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Core Scientific Questions and Research Priorities for Sustainability Science in Africa

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1. Introduction

The importance of the contribution of science and technology to sustainable development has become widely recognized within approximately the last two decades. This interest has arisen in response to growing awareness of, and fears about, environmental degradation effected by industrialization, the increasing pressures on resource demands resulting from population (and industrial) growth, and by increasing inequalities in access to resources. Despite this growing awareness, it is only now that concerted attempts are being made to link science with society to address the problems resulting from environmentally deleterious and unequal development. These efforts require a multi-disciplinary approach to science to understand the ways in which the physical and human environments interact.

In response to the growing will to address these development problems, a number of national governments have recently begun to define science policies with the aim of promoting sustainable development[1]. The precise role that has been defined for science varies between countries, and reflects differences in the objectives of development between these countries. It is for this reason that definitions of "sustainable development" differ, and appropriately so. In defining the core questions of sustainability science in the

[1] E.g., Australia (http://www.isr.gov.au/media/speeches/html/enVISION98.html),
Canada (http://www.nrcan.gc.ca/dmo/susdev/sci_tech.html),
Eastern and South Africa (http://www.unesco.org/science/wcs/meetings/afr_arusha_99.htm),
SADC Region (http://www.unesco.org/science/wcs/meetings/afr_pretoria_99.htm),
West and Central Africa (http://www.unesco.org/science/wcs/meetings/afr_yaounde_99.htm).
See also http://www.unesco.org/science/wcs/meetings/afr_malawi_99.htm

African context, therefore, it is first necessary to identify what the objectives of development are within the continent, recognizing that there may be more than one acceptable path, and to acknowledge that this definition may well vary between African states.

Because of the tremendous diversity of the physical and human environments within Africa, it is both impossible and inappropriate to attempt to define in this paper a comprehensive set of core questions for sustainability science that is applicable to all African nation states. However, a number of issues are common to all definitions of "sustainable development", and there are identifiable issues that are common to most, if not all, African states. Firstly, by definition, the aim is to sustain not only economic growth per se (or at least an acceptable level of prosperity for all individuals so that human needs can be met), but also environmental diversity, stability and quality, and cultural integrity. Implicit within the term "sustainability" is the concept of intergenerational equity, which raises important questions about the utilization of renewable and non-renewable resources. Secondly, there are a number of ubiquitous problems related to the interaction between society and the physical environment that are relevant to most of Africa, including problems such as population pressure on water and food security, and disease. Finally, a number of questions arise relevant to sustainability from the nature of Africa's position in the context of the global sustainability of development.

2. Threats to sustainability given trends in the human environment

> *In a very real sense the land does not lie; it bears a record of what men write on it.*
>
> W. C. Lowdermilk, 1953

Primary threats to the sustainability of development result from trends in the consumption of resources (renewable and non-renewable), and from population growth.[2] Africa has a wealth of renewable and non-renewable resources, but to a large extent the exploitation of these has failed to meaningfully alleviate the needs of most of the continent's population. The exploitation of the

2 U. S. Congress, Office of Technology Assessment, *Perspectives on the Role of Science and Technology in Sustainable Development*, OTA-ENV-609, http://www.wws.princeton.edu/cgi-bin/byteserv.prl/~ota/disk1/1994/9422/942205.PDF

non-renewable resources requires particular attention because, by its very nature, this is unsustainable. Ways need to be found of ensuring that Africa achieves maximum benefit from these resources, which will require careful investment strategies for developing alternative economic activities that are able eventually to replace the primary exploitation of Africa's mineral resources, and will also require changes in trade and business agreements with the industrialized world. More efficient extraction techniques and technologies for improving consumption efficiency should prolong the benefit Africa can take from mining its non-renewable resources. In the longer term, however, research will be required to develop alternative resources to replace those non-renewable resources exhausted by earlier extraction.

