



Executive Summary

Global Environmental Change (GEC) refers to the set of transformations of land, oceans and atmosphere, driven by an interwoven system of socioeconomic and natural processes. Concurrent with the modern phenomenon of *globalisation* (the growing and accelerated interconnectedness of the world) and, to some extent, as a consequence – humans have begun to induce planetary-scale changes in Earth's life support systems.

We now know that human activities match (and often exceed) the natural forces that regulate the Earth System. Recent ice core data show that current levels of carbon dioxide and methane are well outside the range of natural variability over the last 800,000 years (1). Roughly half of the world's ice-free land surface has been altered by human actions(2). Humans now fix more nitrogen than nature does(3). Particles emitted by human activities alter the energy balance of the planet, as well as have adverse effects on human health(4). These may seem to

be unrelated issues; however, over the last decades, we have gained a deeper understanding of the degree to which all of these separate issues are linked. The Earth System is a very complex system with myriad feedbacks, and it has and presumably can still exhibit rapid, global-scale responses to changes in environmental conditions.

A consequence of the interconnectedness of the coupled human-environmental earth system is that no region is independent of the rest of the world. In the case of Africa, processes at work in the

region (e.g., desertification, biomass burning) can have global consequences, and processes occurring in other regions can have influences in Africa (e.g., the possibility that particulate emissions from other continents affect rainfall patterns in sub-Saharan Africa). This interconnectedness manifests itself as well in the fact that global environmental research requires the involvement of African scientists, and global environmental change research in Africa needs the input of scientists from outside the region; we are all interdependent.

The overall purpose of this document is to describe the areas of global environmental change research that are of particular importance and interest for Africa, to describe the basic research needed to support cogent decisions about adaptation and mitigation, and to provide reasonable options for the support structure needed to facilitate and implement the research.

This science plan was prepared in wide consultation with African global environmental change researchers, and also with the international research community outside Africa. It reflects the collective views of this research community as to the needs and special interest areas for African GEC research. The plan is stratified into three levels of increasing detail; the intention is to clearly describe the large-scale issues of particular importance for Africa, outline the kinds of international, multidisciplinary research approaches necessary to approach these issues, give

examples of specific questions and projects that could be part of an African GEC research initiative, and finally to propose a mechanism through which these initiatives could be realized. This initiative is called **AfricanNESS**: the African Network for Earth System Science.

AfricanNESS concentrates on four top-level issues that are the focus of concern with respect to global environmental change and its impacts in Africa:

- **Food and nutritional security**, including crops, wild-gathered resources, livestock resources

and fisheries;

- **Water resources**, particularly in the water-limited sub-humid, semi-arid and arid regions;
- **Health**, especially in relation to the biodiversity-linked, environmentally-mediated and vector-borne diseases that are responsible for the high disease burden in Africa; and
- **Ecosystem integrity**, on which the persistence of biodiversity and the delivery of ecosystem services depends.

These focal issues find expression, for instance, in the Millennium Development Goals.

These four focal issues are directly and indirectly influenced by a number of interconnected drivers of change, the ‘Global Environmental Change Syndrome’, including **land cover change** resulting largely from agriculture, forest clearing and infrastructure development; **atmospheric composition change** as a result of human-induced emissions of greenhouse gases, aerosols and nitrogen- and sulphur-containing trace gases; the **climate change** that they together cause; **biodiversity change** resulting from over-harvesting, loss of habitat and pollution; the interconnected economic and political factors involved in

globalisation; the **demographic** changes in the size, composition, and distribution of populations; including the tendency towards **urbanisation**; and the changes in resource consumption and waste production that accompany **issues of equity, increasing wealth and novel technologies**.

Between the ‘focal issues’ and the ‘global drivers of change’ are a series of causal links, processes and feedback loops. Since it is these interconnections that determine the specific outcome of global environmental change in Africa, the research programme outlined in this document focuses on this connecting layer. It prioritizes those issues that are most critically important for human well-being in Africa; that lend themselves

to adaptive actions; or that are of global importance, but best-studied in Africa.

