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SAEON  
South African Environmental  
Observation Network



# SAEON Egagasini Node

## Science Plan: 2016 – 2018

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## Introduction: the Node and its key environmental issues

*Please note for brevity no scientific references have been included*

South Africa is surrounded by three oceans, the South Indian, the South Atlantic and the Southern Ocean with a larger EEZ (1,5 million km<sup>2</sup>) than landsize (1,2 million km<sup>2</sup>) and a coastline length of 3924 km. Understanding our oceans and coasts that contribute enormously to our economy is essential. The Agulhas Current, one of the global oceans' strongest western boundary currents, dominates the East coast of South Africa, influencing the rich biodiversity found there, as well as local, regional and global weather and climate. On the west coast, the cold upwelling Benguela Current consists of nutrient rich waters which sustains South Africa's extensive and important fishing industry, as well as the desert-like conditions found there. The Southern Ocean, Africa's gateway to Antarctica, remains limited in terms of observations and modelling, yet improving our knowledge of this ocean's role in processes such as acting as carbon source/sink and climate variability (Antarctic Oscillation etc) is essential.

Long-term measurements and models are essential in order to understand the impact of climate variability and global change on the oceans and vice versa. The oceans around South Africa play a key role in determining not only our weather and climate patterns, but global weather and climate patterns as well. The offshore influence on our coastal systems can have significant impact on society, in particular industries such as fisheries, shipping, petroleum and mineral exploration and extraction. The contrast between the physical variability of South Africa's east and west coasts results in exceptionally rich and diverse marine fauna and flora occurring along the coastline and on the continental shelf. Challenges in accessing the deeper regions of the continental shelf, especially benthic habitats, has severely constrained progress in scientific research and our understanding of ecosystem functioning in offshore biodiversity. A greater understanding of our oceans will, in turn, improve our ability to manage our resources effectively and sustainably. In order to contribute towards this goal, the SAEON Egagasini Node for Marine Offshore Systems aims to continue addressing the gaps currently existing in long-term ocean monitoring and research programmes in and around South Africa, as well as assisting with efforts to maintain existing programmes and initiatives. In addition, Egagasini has collated, digitised, archived and, most importantly, disseminated data, and will continue to do so. The Node has also been actively seeking out and engaging with young learners, supporting and encouraging marine science postgraduates, as well as working closely with educators, supporting and encouraging them in their efforts to incorporate marine science into the curricula.

The Egagasini Node work is directly aligned with the DST and DEA Marine and Antarctic Research Strategy (MARS), which has a focus on oceans and marine ecosystems, biodiversity and biodiscovery under global change:

- Understanding modes of ocean variability across temporal and spatial scales.
- Developing a regional observations network.

- Developing end-to-end modelling<sup>1</sup> and operational prediction capabilities.
- Establishing global, regional and coastal system indicators.
- Delivering robust & useful information to society.
- Reconstructing past climate changes.

Using earth systems observations to focus on:

- Understanding the links between ocean-atmospheric physics, ocean iron availability, trace element biogeochemistry and ocean productivity
- Understanding large scale ocean circulation and global climate

In parallel to MARS, the importance of the South Africa's Blue Economy (unlocking economic potential from our oceans) has been highlighted and the Presidential initiative, Operation Phakisa has been introduced. Egagasini is playing a vital role in Operation Phakisa, in particular the B3 initiative – the South African Marine Research and Exploration Forum, which aims to utilize offshore oil and gas platforms to improve our knowledge of the ocean.

Egagasini has **four broad themes** within its science, all of which are closely linked and in some areas overlap. The ocean environment is highly dynamic with offshore processes in the large western boundary current of the Agulhas impacting the slope and shelf of the east coast of South Africa, which in turn drives shelf and coastal processes affecting the biodiversity and ecosystems. Similarly, on the west coast of South Africa, the wind regime plays a very important role in upwelling dynamics in coastal regions inshore of the Benguela Current with net transport advecting offshore. In dealing with the marine environment offshore, the dynamics from offshore to inshore, and the impacts on biodiversity and conservation, need to be addressed holistically.

Theme 1: Climate, Currents and Creatures: The focus of this theme is the marine offshore environment eg ecosystems and physical nature of regional and global oceans and atmosphere.

Theme 2: Shelf Seas and Sky: This theme is concerned with the oceans and atmosphere over SA's continental shelf, from the coast to the shelf edge.

Theme 3: Biodiversity mapping and monitoring: This theme is about developing baseline knowledge of South Africa's offshore benthic environment.

