

NATIONAL STATE OF THE ENVIRONMENT PROJECT

ANTARCTICA AND ISLANDS

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A SHORT HISTORY

South Africa's formal association with the Antarctic Continent can be said to have commenced in January 1960, when the first South African National Antarctic Expedition (SANAE) took over Norway Station near the edge of the ice shelf in Dronning Maud Land (Cooper and Headland 1991, La Grange 1991a). Earlier than this, however, a few South Africans had accompanied Antarctic expeditions of other countries, most notably the Commonwealth Trans-Antarctic Expedition of 1955 to 1958 (La Grange 1991b). Prior to that, indirect involvement came from Cape Town acting as a port of call for a number of expedition vessels from the heroic age of Antarctic exploration, soon after the start of the 20th Century (Cooper and Headland 1991). The original Norway Station (renamed SANAE I), has been successively replaced over the years, and South Africans currently occupy SANAE IV, an above-ground station away from the ice edge at Vesleskarvet, an isolated rocky nunatak in the northern Ahlmannryggen.

South Africa annexed the sub-Antarctic Prince Edward Islands (Marion and Prince Edward) in the southern Indian Ocean in 1948 and has occupied Marion Island ever since, with annual teams conducting research into the natural sciences and gathering meteorological data at a well-equipped base in Transvaal Cove (Cooper and Headland 1991). This base is now being replaced by a modern complex of linked buildings, due to be finished in 2007. The smaller Prince Edward Island is rarely visited and has no permanent structures. A meteorological base has also been run since 1957 by South Africa on Gough Island in the South Atlantic, an island that forms part of the United Kingdom Overseas Territory of Tristan da Cunha (Cooper and Ryan 1994).

Over the years numbers of South African scientists have conducted research at all three South African National Antarctic Programme (SANAP) bases, many earning higher degrees in the process. Research has concentrated on life sciences, earth sciences and physical sciences, the last mainly studies of the upper atmosphere (Cooper and Ryan 1994, Newton *et al.* 1994, Hänel and Chown 1998). Additionally, oceanographic research in the Southern Ocean has taken place from time to time from South Africa's Antarctic supply vessel, the *SA Agulhas*, some as part of international programmes (e.g. Lutjeharms 1991, Miller 1991).

A DESCRIPTION OF THE ENVIRONMENT

Geomorphology and geology

The nunataks of Dronning Maud Land are small outcrops of exposed rock in a sea of ice. Vesleskarvet (which means small cliff in Norwegian) is 858 m above sea level and has an exposed surface of 22.5 ha, with 200-m high cliffs on the northern aspect dropping into a wind scoop (Steele *et al.* 1994). The rocks of the nunatak are igneous, in the form of large frost-shattered boulders.

In direct comparison, the Prince Edward and Gough Islands are volcanic islands that have never been connected to a continent. Marion (290 km²; highest point 1230 m) is still active with occasional eruptions occurring, the last of significance in 1980 (Verwoerd *et al.* 1981). Prince Edward Island, 21 km away, is smaller at 45 km². Landforms are the result of two phases of eruptions: grey lava, now well eroded, and more recent black lava, with many scoria cones, often containing crater lakes (Verwoerd 1971). Gough (65 km²; highest point 910 m) is the remnant of a long-extinct volcano (Cooper and Ryan 1994), and there is little unvegetated lava, in comparison to the Prince Edward Islands. Much of the island is covered with peat (except the upper reaches of Marion where there is a shrinking ice cap within an extensive unvegetated area). In the lowlands of the Prince Edward Islands and upper areas of Gough there are extensive areas of swampy ground.

Climate

Although all three SANAP bases are likely to be associated in the public mind with a cold, inhospitable climate, they occupy different biogeographic zones and their climates differ markedly. The Antarctic climate is well-known: cold, dry (low humidity due to low temperatures, with precipitation falling as snow, not as rain), and with a summer in which the sun does not set, and a winter when it does not rise. Detailed climatic data at ground level for a nunatak near Vesleskarvet named Robertskollen showed winter air temperature dropping to a minimum of -33.6°C and rising in summer to a maximum of only 5.2°C (Newton 1994). The sub-Antarctic Prince Edward Islands and cool-temperate Gough Island are much warmer, much wetter (with precipitation falling mainly as rain) with often strong winds. Because their climate is oceanic, temperature fluctuations across the seasons are not large (Schulze 1971). The effects of climate warming are now noticeable at Southern Ocean islands, and long-term meteorological data collected at Marion Island since annexation have shown that the island is becoming both warmer and dryer, its central ice cap is disappearing, and its surrounding seas are also warming (Smith and Steenkamp 1990, Smith 2002, Mélice *et al.* 2003, Sumner *et al.* 2004, Rouault *et al.* 2005).

