



SAEON
HIGHLIGHTS
2011-2015



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA



SAEON
South African Environmental
Observation Network

SAEON is a National Research Network that establishes and maintains environmental observatories, field stations and sites that serve as research and education platforms for long-term studies of ecosystems. These help us understand and improve our ability to detect, predict and react to environmental change. Through this we strive to bring cohesion and establish collaborations nationally and internationally. We ensure that long-term ecological research data are archived and accessible as a national asset for generations to come.

“SAEON’s vision is a comprehensive, sustained, coordinated and responsive South African environmental observation network that delivers long-term reliable data for scientific research and informs decision-making for a knowledgeable society and improved quality of life.”





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FOREWORD

In 2012, SAEON celebrated its first 10 years of existence and activity. Since inception it grew from an organisation in one office consisting of three staff members, to a network of six research offices, an administrative support office and a staff component of nearly 70. This phenomenal growth in human resources has resulted in a similarly impressive growth in research activities, research sites, research collaborations and networks, and most of all, an increase of research output and impacts. In this report we take a retrospective view on some aspects of our growth over the past five years.

MESSAGE FROM THE NRF CEO

I am pleased to present this five-year overview of the scientific activities of the South African Environmental Observation Network (SAEON). SAEON was incubated by the National Research Foundation (NRF) with financial support from the Department of Science and Technology (DST). Since its founding years, SAEON has matured into an indispensable research platform for environmental research and is currently used by almost all South African universities.

SAEON's unique design as a geographically distributed observation system and the expertise that it has gained in establishing and running environmental observation research infrastructure, including information management systems, serve to position it as a notable instrument of the South African research community and government. Evidence to this effect can be found in the wide range of roles that SAEON plays in support of several government departments by providing policy comments and advice, serving on technical committees, providing administrative support and leadership to government projects, developing decision-support systems, strengthening the basic education system and compiling technical reports. In addition, SAEON is deeply involved in the transformation of the National System of Innovation by generating new knowledge, supporting and supervising research students, presenting academic lectures and training courses, offering accessible data management systems, as well as offering research support in the form of bursaries and research platforms.

SAEON is also growing its connectivity and influence internationally; among others through hosting the first International Long-Term Ecological Research Open Science Meeting in 2016, hosting

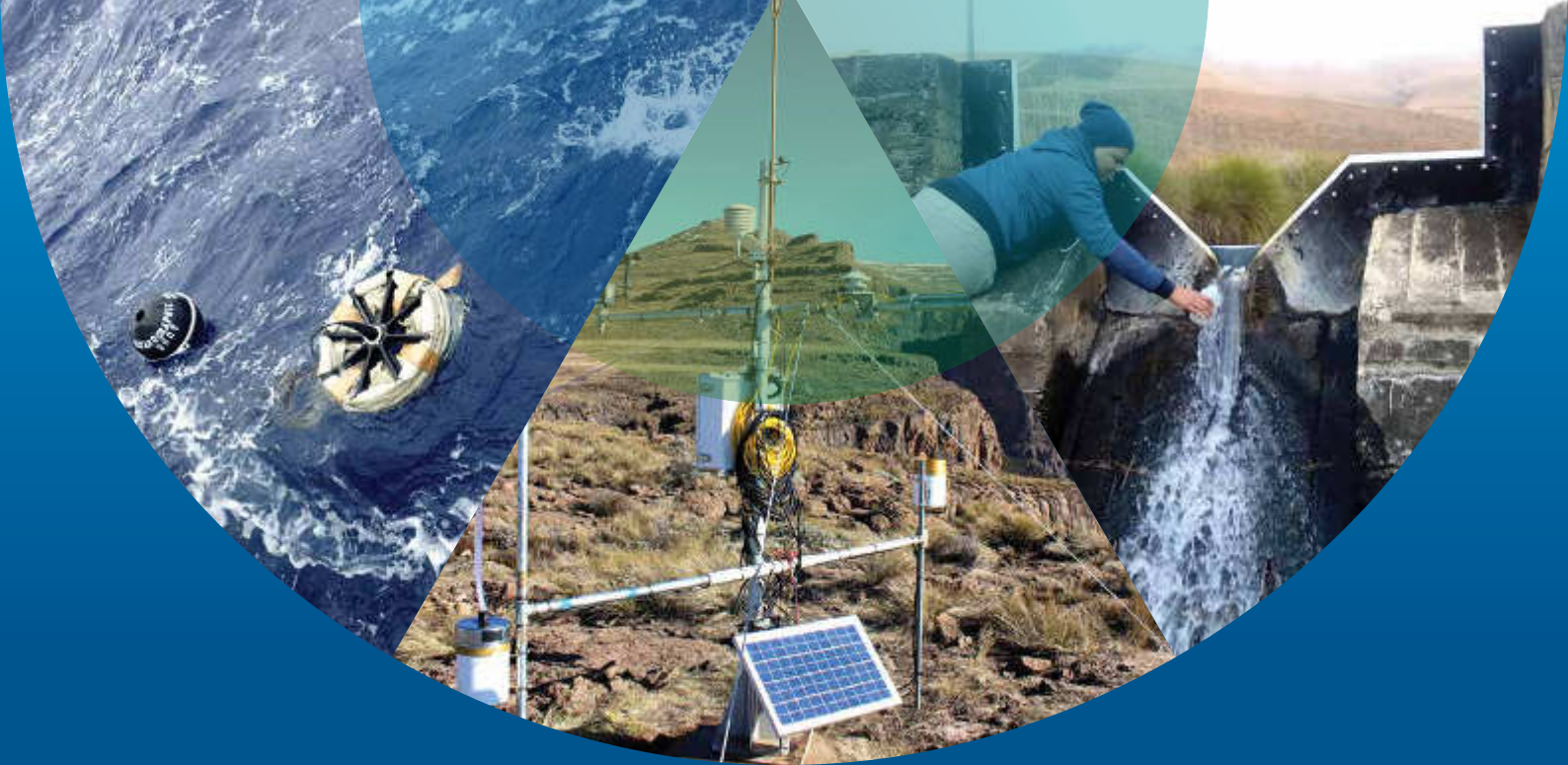


the Global Climate Observing System Steering Committee and a Science Day in 2015, serving on the Indian Ocean Rim Association, active leadership in the World Data System, collaboration in several intercontinental research projects and invited lectures at international science meetings.

This overview provides the reader with a glimpse of some of the scientific endeavours of SAEON. It also serves as a milestone for past endeavours and a benchmark for what is possible into the future. I would like to compliment and congratulate all the SAEON staff and collaborators on their achievements and look forward to the next overview, which I am confident will surpass all expectations.

Dr Molapo Qhobela

Chief Executive Officer of the NRF



SAEON PLATFORMS

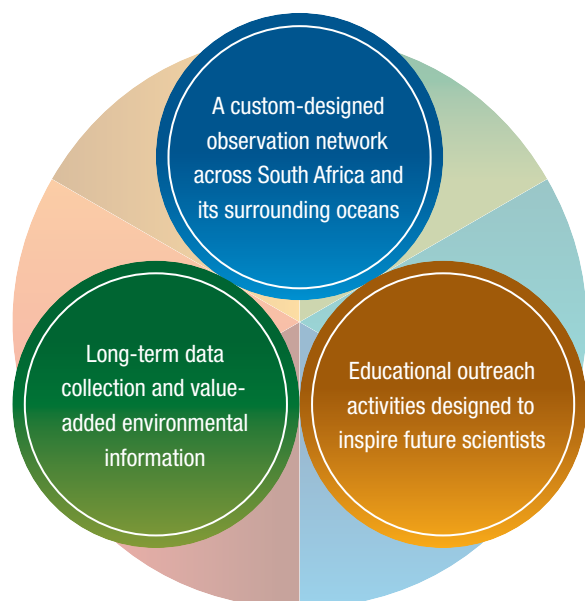
SAEON's six research nodes serve as observation platforms and hubs of research expertise in the various biomes and ecosystems of South Africa. From the outset, SAEON's monitoring activities have been designed to be long-term, but valuable short- and medium-term insights have already been gained from these, supported by recovery, confirmation and retrospective analysis of historical research projects and data sets.

Long-term observations need government infrastructure and cannot be done on the basis of short-term research only. Some environmental changes are slow, but significant. Some are abrupt and disruptive. Observation platforms need to be designed to be able to monitor change over space and time.

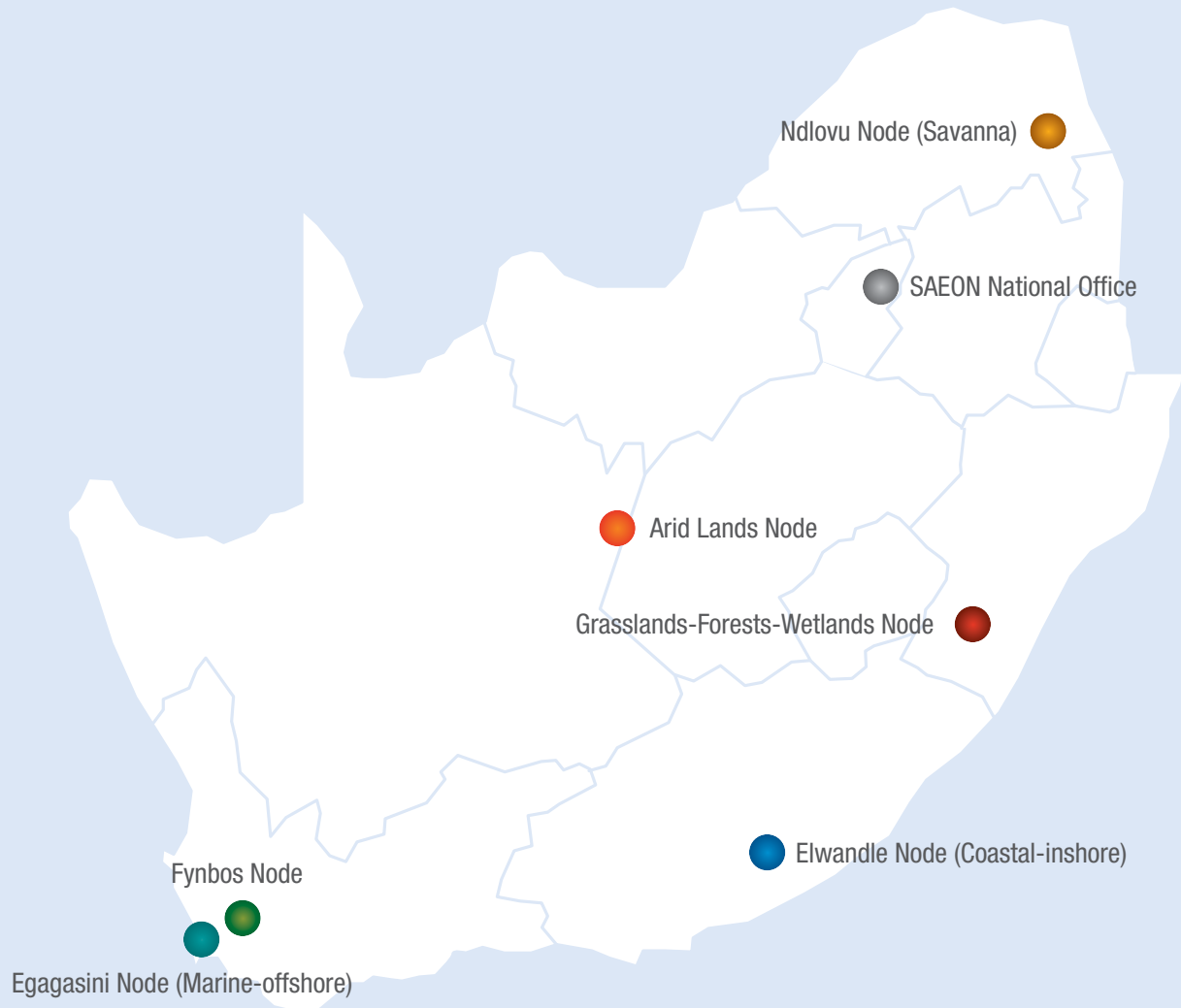
Environmental change is a continuous global reality. The impact of changing systems has become strongly felt as increasing numbers of people become reliant on decreasing resources, with negative effects on economic development, poverty and vulnerability. In order to cope with environmental change, it is important to measure trends and their magnitude in the global life-supporting systems, be it oceans, mountain catchments, forest, savannas and rangelands or urban areas. To be effective, relevant long-term data need to be captured, archived and disseminated to all researchers interested in exploring change in ecosystems.

The most sophisticated monitoring platforms and data are meaningless without people to do the research. SAEON regards it as its mission to expose people to science, empower them to become scientists and help grow the pool of scientists that will deliver answers and guidance in the face of inevitable change.

The three cornerstones that support all SAEON's activities are:



LOCATION OF SAEON'S SIX NODES AND NATIONAL OFFICE



SAEON PLATFORMS: INSTRUMENT ARRAYS

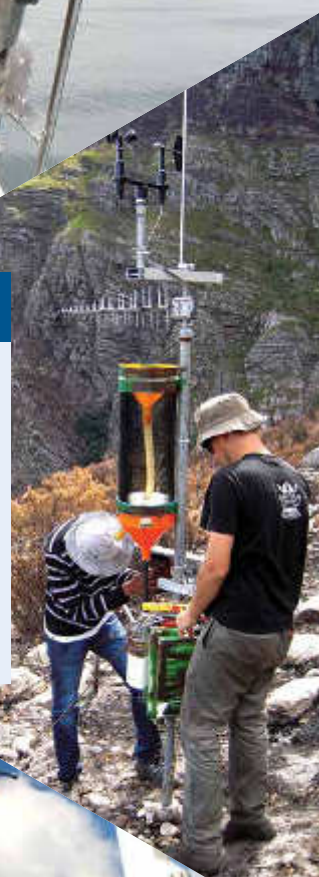
A core function of SAEON is to develop platforms to facilitate global change research across the country's biomes. An injection of funding through the DST's Strategic Research Infrastructure Grant is enabling SAEON to make a significant investment into instrument arrays across its nodes. The aim is to ensure that a coordinated set of physical observation parameters is collected across the terrestrial and coastal/offshore biomes. These parameters will relate to weather, eco-hydrology and energy-carbon-water flux.



