



SOUTH AFRICAN POLAR RESEARCH INFRASTRUCTURE (SAPRI)

FRAMEWORK FOR SANAP CALL

KNOWLEDGE ADVANCEMENT AND SUPPORT

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1. SAPRI STRATEGIC CONTEXT

The South African Polar Research Infrastructure (SAPRI) is designed as a consortium hosted at the South African Environmental Observation Network (SAEON), which has proven experience in managing infrastructures and will fast-track its set up and operations. The ultimate objective of SAPRI is to enable balanced research growth across the polar disciplines, and to maintain and further expand the world-class long-term observational datasets already established. In addition, SAPRI aims to transform the access to, and perception of, the South African polar regions for technicians, engineers, scientists of all disciplines, learners and students, government, industry, and civil society. The establishment of SAPRI is intended to elevate South Africa into a central role within the Antarctic space, with the produced science and international standing directly benefiting the governmental strategies for Antarctica and the sub-Antarctic islands. As a recognized Gateway Country, and the only African country represented in the polar regions, South Africa will further accelerate the implementation of the pan-African Science, Technology, and Innovation agenda, thus achieving the main imperatives of the National System of Innovation.

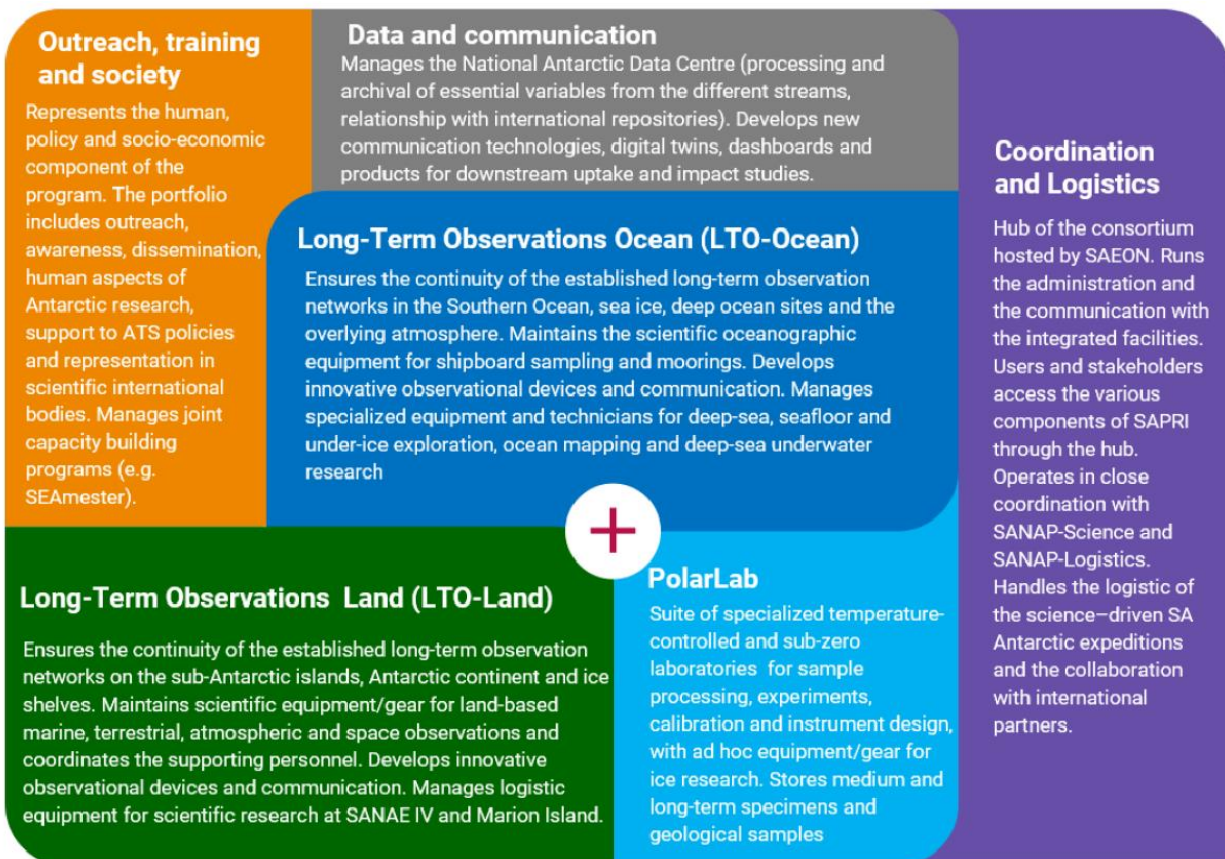
The SAPRI founding principle is to ensure that the investment in research infrastructures translates into the generation of science for the benefit of society, retention of capacity and international recognition of expertise. South Africa has a comparative geographical and historical advantage to study the Antarctic region and the polar sciences. As one of the first signatories of the Antarctic Treaty, and through the existence of the South African National Antarctic Programme (SANAP), South Africa is internationally recognized as an important contributor to Antarctic and Sub-Antarctic knowledge production. To build on this and ensure sustainability, the SAPRI represents a strategic step change in the coordination of national infrastructure for the polar sciences. This infrastructure coordination will enable a more favourable environment for innovation, research, and the development of human capacity. SAPRI forges close collaboration in marine and Antarctic sciences between the key role players from government, higher education, science councils, private business and civil society. The infrastructure and coordination offered through SAPRI will ensure integration of South African marine and Antarctic research, maximising knowledge production and uptake by facilitating access to existing and new infrastructures.