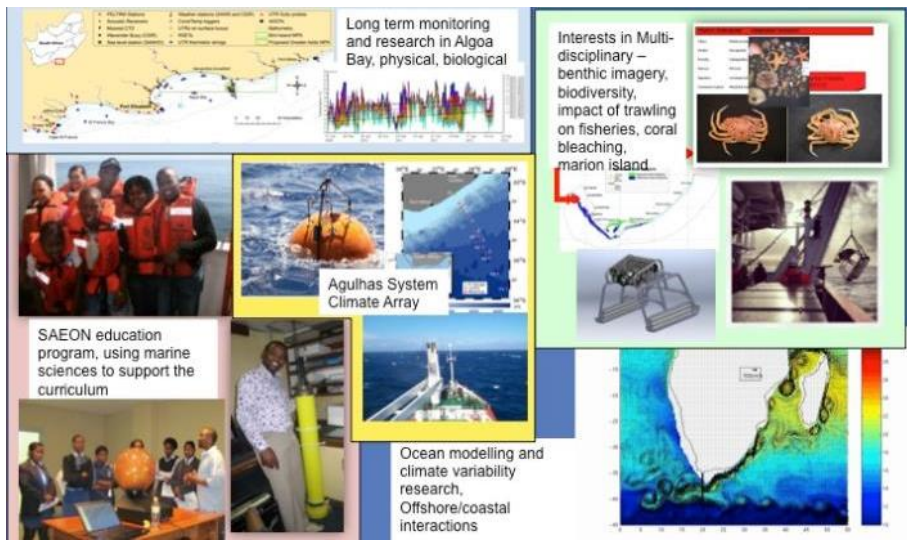
Theme 4: Sentinel Sites: A collaborative theme with Elwandle on long term environmental monitoring and research at selected locations.

The two SAEON marine Nodes, namely the Egagasini and Elwandle Nodes, work closely on many of their respective projects, in particular the Algoa Bay sentinel site,

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<sup>1</sup> physicochemical oceanographic descriptors and organisms ranging from microbes to higher-trophic-level (HTL) organisms, including humans, in a single modeling framework

(which has developed a dedicated science plan, addendum A) as these are often complimentary in nature. It is therefore of interest to the reader to be aware of the SAEON Elwandle Node's science plan. The two Nodes, however, remain separate entities. It should also be noted that the collaboration is not purely offshore vs. coastal. The different skills at both Elwandle and Egagasini complement each other with Elwandle's strengths in biology, phytoplankton, reef biodiversity and monitoring through coastal *in situ* work and Egagasini's knowledge of physical oceanography, offshore benthic biodiversity and modeling.



## Theme 1: Currents, Climates and Creatures

### Relevance to key environmental issues in the region covered by the Node

The location of South Africa with respect to the global oceans, namely on the western edge of the South Indian Ocean, on the eastern edge of the South Atlantic Ocean and bounded by the Southern Ocean in the south, places it in not only a unique, but also a highly significant position with respect to global ocean circulation. The oceans, along with the atmosphere, play a key role in global heat transfer, which ultimately drives global climate and weather patterns. In terms of the varied ecosystems around southern Africa, South Africa plays a key role in two (potentially three) large marine ecosystem programs – the Agulhas Somali Current Large Marine Ecosystem in the southwest Indian Ocean and the Benguela Current Commission focused on the southeast Atlantic Ocean (and the Southern Ocean Large Marine Ecosystem). South Africa's west coast hosts an abundant supply of commercially important fish resources, whereas the east coast hosts incredibly high biodiversity in comparison.

The strength and warmth of the Agulhas Current influences storm tracks, storm development, and the large moisture source of the warm Agulhas Current region contributes significantly to frequency and strength of African precipitation, where it feeds societal water resources, potentially impacting millions of people who depend

on rain-fed subsistence farming to survive. Agulhas Current meanders also drive upwelling and cross-shelf transports, affecting fisheries and recruitment over the Agulhas Bank. Variability in the path and strength of the Agulhas Current is linked to coastal upwelling, marine productivity, and fisheries along the east coast of South Africa and over the Agulhas Bank. For instance, the size of coastal fish catch during the Natal sardine run is thought to be affected by Agulhas Current meandering. Agulhas Current leakage, south of Africa, into the South Atlantic also has direct impacts on the Benguela Current and the fisheries it sustains.

The most abundant fish in the Benguela Current system are *Sardinops ocelata* (pilchard), which has been intensely fished since the 1950s, peaking in 1968 with landings over 1.3 million tons. Since then, the *Sardinops* fishery has declined and the *Engraulis capensis* (anchovy) has taken over. The Benguela Current is also subject to a warming phenomenon known as 'Benguela Niños', whereby anomalously warm, tropical water shifts southwards from the Angola Current, bringing heavy rains and changes in fish abundance. The causes and effects of the Benguela Niño are not yet well understood.

As well as the large ecosystems offshore, the submesoscale processes such as those occurring in the Cape Basin are also of significant importance, given the recruitment of anchovy, as well as the interocean exchange occurring in this region.

Given the costs and logistics around utilizing large, offshore vessels, the Node focuses attention on both *in situ* observations, led by the Node or in collaboration with partners, remote sensing observations as well as numerical modelling to better understand South Africa's oceans.

Currently the Node has the capabilities to investigate the Benguela Current and Agulhas Current systems, however the Southern Ocean, due to lack of capability and issues around logistics, is not a key focus of the Node, although Node scientists do collaborate on projects.