SAEON'S EXPANDING INSTRUMENT ARRAY

The data generated from these platforms complement current and historical environmental observations aimed at detecting and understanding the impact of global change on South Africa's ecosystems. Adding carbon-energy-water flux capacity to the instrument array is important to provide the means for understanding the interplay between biodiversity, ecological patterns, and shifts in these in relation to earth system processes.

It is hoped that the knowledge generated from these instruments, in partnership with collaborators and experts in the field, will help SAEON scientists detect global change impacts and lead to a greater understanding of the processes within systems and how change might affect these. The ultimate aim is to reduce levels of uncertainty linked to regional climate models, and enable more reliable future projections.





SAEON INSTALLS SA'S HIGHEST WEATHER STATION

SAEON installed the highest weather station in South Africa in the Drakensberg. This mountain range is a critical source of freshwater (the 'water tower') for the urban and industrial centres in Gauteng and KwaZulu-Natal. Building on long-term catchment experiments established in the 1950s, SAEON's Grasslands-Forests-Wetlands Node has developed an important research platform in the Central Maloti Drakensberg.

Weather stations are very rare in the rugged terrain of our high mountain catchments. New developments in automation make it possible to bridge this critical gap – if you can get the weather station up there! Designing the structure to hold the various instruments has required detailed planning and innovation under the expert guidance of SAEON's hydro-meteorologist Prof. Colin Everson.

The deployment was supported by Ezemvelo KZN Wildlife park managers, Mountain Rescue (Mountain Club of South Africa)

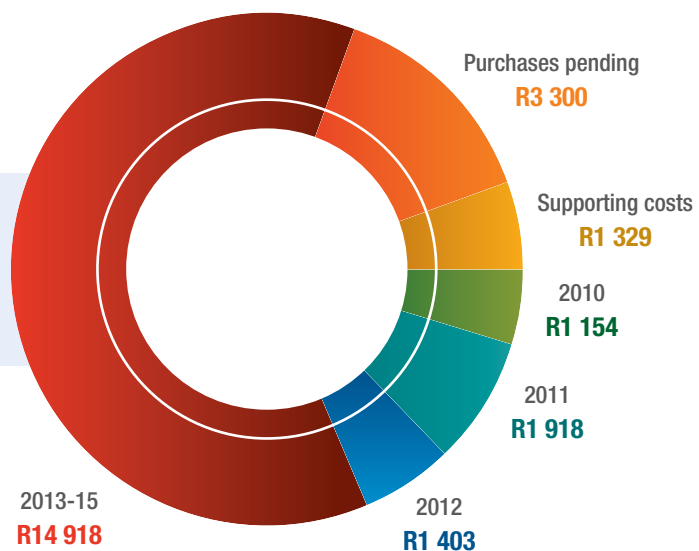
and aviation operators in the area. Aerial scouting had identified an ideal site on a rocky shelf at 3 000 m above sea level, but accessible only by helicopter or rock climbing with breathtaking views of the mountain range.

The weather station was installed on 6 August 2015 and is functioning well. This is the second weather station to be deployed in a high-altitude catchment in South Africa. The first was deployed by SAEON's Fynbos Node at 1 214 m above sea level on top of the mountain at the head of the Jonkershoek Valley. The automated weather stations are expected to provide in-depth understanding of changing environmental conditions in high-altitude environments.

Real-time data from Cathedral Peak are available online at: http://lognet.saeon.ac.za:8088/Mikes_Pass/index.html

INVESTMENT IN RESEARCH PLATFORMS

Equipment and research materials (R'000)



SAEON PLATFORMS: INTERNATIONAL RELATIONS

From its unique geographic position at the tip of Africa, SAEON is providing an array of infrastructure that is used by visiting local and international researchers. The network provides the distributed field laboratories and research sites necessary for ecosystem research, which are not always accessible in other countries. This capitalises on the global competitive edge that South Africa has, and enables valuable research opportunities and international partnerships.

ASCA – UNRAVELLING THE AGULHAS CURRENT

The Agulhas System Climate Array (ASCA) is an international oceanographic project with partners from South Africa, the United States of America (USA) as well as the Netherlands. Funding support is provided by the DST, the NRF, the Department of Environmental Affairs (DEA), the USA National Science Foundation and the Royal Dutch Institute for Sea Research. The array is designed to provide long-term observations of the Agulhas Current volume, heat and salt transport as well as its variability from mesoscale (eddies) and seasonal or interannual timescales.

April 2015 marked the inaugural ASCA mooring deployment cruise where the two shelf moorings and four of the seven tall moorings were deployed. The project has attracted international interest and recognition.

See www.asca.dirisa.org for more details.



POLISH COLLABORATION HELPS UNDERSTAND PLANKTON



Changes in ocean temperature, in conjunction with other impacts, are rearranging the distribution of species in the oceans. The Elwandle Node is engaging with the University of Szczecin (US), Poland, to investigate temperature as a determinant of diatom biogeographical patterns and ecosystem processes along the coast of South Africa.

This research focuses on how temperature arranges communities of benthic diatoms along gradients with localised disturbance. The physico-chemical environment is studied from long-term continuous underwater temperature loggers and from water column sampling during field work. Benthic and phytoplanktonic diatoms are being collected for identification using morphological and molecular analyses. The nutrient samples are analysed on SAEON's nutrient auto analyzer, whereas the expertise of identification of taxa is provided by the Polish partners.

WHAT HAPPENS TO DISSOLVED ORGANIC CARBON IN OUR RIVERS?

Natural streams in water catchments contain carbon (resulting from vegetation and soil metabolic processes) in the form of dissolved organic carbon. The increased export of this carbon from rivers to oceans as a result of increased global temperatures and human activities was initially seen as a means to sequester atmospheric carbon and mitigate against climate change. It is now perceived as a major threat to the overall functioning of natural ecosystems and to human health, due to induced water pollution, eutrophication and diseases. There is a crucial need to better understand the dynamics of dissolved organic carbon in river basins, including its production, transport and effect.

An NRF-funded grant between South Africa and France supports a project on dissolved organic carbon in mountain catchments. The grant enabled the French research partners to visit South Africa during April 2015 for field work at the Thukela mouth, joint meetings and capacity building.

The sampling and analysis performed will provide data and insights into the prevalence of dissolved organic carbon in our systems, and the role of natural systems and land management practices in carbon sequestration.



STARFISH WORKSHOP ATTRACTS INTERNATIONAL 'STAR'



In 2014 an internationally recognised expert taxonomist on Asteroidea (marine starfish) from the Smithsonian Institution, National Museum of Natural History (USA) visited the Egagasini Node. SAEON hosted Dr Christopher Mah, the first starfish taxonomist to work on South Africa's Asteroidea collection, through funding awarded by the NRF.

Dr Mah identified and catalogued the existing starfish collection housed at Iziko Museum and confirmed and completed approximately 40 descriptive starfish species pages of the SAEON offshore invertebrate identification guide. He also engaged with students and spoke at three public events that enabled broader engagement with the scientific community, citizen scientists, young school learners, educators and members of the public.



Some of the most exciting 'finds' from working through the collection include the re-discovery of some rarely seen starfish species (*Hymenaster lamprus*, not seen in South Africa since the 1930s), and range extension records of the rarely encountered deep-sea *Gilbertaster anacanthus*, *Calliaster mamillifer* (Indian Ocean) and *Glyphodiscus perierctus*, previously known only from the Pacific. Up to seven possibly new, undescribed species (and possibly one new genus) were recovered from historical collections from deep-waters off South Africa, specifically along the east coast. These new species are currently being described in collaboration with South African researchers.



FYNBOS NODE

Fynbos ecosystems and the properties of the species that live in them, provide a number of functions and products that are critical to society, including carbon storage, nutrient cycling, and the interception, retention and filtration of fresh water.

OVERVIEW

Fynbos ecosystems are under threat from a number of global change factors driven by human activities such as:

- Invasive alien species;
- Habitat transformation and fragmentation;
- Pollution;
- Changes in atmospheric CO₂; and
- Climate change.

These change factors impact on the processes and drivers that determine the assembly of ecosystems, altering their composition and structure, with consequent impacts on ecosystem function and the benefits provided to society.

Research platforms include:

- Constantiaberg HydroMet site;
- Jonkershoek HydroMet site;
- Cape Point vegetation plots;
- Elandsberg;
- Table Mountain National Park;
- Cape Peninsula fire plots;
- Hospital Bend HydroMet site;
- Baviaanskloof; and
- Cederberg (Engelsmanskloof).

The Fynbos Node is hosted by the South African National Biodiversity Institute at its research hub in the Kirstenbosch National Botanical Gardens.

Fynbos Node researchers aim to understand the impacts of global change in fynbos and how these will affect us by answering these questions:

- How does fynbos work?
- How are we changing fynbos and what it does for us?
- Why fynbos?

The fynbos region on the southern tip of Africa harbours plants and animals of immense diversity and distinctive character.

The unique flora are best known and have led to this area being declared one of six floral kingdoms in the world. The Cape Floral Region contains almost 9 000 plant species, and of these, two-thirds are found nowhere else. The fauna in the region is similarly unique, albeit for the most part less speciose. This region has a long evolutionary history, with both ancient and young lineages resulting in a hyperdiverse system of intricate complexity.

Jonkershoek stream monitoring

The Jonkershoek experimental catchment project was established in the mid-1930s to investigate the impacts of exotic tree plantations on water delivery by catchments. The Eersterivier has its source in a number of small catchments in the Jonkershoek valley. Six of these small catchments have been continuously monitored with water level data recorded hourly at V-notch weirs. Weather monitoring complements streamflow monitoring at Jonkershoek to help us understand the interaction between climate, vegetation and runoff. SAEON has been supporting this monitoring since 2007 and took over full responsibility in 2010. Since then old monitoring equipment has been replaced with electronic instruments that can relay data to the Fynbos Node offices.

For live weather data from Jonkershoek go to <http://www.saeon-fynbos.org/#!blank/clr8>



Nicky Allsopp
Node Manager



Jasper Slingsby
Scientist



Margaret Koopman
Data Librarian



Abri de Buys
Technician



Glenn Moncrieff
Postdoctoral Fellow



Julia Glenday
Postdoctoral Fellow



“The unique flora are best known and have led to this area being declared one of six floral kingdoms in the world.”



HIGHLIGHTS

Anatomy of a drought

The greater part of 2015 has been characterised by extensive drought in South Africa. SAEON has been involved in recording and documenting the extent of the drought through the rainfall data that are measured near Stellenbosch at a very special place in the history of South African meteorology:

In 1945, Dr CL Wicht of the Jonkershoek Forestry Research Station established a rain gauge at one of the highest accessible points in the Jonkershoek range at about 1 200 m above sea level to complement an existing network of rain gauges at various lower elevations. Rainfall amounts collected on a monthly basis, on foot, from this 1 200 m rain gauge provided one of the longest rainfall data records over a 45-year period until the early 1990s when regular data collection stopped.

Recently SAEON installed an automatic weather station at 1 214 m above sea level, very near Wicht's original rain gauge, to continue with these measurements.

Why are the rainfall figures from the SAEON weather station worrying?

The long-term average until 1990 for May, June and July combined (1 552 mm) is notably higher than the 2015 figures (909 mm). The rain is measured at the heart of the mountain catchments that supply the Berg River and Theewaterskloof dams with water. These dams are two of the most important dams which supply Cape Town and surrounding agricultural areas with water. Less rainfall means less water to the city.

The rainfall for the period April 2014 to March 2015 is among the five lowest rainfalls recorded in the period 1945-1990.

Historic rainfall and streamflow data in South Africa

In the 1930s, concern about the negative impact of plantations of non-native trees on streamflow, and counterarguments that trees brought rain to an area, led to the establishment of one of the world's earliest catchment experiments at Jonkershoek. Under the leadership of Dr CL Wicht, catchments were planted with pine trees or left as fynbos. Streamflow and rainfall were monitored in these catchments for many years before and after tree planting.

The results showed that afforestation reduced stream flow relative to fynbos. SAEON took over the monitoring network from the Council for Scientific and Industrial Research (CSIR) in Jonkershoek and Cathedral Peak. In the current era, the long-term streamflow and climate data provide key data on how global change is impacting our mountain catchments and the critical water resources they provide. SAEON now archives the historic data from the catchment experiments, following agreements with the CSIR.

Response of bird communities to habitat fragmentation in fynbos

Fragmentation of natural vegetation as a consequence of human activities is viewed as a major threat to biodiversity, since many processes that maintain systems (e.g. fire, visits by pollinators, and natural seed dispersal mechanisms) may be disrupted through isolation. The fynbos 'islands' of the Southern Cape comprise naturally isolated patches of vegetation communities in a sea of afro-temperate forest which arose early in the Holocene.