SAPRI is explicitly designed to provide the infrastructure required to develop and enhance long-term observations within South Africa's polar region, with the objective of ensuring continuous research growth, maintaining, and building on existing world-class long-term observational datasets and training the next generation of technicians, engineers, natural, humanities and social scientists. It will ultimately contribute to societal benefits and the strengthening of South Africa's Antarctic legacy through science-based advice to policy makers and international treaties and easy access to advanced data products for downstream utilisation.

2. OBJECTIVES

2.1 SAPRI STRUCTURE

The SAPRI, as a systemic innovation, will enable polar research through its integrated facilities (IFs), which are components combining various kinds of research infrastructures that share common objectives and/or logistical needs. Four IFs will be coordinated and connected through a hub, responsible for polar science logistics, data management and administration as shown in the figure below.



Data and Communication - dedicated to digital data transformation, product dissemination, training, outreach, and societal benefits.

Long-term observations - two of the three research-related SAPRI IFs are to ensure sustainability of long-term observations (LTO) on land, ocean, seafloor, atmosphere, and space, by means of a balanced combination of autonomous devices and dedicated equipment for fieldwork on the Antarctic continent and on the islands.

PolarLab - an innovation that seeks to provide new opportunities for ice-related research in Africa by establishing the first sub-zero, temperature-controlled laboratory for the simulation of the Antarctic and sub-Antarctic environments. Thanks to the Polar Lab, more students, scientists and technicians will be exposed to polar science and technology without the need to leave the continent and participate in

research cruises to Antarctica. These technologies represent a novel and innovative approach in thinking, which the SAPRI will develop to support new science on the continent of Africa.

2.2 PLATFORM RESEARCH OBJECTIVES

One of the key objectives of the SAPRI is to work with the Department of Forestry Fisheries and the Environment (DFFE): Ocean and Coast Branch and the SANAP community to unblock communication and logistics challenges and to assist with additional national and international research operations that may need to make use of the vessel or research bases. The interactions are intended to encourage open and effective communication and to establish close coordination between logistics operations and research operations in terms of time and space management. The work undertaken by the DFFE: Ocean and Coast Branch is imperative to the successful undertaking of the SAPRI.

Key service areas:

The SAPRI is meant to become the collating agent between SANAP-Science and SANAP-Logistics. The main services are framed in 4 main pillars of operations:

1. Polar research coordination and logistics
2. Sustainability of long-term polar observations
3. New infrastructures, innovation, and engineering
4. Capacity building in polar research for societal benefits.

Polar research coordination and logistics:

This set of services is currently distributed between SANAP-Science and SANAP-Logistics. The SAPRI aims to support the joint coordination of the SANAP-Science component and in the following:

- Endorsement of the logistic requirements of national and international scientific projects that align with the Antarctic and Southern Ocean Research Plan as defined within the context of the Marine and Antarctic Research Strategy (MARS);
- Dedicated office to coordinate the infrastructural needs of SANAP-endorsed projects (expedition planning, access to large infrastructure, equipment clearance, etc.), in close collaboration and agreement with the mandate of the SANAP-Logistics component and the Antarctic and Southern Ocean Strategy. This includes the support of a science Logistics Coordinating Officer.
- Access to facilities managed by the SAPRI and facilitating access to other national and international Research Infrastructures. This component will ensure equal distribution of SAPRI facilities among the endorsed projects beyond SANAP, as well as making instrumentation that is not deployed during the seasonal polar activities available for other existing research programmes in South Africa;
- Provision of specialised polar garments and gear for field expeditions in addition to the SANAP-Logistics stocks. This will complement the current service offered by SANAP-Logistics and will ensure the appropriateness of gear for scientific work.

