Indian Ocean are:

- a) The Nikitin Seamount
- b) The Banzare seamount
- c) The Africana Seamount

- d) Girand Seamount
- e) The Coco-de-mer Seamount
- f) The Gulden Seamount
- g) The Batavia seamount
- h) The Lena Guyot.

Indian Ocean contains a lot of marine sediments enriched with metallic minerals.

North of 50° south latitude, 86% of the main basin is covered by pelagic sediments, of which more than half is globigerina ooze.

The remaining 14% is layered with terrigenous sediments.

5. ENVIRONMENTAL ISSUES OF INDIAN OCEAN

Due to the relatively high traffic of petroleum tankers, piracy off the Somali coast has been rising. This has been a threat to international shipping since the second phase of the Somali Civil War in the early 21st century.

The Indian Ocean provides major sea routes connecting the Middle East, Africa, and East Asia with Europe and the Americas.

It carries a particularly heavy traffic of petroleum and petroleum products from the oilfields of the Persian Gulf and Indonesia.

Oil and ship pollution threatens the Arabian Sea, Persian Gulf, and the Red Sea.

Pollution is increasing in the Indian Ocean because of metal and chemical production and the outpouring of sewage, petroleum, and food-processing waste. In addition, the Persian Gulf suffered severe oil pollution resulting from the Persian Gulf War of 1991.

Iraq dumped an estimated 1.75 billion litres of Kuwaiti crude oil into the gulf.

The **culture of the Indian Ocean islands** reflects the ethnic diversity, history, politics, music, dance, food, drink, arts, sports and international influences in that region.

Besides the large-scale processes described above, the coastal zone is subject to the impact of tides, local winds, river runoff, etc., all are differing from place to place,

The notable environmental issues of the Indian Ocean region are:

- a) Coastal erosion
- b) Loss of biodiversity
- c) Marine pollution: The main sources are land-based, notably sewage, agrochemicals, industrial wastes, oil spills, and nutrients. Sand mining has been a problem, but is now stopped.
- d) Harmful algal blooms with fish kills
- e) Overexploitation of inshore fish and invertebrate stocks
- f) Sand and coastal-dune mining.
- g) Inappropriate coastal development
- h) Fisheries
- i) Degradation of marine ecosystems
- j) Frequent Cyclones
- k) Increased nutrient concentrations

- l) Habitat alteration and loss
- m) Marine pests
- n) Turbidity.
- o) Coastal pollution

Census of Marine Life (CoML) is a one such recent initiative in the marine context. CoML is a growing global network of researchers involving more than 70 countries engaged in a ten year initiative (2000 - 2010) to assess and explain the diversity, distribution and abundance of life in the ocean and the changes in it over time.

Ocean Biogeographic Information System (OBIS) (<http://www.jobis.org>) is the information component of the CoML and the marine component of Global Biodiversity Information Facility (<http://www.gbif.org/>) established in India.

It is necessary to protect the oceanic natural resources. It helps in not only for National Development but also for Regional Development.