In a recent study, the University of Stellenbosch and SAEON investigated the effect that isolation, both of natural fynbos islands and artificially created fragments, would have on bird communities. Master's student Rory Sandberg visited both fragment types and compared the avifauna of these patches to 'mainland' Outeniqua Sandstone Fynbos.

Distance from the 'mainland' did not influence fynbos-typical bird species occurring on either natural islands or artificial fragments. Hence, the isolation distances in this landscape cannot be regarded as a generally limiting factor for bird movement. In most cases bird feeding guilds were similar on all three habitat types.

However, one species which is common on mainland fynbos, the Cape sugar bird, *Promerops cafer*, was not encountered on either natural islands or artificial fragments. Plenty of Proteaceae, the birds' diet, were in flower, so it seems that the aversion Cape sugar birds have for flying over non-fynbos kept them away. This may have implications for the persistence of members of the Proteaceae, since the Cape sugar bird is an important pollinator of these species. Other nectarivorous species did visit natural islands and artificial fragments, so this pollinator guild was not entirely lost.

Generalist feeding birds and granivores were more common on artificial fragments, possibly because of the wider range of non-natural and natural habitat types surrounding these patches and the higher likelihood of finding non-fynbos plant species. More fruit-eating birds were found on natural islands, possibly a response to fruit-bearing trees in the surrounding forest.

Artificially fragmented fynbos in this system seems to support fynbos vegetation and fynbos-specific birds effectively, compared to both natural islands of considerable age and mainland fynbos. Such fragments may serve as resource refugia and stepping stones for birds in the face of fire, alien plants and global change.

“Fragmentation of natural vegetation as a consequence of human activities is viewed as a major threat to biodiversity, since many processes that maintain systems may be disrupted through isolation.”





EGAGASINI NODE

Long-term measurements are essential to understand the impact of climate variability and global change on the oceans and their ecosystems, and vice versa. The oceans around South Africa play a key role in determining weather and climate patterns over southern Africa, and can also influence global patterns.

OVERVIEW

A greater understanding of our oceans, their ecosystems and the biodiversity therein will improve our ability to manage our resources effectively and sustainably.

To contribute towards this, the SAEON Egagasini Node for Marine Offshore Systems aims to continue filling the gaps currently existing in long-term ocean monitoring programmes in and around South Africa, as well as assisting with efforts to maintain existing programmes and initiatives. In addition, Egagasini continues to collate, digitise, archive and, most importantly, disseminate data. The node is also engaging with young learners, supporting and encouraging marine science postgraduates and capacity building, as well as working closely with school teachers, supporting and encouraging them in their efforts to incorporate marine science and long-term monitoring into the curricula.

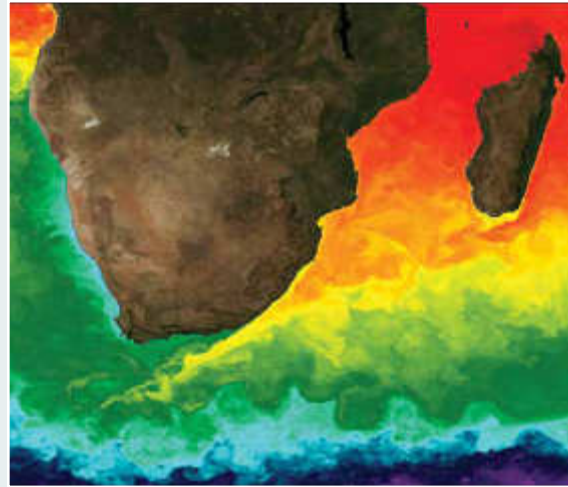
Research platforms include:

- Agulhas Current;
- Child's Bank, West Coast (trawl experimental closure);
- Offshore from Orange River mouth to Port Elizabeth (trawl invertebrate monitoring);
- False Bay (Monitoring and Modelling Consortium); and
- Prince Edward Islands.

The Egagasini Node for Marine-Offshore Systems is hosted by the Oceans and Coasts branch of the DEA, and also works closely with the Fisheries Branch of the Department of Agriculture, Forestry and Fisheries (DAFF). The node works with a wide range of partners to combine data, resources and knowledge of the oceans surrounding South Africa, their ecosystems and biodiversity, to comprehend and fully appreciate their role in climate change as well as the impact of climate change on the oceans' resources and dynamics. The node collaborates with relevant universities and supports a cohort of research students.

International context

The location of South Africa with respect to the global oceans – 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 weather patterns. The linking, therefore, of Egagasini with international ocean and atmosphere observation programmes becomes imperative. The Egagasini Node has a number of strong partnerships with international research institutions and conservation organisations.



Juliet Hermes
Node Manager



Lara Atkinson
Scientist



Tammy Morris
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Thomas Mtontsi
Education Officer



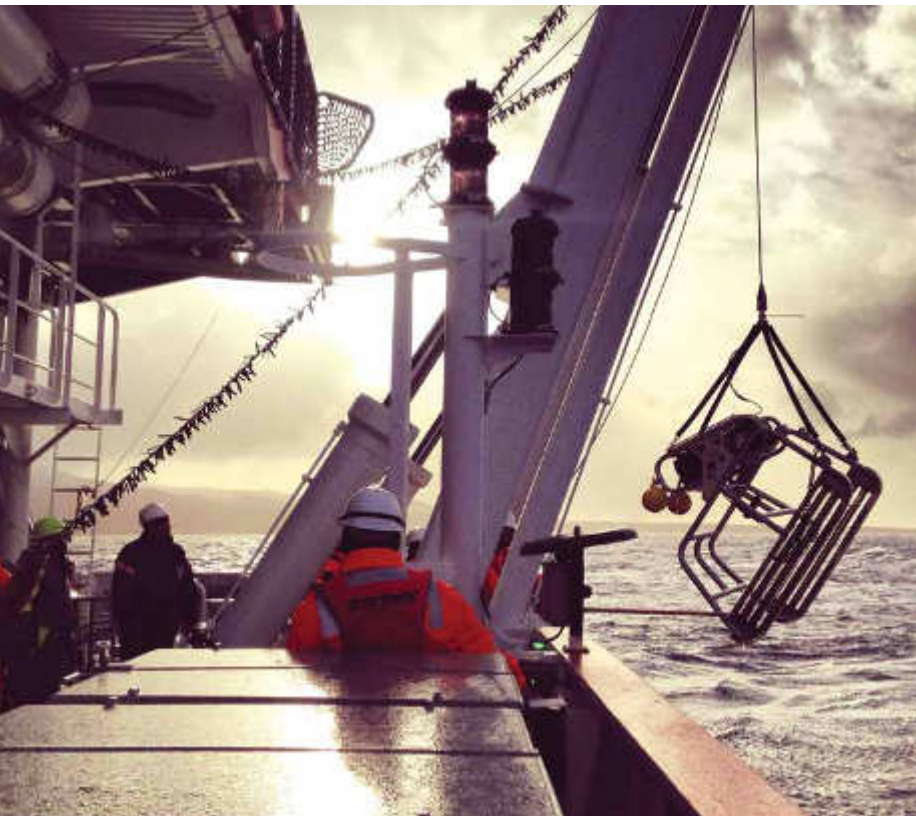
**Charles von der
Meden**
Postdoctoral Fellow



Charine Collins
Postdoctoral Fellow



“The oceans around South Africa play a key role in determining weather and climate patterns over southern Africa, and can also influence global patterns.”



HIGHLIGHTS

Assessing climate change effects in sub-Antarctic seabed biota

Southern Ocean ecosystems have experienced substantial temperature increases over the past 25 years and are reflecting dramatic effects of climate change. These effects, in combination with human impacts on continental shelf and deep-sea habitats, are poorly understood.

Invertebrate communities living on the seafloor provide important ecosystem services, and indirectly support commercial fisheries. Species composition of benthic communities have been shown to reflect changes in environmental conditions and are useful indicators of change. In 1988 Prof. George Branch and colleagues from the University of Cape Town photographed the seabed around the Prince Edward Islands. These slides were 'discovered' and archived by SAEON's postdoctoral fellow, Dr Charles von der Meden. This led him to join the 2013 annual relief voyage to the Prince Edward Islands to re-photograph these sites, using the recently acquired deep-sea camera system (SkiMonkey III). By comparing benthic community composition and spatial patterns after 25 years, this project aims to identify changes in benthic communities of the Prince Edward Islands.

Marion and Prince Edward islands serve as ideal 'laboratories' in which to conduct research to distinguish the effects of climatic-driven change from those driven by human pressures, since these island ecosystems are still relatively pristine. Additionally, the marine environment around these sub-Antarctic islands was declared a Marine Protected Area in 2013, further enhancing the value and importance of tracking changes in the region.

Twelve sites were re-surveyed with the SAEON SkiMonkey III camera (rated to 700 m depth) during 2013 and both sets of images (1988 and 2013) were digitally processed. Results from these snapshot surveys show significant changes in composition of the benthic community around the islands. Differences observed were primarily driven by density increases in suspension feeding and bioengineering taxa, specifically bryozoans and the polychaete *Lanice marionensis*. To improve our interpretation and understanding of these changes, biennial seabed surveys have been introduced. Since 2013, SAEON's sub-Antarctic research activities have grown to include larval ecology and several student projects, with graduation of one MSc student and two others in progress.

In addition to the contribution to climate change research, this project has ensured that the original 1988 photographs and metadata were digitised and securely archived for future long-term ecological research.

Surface drifters involving the next generation of marine scientists

As part of the ASCA project (see page 8), the South African Weather Service (SAWS) donated five satellite-tracked surface drifters to enhance the research being undertaken on the cruise. Satellite-tracked drifters remain on the surface, providing location data, sea surface temperature and barometric pressure data to passing satellites every four hours on average. These data feed back into the SAWS database for modelling and forecast purposes.

Drifters are autonomous research platforms that monitor ocean features (currents and eddies), providing a 'snapshot' image that can be combined with data from other moorings and instrumentation (including conductivity, temperature and depth casts) to create a time-series image of the features studied, as the drifter moves through the ocean.

To make the experiment meaningful to the next generation of marine scientists, an Adopt-a-Drifter project was initiated for schools working with the Egagasini Node's educational programme. Learners and teachers from four schools in the programme (Usasazo, Masiphumele, Sophumelela and Hout Bay High) met at the DEA's East Pier workshop where they were given a hands-on demonstration on drifters and how these work.



Each school had the opportunity to formally adopt a drifter by writing their names and those of their schools on the body of the instruments. Each instrument has a unique identification number, which enables the schools to follow their adopted instruments after deployment.

The ASCA cruise deployed the drifters along the transect in mid-April and the schools have been able to follow their instruments and learn more about the Agulhas Current and the oceanography around South Africa. The schools take an active role in tracking their drifters, so that these projects will open up the world of marine science to the learners.





ELWANDLE NODE

An estimated 60% of the world population live in close proximity to the coastline. Access to a variety of natural resources, passage, recreation and natural aesthetics are but a few of the many attractions. The manner in which climate change is likely to impact our interaction with, and dependencies on the coastal oceans, is a key question to be answered as we look into the future.

OVERVIEW

South Africa is likely to experience substantial climate change in the next decades, leading to a dramatic decline in biodiversity, altered climates, change in the physical properties of our oceans, sea-level rise and an intensification of extreme events. Our preparedness to address and mitigate impacts is improved as we upscale and enhance the ways we detect, understand and predict changes in the coastal environment. This, the SAEON Elwandle Node executes over the long term through several observation platforms widely dispersed along the coastline of South Africa.

Research platforms include:

- Algoa Bay Sentinel Site (incorporating St Francis Bay);
- National Estuaries Network (Kromme, Gamtoos, Swartkops, Kariega);
- National Coastal Temperature Network;
- Marine Protected Area (MPA) Network (Amathole, Tsitsikamma, Addo Elephant National Park);

- Sea-level rise RSET Network in estuaries (Swartkops, Kromme and Knysna); and
- Tufa Stromatolite LTER.

The coastal environment is the main point of interaction between humans and oceans. Coastal regions are physically altered as we establish cities, harbours, breakwaters and canals, while natural resources are exploited for recreational, subsistence and commercial purposes. Concerted efforts to manage human impact on coastal ecosystems effectively worldwide are muted by an ever-increasing demand for resources and services, and South Africa is no exception. Our 3 000 km coastline is intersected by six major metropolitan areas, each of which hosts at least one commercial port trading goods ranging from minerals and metals to consumables and harvested marine resources. As cities and industries grow, so do the many pressures they impose on the coasts they occupy. Consistently observing variation in key physical and biological attributes of the coastal ocean is one way with which our predictive capability of the

long-term implications of human interventions in these environments can be improved. For this purpose, SAEON's Elwandle Coastal Node in conjunction with the Egagasini Offshore Node and many partner institutions and agencies, set out to establish several long-term coastal observatories along South Africa's coastline.

The recent and continuous collapse of many reef fisheries has demonstrated that considerable gaps exist in our knowledge on how to optimise sampling design, monitoring protocols, and interpretation of large datasets. Over the past 10 years, research activities led by the MPA Unit of the Elwandle Node have identified the most suitable methods to monitor reef fish resources on the continental shelf of South Africa, while work is currently underway to establish suitable methods to survey subtidal reef invertebrate communities. In the past four years, SAEON and the South African Institute for Aquatic Biodiversity have been developing the Optical Platform which is available, in collaboration, to other research entities. The platform includes stereo- and mono-baited remote underwater video systems, jump cameras and a remotely operated vehicle. Future work is poised at expanding observation capabilities to depths of up to 600 m, which would greatly enhance our ability to observe these fragile ecosystems with minimal human interference.