Management of long-term observation networks and product dissemination

- Integration of science-driven existing polar observational networks of recognised scientific value and/or national interest long-term, ensuring economic sustainability;
- Management of designated long-term observational systems in terms of instrumentation, data communication, overwintering personnel, and coordination between institutional stakeholders (e.g., SAWS, SANSA, DFFE, SMCRI, SOCCO)
- Preservation of metadata, data, multimedia data and, where applicable, digital links to physical samples (stored in external, organised collections facilities) through the SAPRI data facilities;
- Dissemination of downstream data products (observational and model-based level 3 and 4 products), that have been proven scientifically effective and can be incorporated in the SAPRI data processing;
- Technical service that will support the maintenance and calibration of instrumentation using established standard operating procedures;
- Provision of equipment and technical support to assist in instrument deployment for observations including the deep-sea and the geology/glaciology of the Antarctic region.

New infrastructures, innovation, and engineering

- Creation of the first laboratory on the continent for the simulation of polar environments, the training of polar scientists and the design and testing of instruments and material for extreme conditions;
- Calibration and testing of instrumentation for extreme environmental conditions within the temperature-controlled facility. This service will be offered at minimal cost for the consortium partners and commercially charged to external customers (other international institutions and private companies);
- Preservation and storage of ice and geological samples at the temperature-controlled facility will be provided free of charge or at concessionary rates cost for the projects endorsed by SAPRI, and it will be offered to external customers at commercial rates;
- Establishment of an interdisciplinary team of engineers to support the development of new equipment and infrastructure for collecting data in polar regions and remote environments in general. This includes the design of new instruments and sensors for multidisciplinary research;
- Expertise in polar navigation and improved methods for designing polar vessels in maritime engineering with a specific focus on ice-going operations;
- Appointment of dedicated data scientist(s) to enable the remote transfer and archival of data by means of digital twin technology and Internet of Things communication;
- Coordination with the South African network of nanosatellites for the cost-effective transmission of real time and near-real time data to the national facilities;
- Coordination with the South African National Space Agency (SANSA), in support of space weather monitoring and forecast services to national and international partners.

Education and Training

- Given the multidisciplinary nature of the SAPRI, the possibility of training technicians, interns,

post-graduate students and employing postdoctoral researchers is substantial. Students from Honours/BTech to PhD/DTech are encouraged to take advantage of opportunities for capacity development. Students and interns will be trained from the development and creation of instruments through project management, observations, and modelling, in situ training (at sea or on the Islands/continent) all the way through to data quality, processing, archiving and interpretation. The SAPRI also supports students and interns being trained through DFFE and will continue to foster and grow the strong co-supervision model that is currently in place.

- The SAPRI encourages stakeholders or Principal Investigators to involve postdoctoral researchers in promising and growing projects to facilitate expansion and maximum impact in achieving research and human capacity development objectives. The SAPRI has a strong equity and redress agenda and will actively commit to recruiting female students and students from disadvantaged backgrounds by utilising programs such as SEAmester and supporting black academics at HBUs to access the SAPRI platforms.
- The SAPRI will actively encourage skills development of young technicians, engineers, and scientists about new technologies and industry-endorsed techniques and methods. These skills will provide an excellent complement to Operation Phakisa Ocean, a major Blue Economy initiative, that will increase the demand for skills in marine observations and highly numerate marine science applications to service developing operational capabilities such as the DEFF-led Ocean and Coastal Information Management System (OCIMS).
- The continued support of overwintering personnel at Antarctic and sub-Antarctic bases to facilitate skills development, life experience and research.

2.3 ESSENTIAL VARIABLES

The long-term observation of the following essential variables are a priority for the SAPRI. Activities addressing these essential variables will inform access to the SAPRI existing infrastructure and resources, and the investment into future infrastructure. Final approval of the use of SAPRI infrastructure and resources will be made by the SAPRI Governance and approval structures.

