

Kerguelen and South Georgia: Sub-Antarctic islands facing climate change

Guillaume Prudent

By virtue of their location in the Austral Ocean and their insularity, the sub-Antarctic islands form an exceptional environment. These islands are not part of the classic representation of mountains but have summits above 2,000 metres. Most of them do not have an extreme climate but rather borderline climatic conditions that prevented species from temperate regions, whose developmental thresholds are a few tenths of a degree above the usual sub-Antarctic temperatures, from establishing. Recent warming in these islands has opened the door to the colonisation of species that are potentially invasive or that at the very least can compete with sub-Antarctic species.

The present article focuses on British South Georgia and French Kerguelen. The Kerguelen are located in the southern Indian Ocean, approximately 2,000 kilometres from the coast of Antarctica. South Georgia is located approximately 2,150 kilometres south of Tierra del Fuego.



The Kerguelen, southern Indian Ocean. Photo Guillaume Prudent

A unique biodiversity

In the Kerguelen, the plant communities are low and not a single tree breaks the monotony of the grassy landscape. The Kerguelen cabbage (*Pringlea antiscorbutica*), the cushion plant (*Azorella selago*) and the acanea (*Acanea magellanica*) dominate in the non-degraded islands where no herbivore mammals have been introduced. Sink holes and wet, slightly sloped zones are dominated by bryophytes and grasses. In the coastal grasslands that are directly exposed to sea spray, musky crassula (*Crassula moschata*) and the fern moss (*Cotula plumose*) dominate. There are 68 introduced species on the Kerguelen and some of them, such as the dandelion (*Taraxacum officinale*) and the meadow grasses (*Poa pratensis* and *P. annua*), are considered invasive.

There are no reptiles or amphibians on the archipelago and there were no land mammals before humans arrived. Caribou (*Rangifer tarandus*) were introduced in 1955 on Grande Terre; today they make up a population of approximately 1,000 head. In 1957, European mouflon (*Ovis musimon*) were introduced on Ile Haute. Feral cats (*Felis silvestris*) were also introduced on the main island in an attempt to control the black rat (*Rattus rattus*) and house mouse (*Mus musculus*), but the petrels were easier prey and their populations quickly declined. However, the most problematic exotic species on the Kerguelen Islands is the European rabbit (*Oryctolagus cuniculus*), which has profoundly changed

the archipelago's vegetation and landscape.

In South Georgia, there are no trees or bushes and the vegetation is similar to that found in Tierra del Fuego. South Georgia's indigenous vascular flora is relatively poor, with only 25 species and no endemic species. Tussocks constitute the largest plant communities on the island. At least 70 species of higher plants were introduced, of which only 25 truly established themselves. This introduced vascular flora, which is concentrated mainly around the former whaling stations, remains more abundant than the indigenous species (Frenot et al. 2007).

The fauna is characterised by the absence of land mammals, amphibians, reptiles and freshwater fish. In these conditions, invertebrate fauna dominate even if the number of species and the number of individuals remain limited. Approximately one-third of the 230 species of arthropods is considered endemic. In freshwater environments, around 70 invertebrates have evolved along with six spiders. All this invertebrate fauna is pressured by rats and mice introduced onto the island because the former serve as food for the latter. There is also one species of land bird, an endemic passerine, the South Georgia pipit (*Anthus antarcticus*) and five species of freshwater birds.

Warmer temperature and glaciers fluctuations

After a cooling period observed in the 1960's and 1970's, air temperatures increased by 1.3°C on the Kerguelen Islands (Weimerskirch et al. 2003). Summer temperatures on the Kerguelen Islands show a similar change, with warming since the 1960s and a series of successive warm summers during the second half of the 1990's. A 100 – 250 millimetre decrease in annual mean precipitation has been observed between 1994 and 2004.

The Ampère glacier front in the south of the ice cap on Kerguelen retreated 1 kilometre between 1800 and the beginning of the 1970's and its retreat has significantly accelerated during the last few decades. In 1993 the glacier front was more than 3 kilometre from its position during the Little Ice Age (Frenot et al. 1993). The glaciers located on the Railler du Baty peninsula have also retreated significantly.

