

SANCOR NEWSLETTER

South African Network for Coastal and Oceanic Research

Inside this issue:

GEF-UNDP publications feature LMEs 4

Negotiating knowledge for coastal governance 5

The African Marine Atlas of ODINAFRICA 6

Global network for ocean acidification 7

Monitoring coastal dynamics from space 8

The inaugural winter cruise of the SA Agulhas II 11

How healthy are our dolphins really? 13

BASICally – It works! 15

Ma-Re Students Network – get involved! 15

A different kind of Carnival - Rio +20 dialogues 16

Science education—getting the message across 17

MCEN National Conference 2012 18

Mandela Day Celebrations 19

Kudos to Larry Hutchings 20

Tribute to Rudy van der Elst 22

Accelerated eddies moving around Africa's southern tip

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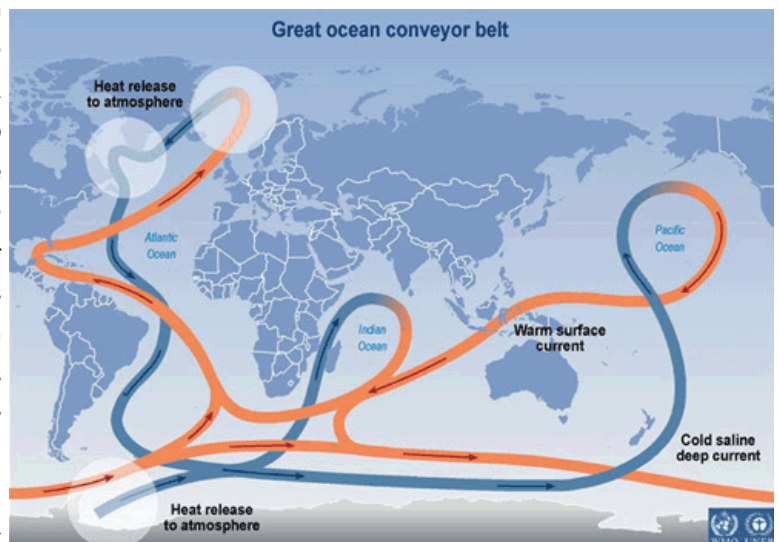
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Over the past 10 years, research of the Agulhas Current has received increasing attention from the global scientific community. And recently, the Agulhas has become recognised as a key element in the global climate system. A SCOR working group investigating the climatic importance of the greater Agulhas system was formed and a review paper was published in *Nature* in 2011.

In the Department of Oceanography at the University of Cape Town, researchers from

the Nansen-Tutu Centre for Marine Environmental Research, the *Institut de Recherche pour le Développement* under the International Centre for Education, Marine and Atmospheric Sciences over Africa and the Marine Research Institute have been working together to advance our understanding of the Agulhas system.

The Agulhas Current is a western boundary current located at the western edge of the Indian Ocean basin. It flows southward along the East Coast of South Africa, and is counted among the fastest currents in world's ocean.



In the North Atlantic, heat from the ocean causes it to become denser and sink, driving the great ocean conveyor belt that transports heat from the equator to the poles. Freshwater input from the melting glaciers on Greenland may cause the conveyor belt to shut-down.



Monitoring coastal dynamics from space

By *Melanie Lück-Vogel & Louis Celliers*

CSIR - Natural Resources & the Environment

The coast of South Africa is a highly dynamic environment. Tidal influences, seasonal variations and the effects of storm events can rapidly and dramatically change the face of the shoreline. This is particularly true for sandy beaches. Besides the natural forces, humans and their activities shape the coast through the transformation of the natural environment to the sealed surfaces common of urban settlements, crop agriculture or more subtle changes through the gradual degradation of dune vegetation.

As a coastal manager, some of the coastal processes have to be monitored over time to decide if, for instance, the retreat of a beach is just a seasonal and natural phenomenon or whether it is an anthropogenically-driven process which requires a management intervention. However, the scale of monitoring is a challenge given the considerable length of the national coastline of more than 3,500km.

As a result, the assessment of coastal processes and dynamics usually focuses on "hot spots" of high economic value, such as urban areas and ports. The assessment of rural and undeveloped coastal areas remains largely unmonitored.