Tommy Bornman
Node Manager



Shaun Deyzel
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Wayne Goschen
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Sean Bailey
Technician



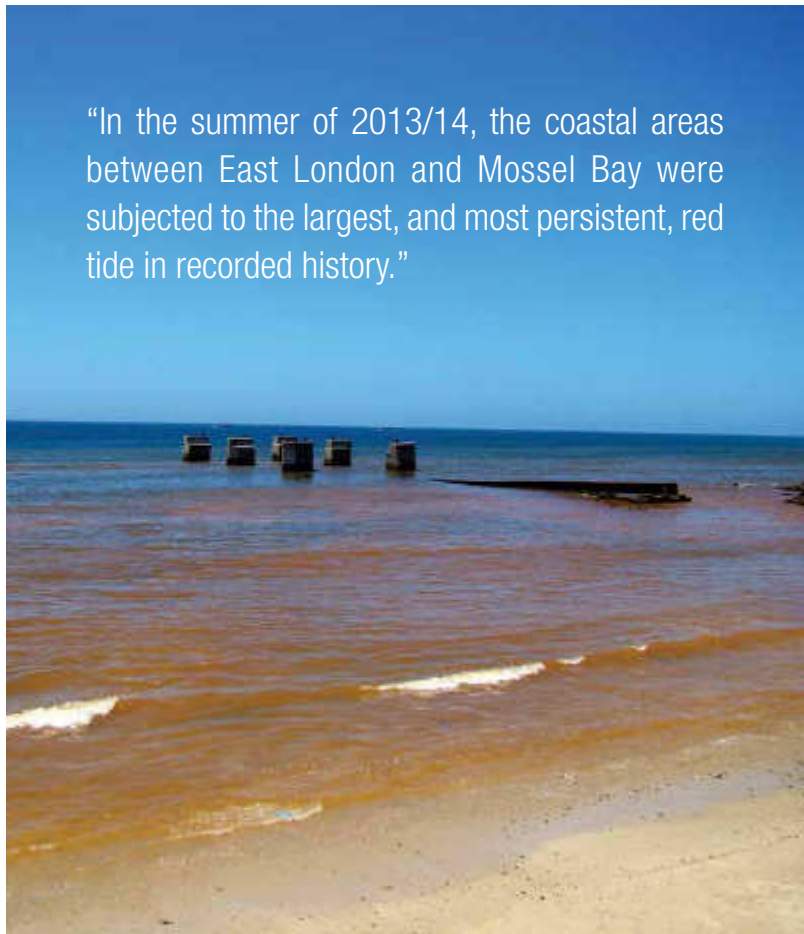
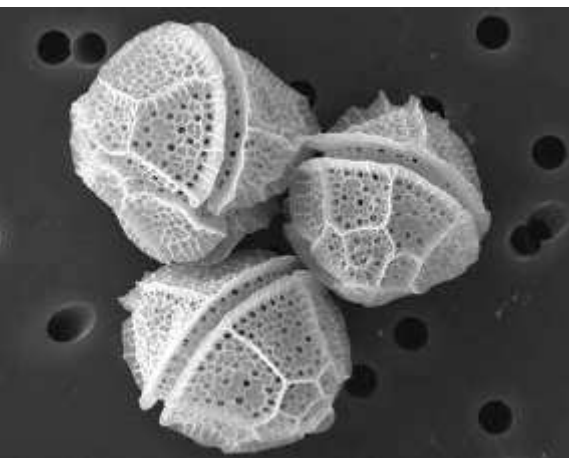
Elodie Heyns
Postdoctoral Fellow



Nozipiwo Hambaze
Education Outreach Officer



“Innovation and the smart use of technologies are key enablers of sustainable management of marine subtidal habitats.”



“In the summer of 2013/14, the coastal areas between East London and Mossel Bay were subjected to the largest, and most persistent, red tide in recorded history.”

HIGHLIGHTS

Examining the impacts of the largest continual south-east coast red tide in history

In the summer of 2013/14, the coastal areas between East London and Mossel Bay were subjected to the largest, and most persistent, red tide in recorded history. Red tides along the south coast are not uncommon, occurring once or twice a year, but this event was unique. Spatially the event covered close to 600 km of coast, lasted four months and was caused by an invasive dinoflagellate species that never before bloomed in South Africa. Samples collected by SAEON and the Nelson Mandela Metropolitan University in Algoa Bay over a period of three weeks in January 2014 confirmed the red tide was caused by *Lingulodinium polyedrum* (F. Stein) J.D. Dodge, which produces yessotoxins and is included in the IOC-UNESCO Taxonomic Reference List of Harmful Microalgae.

Marked deleterious effects on the marine life of the region were documented by several research entities. Low concentrations of dissolved oxygen resulting from decaying cells led to fish kills and

changes in the feeding behaviour of several top marine predators. African Penguins and Cape Gannets, for instance, had to travel much farther afield to forage for prey, putting at risk their young for extended periods as they fall prey to gulls while their parents are foraging for food. Subsequent analysis of plankton samples yielded evidence that the lower-trophic component of the pelagic ecosystem has undergone significant changes in response to the red tide. The predominance of copepods (the link between primary producers and upper trophic levels) was replaced by tintinnid ciliates, cladocerans and siphonophores.

Shifts in species composition have trophic implications. Copepods, especially the larger species, are vital links in the pelagic food chain as they feed on phytoplankton and microzooplankton and in turn become preyed upon by larger predators (e.g. anchovy). Their absence from the bay would have rendered this area an unfavourable feeding ground for their normal predators. The Algoa Bay pelagic ecosystem gradually recovered as the red tide subsided, but the dinoflagellate responsible is likely to remain present in the system in its dormant phase. SAEON and partners will continue monitoring Algoa Bay to timeously predict the return of such a harmful algal bloom should favourable conditions present themselves again.

A closer look at remote video methods for monitoring of fish in South Africa

Baited remote underwater video techniques were introduced to South Africa by the MPA Unit of SAEON Elwandle in 2006. Since then continuous development, technological advances and international collaborations have evolved their application in South Africa from simple tethered mono-camera systems to fleets of simultaneously deployable stereo-HD-camera systems.

The method has proven cost-effective and popular and, as a result, has been applied by many researchers and government departments with several thousand hours of underwater video footage collected in South Africa to date. Further advantages of the method are the high level of standardisation, data quality and the fact that video footage (raw data) can be archived indefinitely and re-analysed as needed.

At SAEON Elwandle alone, remote video methods have been the principal tool of fish assemblage and size structure data collection for two postdoctoral degrees, four PhDs, nine MScs and five BScs.

These video methods have resulted in numerous scientific publications and are tracing long-term resource trends that will continue to result in numerous scientific publications, providing important data to assist management entities in making informed decisions.





GRASSLANDS - FORESTS - WETLANDS NODE

The South African temperate grassland biome is important for the country's economy because of its size and agricultural value. Grasslands provide essential ecosystem services such as water provision, flood mitigation, nutrient cycling, soil retention, greenhouse gas mitigation (especially through efficient soil carbon storage), fodder production, recreation, and provision of consumptive goods. Forests and wetlands are features embedded in these grasslands.

OVERVIEW

Global change is impacting these ecosystem services but our understanding of this impact is limited and hampered further by uncertainty in predicting global change trajectories.

The SAEON Grasslands-Forests-Wetlands Node aims to reduce this uncertainty by developing platforms that enable change detection through long-term *in situ* observation. The observation systems comprise an integrated approach spanning biological, physical and biogeochemical components including feedbacks between these. This enables SAEON to conduct and support collaborations focused on process-level research on net effects, stimulating integration across disciplines.

Two platforms are being developed, one high-altitude area and one low-altitude coastal area. Within each of these we work in benchmark (pristine), degraded/transformed and restored sites.

Research platforms include:

- Mesic high-altitude system: Cathedral Peak, Two Streams and Okhombe; and
- Subtropical system: Maputland coastal plain – iSimangaliso Wetland Park and Vazi Pan area.

The SAEON Grasslands-Forests-Wetlands Node is hosted by Ezemvelo KZN Wildlife in Pietermaritzburg. Our vision is to provide researchers with cutting-edge global change research infrastructure platforms. The aim is to stimulate policy-relevant knowledge and build human capacity.

Little is known about the potential role of landuse-landcover change and biological feedbacks in earth system processes (e.g. changes in carbon cycling or radiative forcing with changes in land use, climate and vegetation). What is the net effect of these changes on ecological functioning and the consequences for ecosystem services essential for society? We want to identify the moderating or amplifying interactions between physical, biological and biogeochemical processes undergoing global change in South Africa's grasslands.

South Africa's water tower

South Africa is a water-scarce country. Soon demand is likely to outstrip supply, which may be exacerbated by global change. One of the largest areas of natural grassland in South Africa occurs along the Drakensberg mountains. These mountains are also the water tower for the country. Situated within the uKhahlamba Drakensberg Park, the Cathedral Peak Research catchments have climate and streamflow records dating back to the 1940s. They are thus ideal for assessing the effect of anthropogenic forcing on water delivery for the country. We began the reimplementation of historic monitoring efforts in 2012. Important biological, physical and biogeochemical components have also been added to the platform.



Sue Janse van Rensburg
Node Coordinator



Tim O'Connor
Specialist Scientist
(based at Grasslands-
Forests-Wetlands
Node)



Paul Gordijn
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Sphiwe Mjeka
Technician



Nicole Hagenah
Postdoctoral Fellow



Colin Everson
Hydro-meteorologist (based at Grasslands-Forests-Wetlands Node)

A living laboratory

The platform provides a living laboratory for a new generation of scientists to develop their skills, exposing them to multiple research disciplines. Providing an opportunity for young minds to work across silos, developing ways of integrating their research, is a key aim of the platform. We host students, university field trips, postgraduate winter schools, internships and technical workshops.





HIGHLIGHTS

Vegetation change: Local versus global drivers

Vegetation serves as an indicator of environmental influences. It is also a key role player in ecosystem processes. SAEON is attempting to dissect the individual and combined effects of key global change drivers of vegetation in the Drakensberg making maximum use of historic data and long-term monitoring. Aspects of global change of relevance to the Drakensberg include climate (temperature, precipitation), land use and transformation specific to the three main land tenure systems of the region, especially regimes of fire and herbivory, and increasing atmospheric CO₂ change.

A starting point has been to investigate the distribution of plant diversity, selected species, and C3 grasses in relation to climate and land use. Follow-up of 30-year-old data sets collected by Ed Granger in conjunction with analysis of changes evident on aerial photographs, is providing an opportunity to determine the influence of land tenure and use on vegetation change. SAEON has at its disposal a rich history of fire research concerning experiments maintained by Ezemvelo KZN Wildlife. One such example is the Brotherton Burning Trial at Cathedral Peak initiated in 1981. This trial has been surveyed by Terry and Colin Everson since its inception 34 years ago. During a resurvey in 2015, they passed

their knowledge on to SAEON. Demography of *Protea roupelliae* in response and subsequent to experimental burning is another study. These long-term studies not only reassert the importance of fire as a critical determinant of Drakensberg vegetation, but also demonstrate complexities of response not evident in short-term studies. Collectively these studies provide insights on the relative impacts of local land use, especially grazing and fire regimes, versus those of global drivers such as changes in temperature, precipitation, and increasing atmospheric CO₂.

Integrating the biological with the physical

There is little information in South Africa on the influence of terrestrial ecosystems on biosphere-atmosphere interactions and their impact on the earth system. Climate modellers require data on energy exchanges between the soil-plant-atmosphere continuum to develop surface models of carbon, energy and water in order to scale up from the different biomes in South Africa to regional and, ultimately, global scales. The important ecosystem services (including water) delivered by our ecosystems and their potential role in the long-term CO₂ uptake from the atmosphere and carbon storage is a key gap in South African research. The biological monitoring and integrated instrument array being developed at Cathedral Peak aims to address this gap in South Africa's key water tower. We invite collaborators and students to join us.

Students learn from Cathedral Peak research infrastructure observation platform

Since initiating work in 2012, SAEON has developed a unique integrated research infrastructure platform at Cathedral Peak, which has enabled several students to earn their degrees working on the platform.

Thigesh Vather completed his MSc on soil moisture, an important hydrological variable needed for a variety of applications, spanning numerous disciplines. He used the cosmic ray probe, an innovative and novel instrument for South Africa, which provides area average estimates of soil moisture by measuring the cosmic ray neutrons above the soil surface. His project focused on calibrating the system to provide spatial estimates of soil moisture.

Feroza Morris uses contemporary geo-statistical interpolation methods to provide improved estimates and understanding of the rainfall distribution across the Cathedral Peak catchments for her MSc. Her analysis shows a general decrease in the total daily rainfall and total number of rain days from west to east.

Sibusisiwe Majozi looked at changes between the historical (1949-1997) and short, current rainfall record (2013-2015), streamflow and temperature data. Her analysis indicated that historic rainfall and streamflow showed a declining trend (drier) and temperature-increasing trends (hotter). However, given the short current period of data used, these results are considered preliminary and must be viewed in that light, especially given the current dry conditions.

This work is made possible through collaborative partnerships and funding between the DST-NRF, SAEON, University of KwaZulu-Natal, Water Research Commission, ACCESS, USAID-PEER and DEA Natural Resources Management programme.





ARID LANDS NODE

The SAEON Arid Lands Node conducts observations on the ecological effects of global change and land-use changes across the hyper-arid to semi-arid western half of South Africa, where mean annual precipitation is 45-450 mm, and potential evapotranspiration exceeds precipitation 5-50 fold.