The researchable topics in such a wide-ranging area are unavoidably many and interconnected. To achieve a degree of focus and clarity, they have been arranged in the body of this document into eight **thematic clusters**. The elements of such clusters typically interact strongly among themselves, and so are best treated in a coordinated fashion. There are also connections between clusters, so one element may have relevance in several themes, although for conciseness it is described only in one. The thematic clusters are deliberately not aligned with traditional disciplinary boundaries.

Thematic clusters (blue text) and research elements

<p>Rainfall Variability Distribution Processes Land surface feedbacks Rainfall in GCMs</p>	<p>Land Cover Degradation Fragmentation Fires Biodiversity loss Water resources Wetlands</p>	<p>Livelihoods Fisheries Pastoralism Crop farming Vulnerable people and places</p>	<p>Cities Flooding Sea level rise Pollution Water resources Infrastructure</p>
<p>Diseases & Pests Environmental and emergent Advanced bioclimatic modelling</p>	<p>Africa and the Earth System Carbon cycle Dust aerosols Water cycle Ocean-land interaction Palaeoclimate Biogeochemistry Regional climate modelling</p>	<p>Integrated Development Energy Transportation Air quality Scenarios Governance</p>	<p>Marine Ecosystems and coral reefs Biodiversity and food resources Large-scale circulations</p>

To further organize and prioritize the research topics in this African Global Change Research Strategy, we applied the following seven principles:

1. Favour a limited number of multi-year coordinated research programmes over a large number of short-term, independent projects;
2. Promote inter-disciplinarity, multi-institutional and regional research;
3. Develop science-policy-practice interfaces;
4. Build lasting human and institutional capacity;
5. Ensure that the products of scientific research are credible, salient and legitimate;
6. Contribute to the global research agenda from an African perspective;

7. Recognise and develop indigenous knowledge and capacity.

The resulting themes represent the intersection of the information needed to support development of favourable research opportunities, and the research capabilities desired in Africa. The objective is to develop the capacity, within Africa, to anticipate and adapt to global change and to adopt a development path that is locally and globally sustainable.

It is taken as given that only research that meets widely-accepted quality standards is useful in this quest, and that the mechanisms by which a coordinated research effort is implemented must be transparent, accountable and efficient. Each of these eight *thematic clusters* (and their associated *research elements*) are described in

the science plan, with more detailed information (including examples of specific research questions and issues) presented as supplementary material in the Annex.

Finally, the science plan proposes a structure and mechanism by which these themes and elements can be approached, and gives an estimate of the level of support needed to make AfricanNESS into a functional research network for Africa.

Footnotes

1. Siegenthaler, et al., 2005; Spahni, et al., 2005
2. Foley, et al., 2005
3. Galloway et al., 2004
4. Charlson et al., 1992; Pope III & Dockery, 2006

This science plan has its primary origins in two efforts to describe the global environmental change issues most relevant for Africa. One was through the AfricanNESS initiative that started with a scoping workshop in September 2005 in Nairobi, Kenya that attracted more than 70 participants from across Africa and beyond. The first AfricanNESS science plan was drafted after a second workshop in Pretoria, RSA in June 2006, with the input from many of the participants from the original workshop. It was further refined during and after a meeting in Nairobi, Kenya in December 2006. The second effort was coordinated and published by the International Council for Science (ICSU) Regional Office for Africa. In drawing up the ICSU science plan, the authors took into consideration the ICSU Strategic plan 2006-2011, the AU/NEPAD Africa's Science and Technology Consolidated Plan of Action, the UN Millennium Development Goals for Africa, and reports from interdisciplinary bodies and joint initiatives. The ICSU ROA convened its 2nd Regional Consultative Forum for Africa in Boksburg, South Africa, on 25-27 September 2006, to provide a platform for this science plan (and others developed by ICSU) to be critically evaluated by the broader scientific community. Both science plans were circulated through several media to the international community at large for comments and input. The processes by which both were developed were transparent and participatory in nature.