

# The Workshop for Enhancing Collaborative Research on the Environment in Sub-Saharan Africa

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## EXECUTIVE SUMMARY FOR THE WORKSHOP REPORT

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# Introduction: Workshop Rationale and Objectives

The U.S. National Science Foundation (NSF) supports extensive cutting-edge science in sub-Saharan Africa (SSA). The majority of this research is in the general area of the environment and extends across a range of disciplines. NSF support in SSA is addressing important global environmental issues, advancing frontiers of knowledge in the biological and physical sciences, while at the same time providing important scientific foundations for social-economic development in the SSA region. The potential scientific and broad impact of NSF's investment in Africa could be significantly strengthened by greater scholarly collaboration between U.S. and SSA scientists and stronger partnerships among institutions, organizations, and NSF programs funding SSA projects. In addition, recognizing that major discovery often occurs at the interface of individual disciplinary endeavors, there is strong need to build an international and multidisciplinary SSA community of scholars in the general area of the environment, and to forge partnerships among agencies and organizations, to realize the full potential and impact of NSF support and to address important global and regional issues.

The National Science Board (NSB) recommended that the NSF strengthen international cooperation in science and engineering with developing countries ([www.nsf.gov/nsb/documents/2003/nsb03151](http://www.nsf.gov/nsb/documents/2003/nsb03151) and [www.nsf.gov/nsb/documents/2002/nsb01187](http://www.nsf.gov/nsb/documents/2002/nsb01187)). However, a key constraint of the NSF, as a U.S. domestic federal agency, is that it is unable to fund non-U.S. institutions or non-U.S. scientists. Thus, it is clear that the NSF cannot accomplish this objective alone, and the NSB recommended that NSF develop partnerships with other funding groups that can provide complementary support by funding foreign collaborators and institutions, and creating opportunities for sharing institutional experiences in overcoming practical logistical difficulties that could impede effective research collaboration. To address this issue, and to explore ways to strengthen NSF's portfolio of awards in SSA, the Workshop for Enhancing Collaborative Research on the Environment in Sub-Sa-

haran Africa was held January 24-26, 2005 in Arlington, VA. The 114 participants included scientists from 10 African countries, NSF-funded scientists representing several disciplines and numerous U.S. institutions, graduate students and post-doctoral researchers, and representatives from U.S. and international agencies and organizations. This report is produced for the National Science Foundation, other agencies and organizations, and the community of U.S. and African scientists and scholars working in SSA

The specific objectives of the workshop were to:

- 1) Explore strategies for strengthening scholarly collaboration in science and engineering between the U.S. and SSA and strengthening NSF's portfolio of sponsored research in the region.
- 2) Articulate and promote the realms of scientific investigation that are best and uniquely suited to the SSA environment
- 3) Identify and recommend mechanisms to enhance and sustain communication, connectivity, and networking of people and programs

## Unique scientific opportunities in the SSA region

In the global context, SSA represents a unique geographic region, comprising a great diversity of ecosystems, cultures, and unique human-land-water-atmospheric interfaces and interactions. It is a globally significant region with respect to biodiversity, geosciences, and atmospheric sciences, and hosts a number of world-class research sites and institutions. It presents singular opportunities and resources for advancing scientific knowledge and addressing important regional and global environmental problems. With respect to biological sciences, the tremendous diversity of biota and ecosystems in SSA provide extraordinary opportunities for improved understanding of patterns and controls of biodiversity and fundamental ecological processes. Unique biological aspects of the SSA environment include spatially

4) Promote multi-disciplinary collaboration and synthesis of results across hierarchical levels, and the capacity building necessary to address important regional and global environmental issues

5) Explore strategies to expand opportunities for U.S. students and young scientists working in SSA.

6) Build partnerships between the NSF scientific community, other funding groups, and other organizations and agencies that can support the African side of collaborative research and training.