### **Key questions motivating the theme**

One of the main 'key questions' is to determine important current features and their variability. More work has been done in the Benguela region, compared to the Agulhas Current, with over 10 years of *in situ* data from the St Helena Bay monitoring line. The Agulhas Current is less well observed, given that it has speeds of over 2 m/s it has been difficult to maintain moorings. However, technical developments have now enabled this and the Node is leading the Agulhas Current System Array providing the first sustained (5 years or more) observations of heat and volume transport in the Current.

Examples of key regions of interest from both a physical as well as a biological point include: 1) the Benguela Jet, a key feature on the west coast in terms of larvae recruitment, 2) the strength, heat and variability of the Agulhas Current, vital for

global thermohaline circulation, as well as a variety of regional processes including, 3) the East Madagascar Current and bloom, a source region of the Agulhas Current and one of the largest phytoplankton blooms in the world.

Some of the key questions to be answered are highlighted below. These questions relate to the Agulhas Current system but most can be applied to the Benguela:

- Characterize the relationship between volume and temperature transport in the Agulhas Current.
- Quantify the seasonal variability in basin-wide overturning and heat transports of the Indian Ocean, by synthesizing Agulhas Current measurements with Argo and satellite data over the ocean interior.
- Investigate the annual and interannual variability of the Agulhas Current in the context of wind forcing and changes in retroflexion and leakage.
- What are the primary modes of variability within the Greater Agulhas Current System (GACS)? Are they coherent between latitudes? And onshore to offshore? How are they correlated with coastal sea level?
- Are Agulhas meander events related to Mozambique eddies upstream? To Agulhas Ring formation and leakage downstream? To coastal upwelling and productivity events? Is there predictability? At what time lags?
- Is the fate of an Agulhas ring preconditioned?
- How is the variability of GACS related to large-scale basin variability, such as ENSO or the Indian Ocean Dipole?
- How is the variability of GACS related to regional sea surface temperature, air-sea fluxes, and climate and rainfall over South Africa?

#### **Key beneficiaries of the science**

- Coastal scientists.
- Atmospheric scientists
- Government e.g. fisheries resource managers
- Society (e.g. from improved weather forecasting)
- The International research community, including organizations such as IPCC
- Conservation planners
- Status and impact assessors (environmental impact assessments, national biodiversity assessments, environmental status reports etc.)
- Policy makers
- Fishing, petroleum and mining industry
- Education sector

#### **Relevant legislation that the science will help serve**

- National Environmental Management Act (NEMA), including the Protected Areas Act and Biodiversity Act

- Marine Living Resources Act
- Mineral and Petroleum Resources Development Act
- Environment Conservation Act
- Any legislation arising from Operation Phakisa

### **Actual/potential science collaborations**

- Government Departments - Dept. of Environmental Affairs, including the South African Weather Service and Dept. of Agriculture, Forestry and Fisheries, Dept Science and Technology
- Navy and Institute for Maritime Technology
- The South African Data Centre for Oceanography, as well as other international databases
- International programs such as Argo, Adopt a drifter, CLIVAR, IndOOS, GOOS, IOC, BCC, GCOS, International Indian Ocean Expedition II, POGO etc etc
- Higher Education institutes and National facilities, eg NMMU, UCT, CPUT, UWC, RU, UP & SAIAB
- Department of education, schools and other marine outreach programs, eg Two Oceans Aquarium
- CSIR.
- ORI
- South African National Biodiversity Institute
- Fishing, petroleum and mining industry

### **Opportunities for developing research platforms which could attract science collaborators**

Many opportunities can be presented when a ship is made available. For example, as part of ASCA, Egagasini rents the DEA vessel, the *R/V Algoa* for 2-3 weeks each year. This platform is opened up to anyone wanting to do research in the Agulhas area and they are invited to use the vessel for their work (although mooring deployment takes priority).

The numerical models which are being run by Egagasini staff and students are made available to anyone and can thus be used to provide boundary conditions for higher resolution coastal modelling. The higher resolution modelling which is currently being done can be saved in 6 hourly timesteps which will be useful for atmospheric models as it resolves the diurnal cycle.

There is a large scope for a national ship facility to be created but this is beyond the scope of Egagasini.

### **Opportunities for cross-nodal collaboration**

As mentioned in the introduction, there is clearly scope for collaboration between Elwandle and Egagasini. The offshore environment will generally always have an impact on the coastal seas and hence any research performed in the offshore regions of South Africa will be of interest to Elwandle. There can also be sharing of

ships time for any coastal work as well as the provision of realistic large scale lower resolution models to act as boundary conditions for higher resolution nested models.

Having mentioned the more obvious linkages between the two marine Nodes, one should not ignore the perhaps more subtle, but nonetheless fundamental linkages between Egagasini and the terrestrial SAEON Nodes. As previously stated, ocean atmosphere interaction occurring within the marine offshore environment surrounding South Africa is a key driver of our weather patterns. Long-term monitoring will improve our understanding of these exchanges and feedbacks driving climate variability and extreme events, which in turn impact, on the terrestrial environment. It is these impacts on the terrestrial environment and the attendant responses of the ecosystems to these variations and extreme events that the SAEON terrestrial Nodes are monitoring. There is a strong scope for the terrestrial and marine Nodes to work together in understanding climate signals evident in many of the timeseries being collected. Ultimately the benefits of SAEON being composed of Nodes with different biome focuses is the multidisciplinary nature it embodies, creating an environment wherein the sharing of data, science and ideas among Nodes is encouraged and facilitated.