OVERVIEW

The area stretches across 500 000 km², encompassing the Northern Cape and parts of the North-West, Free State, Eastern Cape and Western Cape provinces. It includes five biomes, namely Desert, Succulent Karoo, Nama Karoo, Arid Savanna, and Karoo Escarpment Grassland.

Habitats include plains, rocky outcrops, escarpment mountains, sand dunes, ephemeral rivers, endorheic pans, and perennial rivers, including the Lower Vaal and Lower Orange Rivers. SAEON manages several sites and collaborates with other institutions in projects at different locations in this area.

Research platforms include:

- Tierberg LTER;
- SKA LTER;
- Karoo Grazing Trials LTER;
- Kompasberg;
- Karoo Escarpment Transects; and
- Lower Vaal and Orange Rivers.

The SAEON Arid Lands Node is hosted by the SANParks Conservation Services and Game Capture offices in Kimberley. Apart from offices for permanent staff members, the Arid Lands Node has a laboratory, archive room, and work space for visiting students and scientists. The node also has access to the SANParks herbarium and conference facilities, as well as affordable overnight accommodation for visitors. Since 2014, SAEON has been managing the Tierberg Karoo Research Centre in Prince Albert as Tierberg LTER.

SKA baseline study

The Square Kilometre Array (SKA) site is situated to the north of Carnarvon in the Northern Cape province. The SKA is ideally located in the central part of South Africa within the Nama Karoo biome. This area, known as Bushmanland, is largely unstudied and little is known of the biotic and abiotic elements present in the landscape. Additionally, the SKA is removing a large area of Nama Karoo from livestock production and placing it under conservation-oriented management. The SAEON Arid Lands Node is conducting baseline studies at the SKA core site and across the radio astronomy area across Bushmanland to:

- Increase knowledge and understanding of the Nama Karoo biome and in particular the Bushmanland;
- Monitor changes over time following cessation of farming and minimal disturbance after construction of the SKA is complete;
- Compare with peripheral areas still farmed; and
- Potentially compare with nearby future disturbed sites, such as shale gas mining or renewable energy developments.



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Node Manager



Helga van der Merwe
Scientist



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Ecologist



Tshililo Ramaswiela
Technician



Marco Pauw
Technician



Omphile Khutsoane
Education Outreach Officer

Did you know?

The world's longest running field grazing trials were initiated in the eastern Karoo during 1934 with sheep at Camp-6 by the Grootfontein Agricultural Development Institute (GADI). Several other trials were established and maintained over the years, and since 2011 SAEON joined GADI in the effort of archiving all existing data and periodic resurveying of the grazing trial paddocks, using the same techniques and apparatus used since the beginning. The data associated with these trials are of high value due to uniform and uninterrupted management of experimentally well-designed grazing trials, as well as accurate and thorough record keeping over the years. Rainfall has been increasing in the past four decades, and has shifted from late summer to early summer. Grass abundance and diversity is on the increase, as are the incidents of fire. Continuation of these trials facilitates the detection and interpretation of shifts in vegetation as part of global change.



HIGHLIGHTS

Perpetual pendulum: The brown locust

Populations of the Karoo brown locust, *Locustana pardalina*, periodically irrupt and cause damage and destruction to agriculture across southern Africa. Agriculturalists have kept records of their oscillations since 1797. The brown locust is one of the few surviving mega-herd phenomena, which periodically reshuffle things across the Karoo. In addition, scientists have identified a correlation between locust outbreaks and sea surface temperature patterns in the Indian Ocean. These factors are enough to indicate that the locust pendulum warrants observing, but surprisingly, we know little about the brown locust, besides its natural history.

Agriculturalists fear the collective consumptive power of billions of locusts, but have never actually compared the economic effects of all that consumption with the costly control measures. There is probably no other Karoo species for which so much money has been allocated by government continuously for over a century, not to improve understanding and conservation, but to destroy. Conservationists have been concerned with the impacts of repeated large-scale applications of insecticides on all Karoo biota, while they are amazed by the brown locust's incredible resilience. Biologists are intrigued by the complexities of different morphs of eggs, hoppers

and imagines, alternating in one species. Particularly puzzling are the complexly coded eggs of the locust's solitary phase, whose hatching appears to be triggered by very particular combinations, timing, and sequences of seasonal rainfall and temperature, a code that could be the key to the mechanism of population outbreaks.

Ecologists mention the locusts' presumed ecological roles in nutrient recycling (resulting from feeding, defecating and dying), but have not actually investigated this. Furthermore, locusts are thought to lend dynamism to food webs, with numerous predators tracking locust abundance cycles and movements. Although it is thought that locusts are keystone species, critical for the integrity of Karoo ecology, this remains to be clarified.

Alerted to the locusts' potential indicator value for global change and ecological integrity, SAEON is developing a locust research and monitoring plan based on a valuable 200-year long-term data record. This will take into account patterns of rainfall, drought and temperature across the Karoo, the abundance, cover, species composition, nutritional value and regrowth of grass in locust outbreak areas, the densities of locusts of the two morphs, movements of hopper bands, locust swarms, and their predators. The plan also entails comparing insecticide-treated areas with untreated areas.

Tierberg LTER – SAEON Arid Land Node's crown jewel

SAEON's acquisition two years ago of Tierberg LTER, comprised 100 ha of Karoo land along with a host of well-established ecological experiments. This scoop was accompanied by numerous sets of data and meta-data spanning up to 30 years, as well as a lengthy list of scientific and popular publications concerning the Karoo ecosystem, its structure, patterns and processes.

Data have been collected regularly or intermittently with repeat surveys capturing environmental change over time. The unique situation of the enclosed Tierberg (i.e. stock exclusion), adjacent to a farm currently grazed by sheep and cattle, and a horse farm that had been historically overgrazed, enables the comparison of these three land uses.

The responsibility of SAEON managing Tierberg includes providing accommodation; maintaining fencing and markers of experimental plots; extending long-term data sets by re-surveying experimental plots initiated in the 1980s and 1990s; initiating additional experiments to expand knowledge; coordinating research by visiting scientists; and the publication of scientific results of a high standard.

Tierberg has an outstanding reputation, nationally and internationally, and SAEON is building on this solid foundation by adding value through hosting researchers and projects.



Long-term data sets continue to grow and new research builds on this prior knowledge. The impact of various large-scale developments in the Karoo can be better understood using detailed insights gained from Tierberg.

40 years of data from Goegap Nature Reserve

The Goegap Nature Reserve (previously Hester Malan Wildflower Reserve) was proclaimed in 1966 and fenced in 1969 following the purchase of overgrazed farmland in Namaqualand. In 1974 a long-term monitoring project was initiated by the Department of Agriculture to record vegetation change following the removal of livestock and the introduction of game species.

Vegetation change was monitored using two line transects, 1 km (1 000 points) each in length, and has been surveyed annually by means of the descending point method for 40 years. This long-term data set showed an increase in vegetation cover, species richness and diversity as rangeland condition improved with time (over decades) and could be related to the removal of the high numbers of livestock and replacing these with low wildlife numbers in the first years of survey. Later a gradual decline in the rate of increase in some of these parameters could be seen, which was accredited to the higher grazing pressure by increasing wildlife numbers during the latter monitored years.





NDLOVU NODE

The scientific focus of the SAEON Ndlovu Node is to determine the causes of the major environmental changes occurring in the north-eastern part of South Africa, and predict the consequences of these changes for society.

OVERVIEW

Savanna ecosystems provide a range of services to society. These form the basis of:

- A large eco-tourism industry, centred on the aesthetic appeal of rare and iconic species and the wilderness landscapes that are found in the extensive conservation areas;
- A large game farming and hunting industry, which makes a substantial contribution to the national sector; and
- A significant contribution of natural resources to the livelihoods of millions of rural people (particularly fuelwood, forage for domestic livestock, food plants and insects, and medicinal plants). Furthermore, the full extent of the main savanna type (semi-arid savannas) may make a globally significant contribution to the regulation of the carbon and water cycles, and hence the global climate.

The SAEON Ndlovu Node aims to understand the ecological mechanisms which result in the above services, and to predict how changes in land use and the earth's climate are likely to affect them.

Long-term research is conducted in partnership with SANParks and a number of local and international universities, at sites in pristine, degraded and novel savanna ecosystems.

Education outreach is an important part of the node's work. Each year, three science camps are conducted, with a focus on high quality and repeated interventions for a selected group of learners and educators. School-based environmental projects are also conducted, as well as environmental awareness events with rural communities in the Phalaborwa area where the node is situated.

Current research themes are:

- Structural changes in savannas, with a focus on bush encroachment;
- Changing distributions, which investigates changes in the distribution of species and ecosystems, in response to global climate change; and
- The ecology and hydrology of savanna rivers, which aims to understand the impacts of river degradation.



Research platforms include:

- Greefswald Forest (Mapungubwe National Park);
- Haenertsburg;
- Lajuma (Soutpansberg);
- Letaba Exlosure (Kruger National Park);
- Letaba River Hydrological Observatory;
- Lower Olifants River;
- Makhushane and Mashishimale rural rangelands (Phalaborwa);
- Olifants West Private Nature Reserve;
- Palabora Copper Mine, including Cleveland Game Reserve and Pompey Game Farm;
- Malopeni Flux Tower (Kruger National Park);
- Pompey Game Farm;
- Raptors View Wildlife Estate;
- Satara Experimental Burn Plots (Kruger National Park);
- South African Wildlife College; and
- Welverdiend rural rangelands.



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Mightyman Mashele
Technician



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Education Outreach Officer



Marti van der Westhuizen
Administrator





HIGHLIGHTS

Letaba River Hydrological Observatory

Over-allocation of freshwater resources is a major social, economic and environmental problem for South Africa, and many other African countries. The severe drought of 2015 and 2016 has led to critically low flows in many major dams and rivers, but even in 'good years' flows of many rivers drop well below historical levels. While much is known about what determines the supply of freshwater in high rainfall catchments, little is known about rivers in the drier parts of the country. The amount of freshwater that makes it from water source areas in mountain catchments down to drier areas, where more water is taken out than put back in, is critical for massive areas of irrigated agriculture, millions of domestic users, and for maintaining biodiversity in major conservation areas.

To what extent does land use or land management affect the flow of rivers in these arid and semi-arid areas? And how is climate change affecting (or going to affect) the flow of rivers downstream of water production areas?

In collaboration with SANParks, the Department of Water and Sanitation, the University of KwaZulu-Natal, and the Water Research Commission, a long-term project has been established to quantify all hydrological processes linked to river flow in a semi-arid savanna. A stretch of the Letaba River, just upstream of the Kruger National Park, is the site for the initial phase. Related projects are investigating the determinants of flows in smaller, seasonal rivers that may be important for sustaining perennial rivers in the drier parts of their catchments.

Phalaborwa Land-Use Laboratory

While urban development destroys almost all natural biodiversity, many land transformations result in only partial losses of biodiversity.

Communal rangelands, small-scale cultivation, game farms and rehabilitated mine dumps are examples of modified ecosystems that, although different in appearance to the original natural systems, still retain significant biodiversity and deliver important ecosystem services.

Exactly how much biodiversity is retained in such land uses? How stable are these modified ecosystems and the ecosystem services they provide? Will they persist in the face of global climate change?

The Phalaborwa area provides a good location for addressing these questions, with a variety of common land uses within close proximity. In collaboration with SANParks and the Palabora Mining Company, a number of research projects have been initiated in the Phalaborwa area to determine states and trends in key indicators of biodiversity and ecosystem services.

SAEON PUBLICATIONS

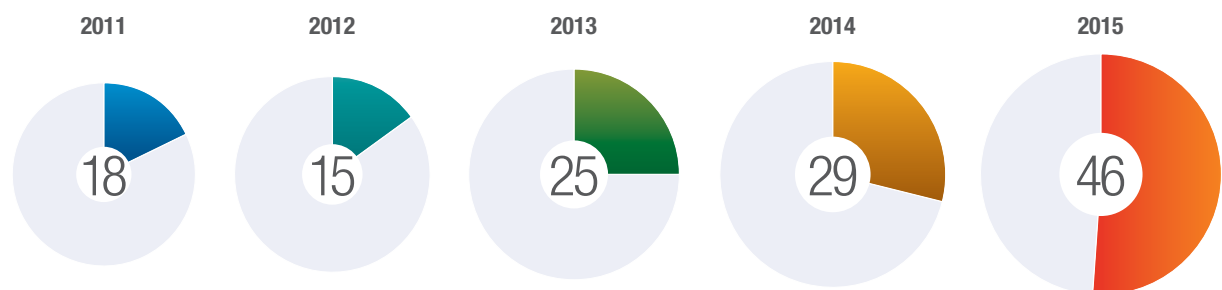
The currency of research is measured in publications and published research outputs. Through publications SAEON contributes to the global research landscape and strives to build a reputation for world-class science.

HOW ARE WE DOING?

