ESTUARIES

Putting a price on 'blue carbon' water habitats

Shallow water river estuaries have provided a rich variety of benefits to humanity for thousands of years. More recently, a Water Research Commission study has thrown light on their undervalued role in climate regulation and carbon storage. Article by Tony Carnie.

Janine Adams

South Africa has 290 river estuaries spread along its nearly 3 000 km long coastline. These are the meeting places where freshwater and nutrients have tumbled down from the land to mix slowly with the salt water of the ocean.

Because they are mostly shallow, vegetated and sheltered from the crashing waves and predators of the open sea, estuaries provide an ideal nursery ground for marine fish, as well as crabs, snails, worms and other aquatic creatures. For millennia, this abundance of food, water and vegetation has attracted human communities as well as birds and animals. In some estuaries, coastal mangrove forests also provide people with firewood or timber for home building, fencing and other uses.

Yet estuaries have another critical role that is less well known or appreciated: the long-term capture and storage of 'blue carbon'. This is a term coined by coastal researchers to describe habitats such as mangrove forests, salt marshes and seagrasses which help to capture and store large volumes of carbon dioxide in 'blue' aquatic environments.

These coastal systems also capture and store carbon at a much faster rate than land-based forests, potentially for millions of years. Dr Jackie Raw, a postdoctoral researcher and member of the DSI-NRF Research Chair in Shallow Water Ecosystems at the Nelson Mandela University's Ocean Sciences Campus, says one of the reasons these habitats are so effective is because the carbon is stored in anoxic (oxygen-depleted) sediments below the waterline.

Raw says these carbon-rich sediments build up in thick layers in these habitats, where they are locked up – thereby reducing the increasing volume of carbon dioxide which heats up the Earth's atmosphere. Conversely, if these habitats are degraded or destroyed, they release disproportionately higher volumes of carbon.

Raw was one of the lead researchers of a recent report to the Water Research Commission entitled 'Climate Change and South Africa's Blue Carbon ecosystems'. The research team included Nelson Mandela University colleagues, Prof Janine Adams, and PhD student, Sinegugu Banda; Prof Tommy Bornman of the South African Environmental Observation Network (SAEON); Dr Anusha Rajkaran of the University of the Western Cape and Dr Lara van Niekerk the Council for Scientific and Industrial Research (CSIR) in Stellenbosch.

Their study, conducted in several estuaries, was the first attempt to quantify carbon capture and storage capacity by blue carbon habitats in South Africa. At a global level, these areas cover just 2% of the ocean, yet are believed to capture up to 70% of the carbon stored by the sea.

Raw says the baseline data gathered in the study could be used to explore the potential for carbon credit trading schemes which aim to reduce global greenhouse gas emissions.

Carbon trading, which can incorporate the buying and selling of carbon "offsets", may also create financial incentives for ecosystem restoration and conservation projects.

At a global level, mangrove habitats are being lost at a rate of 2% per year. Experts from the International Blue Carbon Initiative estimate that carbon emissions from mangrove deforestation account for up to 10% of emissions from deforestation globally, despite covering just 0.7% of land coverage.

Tidal salt marshes are being lost at a rate of 1-2% per year. They now cover roughly 140 million hectares of the Earth's surface after losing more than 50% of their historical global coverage.

Seagrasses cover less than 0.2% of ocean floor, but are estimated to store about 10% of the carbon buried in the oceans each year. Seagrasses are being lost at a rate of 1.5% per year and have lost approximately 30% of historical global coverage.

According to the new WRC report, blue carbon estuarine habitats in South Africa are threatened by increasing freshwater abstraction, urban development, pollution, climate change and sea level rise.

It says that the continued loss of estuarine ecosystems reduces their capacity to act as carbon sinks and this has the potential to release large quantities of carbon into the atmosphere as CO2.

Prof Adams and her colleagues note that coastal wetland conservation projects linked to carbon markets have been launched in Kenya, Madagascar, Indonesia and other tropical nations.

Janine Adams

The salt marsh succulent (Sarcocornia tegetaria) at Wavecrest.

Lucienne Human

A sediment core from the salt marsh in the Swartkops Estuary.

The Mikoko-Pamoja mangrove restoration and reforestation project in Kenya is one example of a community-based conservation scheme financed by voluntary carbon credits.

In Cameroon, a Clean Development Mechanism (CDM) scheme aims to conserve coastal mangroves to ensure that they continue to sequester carbon into the future. This project involves coastal fishing communities who burn mangrove trees to smoke fish. While a traditional smoking oven typically consumes up to 1 205 kg of red mangrove wood to prepare the fish over 53 days, a modern cinderblock oven is said to consume only 122 kg of mangrove wood and to reduce the smoking time to 5 hours.

