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9.4 Climate Change

Climate change is no longer an abstract topic debated by a fringe group of scientists; the evidence of climate change is unequivocal. In view of its serious global impact the UN established a team of top international scientists to objectively evaluate all available climate data. This Intergovernmental Panel on Climate Change (IPCC) first met in 1988 and periodically produces definitive assessment reports, progressively reflecting improvements in data collection.

The IPCC has indeed brought climate change into focus and in its 5th assessment report[1] in 2013 concludes:

> *"Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased…"*

Drivers of climate change

It is not uncommon to attribute everyday events to climate change. However not every storm, drought or cold winter is the result of climate change and many may be normal climatic occurrences. However, there is now a much better understanding as to the drivers of climate change.

There are a number of natural drivers of climate change, including natural events such as solar and volcanic activities. However, human influence on the climate system are clear and evident from the increasing greenhouse gas concentrations as a result of fossil fuel use.

Implications of climate change on marine environment

There is now a much better understanding as to the mechanisms that explain some of the climate change implications for coastal and marine environments, all of which affect human activities and resource use.

Oceans

Much of the Earth's increased climatic heat is stored in the oceans, some 90% of the accumulated energy, causing oceans

Damage to property as a result of an unusual climatic event.

Photo: Simon Bundy

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to warm, especially near the surface (60%), where the upper 75 m has warmed by 0.11°C [0.09-0.13°C] per decade over the past 40 years.[1] Year-on-year trends are highly variable as they are also driven by the El Niño phenomenon, making predictions less precise. Nevertheless, global mean surface temperature has increased by 0.6°C [0.4-0.8°C] over the last 100 years.[2] Ocean warming is projected to continue with heat increasingly penetrating from the surface to the deep ocean and thus affecting ocean circulation and currents.

The greatest increases are predicted for tropical and Northern Hemisphere surface waters, while warming will be most pronounced in deeper waters of the Southern Ocean. Best estimates of ocean warming in the top 100 m range from 0.3-2.0°C and from 0.3-0.6°C at depths of about 1 000 m by the end of the 21st century. Indian Ocean surface waters have warmed over the last 50 years although deeper layers appear to have cooled,[3] which in turn has increased rainfall in the tropical regions of the Indian Ocean and decreased the rainfall over eastern Africa.[3] Here too the interplay between ocean warming and the El Niño Southern Oscillation of the Indian Ocean and associated current systems (e.g. Indian Ocean Dipole) complicates climate change predictions.

Warmer oceans have numerous consequences; changes in current systems will have major impacts on climatic factors such as rainfall. Besides, many marine species have life cycles linked to current systems, such as the case for KZN where currents play an important role in our coastal biodiversity.

Salinity too is effected. For example, regions of high salinity where evaporation dominates have become more saline, while regions of low salinity where precipitation dominates have become fresher, indirectly confirming that evaporation and precipitation over the oceans have changed. As temperatures change, conditions become unfavourable for species, causing them to relocate to more favourable temperatures, ultimately changing their distribution and habitat. Evidence of such changes has already been reported in South Africa with shifts in populations of commercial pelagic species.

Sea-level rise

As oceans warm, thermal expansion causes sea levels to rise. Based on tide-gauge and satellite altimeter data it has been shown that thermal expansion together with melting ice sheet and land-derived water is now known to have increased the world's sea level by on average 2.8 mm [2.3-3.4 mm] per year over the past decade – up from previous decadal estimates of 2.0 mm [1.7-2.3 mm] per year. Global mean sea level will continue to rise during the 21st century and the rate of sea-level rise will very likely exceed that observed during 1971-2010 due to increased ocean warming and increased loss of mass from glaciers and ice sheets.[1] The implications for sea level rise vary for different regions. While KZN may not be at the same levels of risk as some low lying islands, the impact is nevertheless likely to be severe, as detailed in *Section 9.5*.

Coral bleaching

Many organisms are sessile and sedentary, hence cannot easily relocate. Reefs and especially coral reefs are a good example of this, considering their slow growth and often centuries old reef ecosystem. With increased temperatures corals may undergo mortality through a process called "bleaching". Corals are made up of individual coral polyps that secrete aragonite, a form of calcium carbonate ($CaCO_3$) skeletons that over time creates the reef structure. Corals polyps are host to microscopic algae, known as zooxanthellae, that live in the outer layer of the coral's tissue and that give reefs their colour. These algae provide corals with about 95% of their food and are essential for the survival of coral reefs.

Coral bleaching occurs when their environment becomes stressful causing the zooxanthellae to be expelled or die, revealing the white calcium carbonate skeleton of the coral below.[4] It has been shown that temperatures in excess of 28ºC for a few days can cause catastrophic bleaching.[4] This happens especially when elevated sea temperatures are associated with El Niño Southern Oscillation events.

