

## Guest Editorial

# Long-term ecosystem networks to record change: an international imperative

To understand Antarctic ecosystems and their resilience during rapid environmental change, a new research approach is required - one that is coordinated, interdisciplinary, long term and international. Climate changes in Antarctica are rapidly altering marine and terrestrial ecosystems in many ways - changing temperature, UVB, ocean acidification, invasive species and direct impacts from scientific research and tourism. The long-term (decadal and longer) effects of these changes have implications and feedbacks beyond the Antarctic and even the Southern Hemisphere. These feedbacks are not limited to natural systems, but also impinge directly on human activities, with significant economic consequences. Understanding these collective interactive factors can best be achieved through team research using multidisciplinary and interdisciplinary integration of biological, physical and chemical processes across multiple spatial and temporal scales. The long-term research required is not achievable by any one nation, and requires a continental scale approach. As a basis for this vision, pan-Antarctic experimental and monitoring networks, established through national programmes but coordinated through international efforts, will be essential to a) provide comparable data for a synthetic framework, and b) for models that will predict the responses of the connected Antarctic ecosystems to changing climates.

Unlike other ecosystems Antarctica has few examples of long-term research addressing the complexity of ecosystem responses to either natural variability or rapid changes in climate. But we do have some experience to build on. The US Palmer marine Long Term Ecological Research (LTER) revealed that a southern shift in ice-dependent Adélie penguins was due to reductions in sea ice duration affecting the marine food web for birds and other apex predators. The McMurdo Dry Valley terrestrial LTER programme recorded a series of ecosystem responses to cooling that directly affected lake levels, melt streams, ice thickness, soil moisture and indirectly affected the composition of the soil invertebrate communities, and limnetic primary production. The results ([www.lternet.edu](http://www.lternet.edu)) came from multidisciplinary teams using a long-term systems level approach. The importance of ice driven dynamics on ecosystem change was documented by the Latitudinal Gradient Project, ([www.lgp.aq](http://www.lgp.aq)), but this work also indicated that some impacts of climate change on ecosystems are less predictable and highly scale dependent. There are other examples from Signy Island linking lake ice cover and increased summer primary production, and long-term data on changing distributions of plants on sub-Antarctic Marion Island showing rapid community reorganization, rather than simple changes in altitudinal ranges. An internationally coordinated, cross-continent but multi-scale experiment that could test whether these indirect responses to climate changes are generalizable at larger scales across Antarctica should be the next step in addressing how rapid climate change is modifying Antarctic ecosystems.

The scientific community needs to move quickly to structure continental-scale, long-term Antarctic observational networks and experiments that address how Antarctic ecosystems are responding to a changing environment. An international committee could initially plan to investigate variation at small and larger spatial scales for: a) the extent of geophysical change, b) ecosystem response and resilience to geophysical changes such as regional climate change and ocean acidification, c) biodiversity change (e.g. invasive species, species composition, biogeographical ranges), d) ecosystem services, and e) environmental governance and its effects. These goals are based on the need for an ecosystems level, integrated and comprehensive, long-term, internationally coordinated research plan that is geographically representative. The Scientific Committee on Antarctic Research (SCAR) should certainly play a role in this, but rapid and innovative action is needed using interdisciplinary funding schemes (such as those of the European Union Framework Programmes and private foundations) to supplement the national support for this urgent research need.

DIANA H. WALL, W. BERRY LYONS, STEVEN L. CHOWN, PETER CONVEY,  
CLIVE HOWARD-WILLIAMS, ANTONIO QUESADA & WARWICK F. VINCENT