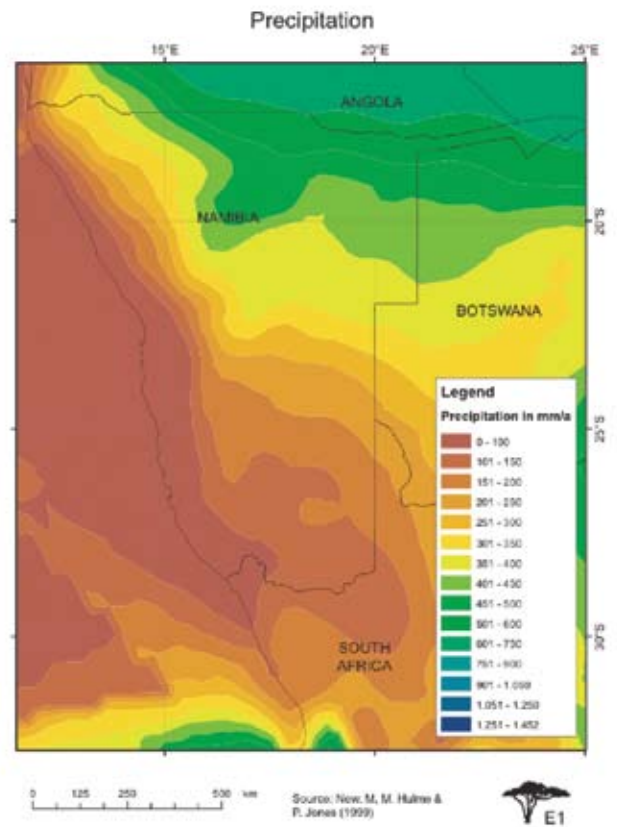
The workshop focused on environmental science in SSA for several reasons. First, scientific research in SSA can contribute significantly to our fundamental understanding of ecological processes and the global environment. For example, comparative studies of congruent SSA and North American ecosystems can provide crucial understanding of the generality of ecological principles and ecological rules and contingencies that govern the earth's ecosystems and the services they provide. Studies of atmosphere-biosphere interactions and other processes in SSA can add significantly to our understanding of global processes. Holistic and multidisciplinary study of SSA environments can also provide greater understanding of complex coupled human-natural systems.

extensive grazing ecosystems with high biodiversity of mammalian fauna; high rates of biodiversity discovery; highly diverse and rapidly changing terrestrial ecosystems, landscapes and land use patterns, unique human-wildlife-livestock interfaces influencing the ecology and consequences of disease; and steep, extensive gradients of terrestrial and coastal zone environments (Fig. 1).

Africa presents an unprecedented wealth of research opportunities in earth and climate sciences. SSA in particular provides unique opportunities for advancing our understanding of atmospheric processes and improving climate models. Tropical Africa is the second largest source of latent heating in the world, and several African climate systems have both direct and indirect linkages

to weather developments in other regions. Research on the SSA region can enhance our basic understanding of the inter-relationships between biological processes and climate, the role of natural and anthropogenic aerosols, and our general understanding of the causes, patterns, and consequences of global climate change. Limited climate change adaptation/mitigation mechanisms (policies) have been developed by many SSA countries, although the region is potentially one of the most vulnerable to extreme climate anomalies and climate change (Fig. 2). Endowed with complex terrain and enormous mineral resources, SSA also provides unparalleled research opportunities in geology, geophysics, mineralogy, and the influence of geological processes on ecosystems. Recent significant advancements in geosciences research in SSA have been driven in large part by the continent's mineral wealth.

With respect to the social sciences, SSA is a unique region of mostly developing countries where accelerated economic transition is driving rapid environmental change. It is a region with particularly strong linkages among ecology, sociology, and economics and where human livelihoods are directly linked to environmental integrity and biodiversity conservation. SSA provides tremendous scientific opportunities for better understanding the causes, patterns, and consequences of ecosystem transformations, changing land use, economic shocks, disease, and climate, their effects on poverty dynamics and the environment, and implications of high population diversity for regional environmental impacts.



**Fig. 1 - Steep and extensive environmental gradients, unique human-biosphere-atmosphere interactions, and high biodiversity provide excellent scientific opportunities in SSA**

## Key Issues and Challenges

The workshop evaluated the current status of environmental research in the SSA region. Researchers addressing SSA environmental issues are performing leading edge science and contributing much toward conceptual advances in several scientific fields. However the potential broad impact of much of this work is currently hindered by very limited interaction or collaboration among projects, programs, disciplines, and countries. There have been no efforts to develop a comprehensive approach to address regional and global environmental issues by enhancing cooperation and intellectual collaboration across disciplines, regions, and hierarchical levels. The workshop identified factors hindering strong and balanced intellectual collaboration between U.S. and SSA researchers and limiting progress in addressing key scientific questions. These include: a) lack of adequate infrastructure in SSA, including IT capacity, b) inadequate sup-