## **Theme 2: Shelf Seas and Sky**

### **Relevance to key environmental issues in the region covered by the Node**

The continental shelf of South Africa is an area where commercially important fish species live out their lifecycles, while closer inshore the squid, lobster and shell fish industries are significant. These industries supply most of South Africa's local seafood and it is important to keep the stocks at a sustainable level for the nation's food security. Many kinds of larvae and pelagic fish migrate over the Agulhas Bank and move up and down both the west and east coast continental shelves; this is necessary for the regeneration of stocks. These movements are partly controlled by the ocean currents, sea temperatures, dissolved oxygen, pH and other physical, chemical and biological variables. Atmospheric conditions, in particular wind, air temperature, air pressure and solar radiation affect the depth of the surface mixed layer, which determines whether upwelled nutrients reach the euphotic zone, a necessity for primary production. Although time scales for these influences range from days to years, multi-decadal and longer variability are important, although less well known. Climate change and its influence on oceanographic conditions will have a large influence on South Africa's fishing industry. It is thus important to determine if there are long-term trends in shelf waters and this means research, modelling and monitoring the physical ocean, as well as the biome, for ecosystem change. The scope of research will depend on the expertise present within the node.



## **Key questions**

- What drives the physical characteristics of the ocean over the continental shelf of South Africa?
- What external influences, i.e. weather, climate and the open ocean, act upon the continental shelf?
- What are the influences of the continental shelf seas on the waters of the coastal zone?
- Are the physical properties (e.g. temperature, salinity, chlorophyll, currents) of the waters of the continental shelf changing over the long-term, and how so?
- If there are changes, what are the impacts on the ecosystem?
- Is the biome (that which falls within the node's field of expertise) of the continental shelf changing?
- If there are changes in the physical characteristics of the ocean or the biome, are they naturogenic or anthropogenic?

## **Key beneficiaries of the science**

- The biome of the continental shelf.
- Fisheries and the economy of SA.
- The population of SA who consume sea food.
- Marine sciences from an increased knowledge of how the shelf ecosystem functions.

## **Relevant legislation that the science will help serve**

- National Environmental Management of the Ocean.
- National Environmental Management: Integrated Coastal Area Management.
- Marine Living Resources Act.

## **Actual/potential science collaborations**

- DEA and DAFF – have scientists working extensively around SA. Access to their ships is important.
- UCT – lectures and students collaborate on marine projects around SA.
- RU & SAIAB – some marine scientist work in the Algoa Bay region, often on multidisciplinary projects.
- NMMU – researchers mostly working close inshore and over the inner shelf.
- CSIR – has a sea glider facility, so collaboration is important.
- UWC – potential for more collaboration.
- ORI – an untapped source of collaboration for research on KZN offshore waters.

### **Opportunities for developing research platforms which could attract science collaborators**

The waters over the *inner* continental shelf around South Africa can be hazardous but are generally accessible by large ski-boats in good weather and sea conditions. Not many research expeditions have been undertaken over the shelf area on ski-boats, so this method can be developed further. Field trips should be multi-disciplinary in order to attract collaborators from different institutions. Obviously, close proximity of a port to the study area, for the boat launch, is need. Larger ships are more suited for research over the outer shelf and further offshore, as can be found at shelf edge and over the Agulhas Bank, but funding for cruises and access to them are limited. Advanced tools for marine research are becoming more available. New satellites for remote sensing have been launched and remote controlled vehicles, such as sea gliders, are making the shelf more accessible to researchers. Sea gliders can sample properties of water, such as temperature, salinity, dissolved oxygen, chlorophyll and pH that are relevant to biological and environmental research. With collaboration, uses of these new tools can be developed to their full potential. Satellite drogues and drifters can be made more use of and Synthetic Aperture Radar (SAR) and High Frequency (HF) Coastal Radar can be developed further.

### **Opportunities for cross-nodal collaboration**

Events that happen in the open ocean must, of necessity, cross the continental shelf in order to impact the coast. For example, upwelling, which is important for primary production and hence the whole food chain, is fed by cold, nutrient rich, bottom water moving up over the shelf edge and towards shore. Around SA upwelling is mostly driven by wind eg Benguela Current and coastal upwelling, and by the Agulhas Current off the east coast. Another example is of coastal seas being warmed by onshore surface intrusions of the Agulhas Current, affecting local productivity. Internal waves may be generated at the shelf edge which can, under stratified conditions, break near the shoreline and influence biomass aggregations. Several other wave types propagate around the SA in sympathy with weather systems. Storms over the shelf and in the Southern Ocean could cause large swells that propagate over the shelf, which coastal fish try to avoid by seeking refuge in estuaries or else moving offshore. These are just a few examples. Thus, what happens over the shelf will affect coastal waters and so these phenomena will be of interest to the researchers of the Elwandle Node. In particular, Egagasini's expertise in physical oceanography will provide that component of research which will compliment the skill set at Elwandle.