However, these coasts which are considered to make a limited economic contribution are becoming increasingly important since they provide natural goods and services the rural coastal communities depend on.

Based on a growing understanding of such ecosystems goods and services, governments are starting to respond by promoting management interventions that will restore and maintain these services. This is particularly important for the growing need to increase the resilience of communities to the projected impacts of global environmental change, particularly for the tropical African shores. As many of the continental shores are predominately sandy, these coastal communities often live in low-lying areas exposed to natural hazards such as storm surges and hurricanes. The force and the frequency of such extreme events are expected to increase in the predicted future climate. The expectations are that the natural coastal environment will be changing faster than we can monitor using traditional methods.

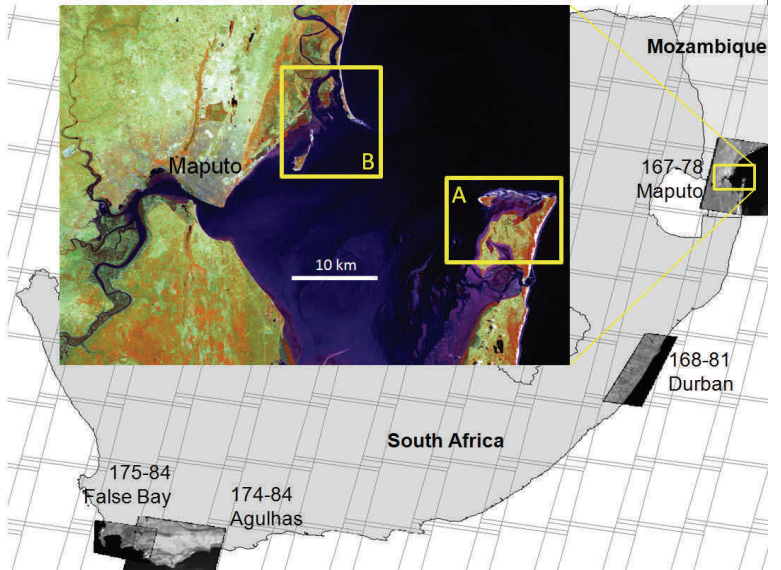


Figure 1: Location of the test sites in South Africa and Mozambique. Colour image inlaid: details of Maputo image; A and B: areas displayed in figures 2 and 3.

Remote sensing technology can be employed to identify areas at risk from coastal and marine hazards by assisting with the collection and interpretation of data over large areas, over time, while being fast, cost-effective and consistent in delivering information and data with high-levels of accuracy. Some of the environmental earth observation satellites, such as the satellites of the Landsat family, have been in space since the 1980s and can therefore provide information on the Earth dating back more than 25 years. The value of remote sensing for coastal management purposes has been recognised for many years, yet its full application and benefit is still to be realised in Africa.

