AN OCEAN LIKE NO OTHER

5.1 AN OCEAN LIKE NO OTHER: THE DYNAMICS AND BIOGEOCHEMISTRY OF WIO

VIDEO DURATION– 06:25

This lecture will introduce you to the key oceanographic features of the Western Indian Ocean. You will learn about ocean currents and their monsoonal variability, about their role in shaping marine ecosystems and about productive upwelling systems along the African coast.

The Western Indian Ocean features a large diversity of the marine and coastal ecosystems, including warm tropical waters and temperate areas along the coast of South Africa; it features coral reefs, mangroves, wide sandy beaches and the deep ocean ecosystems with zones of intense upwelling-driven productivity. The Northern Mozambique Channel represents a core region for high tropical marine biodiversity while the Mascarene Islands have the highest level of marine endemism on Earth.

The oceanography of the Indian Ocean compared to other ocean basins is quite unique. It is enclosed by a major landmass on the north, driving the strongest monsoon on Earth. North of the equator, strong north-easterly winds blow in winter, with the reverse, south-westerly winds prevailing in summer. These seasonally changing monsoonal winds dominate the weather pattern leading to a seasonal reversal of the ocean currents.

Let's have a closer look at the circulation of the Western Indian Ocean which shapes the dynamics of its ecosystems. We will start with the South Equatorial Current, which flows westward across the Indian Ocean just south of the equator all year round. Upon reaching the coast of Madagascar it splits into two branches. This split forms two distinct regions: the Agulhas Current and Somali Current large marine ecosystems.

The Southeast Madagascar Current flows south where it combines with the flow from the Mozambique channel, which consists of large, energetic eddies, to continue southwest as one of the largest western boundary currents in the world, the Agulhas Current.

The Agulhas Current flows along the coast of South Africa before diverging from the coast and flowing along the edge of the Agulhas Bank. It then separates from the shelf at what we call the retroflection region, to flow back towards the southern Indian Ocean as the meandering Agulhas Return Current.

The Agulhas Current large marine ecosystem is considered to be moderately productive. You can see its relative low values of surface chlorophyll in this model animation. In this relatively oligotrophic system, primary production is driven by the wind induced turbulence, and localized upwelling driven by mesoscale eddies, or nearshore currents influenced by seafloor topography and the direction of

the prevailing winds. The mesoscale eddies are especially pronounced in the Mozambique Channel. You can see these eddies clearly in this model animation of the surface ocean currents, as well as their biological signature in the surface chlorophyll.

Back to the equatorial region, the Northeast Madagascar Current flows north-westward around the tip of Madagascar towards the East African coast. Here, it bifurcates with the northward brunch forming the East African Coastal Current, which travels along the Tanzanian and Kenyan coasts shaping the southern part of the so-called Somali Current Large Marine Ecosystem. Its northern part is shaped by a seasonally reversing Somali Current which is the fastest current in the world, reaching speeds exceeding 3m/s. The interplay between these two powerful currents driven by the seasonally reversing monsoonal winds creates a highly complex dynamic system operating differently during the north east and south west monsoons.

In summer, during the south-west monsoon, the East African Coastal Current strengthens and the Somali Current changes direction to flow towards the north-east. In this season, the two currents form a continuous flow along the coast of Tanzania, Kenya and Somalia. Where Somali Current deviates from the coast, one of the most intense seasonal upwelling of the world is formed, bringing large quantities of nutrients to the surface and giving rise to a highly productive ecosystem. You can see this system very clearly on the model animation of the inorganic nutrients and in the response of the surface chlorophyll.

In winter, during the north-east monsoon, the Somali Current reverses its direction and flows towards the south-west to meet the northward-flowing East African Coastal Current forming a confluence zone before deviating offshore. The Somali upwelling is no longer active, but the confluence zone forms another interesting but short-lived upwelling system – the North Kenyan Banks Upwelling – fuelling rich and productive fisheries along the Kenyan coast. Later in the MOOC we will tell you more about this fascinating feature and the important role it plays in the lives of the Kenyan coastal population.

Similarly, to the Agulhas current, the Somali Current large marine ecosystem is also considered to be on average only moderately productive. However, unlike the Agulhas current ecosystem, which is mostly driven by the mesoscale variability and wind mixing, productivity of the Somali current ecosystem is predominantly driven by the seasonal upwellings.

A very energetic and seasonally reversing ocean circulation makes the Western Indian Ocean one of the most ecologically connected region on Earth. Strong ocean circulation connectivity between its remote areas make Indian Ocean ecosystems highly sensitive to human activities almost anywhere in the region, making the balance of the environmental health and economic pursuits especially challenging to achieve. In this region, the need for international cooperation in managing of the marine environment is probably the most pressing, being dictated like nowhere else on earth, by the unique features of its oceanography.

In this lecture we have learned about the key oceanographic features of the Western Indian Ocean, about factors controlling its primary productivity and unique challenges its unusual geography presents for the management of marine ecosystems.