### Theme 3: Biodiversity mapping and monitoring

In order to detect, quantify or monitor change, good information must be known about the baseline conditions against which change will be measured. South Africa's offshore benthic environment remains poorly researched, resulting in a gap in knowledge in this regard. It is imperative that baseline information about benthic ecosystems be systematically collected from South African offshore regions. Benthic ecosystems support higher trophic levels and due to their long-term stable nature, provide an excellent platform for measuring ecosystem health. Seabed habitat characterisation and the associated biodiversity are widely used as a component of habitat classification and biodiversity assessments. The most recent (2011) South African national benthic habitat map requires validation of the proposed habitat types, especially those in the offshore regions, which have received little research attention to date. This is most effectively achieved by means of *in situ* ground truthing through habitat and biodiversity mapping. Importantly, this can now be achieved through non-destructive visual surveys using deepsea camera systems. This urgently needed, baseline research in the marine environment is directly comparable to the South African terrestrial "vegetation map" which was initially produced in the 1940s to 1950s, with revisions occurring in 1996, 2006 and 2009. The vegetation map provides critical baseline information that underpins a substantial amount, if not all, terrestrial ecological research in South Africa.

Long-term monitoring of benthic habitats and biodiversity facilitates improved understanding of ecosystem functioning, which is important to assess how changes in these components may affect ecosystem integrity across a range of trophic levels. Shifts in the position and extent of critical habitats can significantly affect the provisioning services of the ecosystem. Changes in benthic habitat and/or biodiversity can manifest as a result of anthropogenic impacts (both increases or decreases in activity), changing climate scenarios or natural variability. South Africa's recent focus on the Blue Economy is likely to result in both an increased use of the offshore environment and areas of decreased anthropogenic activity due to introduced protection levels. This impending change of use patterns in offshore habitats requires that baseline conditions are well documented prior to environmental changes that may manifest as a result of such anthropogenic activity shifts. Ongoing, long-term monitoring within and outside marine protected areas is essential to enable quantification of ecosystem change as a result of such protection. Similarly, effects of an increased intensity of activity are equally important to monitor. Monitoring for changes in 1) the extent and location of marine habitat types, 2) biodiversity richness and composition and 3) distribution and abundance of key species forms the basic suite of ecosystem components that require long-term monitoring. In addition, a long-term monitoring program should aim to enable improved understanding of the key drivers of change.

### **Key questions motivating the theme**

- What benthic habitats and associated biodiversity occur in South Africa's offshore regions?
- How are benthic habitats and biodiversity changing? What are the drivers of this change?
- Are certain habitat types more vulnerable to effects of change than others? And if so, what are the more vulnerable habitats and how will they change?
- Can the drivers of observed ecosystem change, such as exploitation of fish stocks and minerals, changing climates or natural variability, be detected, defined and directly attributed to shifts?
- Can we quantify positive changes as a result of protecting benthic ecosystems?

### **Key beneficiaries of the science**

- Fisheries resource managers
- Conservation planners
- Status and impact assessors (environmental impact assessments, national biodiversity assessments, environmental status reports etc.)
- Marine taxonomists
- Policy makers
- Fishing, petroleum and mining industry
- Eco-certification bodies
- Education sector (due to the high visual impact of the research)

### **Relevant legislation that science will help serve**

- National Environmental Management Act (NEMA), including the Protected Areas Act and Biodiversity Act
- Marine Living Resources Act
- Mineral and Petroleum Resources Development Act
- Environment Conservation Act
- Much of the science generated through offshore mapping and monitoring is directly incorporated into South Africa's National Biodiversity Assessment which is used as a high-level management decision-making tool.

### **Actual science collaboration**

- Department of Environmental Affairs: Oceans & Coast; 1) facilitating the platform for Prince Edward Island research which investigates changing biota over long time scales where there is limited anthropogenic impact, 2) Support of invertebrate monitoring surveys which map and monitor for changes in benthic biota.
- Department of Agriculture, Forestry and Fisheries: Demersal trawl Unit; 1) Benthic trawl experiment vessel provision which will improve knowledge about the impacts of demersal trawl on benthic biota, 2) Incorporate invertebrate

monitoring surveys as part of routine monitoring which map and monitor for changes in benthic biota.

- South African National Biodiversity Institute: Marine Programme; 1) National Biodiversity Assessment data and expertise inputs, Benthic trawl experiment contribution, habitat mapping as part of the NBA, co-supervision of students.
- South African Institute for Aquatic Biodiversity: In terms of access to ROV and other imagery monitoring equipment.
- Fishing, petroleum and mining industry (key stakeholders of South Africa's offshore environment); 1) South African Deep Sea Trawl Industry Association strong collaboration on the benthic trawl experiment, 2) PetroSA collaboration on pollution impact study (potential future collaborations).
- Higher level Education institutes: Universities (Cape Town, Stellenbosch and Western Cape) in terms of student supervision and lecturing.
- Marine technology industry: Sea Technology Services in respect of benthic imagery / camera development.
- Marine Stewardship Council (eco-certification body): with respect to the benthic trawl experiment.