DURING 2011-2015 SAEON PUBLISHED THE FOLLOWING:



SAEON ISI (WEB OF SCIENCE) PUBLICATIONS PER YEAR



For a complete list of SAEON publications go to <http://www.saeon.ac.za/projects-and-publications/scientific-publications>

Papers co-authored by SAEON staff that appeared in the leading journals *Science* and *Nature*

- Beal, L.M. *et al**. 2011. On the role of the Agulhas system in ocean circulation and climate. *Nature* 472: 429-436 (*Co-authors J. Hermes & T. Bornman are members of the IAPSO Working Group 136)
- Edgar, Graham J. *et al**. 2014. Global conservation outcomes depend on marine protected areas with five key features. *Nature* 506 (7487): 216-220 (*Co-author Anthony Bernard was a Postdoctoral Fellow at the Elwandle Node)
- Hempton, G.P.; Archibald, S. & Bond, W.J. 2015. A continent-wide assessment of the form and intensity of large mammal herbivory in Africa. *Science* 350 (6264): 1056-1061
- Midgley, G.F. & Bond, W.J. 2015. Future of African terrestrial biodiversity and ecosystems under anthropogenic climate change. *Nature Climate Change* 5: 823-829

Books and book chapters

SAEON staff have contributed chapters and/or have edited the following books:

- Atkinson, Jarre, Shannon, & Field. *Evidence for shifts in demersal fish populations on the West Coast of South Africa: 1986 to 2009*. In: Global Progress in Ecosystem-Based Fisheries Management. G.H. Kruse, H.I. Browman, K.L. Cochrane, D. Evans, G.S. Jamieson, P.A. Livingston, D. Woodby and C.I. Zhang (eds.) Alaska Sea Grant, University of Alaska Fairbanks. 2012
- Zietsman, L. (ed.) *Observations on Environmental Change in South Africa*. Sun Press, Stellenbosch. 2011
- Allsopp, Colville and Verboom. (editors) *Fynbos: Ecology, evolution and conservation in a megadiverse region*. Oxford University Press, UK. 2014
- Bornman, Atkinson, Bernard, Cowley, Deyzel, Goschen, Götz, Hermes, Hugo, Paterson and Von der Meden. *Long-term marine research platforms of the National Research Foundation*. Chapter 5. In: Reflections on the State of Research and Development in the Marine and Maritime Sectors in South Africa. Funke, N., Claassen, M., Meissner, R. and Nortje, K. (eds). Pretoria: Council for Scientific and Industrial Research. 2014.

SAEON's electronic newsletter

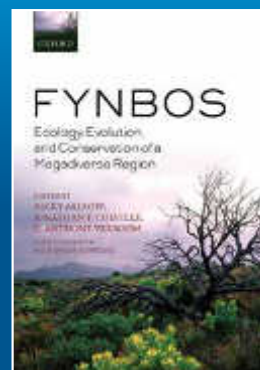
In 2015, *SAEON eNews* not only celebrated its 10th anniversary, it was also the runner-up in the "Best Electronic Newsletter" category of the South African Publication Forum Awards.

The newsletter scored a total of 87% and received a Certificate of Merit for excellence in writing, communication and design.

Subscribe to *SAEON eNews* online via www.saeon.ac.za



PUBLICATIONS



SUPPORTING POLICY



Prof. William Bond, Chief Scientist

CHANGE IS IN THE AIR – ARE WE READY?

A group of South African scientists led by SAEON's Chief Scientist, Prof. William Bond, have presented radical evidence of fundamental changes in African ecosystems, which threaten the future of our savannas and their wildlife. This is outlined in the publication *Change is in the Air*, which was launched at the first DST Science Forum in Pretoria on 9 December 2015, in a lively and stimulating panel discussion. This radical new view of how global change plays out in South African ecosystems is of wider relevance to much of Africa, which has the most extensive savannas of any continent.

Unlike in the northern hemisphere, the global driver that has the largest impact is not global warming, but increasing carbon dioxide in the atmosphere. Increasing CO₂, the scientists argue, is altering the balance of trees and grasses to favour trees – causing savannas to close up and form dense woody thickets. “Savannas were born under low atmospheric CO₂ and could disappear under high CO₂,” says Prof. Bond.

Indeed, simulation models designed for African vegetation predict that savannas will be replaced by scrub woodlands and thickets by the end of the century. Land users have long been aware of ‘bush encroachment’. Dense bush on one side of a fence and open grasslands on the other is a familiar indicator of the importance of land management in structuring our ecosystems. But where once we could blame the land user for mismanagement, we now have to blame the additional effect of a global driver, increasing CO₂, a by-product of industrialisation, promoting tree growth to a level never seen before. Increasing tree cover will have a profound effect on the water sources, which originate from the grasslands of high mountain ranges.

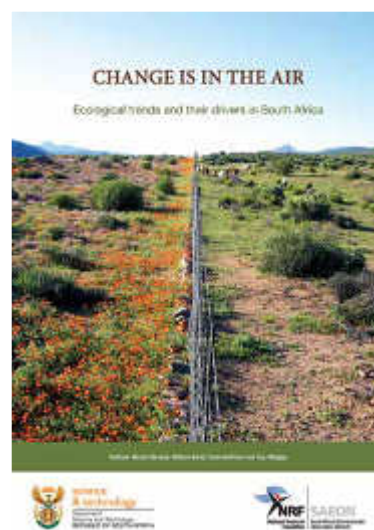
Ironically, while savannas and grasslands are turning into woodlands and thickets, the arid shrublands of the eastern Karoo are being invaded by grasses. For the first time, farmers have to cope with grass-fuelled fires as a result. Again, land management, through livestock farming, strongly influences the process but the shift to

grasslands is new and unexpected. The old tools, fire and herbivory, will not work in the same way as in the past, but radical new ways of using them are already being developed in South Africa.

The rise of trees also presents economic opportunities. Biomass burning, charcoal production and hardwood trees for high-value products need to be explored as new avenues for job creation. Tree invasion in semi-arid areas may also be turned into economic opportunity by developing the small livestock industry in poor rural communities, supplying livestock to urban areas and for export.

South Africa has an impressive track record of managing national environmental issues as seen in the analogous problem of alien invasive plants. We need to develop credible science, based on our wealth of long-term datasets to inform policies and actions relevant to South Africa's needs.

To download the booklet, go to [http://www.saeon.ac.za/downloadable-publications/Change is in the air_WEB VERSION.pdf](http://www.saeon.ac.za/downloadable-publications/Change%20is%20in%20the%20air_WEB%20VERSION.pdf)





OPERATION PHAKISA AND THE BLUE ECONOMY:

Exploiting broader research opportunities presented by offshore oil and gas exploration

One of the products of the Operation Phakisa Oceans Economy Lab report of 2014 was Initiative B3: “Exploiting the broader research opportunities presented by offshore oil and gas exploration”. The overall objective for Initiative B3 was framed as a desired outcome as follows:

By 2024, South Africa’s knowledge of its marine living natural resources, marine environment and ocean-related renewable energy resources is greatly enhanced through collaborative research with private sector exploration activities.

To realise this goal, SAEON was charged to create a forum which could facilitate collaboration between the oil and gas sector and researchers, namely the South African Marine Research and Exploration Forum. In the establishment of the forum, two workshops were held: A kick-start meeting in July 2015 to introduce the idea of the forum to researchers and industry and gauge the receptiveness of these communities to the creation of the forum, and the Research Sector meeting in September 2015, which focused on the types of research which could be addressed through the forum. Stakeholder engagements resulted in a decision that the forum should include representatives from other marine offshore industries, such as fisheries, tourism and mining.

The project team also produced documents to highlight the gaps and opportunities presented by collaborating with the oil and gas industry.

The Research Opportunity and Exploitation Report provided an assessment of the research opportunities that are currently available, and which could practically be exploited through collaboration with oil and gas exploration, and other private sector activities.

A website was established to provide updates on the project, provide access to the various reports produced and to provide a platform for the research community and private industries to indicate their research interests and any opportunities which may be available. <http://samref.dirisa.org/>



DATA

SAEON plays an increasingly active role in national and international forums that promote access to scientific and research data.



Internationally, SAEON is currently a member of, or has made contributions to:

- ICSU World Data System: Vice Chair of the Scientific Committee
- GEO (Group on Earth Observation) and GEOSS: Member of EuroGEOSS Steering Committee, participation in Architecture
- GEO BON (GEO Biodiversity Observation Network): Co-chair of Workgroup 8
- Research Data Alliance: Member of programme committee for Plenary 4, membership and/or chair in several working groups
- CoDATA: Session organiser for SciDataCon 2014, member of the Task Group for Preservation of Data in Developing Countries
- Belmont Forum: Working Group contributions
- Eye on Earth Summit, 2012: Participated in development of a White Paper.

A COMPREHENSIVE INFORMATION MANAGEMENT SYSTEM

In 2010, SAEON was contracted by the DST to provide platforms for SAEOSS (South African Earth Observation System of Systems) and SARVA (South African Risk and Vulnerability Atlas). This opportunity was used to create a 'shared platform', combining the meta-data aggregation and management functions, discovery functions, and visualisation/download functions required by these two gateways as well as by SAEON portal users.

As a result, a suite of components was developed to fit into an existing framework to support more sophisticated requirements. Simultaneously, the shared platform was converted over a period of two to three years to a service-oriented architecture. The conversion to service-oriented architecture had three benefits that were realised during the period under review. It firstly allows any broker or harvesting service to access the metadata records aggregated by SAEON across its contributing systems and stakeholders. Secondly, it allows stakeholders to make use of the shared platform in innovative ways, either by embedding stand-alone client components into their own web environments, or by calling services and processing the service outputs in their own systems.

Thirdly, it allows the rapid deployment of parallel portals and gateways based on the shared platform. As such it was used to develop a number of prototypes and operational implementations (BioEnergy Atlas, Network Centre for Socio-Economic Data in Africa, and community collaboration sites, among others).

Starting in 2014, SAEON became the first African member of DataCITE, allowing the creation ('minting') of Digital Object Identifiers (DOIs). Work has just been completed on automating this process, so that users who commit metadata to SAEON's shared platform are automatically able to obtain a DOI if desired. This capability is in support of an expected increase in demand for data publication and citation, not least because of the NRF's movement to open access publication for all grant-funded research.

SAEON's shared platform now hosts in the order of 23 000 metadata records, of which 2 300 data sets are available publicly.



OPEN DATA FOR OPEN SCIENCE

SAEON has established an open data platform for publication, discovery, dissemination, and preservation of earth and environmental data with funding from the NRF and the DST. This platform hosts several portals and gateways, including SARVA, SAEOSS, the BioEnergy Atlas, and SAEON's own data portal. In addition, it serves as a host for the South African Spatial Data Infrastructure (SASDI), and has been used for internationally funded exploratory work to establish prototypes for data management in the domains of biodiversity, human health, and socio-economic sciences.

The platform allows any number of harvesters (capable of brokering mainstream meta-data standards and service protocols) to be configured for any portal that it supports, and can automatically synchronise meta-data collections from as many contributors as needed, including the South African National Space Agency (SANSA) Earth Observation Data Centre. With the operationalisation of SASDI, this portfolio will hopefully grow to include most government departments. Over time, several research institutions and contributors have been added to the portfolio as and when required.

SAEON now operates significant physical infrastructure in its own right (up to 75 TB of online storage, split between operational, test, and fail-over/disaster recovery facilities), and the shared platform allows rapid deployment of new portals and gateways at low cost. SAEOSS serves as a gateway to GEOSS through the GEOSS Broker, exposing locally produced research outputs to a global user base, and in principle affording South African researchers access to globally available data sets.

The components for linking specific quality assured data sets to the ICSU World Data System (WDS) are also in place, and once other aspects of sustainability and governance have been addressed, portals within the shared platform can be accredited as members of the WDS. This accreditation serves as recognition by peers that the data platform is properly managed, serves quality assured data, and is sustainable.

Finally, the technical and licensing aspects of issuing data sets with DOIs have also been addressed, and researchers' identification via ORCID is in implementation. This allows data sets to be published internationally and for data sets to be cited reliably in scholarly publications. Data sets thus become formal scientific outputs that attract a citation index.

SAEON is also in collaboration with Data-Intensive Research Infrastructure for South Africa. This will likely result in additional benefits to the user community, including additional storage and fail-over capacity to become available in a private cloud and increased access to deposited data and digital content from universities and research councils.

For more information, go to:

- SASDI Act, <http://www.sasdi.gov.za/About/SDI Act.aspx>
- Group on Earth Observations – <http://www.earthobservations.org/index.php>
- <http://www.icsu-wds.org>
- <http://datacite.org>



SCIENCE EDUCATION PROGRAMME

Hands-on opportunities to participate in environmental monitoring projects can change young people's lives and inspire them to pursue a career in science. This is the philosophy behind educational outreach at SAEON where the emphasis is on the depth of the engagement, rather than on reaching large numbers of learners and teachers. In the past five years, SAEON's education programme has grown to active school-based intervention in four nodes, with regular intensive interaction with learners from 28 schools.



Some highlights of the programme are:

- Weather stations installed at targeted schools: The data are being used as part of the curriculum in maths and science. SAEON has developed a teacher and learner resource on the creative use of these data.
- Eskom Expo for Young Scientists: SAEON learners are encouraged and supported with their own research projects. At the national finals, SAEON adjudicates and presents a special SAEON prize to the best project with a monitoring approach.
- Science camps are held where young learners are given the chance to become scientists themselves and conduct their own mini-research projects under the guidance of SAEON researchers.

THE ELWANDLE NODE'S NURTURING JOURNEY WITH A TOP YOUNG ACHIEVER

Ntsikelelo Charles joined the Elwandle Coastal Node's education programme in 2011 when he was still in grade 9. He was one of the SAEON learners participating in workshops during Scifest Africa, which is held annually in Grahamstown. Having shown keen interest in climate change, he was supported to attend a COP17 activity at Rhodes University in the same year.

In 2012, Charles attended the Elwandle Node's science camp, which inspired him to enter a research project into the Eskom Expo for Young Scientists. He was awarded a gold medal at the Regional Science Fair, a silver medal at the International Science Fair and two bursaries to study science.

In the matric examinations of 2014, Charles scooped second place on the list of top achievers in the Grahamstown district, being the top achiever in the district's previously disadvantaged schools, with 94% in physics, 88% in life sciences and 82% in maths. He is a recipient of the prestigious SKA bursary, only awarded to 10 science and technology students in South Africa each year.