Ocean Physics Essential Variables (surface and subsurface):

Sea surface temperature, Sea surface salinity, Sea surface height, Sea state, Sea ice, Ocean surface stress, Ocean colour, Surface currents, Surface heat flux, Subsurface currents, Subsurface temperature, Subsurface salinity, and Ocean sound

Ocean Biogeochemistry Essential Variables:

Oxygen, Dissolved organic carbon, Dissolved Inorganic carbon, Nitrous oxide, Nutrients, Micronutrients, Particulate organic matter, Stable carbon and nitrogen isotopes, Transient tracers and their isotopes

Biology and Ecosystems within the ocean Essential Variables:

Fish abundance and distribution, Bird and mammal demography, abundance and distribution, Phytoplankton biomass and diversity, Zooplankton biomass and diversity, Hard coral cover and composition, Microbe biomass and diversity, Invertebrate abundance, and distribution

Terrestrial Essential Variables (lithosphere, hydrosphere, cryosphere, and biosphere):

Groundwater, Glaciers, Ice sheets and ice shelves, Permafrost, Snow, Above-ground biomass, Albedo, Evaporation from land, Fraction of absorbed photosynthetically active radiation, Land cover, Land surface temperature, Leaf area index, Soil carbon, Soil moisture, Rocks .

Atmospheric Essential Variables (Surface, Upper-air, Composition)

Precipitation, Pressure, Radiation budget, Temperature, Water vapour, Wind speed and direction, Earth radiation budget, Upper-air temperature, Upper-air water vapour, Upper-air wind speed and direction, Aerosols, Carbon dioxide, methane and other greenhouse gases, Clouds, Ozone, Precursor for aerosols and ozone

Space Weather Essential Variables:

Geomagnetic field, Neutron count, Very low frequency signal strength and phase, Ionospheric total electron count, Ionospheric convection, Ionospheric absorption, Ionospheric scintillation

3. RESEARCH PLATFORM DESCRIPTION AND LOGISTICS**3.1 PRODUCTS OFFERED**

Several products will be developed under the umbrella of the SAPRI, particularly in collaboration with small, micro, and medium enterprises (SMME). SAPRI will also encourage the patenting process of said products where possible but will not directly fund this. Based on the current capacity of South African partners, the following list gives an example of the products that SAPRI intends to make available to the research community in future:

- User-specific sensors designed for use onboard autonomous profilers such as Argo floats, buoyancy gliders and wave gliders;
- Drifting autonomous buoys to track sea ice movement and properties;
- Subsurface mooring designs developed for fast-flowing currents, sea-ice movement and ocean acoustics;
- Filtration systems for seawater used onboard ships and within laboratories to isolate either planktonic size classes or specific dissolved materials;
- Advanced animal tracking and monitoring technologies;
- Semi-continuous long-term observation platforms;
- Digital models for material response to wave and ice interactions and applications to maritime engineering;
- Long-term science-based data and value-added data products to support policy and outreach to society.

3.2 INFRASTRUCTURE AND PLATFORMS

SAPRI encompasses several stakeholders, partners, and entities, who are situated geographically across South Africa. Most notably in terms of physical space where infrastructure will reside and be worked with, the following spaces apply. SAPRI will facilitate access to and use of the following infrastructure on a best effort basis.

- **East Pier warehouse** - in collaboration with DFFE, several pieces of infrastructure will be stored here, prepared for deployment and maintained thereafter. Infrastructure to be housed here includes the container labs (if enough space available), mooring equipment and Argo floats. The exact space to be made available will be negotiated with DFFE. Should equipment required for terrestrial research in Antarctica not be housed at East Pier, warehousing could be facilitated through SAPRI to use NRF facilities in Cape Town.
- **The Southern Ocean Carbon and Climate Observatory (SOCCO) - South African Robotics Ocean Technology Innovation Centre (SA-ROBOTIC)** – This facility is managed by Sea Technology Services and is based at the East Pier. This centre houses the current SOCCO robotics programme, and other instruments including specialized Argo floats, Ski-Monkey camera systems and CTDs, not owned by SOCCO. STS also conducts innovative engineering research and development including high precision sensors, which open commercialisation opportunities.
- **SOCCO Experimental Observational Facilities** - SOCCO also comprises four experimental infrastructure facilities that provide ship and land-based observational capabilities: Ocean CO₂; Ocean bio-optics; Ocean Iron and GEOTRACES.
- **Drifter cage** - this small cage storage area houses SVP drifters received by NOAA and is also based at East Pier. The cage is maintained by the SAWS.
- **Polar Lab** - this innovative laboratory, once built, will be located at the University of Cape Town, and will become a shared space for recreating polar (ice) environments and temperature-controlled instrumentation work.
- **BIOGRIP facility** – this is a shared collaborative space for nutrients, isotopes, and general biogeochemistry analyses hosted by the University of the Free State.
- **Council for Geosciences** - for the storage and curation of geological samples, as well as the GIS facilities and expertise.
- **Seafloor facility** - this facility will be based at SAIAB in Makhanda. The team will develop and assemble the seafloor instruments in this lab and ship to Cape Town for loading onto the SA Agulhas II as necessary.
- **Digital Antarctic facility** – this facility is initially focused on the SA Agulhas II and will be expanded to the other platforms. All digital assets (detail data, raw models, reduced order models) will be housed at Stellenbosch University, including their data and models. This laboratory will further function to calibrate all sensors related to the SA Agulhas II full-scale instrumentation and her scale models.
- **SMCRI Laboratory** - as a partner to the SAPRI, the Shallow Marine and Coastal Research Infrastructure (SMCRI) facility, hosted by SAEON on the Ocean Sciences Campus of the Nelson