It is not just the finiteness of Africa's non-renewable resources that is of concern in their exploitation. The environmental degradation that results needs to be addressed if the quality of the living environment is to be retained or improved. Science can make an important contribution in areas such as hazardous waste management, pollution control, and environmental restoration.

The exploitation of Africa's renewable resources also requires attention: Africa experiences some of the largest population growth rates in the world, which compound the conflicting needs of stabilizing resource bases, and alleviating poverty. The immediate and long-term impacts of these growing pressures on the environment and on development need to be understood, and culturally acceptable means of alleviating the growing population need to be identified. In this regard, affordable means of disease control (such as AIDS vaccines) need to be found. Because of the considerable financial expenditure required, most investment in biotechnology research is made within industrialized countries. International agreements may need to be reach to ensure that opportunities for the industrialized world to financially exploit the disease problems of the developing world are not abused.

Fundamental to improving the quality of life within Africa are the needs for security in food and water supplies. Methods of improving agricultural productivity need to be found, but without using Africa as a guinea pig for the possible health and environmental threats of biotechnology's innovations. The wide range of social and political problems that impact on food security need to be better understood and addressed.

3. Threats to sustainability given trends within the physical environment

In addition to coping with the exponentially growing demands on resources, sustainable development needs to be achieved within the context of a changing physical environment. In some industrialized countries, such as Canada, the importance of the contribution of science and technology to the sustainability of development in the context of a changing global climate is given particular attention[3]. However, it has to be fairly acknowledged that, especially within the poorest countries, the needs for quick solutions to current pressing problems are likely to take priority over longer-term planning for possible trends that may or may not occur sometime in the future. Although there is an increasing consensus that global economic development is likely to have a notable impact on climate, there remains considerable uncertainty regarding the precise signatures of climate changes that may be expected[4]. The reluctance to divert significant resources to long-term issues is even more understandable in the light of the great uncertainties involved. A possibly more fruitful approach in the short term would be to focus on developing a greater resilience to present day climate variability. The focus would then be on identifying the causes of present day vulnerability to environmental variability, and identifying ways to reduce that vulnerability, perhaps through mitigation in response to early-warning mechanisms, or through applications of appropriate technologies to increase resistance[5]. Lessons learnt in responding to present day climate variability, would be directly relevant in the context of developing strategies to respond to the more slowly changing background climate state, and would be beneficial regardless of the magnitude or direction of any longer-term climate change.

As of mid-1999 over a dozen countries within Africa[6] had participated in the U. S. Country Studies Program[7], which was established to assist countries in conducting climate change studies. These studies involve careful analyses of how climate may change in the future, and what impacts those changes will have on the physical and human environments. Similar

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3 e.g., U.N. Convention to Combat Desertification, http://www.nrcan.gc.ca/dmo/susdev/sci_tech.html

4 J. W. Anderson, http://www.weathervane.rff.org/featues/feature009.html

5 B Rouhban, UNESCO, http://www.unisdr.org/unisdr/ISDRInf%202.pdf

6 Botswana, Cote d'Ivoire, Egypt, Ethiopia, Gambia, Kenya, Malawi, Mauritius, Mozambique, Nigeria, South Africa, Tanzania, Uganda, Zambia, Zimbabwe

7 http://www.gcrio.org/CSP/

questions to those raised in the Country Studies could be raised, but with a focus on identifying present-day vulnerabilities and adaptation strategies.

4. Africa's position in the context of global sustainability

Historically, the exploitation of Africa's nonrenewable mineral resources has primarily benefited today's industrialized countries, and has thus contributed little to Africa's sustainable development. Sustainable development requires a more equitable distribution of wealth. There is a danger that even the concept of sustainable development per se could become another expensive export from the industrialized to the developing world, because of the requirements for expensive "western" technology, and because of the introduction of new trading agreements or controls that may inhibit the development of African enterprise. Fundamental changes in the world's markets may be required. Research is required to understand the potential implications for Africa's development of the changing global market as trends toward more sustainable development are implemented.