This bright young talent will be studying towards a BSc at Rhodes University and has chosen physics, chemistry, computer science and maths as his subjects.



SCIENCE CAMPS INSPIRING FUTURE SCIENTISTS



SAEON's annual science camps is the flagship initiative in the science education programme. Each year these camps provide an opportunity for specially selected grade 9-11 learners from local high schools in the regions of the respective SAEON nodes to participate in an environmental 'research' learning experience. Node scientists engage with learners in small-scale research projects aimed at stimulating their scientific knowledge and skills and promoting teamwork. It is in these camps that the foundation is laid for learners to conduct their own scientific research and hopefully pursue science studies post matric.

In addition, learners are introduced to careers in environmental sciences and are stimulated to identify their own abilities and career interests. Some comments from learners who attended these camps:

"Thank you SAEON for making this excursion possible, and thanks especially to our mentors for sacrificing their time to be stuck on a mountain with a bunch of annoying teenagers."

"We were camping on a mountain with valleys, hills and gorges, trees, plants and forbs surrounding us. It was an amazing experience to see our studies unfolding before our eyes."

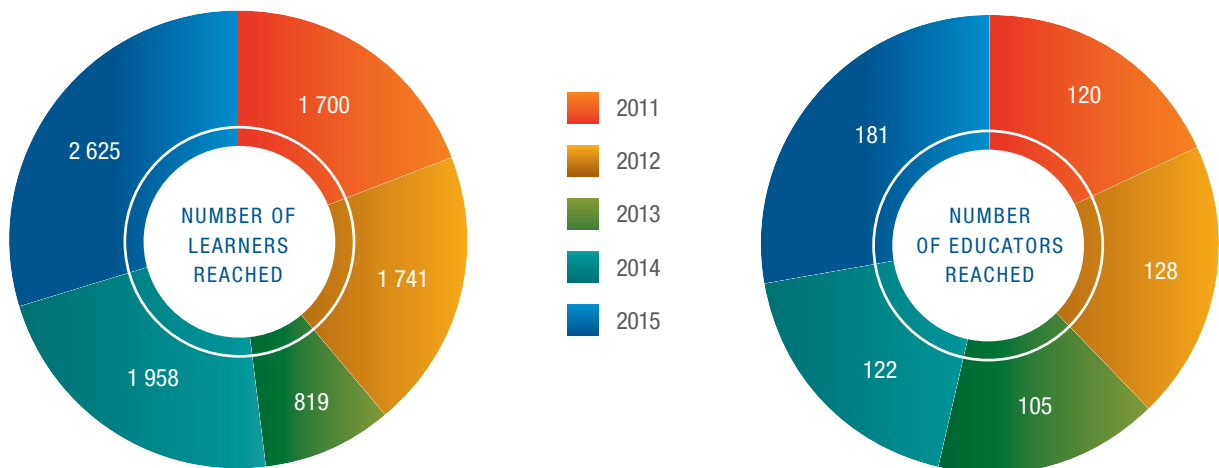
SAEON SCHOOLS WILL ALWAYS KNOW FROM WHERE THE WIND BLOWS

SAEON has provided automatic weather stations to several schools in the programme, to enable the schools to gather their own data and record weather conditions minute by minute, including rainfall, temperature, humidity and wind direction. The stations will provide real-time data at each school and learners will gain knowledge and experience in the collection and recording of data.

These school-based monitoring programmes reflect SAEON's vision of encouraging learners to pursue careers in science at higher education institutions by interacting with scientists and being motivated to work hard at their studies to qualify for further studies.



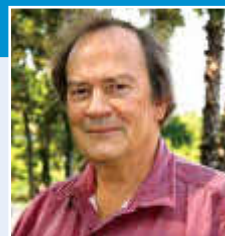
HOW ARE WE DOING?



STAFF HIGHLIGHTS

FOREIGN ASSOCIATE OF US NATIONAL ACADEMY OF SCIENCES

In 2014 SAEON's Chief Scientist, Prof. Wiliam Bond, was elected a foreign associate of the United States National Academy of Sciences, an honour conferred on the world's best scientists by their peers. In addition, he was among six South African NRF-rated researchers ranked by Thomson Reuters to be among the 3 000 most influential researchers around the globe. To top it he has received his fourth consecutive NRF A1 rating, the highest rating that a scientist can receive from the NRF.



DIVING UNDER THE ICE



Dr Albrecht Götz from SAEON's Elwandle Node participated in a nine-week expedition led by the Alfred Wegener Institute to investigate the abundance and distribution of krill larvae under the ice in Antarctica in relation to environmental factors.

Götz and two other South Africans (Sven Kerwath and Lutz Auerswald from DAFF) participated as collaborating members of the krill research scientific diving group led by Ulrich Freier. This was the first successful diving survey under the sea ice away from the continent in the Antarctic winter.

The resulting information will enable predictions of likely effects of environmental change (e.g. decrease of sea ice due to climate change) on the organisms under study and the response of the pelagic ecosystem to a shift in species composition. A documentary has been made of this expedition. Go to <http://dceff.org/film/license-to-krill>



KUDU AWARD

The annual Kudu Awards is an initiative of SANParks which rewards a select number of organisations and people who have made significant contributions to conservation.

Dr Albrecht Götz from SAEON's Elwandle Node was awarded the 2013 Kudu Award in the category 'Research, Initiatives and Innovations' for the Garden Route Section, in recognition of his high-impact research in the Tsitsikamma National Park Marine Protected Area. Through his ground-breaking research, he was the first to unequivocally demonstrate the broad ecological impacts of line-fishing on the marine offshore environment.



CREATING JOBS TO STRENGTHEN SAEON'S MONITORING EFFORTS ON THE GROUND

In 2013 SAEON engaged with SANParks to employ disabled and unemployed members of local communities bordering the Kruger National Park under the DEA's Expanded Public Works Programme. The monitors collect data on environmental variables at several sites to monitor land use, environmental health and use of natural resources. These staff members are receiving training in data collection and analysis, and have made a valuable contribution to the data holdings of SAEON. The data will contribute to a better understanding of ecosystem services in the Kruger to Canyons Biosphere region. At the same time the project contributes to skills development and empowerment of local villagers in science-related activities.



SAEON HONORARY RESEARCH ASSOCIATES

Most scientists generate more data than they can process and publish during the course of their career. They need a period post-retirement during which they can publish results and ensure that the programme can be continued by someone else. But to do this requires some degree of support, often lacking once retired. People employed in a non-academic sphere find themselves in a similar position. SAEON is well positioned to offer such support and accordingly, the idea of the SAEON Honorary Research Associates was conceived.



During the period ending 2015, SAEON is honoured to have appointed seven Honorary Research Associates, who will complement research at the nodes, by contributing decades of long-term monitoring expertise and data sets to SAEON, as well as mentoring SAEON's younger scientists and staff.

The Honorary Research Associates are:

- Dr Ed Granger;
- Dr Francois Smit;
- Assoc. Prof. Lisa Beal;
- Dr Sue Milton;
- Prof. Richard Dean;
- Prof. James Blignaut; and
- Dr Richard Lechmere-Oertel.

DEVELOPMENT OF NEW SCIENTISTS: POSTDOCTORAL FELLOWS

To date SAEON has hosted 10 postdoctoral students (six of whom are female) as part of the DST/NRF Professional Development Programme. These fellows form an integral part of the science teams at the nodes, and contribute by co-supervising postgraduate students, engaging in collaborations, writing publications and providing the diversity and energy that makes the SAEON nodes such dynamic scientific hubs.

INVESTING IN PEOPLE AND SKILLS FOR SAEON'S EXPANDING INSTRUMENT ARRAY



The members of SAEON's technical team provide a vital function for the monitoring platforms. Their work ensures long-term, reliable and continuous data collection across a range of fields – from biodiversity monitoring to hydrological and meteorological monitoring. The expansion of the current terrestrial instrument array, including sophisticated equipment for which skills in South Africa are fairly rare, provided the motivation for a special training workshop for the technical team. Technicians from four nodes came together for three days of hands-on training at Cathedral Peak, under the leadership of Prof. Colin Everson (SAEON hydro-meteorologist) and Sue van Rensburg (Grasslands-Forests-Wetlands Node Coordinator). Twelve participants were trained on equipment, logger programmes and relevant software. Database orientation and meta data standards were also covered. This was the first gathering of all SAEON terrestrial technicians and served as a motivator for closer team work and establishing a collective vision. Additional to up-skilling, recommendations on protocols and database systems management emerged from the workshop. These will be crafted into IT user requirements to be actioned to improve the SAEON data management systems.



STUDENTS

GROWING A REPRESENTATIVE SCIENCE AND TECHNOLOGY WORKFORCE

To contribute to an increasing pool of globally competitive environmental researchers, SAEON has several programmes and interactions with postgraduate students:

SAEON staff members not only supervise research students, they also lecture at universities and science platforms as part of formal university academic programmes. Nine SAEON staff members currently hold research associate positions at universities and one staff member obtained a research career award for a young scientist from the NRF.

Coordinated by the National Office, the Graduate Student Network (GSN) has been running as an ongoing project since 2006. The GSN is a membership-based body of students pursuing studies that have some bearing on the mandate and activities of SAEON. The aims of the body are to encourage students to align their research projects to SAEON activities, and stimulate and promote interactions among graduate students from different disciplines but with a common interest. The National Office funds the annual activities of the body, which consist of committee meetings, a website and an annual sponsored Indibano (conference) – always a highlight on the student calendar.

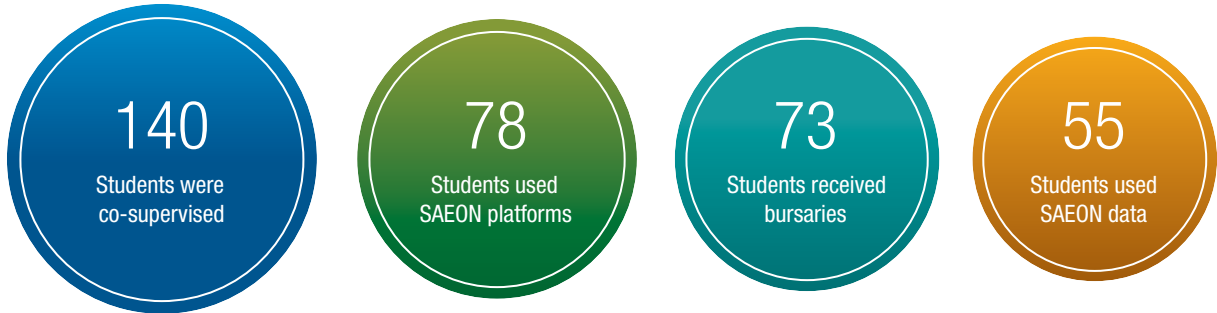
Through the GSN, SAEON is able to generate students' interest in using SAEON facilities and being supervised by SAEON scientists. Announcements of bursary and other student opportunities are distributed to the GSN. Exposure of this nature inspires young students to develop their scientific careers.

SAEON also participates in the DST-NRF Internship Programme. Interns are hosted at the National Office as well as at the nodes. Through this programme, SAEON offers an opportunity to unemployed graduates to obtain on-the-job training and experience workplace conditions. Interns undergo a structured programme to support them to become professionals. On completion of their internships, most interns pursue further postgraduate studies and remain associated with SAEON.

The DST-NRF Internship Programme has inspired young people to high goals of achievement through the dedicated training and guidance of SAEON staff. A SAEON intern was one of 15 women from around the world awarded a 2014 UNESCO-L'Oréal for Women in Science International Fellowship.

HOW ARE WE DOING?

From 2011-2015 SAEON supported a total of 151 students in the following ways:



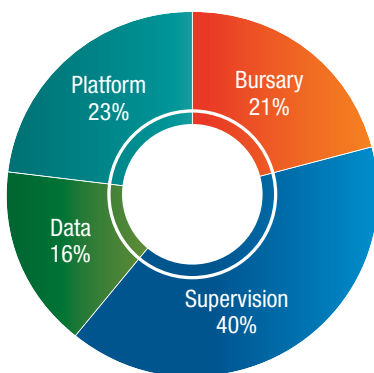
After graduation, 20 students continued their association with SAEON in their next degree.

During this period, SAEON contributed to the training of students at the following levels:

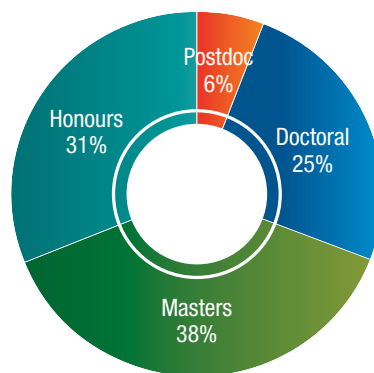


Of all students supported, 52% were female and 40% were black.