The summers of the first decade of the 20th century were relatively warm on the northeast coast of South Georgia; then there was a cooling period between the 1920's and the 1940's, followed by warmer temperatures since the 1950's until the 1980's. Summer precipitation showed an upward trend with a high variability (Gordon, Haynes & Hubbard 2007).

Over the last 50 years in South Georgia, some glaciers have not changed significantly (e.g. Ryan glacier). On the other hand, some have been in retreat since the end of the Little Ice Age. The intensity of this retreat varies markedly. While the Lyell Glacier front has retreated only 70 metres over the last 50 years, the Neumayer and Geikie glaciers had their front stagnate in the 1970's and then retreated 2.5 kilometre and 1.6 kilometre respectively between 1973–1974 and 2003 (Gordon, Haynes & Hubbard 2007).

Vulnerable species vs. invasive species

Invasive exotic species are one of the threats related to global warming. With the rise in temperatures, these species introduced from more a temperate environment were able to adapt to the detriment of indigenous species. These mechanisms do not concern only plants, but were also apparent in insects. In the 1970's, the blue blowfly (*Calliphora vicina*) was introduced on Kerguelen Island. The insect at first remained in the scientific base's heated camps because the outdoor climate conditions were too rigorous. Today's conditions resulting from climate warming allow this Diptera to reproduce outside the buildings and it is beginning to progressively colonize the eastern part of the archipelago. In these new colonised spaces, the larva of this introduced fly competes with the autochthonous wingless fly (*Anatalanta aptera*) (Chevrier et al. 1997). This local aptera fly is already subjected to the predation of another alien insect, the flightless beetle (*Ooapterus soledadinus*). Over the past few years, the beetle populations have greatly increased and some scientists now hypothesise that global warming may explain this population increase.

The consequences of climate change are also manifested by a reduction in the endemic species plant cover (acanea and Kerguelen cabbage) following increasingly frequent summer droughts over the last decade. The foot of the cabbage produces seeds but germination does not develop on the periphery during the years of summer drought (Chapuis, personal communication, 2008).

During the last decades in South Georgia, glaciers that in the past ended on the coast have retreated substantially inland, e.g. Lucas and Cook glaciers. This has caused a mechanical barrier to disappear, which had prevented invasive exotic species, and more particularly rats and mice, from colonising new

spaces. Thus, the opening up of new spaces available for rodents combined with warmer climatic conditions in South Georgia could increase the pressure on sea birds in these spaces that were until now inaccessible. Important changes in the distribution of the usual plant communities have resulted from glacial retreat over the last 20 years in other sub-Antarctic islands, such as Heard Island (Australia).

Ending message: Since 2008, the Observatoire National sur les Effets du Réchauffement Climatique (ONERC) and the International Polar Foundation have been working on a report assessing the impacts of climate on the subantarctic islands (French, British, Australian, South African and New Zealand islands). The report will soon be available in French and English on both web sites (<http://www.ecologie.gouv.fr/-English-.html> and <http://www.polarfoundation.org/>).

Chevrier, M;., Vernon, P; Frenot, Y (1997) Potential effects of two alien insects on a subantarctic wingless fly in the Kerguelen Islands. In Battaglia, B; Valencia, J; Walton, D W H (eds) "Antarctic Communities: Species, Structure and Survival", Cambridge University Press. 1997, pp.424-431

Frenot, Y; Chown, S; Whinam, J et al. (2007) Biological invasions in the Antarctic: extent, impacts and implications. *Biological Reviews* Vol. 80, pp. 45-72.

Frenot, Y; Gloagen, J-C; Picot, G et al. (1993) *Azorella selago* Hook. used to estimate glacier fluctuations and climatic history in the Kerguelen Island over the last two centuries. *Oecologia*, Vol. 95, pp. 140-144.

Gordon, J; Haynes, V; Hubbard, A (2007) Recent glacier changes and climate trends on South Georgia. *Global and Planetary Change* Vol. 60, pp. 72-84.

Weimerskirch, H; Inchausti, P; Guinet, C et al. (2003) Trends in birds and seals populations as indicators of a system shift in the Southern Ocean. *Antarctic Science*, Vol. 15, pp. 249-256.

Guillaume Prudent - guillaume.prudent@maunsell.com works for Maunsell AECOM and is a Departmental Visitor in the Fenner School of Environment and Society (Australian National University).