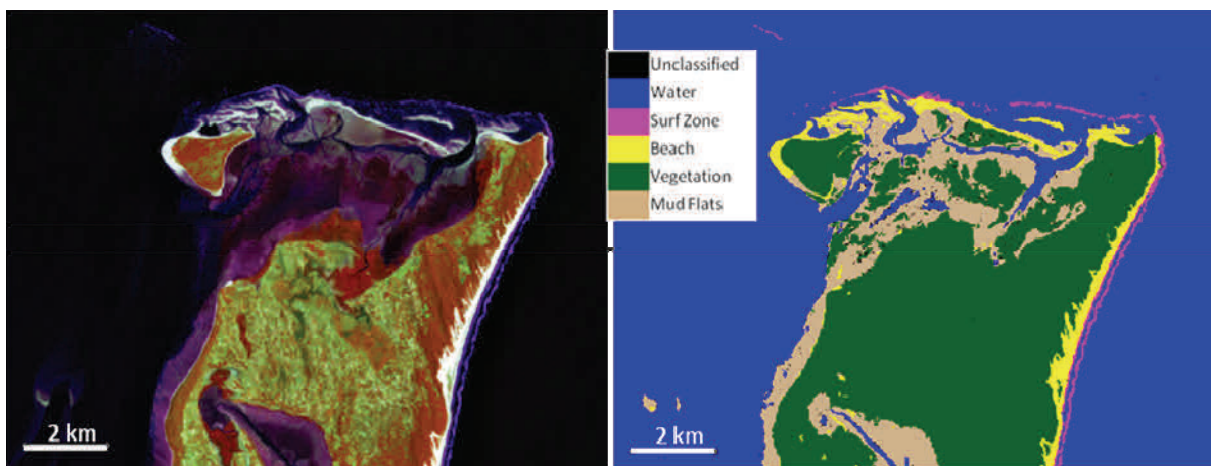


Figure 2: Subset of the Maputo image from 30 Oct 2001. Left: In this band combination of the Landsat image, dense and woody vegetation shows in red, open non-woody vegetation in green tones. Right: classification result.



The remote sensing unit of the CSIR Coastal Systems Research Group in Stellenbosch explored the use of space-borne imagery for the detection and monitoring of coastal dynamics. The aim of the project was to prove that relevant land cover types and the position of their respective borders can be extracted from satellite imagery in a push-button approach. The push-button approach was a requirement to ensure fast and efficient extraction of result for use in an operational coastal management environment. Such a system allows for the rapid, reliable and repeatable extraction of standardised information from a series of images over space and time.

Therefore it was decided to focus on the automatic detection of beaches, coastal vegetation, water (the ocean) and the surf zone. The position of the waterline (as indicator for the shoreline) can then be extracted as the border between beach (or vegetation) and ocean. When comparing images over time and taking into account tidal variation, changes in the position of the water line will reveal potential erosion or accretion of the shore. The tidal effect is of particular importance for shallow areas with great intertidal ranges such as you would find in Mozambique.

We also extracted the surf zone, which is the near-shore area where the waves break. For the waves to break, the water needs a certain shallowness. Therefore, changes in the surf zone can be taken as an indicator for changes in the bathymetry which is the underwater shore topography. For example, a decreasing width of the surf zone might alert the coastal manager of potential erosion processes. Coastal stabilisation measures can then take place.

We tested our approach on four coastal locations which were Maputo Bay, Durban, Cape Agulhas and False Bay (Figure 1).

Maputo Bay is characterised by a shallow sandy shore line which exposes large tidal mudflats during low tides. Using a Landsat image which was taken at low tide, the extensive mudflats could be detected (Figure