Biodiversity

The Antarctic Continent, most especially away from exposed-rock coastline, is a barren place. Southern Ocean islands can be hardly more different: they teem with life. A few nunataks in Dronning Maud Land have colonies of breeding seabirds, such as Snow *Pagodroma nivea* and Antarctic *Thalassoica antarctica* Petrels whose guano supports plants (mosses and lichens) and invertebrate (mites and smaller) life (Ryan and Watkins 1989). Vesleskarvet is especially barren, with no breeding birds, a few lichens but no identified mosses, and few mites, along with nematodes and tardigrades (Steele *et al.* 1994).

The Prince Edward Islands are a haven for large numbers of breeding seabirds and seals, some of which are considered globally threatened (Cooper and Brown 1990, Hänel and Chown 1991, Cooper 2003, BirdLife International 2004). There are four species of penguin, the Macaroni *Eudyptes chrysolophus* and the King *Aptenodytes patagonicus* being the most abundant, five species of albatross, including 44% of the world's population of Wandering Albatrosses *Diomedea exulans*, and a suite of burrowing petrels of the family Procellariidae. There are three species of seals: the Southern Elephant Seal *Mirounga leonina* and two species of fur seal *Arctocephalus* spp. Gough Island also supports seals, penguins, albatrosses and petrels, but also has two endemic land birds, a bunting and a moorhen (Cooper and Ryan 1994). Marion and Gough have introduced populations of House Mice *Mus musculus*. Marion used to have an introduced population of feral domestic cats *Felis catus*, but these have now been eradicated (Bester *et al.* 2002).

The vegetation of the three islands is broadly similar, although the more northerly Gough Island does have two species of trees. Woody plants are absent at the Prince Edward Islands, a defining feature of the sub-Antarctic region. Small forbs, grasses, ferns and mosses make up the bulk of the vegetation (Cooper and Ryan 1994, Gremmen and Smith 2004). Alien plants exist at all the islands. The islands also support an abundant invertebrate life: mites, flies, weevils, moths, earthworms and the like (Crafford *et al.* 1986, Jones *et al.* 2003). Gough especially has many introduced species. Flightlessness is a feature of some invertebrate groups.

The inshore life of the islands is rich. The Prince Edward Islands have extensive kelp beds. A notable occurrence is of Killer Whales *Orca orca* (Hänel and Chown 1991).

A SHORT OVERVIEW OF SCIENTIFIC PROGRAMMES

Scientific research undertaken at South Africa's Antarctic and sub-Antarctic bases and at sea in the Southern Ocean is undertaken as part of SANAP. Logistics and infrastructure are administered by the Department of Environmental Affairs and Tourism, while the science is administered by the National Research Foundation, with funding from the Department of Science and Technology. The mission of SANAP is to increase understanding of the natural environment and life in the region through appropriate research, science and technology. The actual research, in the main, is carried out at universities, although DEAT's Marine and Coastal Management section is involved with fisheries research and seabird monitoring on behalf of CCAMLR (Commission for the Conservation of Antarctic Marine Living Resources) of which international body South Africa is a founder member.

Currently South Africa's research activities within SANAP focus on five main themes, covering the geosciences, physical sciences, life sciences, impacts of human presence, and the history, sociology and politics of involvement within the region. Geoscience research has taken place on the Antarctic Continent and at the Prince Edward Islands, with the emphasis on offering insights into the evolution of the earth's crust on the

continent and on geomorphology and vulcanology at the islands. Physical research has concentrated on studying the upper atmosphere at SANAE IV, although regular monitoring of meteorological conditions also takes place at the bases. Three important physical science programmes are SHARE (Southern Hemisphere Auroral Radar Experiment), AMIGO (Antarctic Magnetospheric and Ionospheric Ground-based observations) and ANOKS (Antarctic Research about Cosmic Radiation). Physical oceanography is also studied on annual relief voyages to Marion Island. Life Science is currently the largest theme, with a long history of activities. Most research takes place at Marion Island, concentrating on ecological investigations relating to climate change, alien introductions and the impact of fisheries on seabirds, perhaps best known by longline mortality. Long-term demographic studies of individually-marked seals and seabirds (especially albatrosses) is a feature of the work, as is tracking them at sea via satellite and with positional loggers. Life science research also takes place intermittently at Gough Island and in the Southern Ocean, including on the Patagonian Toothfish fishery.