Adams says research on local mangroves, seagrass and tidal marshes can help to guide South Africa's climate policies, incentivising the need to protect and restore coastal wetlands and estuaries. She also notes that the South African coastline is currently the southern range limit for east African mangrove species and this provides a unique opportunity to study their response to climate change.

"Globally, mangroves are expanding into warm-temperate salt marshes in response to rising temperatures . . . It is therefore necessary to investigate whether mangroves can potentially expand their habitat range and how these communities and salt marshes respond to climate change."

Overall, the aims of the research project was to determine the extent of blue carbon ecosystems in South Africa and to estimate blue carbon storage using UN Intergovernmental Panel on Climate Change (IPCC) assessment methods.

To assess historical changes, the researchers studied aerial photographs dating back to the early 1930s and compared these to current Google Earth images. On site measurements were also made at estuaries such as Nxaxo , a permanently open estuary at Wavecrest, near Butterworth in the Eastern Cape.

This site was selected as the estuary has a relatively equal area of white mangroves (***Avicennia marina***) and the salt marsh succulent (***Sarcocornia tegetaria***), while seagrass (***Zostera capensis***) is also present.

To study sea level rise, the research team also installed several high-precision measurement devices known as rod surface elevation table (RSET) equipment, in estuaries at Knysna, Nxaxo and Nahoon. Surprisingly perhaps, the research suggests that only 20% of South African of estuaries support submerged aquatic vegetation.

Raw notes that these species are sensitive to changes to water level, turbidity, nutrients and salinity. "We have noted that when an estuary experiences closure to the ocean, then seagrass is lost. Many South African estuaries experience seasonal closure that is natural but can also be caused or exacerbated by freshwater abstraction.

"Even in fairly natural systems we have noted that seagrass appears and disappears from year to year. Seagrasses are also influenced by human activities that can be destructive, such as anchoring of boats."

The researchers have made a strong case for the restoration of threatened and degraded estuaries, so they can regain their potential to store blue carbon and provide other free ecological services.

This is because many estuaries are facing the twin pressures of "coastal squeeze" – a variety of human pressures on the landward side, and sea level rise on the other. This means that there is little or no space for blue carbon habitats to persist in the face of a warming climate and further development.

The report says buffer areas need to be identified to allow for landward expansion of these habitats in response to sea level rise. Adjacent properties for landward migration also need to be identified and protected and, in some cases, purchased from landowners.

"Pressures such as infrastructure development, flow reduction, artificial breaching, mouth manipulation and overfishing have increased their vulnerability to climate change. A strategic programme is needed to restore health so that these blue carbon habitats can continue to provide the ecosystem services of flood regulation, nutrient cycling, nursery habitat, and recreational and tourism opportunities."

These coastal ecosystems are among the most threatened natural systems globally with estimates showing that 50% of salt marshes, 35% of mangroves, and 29% of seagrasses have been lost or degraded by human activities in recent history.

Apart from their critical role in storing carbon, studies show that mangroves also limit the impact of storms by reducing the energy of wind-generated surface waves by 20% per 100 m.

Other studies by Adams et al. show that approximately 50% of blue carbon habitats have been lost in South Africa, and within the Eastern Cape roughly one hectare of mangrove forest is lost every year. As a result, there is increasing interest in restoring mangrove forests along the coast.

On the issue of using carbon taxes and carbon trading to benefit local estuaries, the researchers say that South Africa is one of the top 20 most carbon intensive countries in the world (currently ranked number 13) because of a high dependence on coal, crude oil and natural gas.

South Africa is also the largest CO_2 emitter in Africa and in 2016 it signed the UN Paris Agreement, a voluntary pact to limit greenhouse gas emissions. Last year, South Africa also became the first country in Africa to pass a carbon tax to slowly drive down greenhouse gas emissions.