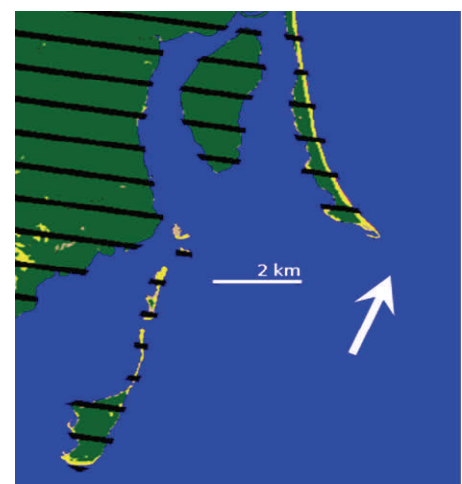
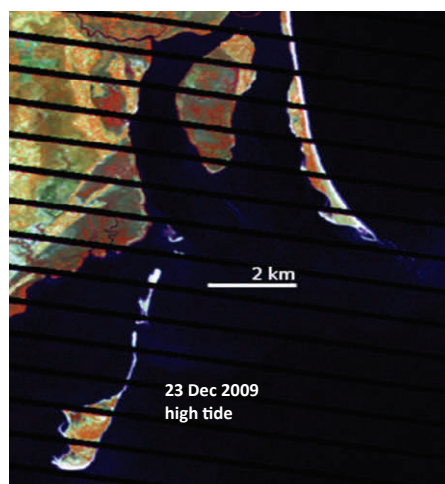
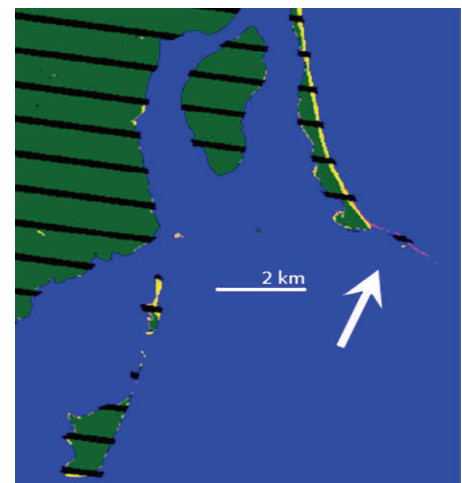
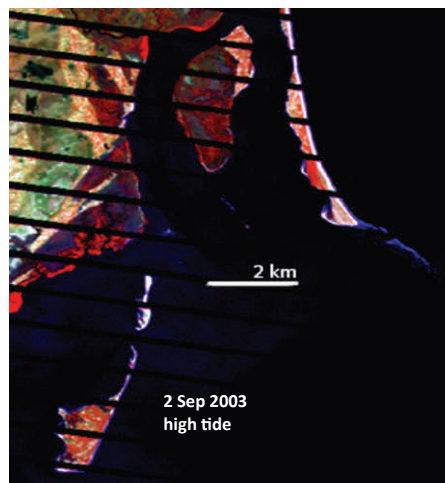
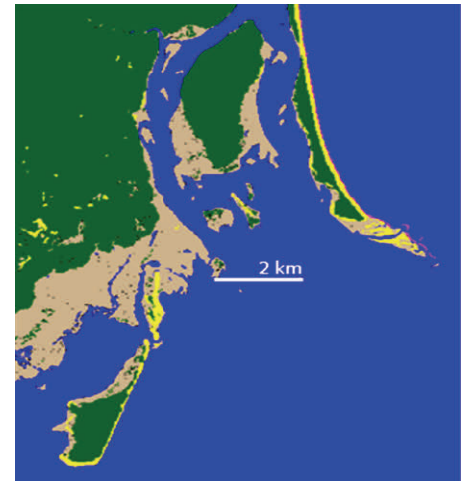
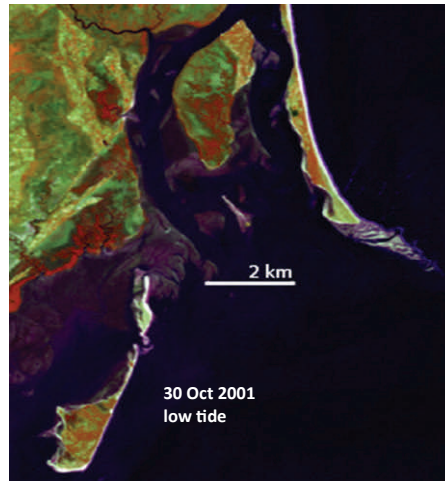


Figure 3: Another subset of the Landsat image for Maputo. Left: False colour image, same as in Figure 2. Right: the respective classification results. The same colour code as in Figure 2 is used. White arrow indicates changes in submerged sandbank. The black stripes in the 2003 and 2009 images originate from an error in the original Landsat images.

2). Comparing the tidal states of a series of images helps to interpret the classification results. For instance, we know that the Maputo image from 30 Oct 2001 (Figure 2 and Figure 3, top) was taken at low tide. Extensive intertidal mudflats are visible. In con-

trast, the images from 2 Sept 2003 and 23 Dec 2009 (Figure 3, centre and bottom) were taken at high-tide. So their tidal state is comparable and the images should look identical. However, at the headland in the right image part (white arrow) there are differ-



ences visible. In the earlier years there was an intertidal sediment bank prelocated to the tip of the headland. In the 2001 low tide image, the sediment bank is exposed and detected as mud flat in the classification. In the 2003 high-tide image the bank is inundated, but its presence still indicated by the pink fringe of breaking waves at its eastern extension. However, in the 2009 high-tide image, this fringe is no longer visible, indicating that the sand bank has eroded. According to local experts this erosion took place during a storm-event in the period between the acquisitions of the images.

Cape Agulhas is South Africa's southernmost and sparsely populated land tip. The shore is relatively low, with a mixture of rocks and sandy beaches. The classification of the Landsat image from 14 May 2003 shows large mobile dune fields in the Cape Agulhas/Struisbay region (Figure 4). Also, as a surprise, the classification detected submerged vegetation, probably kelp beds, close to the coast (red arrow in Figure 4).