The remaining two themes are new, and little research has so far been undertaken. However, a waste management study is underway at all three bases, and historical research has been undertaken by interested persons (e.g. Cooper and Headland 1991) without being part of a specific SANAP-funded project.

Internationally, South Africa undertakes collaborative research, often initiated through its membership of the Scientific Committee on Antarctic Research (SCAR), which forms part of the International Council of Scientific Unions. South Africa also submits information to the international community via the annual Antarctic Treaty Consultative Meetings and its Committee for Environmental Protection.

STATE OF THE ENVIRONMENT

Because of the large differences between the Antarctic Continent on the one hand, and the southern islands of the Prince Edwards and Gough on the other, they are best treated separately in terms of environmental issues.

Dronning Maud Land, Antarctic Continent

SANAE IV at Vesleskarvet is a modern base that aims to be run in an environmentally responsible manner. This has been assured by SANAP undertaking a Comprehensive Environmental Assessment prior to its construction (Claassen and Sharp 1993) following guidelines of the Antarctic Treaty's Committee for Environmental Protection (CEP) and by it undertaking annual environmental audits of the base and its surrounds. Important issues then addressed are waste management and pollution. Much material is sorted and then returned to South Africa for recycling or disposal in dedicated waste-management sites, including hazardous waste such as scientific chemicals, batteries, spent lubrication oils, plastics, metals, and glass). Reducing the risks of fuel spills into the environment forms an important part of the annual audits. South Africa follows all the requirements of

the Madrid Protocol on Environmental Protection and its various annexes that cover such matters as protection of species and of areas, controlling introductions, pollution and liability. At Vesleskarvet itself a small area of exposed rock has been marked off to protect its limited biota (Steele *et al.* 1994, Harris 1996).

As of yet, South Africa has not proposed an ASPA (Antarctic Specially Protected Area) or an ASMA (Antarctic Specially Managed Area) to the CEP. However, the Robertskollen nunataks as the most biologically diverse rock exposures relatively close to SANAE IV (and the site of a five-year biological programme financed by SANAP in the 1990s; Cooper 1991, Newton *et al.* 1994, Harris 1996) are worthy of ASPA status, and the conservation management of Vesleskarvet would be served by declaring it an ASMA. Both actions would entail the production of management plans that would be submitted to the CEP for eventual approval and adoption at an Antarctic Treaty Consultative Meeting.

South Africa has also followed CEP protocols in decommissioning redundant bases and field stations in Dronning Maud Land over the years. In the main, all structures that have not become buried below the ice surface have been recycled to South Africa. Examples are sections of the E (=Emergency) Base close to the site of the now buried SANAE III, and earlier the Sarie Marais field station at Grunehogna, inland from the shelf edge.

With its inhospitable ice-shelf edge and lack of exposed rock where penguin and seals can breed and haul out, Dronning Maud Land is not seen as a prime site for ship-based tourism. The imposing inland mountain ranges and nunataks might lend themselves to visits by adventure tourists, but to date tourism has not impacted on South Africa's activities on the continent in any real way. In contrast, scientific activities in the region are increasing, with collaboration, especially with logistics, now taking place between a number of nations. This includes both the sharing of facilities aboard ship, and by air, utilizing a Norwegian blue-ice runway that can take wheeled aircraft. For both types of operations Cape Town is used as a gateway to Antarctica.

While at sea in the Southern Ocean, both south and north of the Antarctic Treaty Area, the SANAP research and supply vessel, the *S.A. Agulhas*, also avoids pollution by following MARPOL regulations about not dumping wastes at sea, which are stored aboard for return to South Africa or incinerated aboard.

The Prince Edward Islands

The Prince Edward Islands, South Africa's only overseas possession, have been accorded the country's highest state of formal protection, that of Special Nature Reserve in terms of the then Environmental Conservation Act of 1989, now superceded by the national Environmental Management: Protected Areas Act, No. 57 of 2003 (NEMPA). In terms of NEMPA, entry into a Special Nature Reserve is restricted for research and conservation management activities only. One consequence of this high level of protection is that commercial tourism may not be permitted. A management plan was adopted in 1996 (PEIMPWG 1996) and is currently being revised. In terms of the plan

the Prince Edward Islands Management Committee (PEIMC) offers advice to SANAP, especially on the issuing of permits for entry and scientific research.