Mandela University, is a collaborative space. There will be a sharing of instruments, particularly for the Prince Edward Island work, but also of technicians, sample analysis (nutrients, salinities, microplastics, heavy metals, plankton), etc.

- **MRI Isotope laboratory** - the Mammal Research Institute isotope laboratory at the University of Pretoria is a collaborative space to integrate isotopic research from various SAPRI projects.

3.3 RETURN ON INVESTMENT

The SAPRI founding principle is to ensure that the investment in infrastructures translates into the generation of science for the benefit of society, retention of capacity and international recognition of expertise. Polar research is built on infrastructures of various sizes, which result from several investment cycles and are custodied by different players. Given the nature of Antarctic expeditions, the return on investment is maximised if several platforms are exploited at the same time for operational and scientific needs, from large facilities such as ships and bases, to medium facilities such as land-based laboratories, ship-based container laboratories and supply vehicles, down to individual field gear.

SAPRI will be an implementer of the governmental strategic initiatives (MARS and ASOS) and will provide a channel to coordinate SANAP-Logistics and SANAP-Science, harmonizing infrastructure management. This will contribute to rationalizing the distribution of costs between public entities and their relative lines of funding for the benefit of the South African investment to maintain a presence in Antarctica. The investment in a focused set of RI platforms for polar research will release the infrastructural cost from the academic funding cycle and individual science-related projects. The main benefits include:

- The possibility to share platforms among various partners beyond the duration of each project.
- The rationalisation of infrastructural maintenance costs through a centralised system.
- The related redirection of core academic funding from infrastructural costs towards research-based applications.
- The enhanced investments that would stem from historical investments in marine and Antarctic research infrastructure.

SAPRI represents a durable infrastructural pillar that will ensure a more rapid integration of the science components on the backbone of a functioning research infrastructure.

SAPRI will represent a local incubator of small, micro, and medium enterprises (SMME), specifically in remote technologies. SMMEs can access services, equipment, and support in product/technology commercialisation. SAPRI supports the transformation of the demographic ownership profile of these technology-based firms.

SAPRI also serves as a hub for international communities. The cohesive approach will unlock other potential funding sources from international bodies or enable possible quid pro quo type exchanges.

4. NEW INFRASTRUCTURE AND PLATFORMS

In the short to medium term (Phase 1) of SAPRI implementation the following infrastructure acquisitions are planned. As the acquisition of these infrastructure is largely dependent on budget and procurement processes, SANAP PI's should not depend on the availability of the infrastructure for the success of their applications. SAPRI also reserves the right to defer some acquisitions and prioritise others.

Item	Short Term	Medium Term
Multi-beam echosounder		X
Wave Radar		X
DIGSAA Vessel racks	X	
SOCCO Contract (STS)	X	
GAW installation on vessel	X	
PCO2 refurbishment on vessel		X
Floats, drifters, sea ice trackers	X	
Sub-zero polar container lab	X	
Benthic instruments	X	
Vessel refurbishment items (sensors, laboratory benches, etc.)	X	
SOCCO items (batteries, sensors, etc.)	X	
Terrestrial and polar field gear (tents, sleeping bags, etc.)	X	
Terrestrial field refurbishment		X
Marion Island tags (mammals)	X	
Mooring infrastructure	X	
SAPRI Data Centre	X	

5. GENERAL GUIDING PRINCIPLES

SAPRI should not be viewed as an alternative funding source for SANAP related research. The intention of SAPRI is to complement SANAP by providing infrastructure for funded research. These infrastructures are

to be accessible to all researchers and not just one specific project. This therefore implies that the usefulness of the infrastructure will not be determined by the duration of a specific project. PI's should also remember that SAPRI is not a competitor to SANAP or DFFE. It is a programme which facilitates and ensures efficiency in availing the necessary infrastructure for Marine and Polar Research.