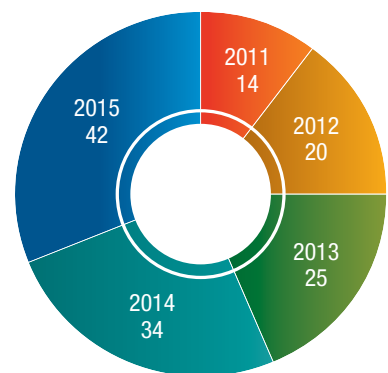
Type of support to students
2011-15



Academic levels of
SAEON students



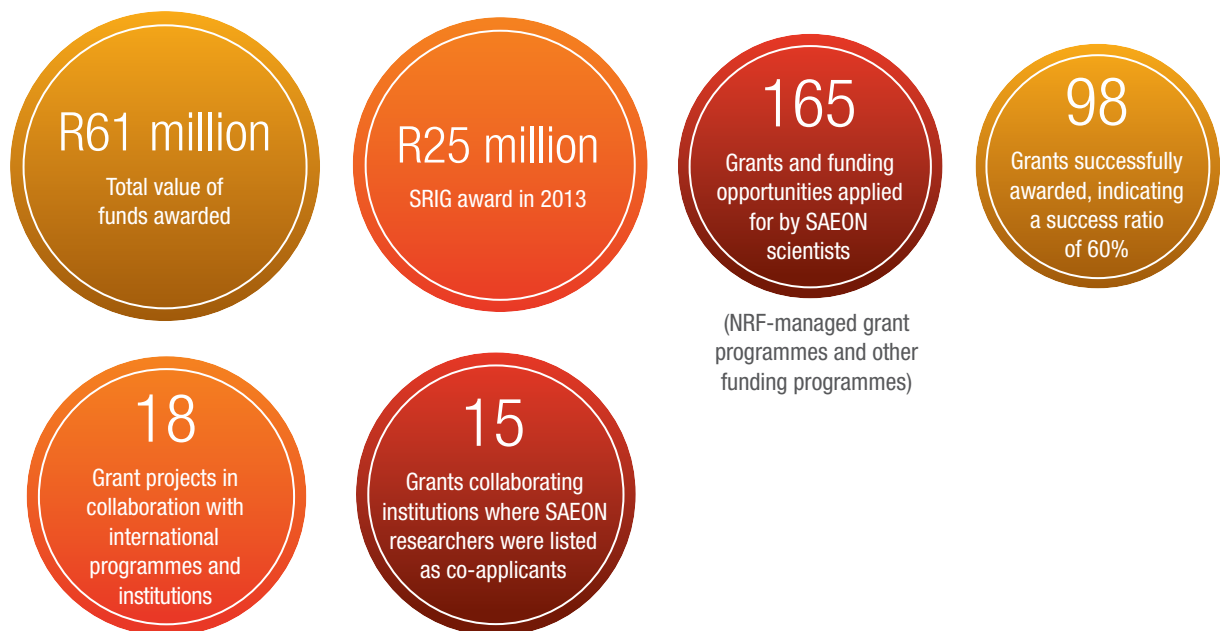
Number of students receiving
bursaries 2011-2015



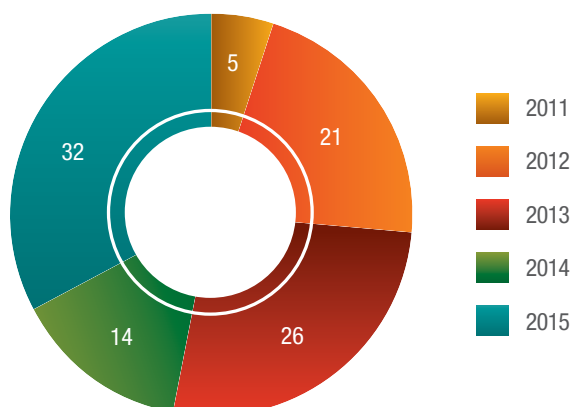
FINANCES AND GRANTS

SAEON relies heavily on additional funds and contracts to achieve all objectives. During the reporting period SAEON's activities were significantly boosted by external research funding. Furthermore, SAEON has engaged with partners such as the CSIR, DST and ICSU in large projects that supplement and enable high-scale collaborative projects.

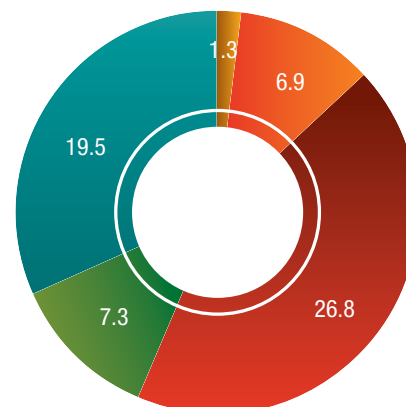
HOW ARE WE DOING?



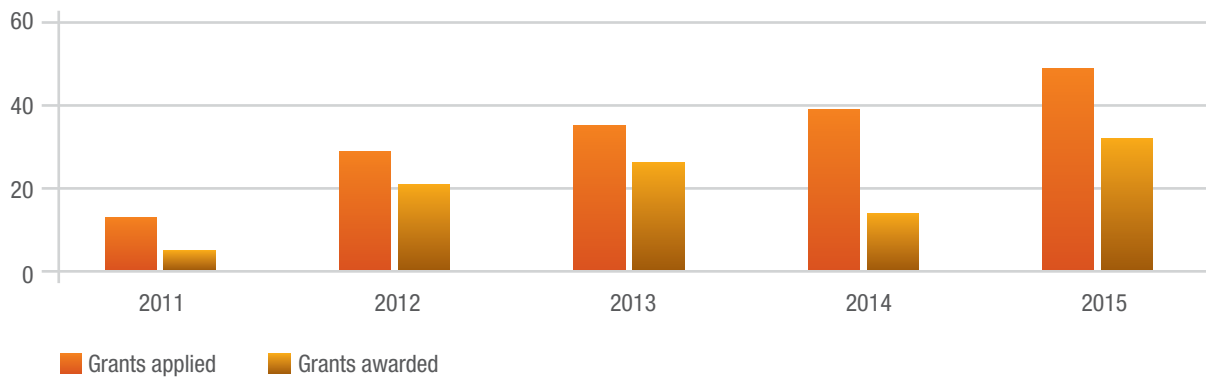
Number of SAEON grants awarded



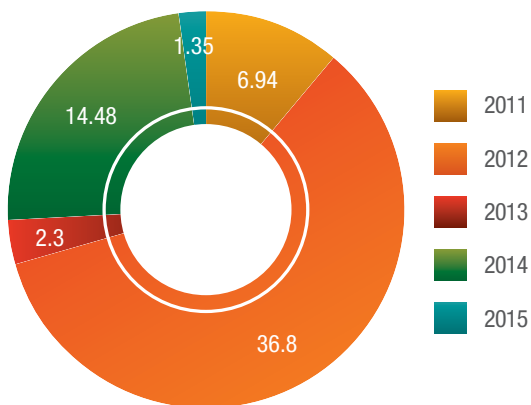
Amount of SAEON funds awarded (R'm)



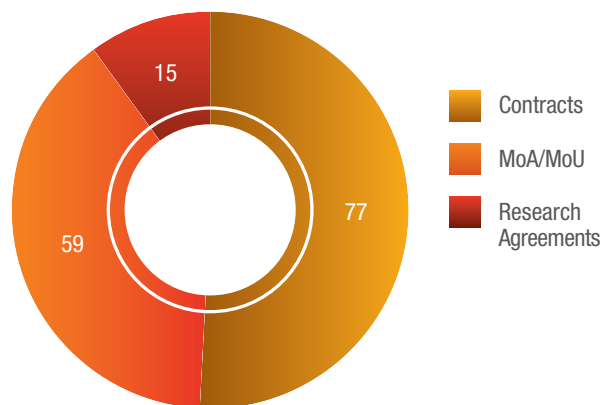
Total grant applications and awards



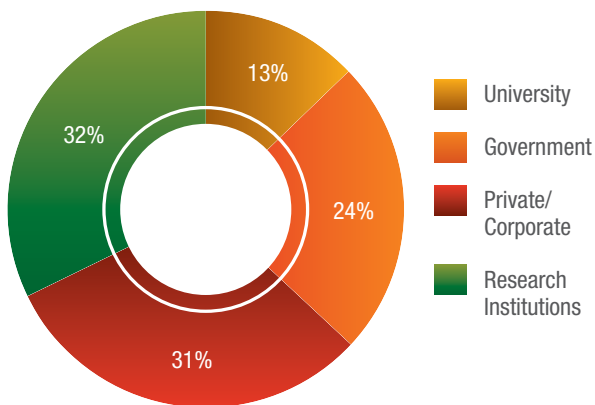
Funds earned 2011-15 (R'm) (excludes ASCA and other contracts)



Type of agreements 2011-15



With whom are the agreements?

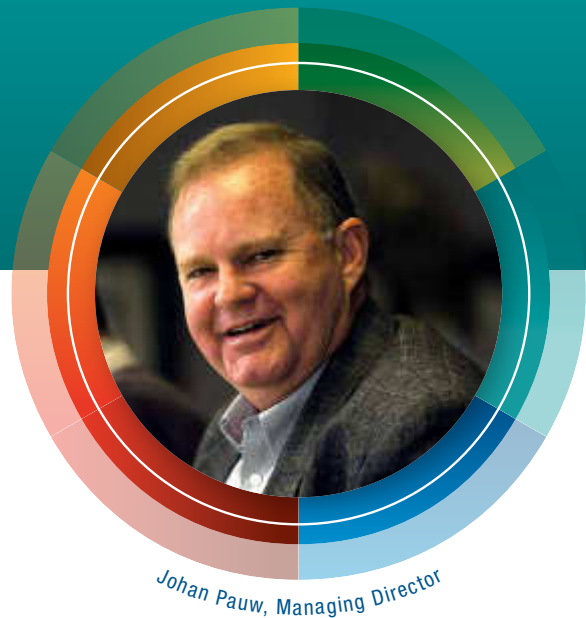


CLOSING REMARKS

SAEON is unique in South Africa as the only geographically distributed research organisation mandated by the South African government to establish multidisciplinary observation systems for terrestrial, coastal and marine systems over time and space. SAEON offers South Africa immense value by conducting research to understand the drivers and impacts of environmental changes and by providing longitudinal environmental data sets. The data are archived and used to inform decisions on sustainable development strategies.

SAEON is truly a network organisation that is entrenched in the science stakeholder community, while institutionalised within the NRF and DST. This is a particular advantage, because it allowed SAEON to have accomplished a distributed array of sites with permanent staff and a wide cohort of research collaborators. SAEON's past achievements form the foundations of a maturing and productive research organisation:

- A research platform with state-of-the-art research infrastructure that is starting to deliver.
- Collaboration across nodes as witnessed by the development of hydro-meteorological observations in terrestrial nodes, oceanographic modelling in Algoa Bay between coastal and offshore-marine nodes and joint estuarine research between coastal and terrestrial nodes.
- Approved plans for a rapid addition of research infrastructure which will further promote cross-nodal integration, for example in the proposed laying out of a flux tower network in terrestrial nodes.
- Leadership in developing nationally and internationally accessible and interoperable earth and environmental science information management systems and products to facilitate global change research and policy making.



- Wide collaboration and integrative initiatives in South Africa with universities, science councils and government institutions.
- Excellent links exist internationally at an organisational level and considerable international collaboration at individual researcher level.
- An approach to education-outreach which has added value to the education system by contributing to delivering quality learners, well-prepared for following a career in science.
- A steady contribution to the transformation of South African environmental science and associated disciplines. The pool of black and female research scientists available to SAEON is being addressed and enhanced through education-outreach, internships, the Graduate Student Network, support for honours-level students, bursary support for research students, offering research opportunities, offering student supervision and supporting postdoctoral research development.

Although SAEON is a comparatively young institution, barely 14 years old, it occupies a unique and irreplaceable niche in the South African research landscape.



SAEON management and National Office staff.

ACRONYMS

ACCESS	African Centre for Climate and Earth System Sciences
ASCA	Agulhas System Climate Array
CODATA	Committee on Data for Science and Technology, ICSU
COP	Conference of the Parties
CSIR	Council for Scientific and Industrial Research
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DOI	Digital Object Identifier
DST	Department of Science and Technology
EKZN Wildlife	Ezemvelo KwaZulu-Natal Wildlife Services
GADI	Grootfontein Agricultural Development Institute
GEO BON	GEO Biodiversity Observations Network
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GSN	Graduate Students Network
ICSU	International Council for Science
IOC	International Oceanographic Commission of UNESCO
ILTER	Long-Term Ecological Research Network
MPA	Marine Protected Area
NRF	National Research Foundation of South Africa
NRM	Natural Resource Management: unit in DEA arising from the Working for projects
PEER	Partnerships for Enhanced Engagement in Research
RSET	Remote sensing, environment and development
SAEOS	South African Earth Observation System
SAMREF	South African Marine Research and Exploration Forum (Part of Operation Phakisa)
SANParks	South African National Parks
SANSA	South African National Space Agency
SARVA	South African Risk and Vulnerability Atlas
SASDI	South African Spatial Data Infrastructure
SAWS	South African Weather Service
SKA	Square Kilometre Array
SKO	Square Kilometre environmental Observatory
UKZN	University of KwaZulu-Natal
WDS	World Data System
WRC	Water Research Council

ACKNOWLEDGEMENTS

Editor: Beate Hölscher, SAEON Research Administrator

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SAEON would like to acknowledge the following people for the use of their photographs in this report: Steve Benjamin (BRUV photos) and Gareth Hazell (Cape Sugarbird).

“It is on the strength of observation and reflection that one finds a way. So we must dig and delve unceasingly.”

Claude Monet

“Global change is already having an effect on southern Africa’s environment. South Africa’s commitment to global efforts to mitigate further change needs to be informed by a greater understanding of the limits beyond which change becomes costly or adaptation becomes impossible. We seek to build an understanding of how our ecosystems are changing, where that change is taking place and how rapidly the change is happening. We need to understand complex interactions that take place within ecosystems and how changing certain aspects will affect other aspects.”

10-Year Global Change Research Plan for South Africa, Department of Science and Technology, 2010



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