For this project, images of the Landsat 5 and Landsat 7 satellites with a pixel size of 30m have been used. Their multispectral sensors Thematic Mapper (TM) and Enhanced Thematic Mapper plus (ETM+) onboard Landsat 5 and 7 respectively have been delivering comparable images since about 1984. This makes Landsat the best available satellite for long term monitoring of environmental processes at a regional scale. A further advantage is that now the images can be

downloaded from the internet free of charge (for instance <http://glovis.usgs.gov/>). This makes the assessment of coastlines even on a national scale affordable taking into consideration that e.g. South Africa's coastline is covered by about 20 Landsat images (compare Figure 1). However, for steep coasts with narrow beaches spatially limited but relevant changes of the coast are likely not to be detectable with Landsat. A retreat of the shoreline for 30 meters or more to be detectable on a Landsat image might already be a disastrous event for such areas. For those cases we will have to come up with solutions using other satellites with a better spatial resolution. Potential options are using [SPOT 5 imagery](#) (2.5-20 m pixel size,) or [RapidEye](#) (6.5 m pixel size,), just to name a few.

The results of the presented CSIR project demonstrate a solution to assess the major coastal land cover types in a fast and efficient way and to monitor changes over time. It is in a ready-to-use state for environments where the level of spatial detail provided by Landsat is sufficient, such as the shallow sandy coasts of the Western Indian Ocean. This approach can also easily be advanced to allow for the detection of other relevant land cover types, such as mangroves, sedges and settlements for a more comprehensive picture of dynamics of the coast as a baseline for integrated coastal management solutions.

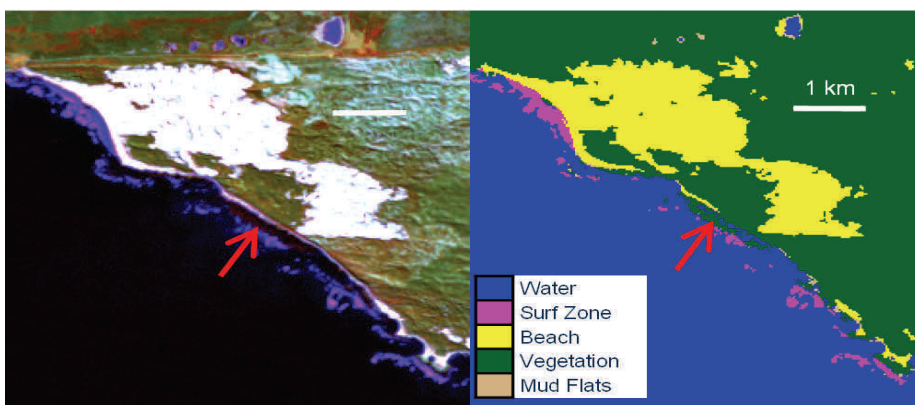


Figure 4: Subset of the Cape Agulhas Landsat image from 14 May 2003 and the classification derived thereof. The red arrow indicates an area where vegetation has been detected in the water, probably kelp beds?

Vacancy for Professor/Associate Professor in Oceanography



The University of Cape Town has a strong international reputation in ocean and climate research and teaching. Within the Department of Oceanography, particular areas of interest include the Agulhas and Benguela Current systems, the Southern Ocean, climate change and variability, marine biogeochemistry and mesoscale meteorology. The department seeks to appoint a senior academic with research expertise in ocean, atmospheric, or climate modelling to complement and extend existing departmental strengths. The department has well developed computing facilities (including access to the Centre for High Performance Computing), a marine biogeochemistry laboratory, and access to ship time for research cruises in the South Atlantic, South Indian and Southern Oceans.

A PhD in Oceanography, Atmospheric Science, or related field is required. The incumbent will be expected to contribute strongly to teaching at both undergraduate and postgraduate levels, develop his/her own research programme and raise associated research funding, and provide academic leadership in the department and more generally within the Faculty of Science.

Closing date for applications:

1 October 2012

Further details are available [here](#).