### **Opportunities for developing research platforms, which could attract science collaborators**

Scientists at SAEON Egagasini have been pioneering the use of deepsea benthic imagery in South Africa through implementation of our deep water benthic camera system, SkiMonkey III. Through the highly successful application of this visual mapping and monitoring tool, we are ideally poised to further develop this research platform, develop capacity and empower South African marine science to undertake internationally acclaimed research. Currently the camera system can only be deployed from a large research vessel which is not always readily accessible. With increased collaboration, however, this may be addressed in two ways; 1) the camera system could be modified to become interchangeable for deployment from both small craft and large research vessels and 2) opportunities to participate in research voyages could be increased. A further limiting factor in long-term monitoring of offshore habitats is that of manpower. South Africa's Exclusive Economic Zone covers just more than 1.5 million km<sup>2</sup> of ocean and seabed, the latter of which mostly remains unexplored. Benthic mapping and monitoring research is currently undertaken on a piecemeal basis in South Africa with approximately 5 employed researchers and up to ~ 6 post-doctoral or post-graduate students actively engaging in such research. Only two researchers employed in SAEON are involved in benthic mapping and monitoring. There is currently no cohesive platform that serves to bring together the fragmented information. SAEON could potentially develop and provide such a platform in the future.

Further to this Egagasini is in the process of developing an offshore benthic biodiversity identification guide, as well as a variety of databases (such as the

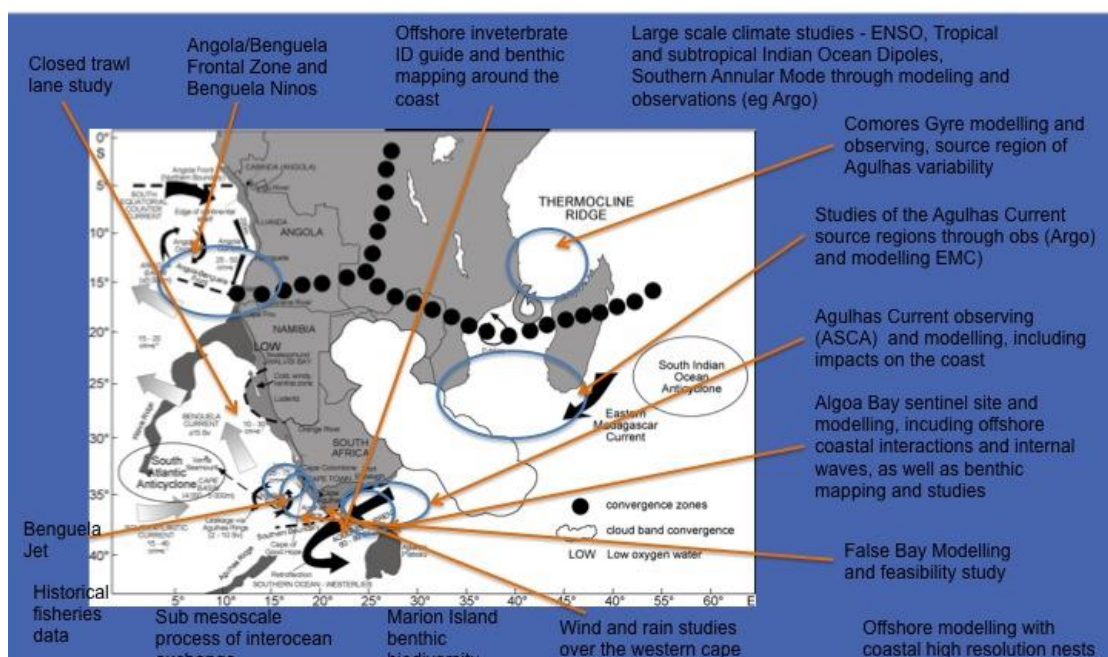
historical fisheries database and species database) all of which serve as ‘platforms’ for the science collaborators. Opportunities for collaboration are increasing and through the Blue Economy drive, are likely to increase further in the near future. It is imperative that SAEON are well-supported and empowered to serve as a key role-player in the future. Key collaborators for SAEON to attract are DEA, DAFF, SANBI and SAIAB with other smaller groups also bringing important contributions.

### Cross-nodal collaboration

The obvious cross-nodal collaboration for benthic mapping and monitoring is with the inshore Node, Elwandle. Currently researchers from Egagasini and Elwandle do interact and there are some joint projects underway in terms of benthic habitats, however, the level of collaboration can and should be increased. There are significant differences in the type of equipment required with an increase in depth underwater. The offshore Node tends to operate up to much greater depths and from larger research vessels. There is however excellent scope to develop tools and technology in collaboration with each other to improve applicability through the different environments to be monitored.

Benthic habitat mapping and monitoring research is an excellent field through which to expose young learners to marine science as a result of the highly effective visual impact the imagery has. This attribute of this type of research is being used extensively in collaboration with the education outreach component of SAEON.