5. The core questions of sustainability science for Africa

The fundamental role of science can be defined, for the purposes of this paper, as to improve human welfare by enabling informed decision-making, and by technological innovation. That science is able to make a significant contribution to improving human welfare in the short and long terms is widely recognized[8], but it is beneficial to enumerate here the possible areas in which science can make a contribution. These areas can be broadly classified under the following four questions.

8 Millennial Perspective on Science, Technology and Development in Africa and its Possible Directions for the Twenty-first Century, http://www.unesco.org/science/wcs/meetings/afr_hammamet_99.htm

- What are the criteria and indicators for the sustainability of development within the African context?[9]
- What are/will be the fundamental problems that limit the sustainability of socio-economic development within Africa?
- What are the appropriate solutions to these problems?
- How can these solutions be implemented given the full range of internal and external constraints (economic, social, political etc)?

These questions are considered in more detail in the following sections.

5.1. What are the criteria and indicators for the sustainability of development within the African context?

- What aspects to the quality of life of all Africans needs to be improved / maintained?
- How can these aspects be measured and monitored?
- How can the long-term sustainability of these aspects be assessed?

5.2. What are/will be the fundamental problems that limit the sustainability of socio-economic development within Africa?

- What are the causes of present day environmental variability (e.g. natural hazards[10], climate variability, seismic activity, epidemics)?
- What are the causes of societal vulnerability to this variability?
- What is the long-term sustainability of the physical and human environments, given present-day environmental practices and levels of technology?
- What are the projected changes in the human environment (e.g. population growth, urbanization)?
- What are the projected changes in the physical environment (e.g. climate, diseases)?
- How are these changes likely to interact and how are they likely to impact socio-economic development?
- What are the uncertainties in these projections?

[9] *Criteria and Indicators for Sustainability*, by Naim Afgan, Instituto Superior Tecnico, Portugal. Commentary posted to the Forum on Science and Technology for Sustainability, 4 November 2001, http://sustainabilityscience.org/commentary.htm.

- How does the trend toward globalization conflict with the sustainability of Africa's own development?

5.3. What are the appropriate solutions to these problems?

- How can current resource consumption be made more efficient?
- What alternative resources (raw materials, crop strains, energy sources etc) are available?
- What are the culturally acceptable options for reducing population pressure?
- What are the various adaptation strategies for reducing the impacts of natural disasters?
- How can Africa's existing scientific knowledge and technologies (including modern and traditional) be used more effectively to contribute to sustainability?
- How can monitoring and prediction be used to help mitigate the impacts of natural and human-made disasters?
- How can current technologies be adapted and developed to be appropriate to local circumstances?[11]
- What are the environmental and health consequences of

5.4. How can these solutions be implemented given the full range of constraints (economic, social, political etc)?

- What are barriers to adopting solutions for sustainable development?[12]
  - Agreement of the problem
  - Build up of knowledge
  - Handling of uncertainties - situational, problemic, significance, causal, resolution
  - Possibilities for alternatives and technical solutions
  - Economic consequences
  - Social implications
  - Political implications

[10] http://www.unccd.int/publicinfo/factsheets/showFS.php?number=7
[11] See e.g., J. Goldemberg, http://ctcs.fsf.ub.es/prometheus/articulos/what.pdf
[12] V. Bernson, http://www.arbld.unimelb.edu.au/envjust/papers/allpapers/bernson/home.htm

- What is realistically achievable? Bearing in mind that "most countries in Africa are yet to transform their political pledges into feasible and manageable science-led development programmes."
- How can African development be achieved in the context of an increasing trend toward globalization.
- How can development be achieved without increasing the North-South disparity?
- How can the apparently competing objectives of short-term and sustainable development be made compatible?
- What changes in the education system have to be introduced in order to promote education of the public at large, to bridge the information gap and to share knowledge and new technologies?[13]

[13] N. H. Afgan, http://sustsci.harvard.edu/commentary/afgan110401.htm