There have been several mass bleaching events in the WIO, especially closer to the equator in 1998 and 2005. This impacted severely on the coral ecosystems of several countries.[4; 5] These bleaching events were geographically widespread, with coral reefs throughout the world being affected.[2] Such warm episodes of El Niño have been more frequent and intense since the mid-1970s.[2] Current trends in sea surface temperature are evidence that bleaching events similar to those associated with El Niño-like water temperatures will increase in frequency and duration by 2030.[4]

Although some bleaching has been reported for KZN's coral reefs, the extent was minimal because of the cooler temperature regime and the fact that local corals are located in deeper water and hence not exposed to excessive heat at low tides.[6] Clearly, this adds extra responsibility to caring for our corals as a future genetic resource. By reducing stressors such as sedimentation, nutrient pollution and overfishing, we can assist in reducing stress on coral ecosystems and thus increase their resilience in the face of rising ocean temperatures.[4]

Impact on coastal ecology

The impact of climate change-induced sea-level rise on coastal ecosystems such as mangroves, marshes, sea grasses and wetlands will vary regionally and will be affected by erosion and deposition processes.[2] For example, mangroves, occupying a transition zone between sea and land, will have a varied ability to adapt to climate change. Mangroves found in low coastal regions where sedimentation is high and erosion low may be better able to deal with the effects of sea-level rise, as deposited sediment will create new habitats for colonisation.

It is anticipated that changes in climatic factors, may adversely affect freshwater wetlands in low-lying regions. These could be displaced by saltwater habitats driven by sea-level rise, more intense monsoonal rains, and larger tidal or storm surges.[2] Estimates show that approximately 20% of global coastal wetlands could be lost by the year 2080.[2]

Call to action

Because climate change is a slow and somewhat uncertain process there is a lack of urgency and political will in dealing with it. However, a response is indeed required, if only for the sake of our next generation. Aside from the obvious need to reduce greenhouse gasses globally, a range of actions were identified by West Indian Ocean experts. Three major areas of intervention were identified: vulnerability assessment, mitigation and adaptation.

A formal process to identify areas, species and communities that may be most vulnerable to climate change is required.[5] Mitigation to offset high levels of CO_2 emission in South Africa is also important and includes energy conservation, clean and energy-efficient urban transport and waste management, forest conservation and the development of ocean-based renewable energy. While adaptation mostly refers to actions taken to reduce the effects of climate change on human and natural systems,[5] it can involve physical responses, such as building of dykes or resettlement of people. Adaptation also infers a biological process where organisms adjust genetically over time to cope with a changing environment. In some cases acclimatization occurs where organisms are able to adjust their physiology immediately to cope with a changed climate.

The African continent contributes less than 4% of total greenhouse gas emissions, yet it is one of the most vulnerable and least resilient regions to climate change. In particular, the effects of climate change are very real for the marine and coastal environments and the livelihoods of many, coastal KZN included.

Most important for KZN is the development of adaptation programmes in key areas such as water, food security, nutrition, agriculture, coastal zone management, health and infrastructure. ■

Coral bleaching has affected KZN coral reefs.

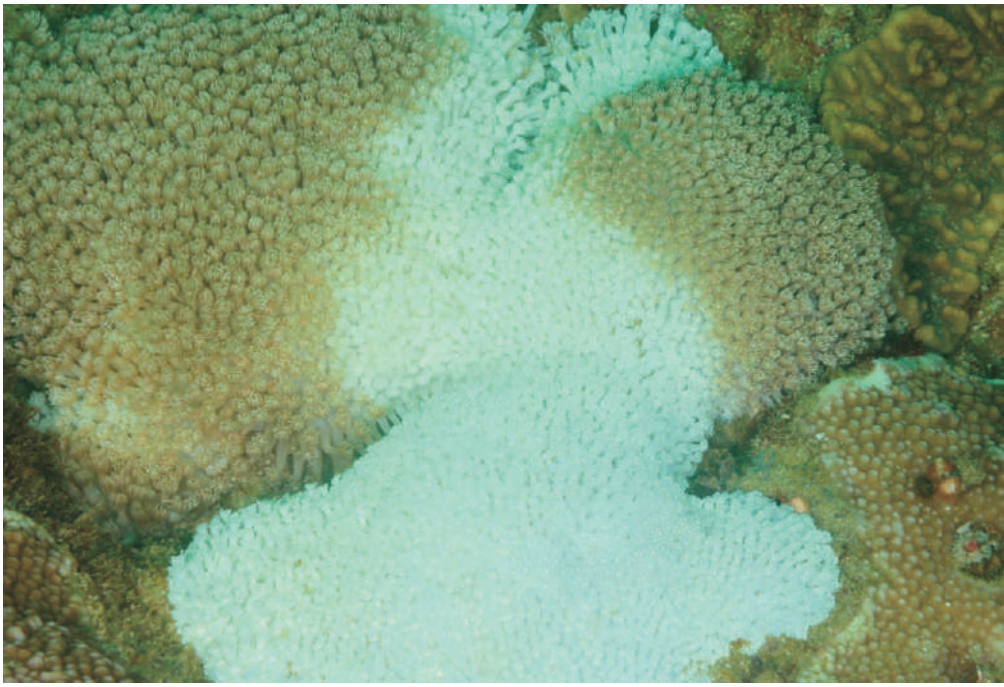

Photo: Camilla Floros