### Examples of Egagasini projects



## Theme 4: Sentinel Site, Algoa Bay Sentinel Site Cross-Nodal Collaboration

The Algoa Bay Sentinel Site (ABSS) is a long-term ecological research (LTER) site of SAEON that encompasses the nearshore, coastal and inner continental shelf areas around Algoa Bay, St Francis Bay and Port Alfred, in the Eastern Cape province of South Africa. In the coastal seas of the site, and along its shoreline, many (>190) instruments measuring physical variables have been deployed. SAEON also undertakes periodic boat-based cruises to observe and monitoring the pelagic and benthic ecosystems. Refer to the Elwandle Science Plan for more details.

The two marine nodes of SAEON, Egagasini and Elwandle have collaborated on the ABSS since its inception and partnership continues to grow. On the technical side, Egagasini contributes by supplying instruments and assisting with data management, and so helps with the functioning the site. In the science arena, Egagasini conducts research in the fields of physical oceanography and benthic biodiversity which provide an important component to joint projects. The skills set from both nodes complement each other and combine well in a multi-disciplinary research approach.

### Sub-theme A: Physical oceanography

#### **Relevance to key environmental issues in the region covered by the Nodes**

The marine flora and fauna found within the boundaries of the ABSS live within a constantly changing and moving liquid medium, called the nearshore and coastal ocean. In this zone, properties of the oceanic waters, such as temperature (upwelling, warm Agulhas Current water, surface heating/cooling), salinity (fresh and saltier water intrusions), oxygen (depletion), currents (water replenishment times, bay flush times, flow regimes, circulation patterns) and waves (beach profiles, surf zone, rips, convergence and divergence zones) influence the conditions under which creatures in the sentinel site live and flourish. Without knowledge of those physical type variables, ecosystems research will lack important parameters in determining the state of, and change in, the biome. Thus, for a holistic approach to environmental research it is necessary for ocean physical variables to be monitored. In order to understand what causes these physical variables to be what they are, their forcing mechanisms need to be understood and quantified. In the waters of ABSS the main drivers are wind, tides, inertia, atmospheric conditions (e.g. solar radiation, air pressure) and the open ocean (e.g. Agulhas Current, El Nino). These drivers play an import role in determining the coastal ocean's structure and dynamics, subject the constraints of coastline shape and bathymetry, which in turn impact upon the ecosystems.

## **Key questions**

- What are the temporal and spatial variability in water structures and dynamics (e.g. temperature, salinity, currents) of the sentinel site?
- Are there long-term trends in the physical variables and are they related to climate variability?
- What mechanisms (e.g. wind, tides, Agulhas Current, waves) drive the circulation and water structures?
- What are the influences of coastline shape (e.g. capes, bays) and bathymetry (e.g. ridges, canyons) on the coastal ocean, and how do the dynamics of ocean influence the shoreline and surf zone (e.g. sea level rise, waves)?
- Are there differences between Algoa Bay and St Francis Bay?
- How can the knowledge of physical variables be better incorporated into multi-disciplinary and cross-disciplinary projects?

## **Key beneficiaries of the science**

Immediate and direct beneficiaries of the science are SAEON Egagasini and Elwandle Nodes, who need physical oceanographic input into their coastal and marine environmental research projects. Other regular beneficiaries are scientists and students at universities (NMMU, UFH, RU, UCT, UWC, CUPT) undertaking marine biological studies in the sentinel site, and who need a physical oceanographic component. Many of these projects use the physical data to study the physical-biological linkages in the ecosystem. Some recent examples of projects are fish and mussel larvae transport, the distribution zooplankton and phytoplankton, migration of fish and top predators, surf-zone diatoms, sea birds and penguin foraging patterns, fish migration, fish farms and squid life cycles. Other more practicable uses of the science have been: rescues at sea, verification of ocean models, wastewater outfalls, coastal protection, coastal management and renewable energy (power) from waves and currents.

## **Relevant legislation that the science will help serve**

- National Environmental Management Act (NEMA), including the Protected Areas Act and Biodiversity Act.
- National Environmental Management of the Ocean.
- National Environmental Management: Integrated Coastal Area Management.
- Marine Living Resources Act.
- Environment Conservation Act.

## **Actual/potential science collaborations**

- DEA and DAFF – have coastal and marine environmental projects in Algoa Bay. They also have physical instruments deployed in the site.
- UCT – lectures and students collaborate on marine projects in Algoa Bay, mostly biological studies on penguins and fish but also on wave studies (US and CSIR collaborations).



- RU, UFH & SAIAB – scientist and students work in the Algoa Bay region, often on multi-disciplinary projects with a main focus on biology.
- NMMU – biological researchers mostly working in estuaries, the nearshore zone and inner bay area.