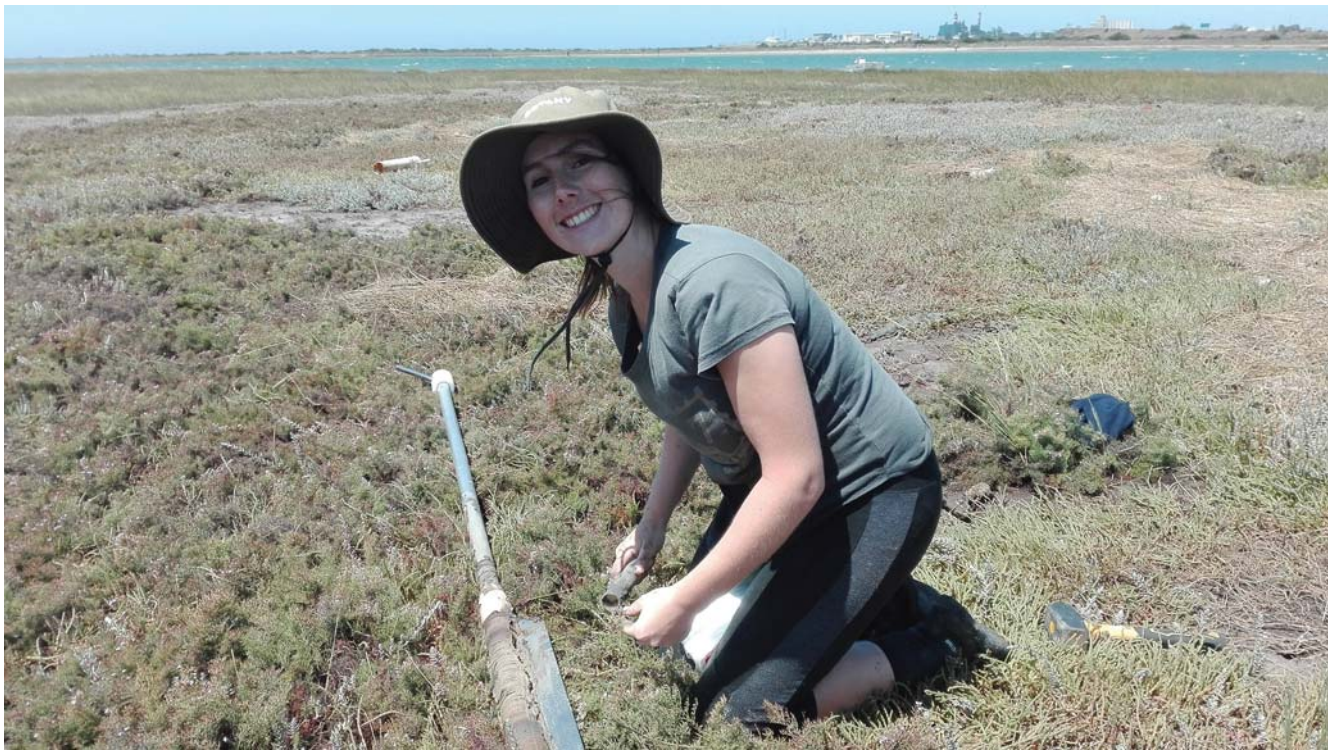
Companies are now required to pay a tax rate of R120 per tonne of carbon emissions released – but because of allowance schemes, the effective tax rate can be as low as between R6 and R48 per tonne.

In the context of finding new ways to finance estuary conservation, the WRC report says carbon markets are based on generating carbon credits by either avoiding greenhouse gas emissions or by removing these gases from the atmosphere through carbon reduction projects.

Janine Adams

Jennifa Mohale, Imtiyaaz Malick and Jackie Raw at one of the an RSET installations at Nahoon Estuary.

Lucienne Human



Researcher Jessica Els collects a sediment core at the Swartkops Estuary.

Janine Adams

Oceanographic technician Imtiyaaz Malick (SAEON) checks an RSET installation at Nahoon Estuary.

CONCLUSIONS

"Our study estimated that blue carbon habitats in South Africa can potentially remove 10.3 million tCO2eq yr-1, an amount higher than the projected sequestration potential from land-based habitats (8 million tCO2eq yr-1 as reported in the National Terrestrial Carbon Sink Assessment, DEA, 2014)."

The research team says this value is comparable to the emissions reduction potential of blue carbon habitats in southeast Australia, reported to be 9.63 million tCO2eq yr-1.

Overall, South Africa's salt marsh habitats made the highest contribution to this value.

The total value of blue carbon habitats was estimated to be between R1.2 billion and R10.6 billion per year (when carbon is traded at a high price) and between R120 million and R150 million per year when carbon is traded at lower carbon prices.

"Based on our results, we suggest that blue carbon Payment for Ecosystem Services (PES) or offset projects will only be economically viable in South Africa if the credits are traded at a higher price in the voluntary markets, which at present are the more attainable options for blue carbon pilot projects."

The researchers suggest that further studies are needed to quantify blue carbon storage in several other places (particularly the Mhlathuze and St Lucia estuaries in KwaZulu-Natal) to provide a more comprehensive carbon inventory base.

"It is also important to note that in South Africa, our blue carbon habitat area is quite small compared to the rest of the globe and major habitat losses (6.9% of mangroves and 44.5% of salt marshes have occurred due to development and agriculture."

Nevertheless, the study has moved South African estuaries a step further towards using carbon trading to protect and conserve these critical habitats, the report concludes.

To view the report, Climate change and South Africa's blue carbon ecosystems (**WRC report no. 2769/1/19**), Visit. www.shorturl.at/cqGJS