Similar to other sub-Antarctic islands, one of the largest threats to the Prince Edward Islands is the arrival of unwanted alien species, both animals and plants, as well as disease-bearing agents. In a time of climate change, with the islands becoming warmer and dryer (e.g. Rouault *et al.* 2005), it appears more introduced species have a chance of becoming established – often to the detriment of the native flora and fauna (e.g. Chown *et al.* 1998, Gremmen and Smith 1999). Alien species already present may become more a problem as the climate ameliorates (e.g. Chown and Smith 1993).

Some alien species that have been introduced in the past can be eradicated. The feral cat *Felis catus* was removed from Marion Island after a long campaign that used disease, night-shooting, trapping and poisoning to achieve eventual success (Bester *et al.* 2002). The remaining alien mammal, the House Mouse *Mus musculus*, will be very much harder to eradicate (Chown and Cooper 1995), whereas some of the introduced plants have spread so far that their removal is now considered impracticable (Gremmen 2004). The PEIMC now places much emphasis on activities designed to reduce the risk of introducing new aliens, with a stringent set of quarantine protocols in place that are regularly reviewed and enhanced.

A commercial longline fishery for Patagonian Toothfish *Dissostichus eleginoides* around the islands and on nearby sea rises and mounts has led to large numbers of seabird deaths since the fisheries inception in the mid 1990s (Nel *et al.* 2002). The adoption by South Africa of mitigation measures set out by CCAMLR and its National Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries (NPOA-Seabirds; Cooper and Ryan 2004), following guidelines set out by the Committee on Fisheries of the Food and Agriculture Organization (FAO) is helping reduce this bycatch to low levels. Illegal, Unreported and Unregulated (IUU) fishing has done much to harm the stock itself (Pakhamov and Chown 2003). A new fisheries patrol vessel commissioned in late 2004, the *Sarah Baartman*, capable of reaching the islands should help alleviate this distressing situation.

A number of other environmental issues affect the islands to a greater or lesser extent. These include human disturbance, pollution, litter and waste management. Regulations in the management plan, coupled with a permitting system operated by the PEIMC, appears sufficient to address them in the main, although a more codified system supported by a best-practice manual and operated by professional environmental management staff employed within SANAP has been recommended (PEIMPWG 1996, de Villiers and Cooper in press).

Several initiatives are underway to enhance the formal level of protection of the Prince Edward Islands. Internationally, South Africa has prepared nominations to register the islands as natural sites under the World Heritage Convention and as a wetland of international importance under the Ramsar Convention. Domestically, South Africa is working towards the proclamation of large Marine Protected Area around the islands that

will encompass territorial waters and at least parts of the Exclusive Economic Zone, extending out to 200 nautical miles. The first stage in this process has been the declaration of territorial waters (out to 12 nautical miles) a no-fishing zone from the beginning of 2005. In addition to the above initiatives, South Africa is a founder member of the international Agreement on the Conservation of Albatrosses and Petrels (www.acap.aq), which offers scope for the enhanced protection of the islands' threatened albatrosses and larger petrels (Cooper and Ryan 2001).

Gough Island

Conservation issues at the Gough Island Nature Reserve (a World Heritage Site) are broadly similar to those at the Prince Edward Islands, with concern about alien species, most especially the House Mouse, being at the forefront (Jones *et al.* 2003b,c, Cuthbert and Hilton 2004). Being a British island, ultimate responsibility for its management does not lie with South Africa, which, however, follows strictly the requirements and regulations of the island's management plan (Cooper and Ryan 1994). South Africa is supporting logistically a UK-funded project to eradicate the introduced Procumbent Pearlwort *Sagina procumbens*, which is currently restricted to the immediate surrounds of the base, and thought accidentally introduced with packing materials from Marion Island sometime in the 1990s.

The Government of Tristan da Cunha receives advice from the Gough Island Nature Reserve Advisory Committee, of which two of its South African-domiciled members are long-standing Honorary Conservation Officers of Tristan da Cunha, thus facilitating close links between SANAP and Tristan. An additional link between the two countries is that one of these Conservation Officers has drafted a new Tristan da Cunha Conservation Ordinance (Cooper 2005), which, along with revision of the Gough Island Management Plan, now underway under contract in South Africa, will lead to enhanced protection for this island and its biota.

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