### **Opportunities for developing research platforms which could attract science collaborators**

The present array of *in situ* instruments deployed in the sentinel site is extensive and it continually attracts many collaborators to SAEON. The physical data is used by node scientist on collaborative projects and is also distributed to external students and scientist for use in their projects. The marine scientists at SAEON are often invited onto external projects due to the expertise developed within the sentinel site. The dissemination of data provides excellent opportunities for collaboration with many institutions. However, the data gathered by the platforms do not cover all observations needed for some new physical or biological projects; at times there is a need to acquire new instruments or rearrange existing deployments to meet the project needs. This attracts collaborators who don't have access to physical data of their own.

### **Opportunities for cross-nodal collaboration**

The ABSS provides an excellent opportunity for collaboration between Elwandle and Egagasini Nodes. The design of the continuously monitoring research platforms in the coastal waters of the site was initially developed by a cross-nodal collaboration. Both nodes work jointly to develop and implement the site's research and monitoring strategy and both nodes contributed funds and instruments to the array. There is continued strong collaboration between the nodes on the site. Although Elwandle has the responsibility of managing the servicing of the site, due to its proximity, students and scientists from Egagasini assist on field trips when the opportunity arises. Much of the instruments deployed in waters of the site measure physical variables, but Elwandle is lacking a physical oceanographer. This deficiency is made up by the physical oceanographer at Egagasini working with Elwandle. Egagasini also processes and analyses the site's timeseries data downloaded from the serviced by Elwandle. Several joint articles, publications, presentations and reports have already been produced. There is much scope for further collaboration.

## **Sub-theme B: Algoa Bay soft-sediment benthic biodiversity and bio-physical links**

### **Relevance to key environmental issues in the region covered by the Node**

In South Africa, as elsewhere, shelf and offshore soft-sediment benthic communities are among the least studied but most impacted by demersal trawling, resource extraction and dumping. The direct importance of unconsolidated (soft-sediment) benthic habitats and assemblages encompasses ecosystem services such as

nutrient cycling and sequestering, and provision of food, habitat and nursery areas for many higher taxa, including commercially important species. Because of this, benthic invertebrate data are pertinent as indicators of ecosystem health, level of disturbance and environmental change. The ability to link physical environmental data from the Sentinel Site Network to benthic ecology in the Algoa Bay region is therefore invaluable, putting SAEON in a strong position to examine these issues.

### **Key questions motivating the theme**

By surveying the benthos of the Algoa shelf, we ask the following questions:

- What are the spatial patterns of benthic diversity on the shelf?
- Can we establish the current baseline ecological condition of these benthic assemblages?
- How do key environmental drivers (e.g. oceanographic features) influence benthic diversity and ecological function?

### **Key beneficiaries of the science**

This science is of direct relevance to national managers, impact assessors and conservation planners, with particular relevance to local marine protected areas and the developing marine industry. It also fills an important knowledge gap in the marine ecology of the area, with relevance and positive feedback to the marine science community, with excellent capacity for student involvement.

### **Relevant legislation that the science will help serve**

- National Environmental Management Act (NEMA), including the Protected Areas Act and Biodiversity Act
- Marine Living Resources Act
- Mineral and Petroleum Resources Development Act
- Environment Conservation Act

### **Actual/potential science collaborations**

Complementary research aims (rocky reef covered by Elwandle, soft-sediment covered by Egagasini) mean that collaboration has the potential to produce broad-scale/high impact research. Direct links to ACEP brings in collaborators at Rhodes University, NMMU and SAIAB. Some parallel research objectives with the Department of Environmental Affairs (DEA) mean that the DEA are also collaborators, but may also compete under some scenarios.

### **Opportunities for developing research platforms which could attract science collaborators**

SAEON is well placed to use the variety of photographic sampling equipment at its disposal to attract outside collaborators, as already demonstrated by the BRUVs and SkiMonkey camera work. The same is likely true of the developing offshore benthic capabilities.

## **Opportunities for cross-nodal collaboration**

Because of the location of the Algoa Bay study area and its relationship with Elwandle, the Sentinel Site Network forms a core area for collaboration between the Egagasini and Elwandle nodes.

## **List of Acronyms**

ABSS	Algoa Bay Sentinel Site
ASCA	Agulhas Current System Array
BCC	Benguela Current Commission
CLIVAR	Climate Variability and Predictability Experiment
CPUT	Cape Peninsular University of Technology
CSIR	Council for Scientific and Industrial Research DEA
DST	Department of Science and Technology
EEZ	Exclusive Economic Zone
ENSO	El Niño-Southern Oscillation
GACS	Greater Agulhas Current System
GCOS	Global Climate Observing System
GOOS	Global Ocean Observing System
IndOOS	Indian Ocean Observing System
IOC	International Oceanographic Commission of UNESCO
IPCC	Intergovernmental Panel for Climate Change
LTER	Long-term ecological research
MARS	Marine and Antarctic Research Strategy
NEMA	National Environmental Management Act
NMMU	Nelson Mandela Metropolitan University
ORI	Oceanographic Research Institute
POGO	Partnership for Observations of the Global Oceans
RU	Rhodes University
SAIAB	South African Institute for Aquatic Biodiversity
SAR	Synthetic Aperture Radar
UCT	University of Cape Town
UFH	University of Fort Hare
UP	University of Pretoria
UWC	University of the Western Cape