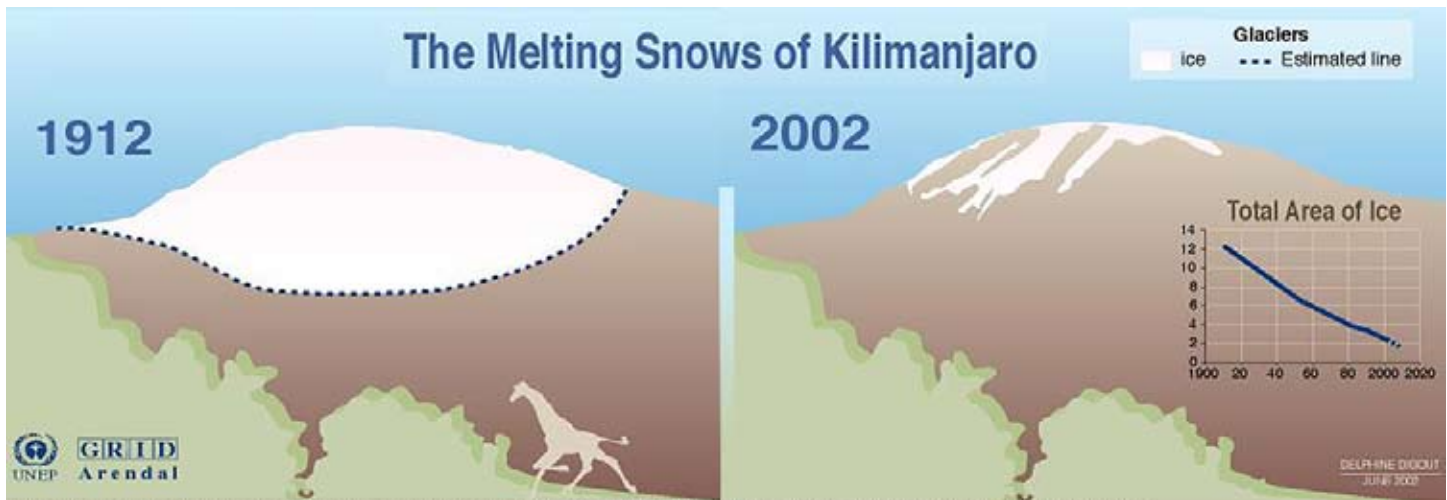
port for African research partners, c) a lack of sensitivity among the U.S. scientific community to values and needs of African host countries and institutions for research that will directly address societal needs and provide policy-relevant information to their wider community, d) inadequate multi-disciplinary networking and integration of the social, biological, and physical sciences to address important issues, and e) weak cross country collaborations among SSA scientists

**The workshop reached a consensual agreement that there is need for a more committed collaboration with SSA scientists and institutions, greater support for SSA participants, and for research to be conducted in a way that mutually enriches the knowledge base and societal needs of participating countries. Inadequate support for SSA collaborators, a lack of sensitivity to local values, and**

**a lack of focus on the applicability of the research to the needs of SSA countries may impede the ability of the U.S. scientific community as a whole to conduct research in the SSA region. Collaborative scientific research in SSA must fully engage and support SSA participants as full partners, and must demonstrate that the research, in addition to meeting the criteria of scientific excellence, also will directly address regional societal needs and provide policy-relevant information to the wider community. This is more than a matter of being altruistic, but rather a fundamental strategic consideration. Failure to address it could have very undesirable and far-reaching consequences for U.S. research in SSA.**

The majority of SSA's peoples are engaged in land-based livelihoods, and human community sustainability is much more directly linked to ecosystem health and environmental conservation in SSA than in many other regions. Much of the ecological research within SSA is driven





**Fig. 2. Monitoring and modeling are required to understand and predict changes in local climates which could exceed thresholds of cyclical recovery for the ecosystems and human settlements.**

principally by societal needs for sustainable, science-based resource management. Innovative research is needed to address the present disconnect between human needs and natural systems and their services. The wellbeing of peoples and of the earth's natural systems requires that our planning and actions be informed by investigations that bridge ecological and sociological components and take a complex systems view. Evaluation of these issues led to two important conclusions relevant to building strong and sustainable U.S.-SSA scientific collaboration.

1) Solving regional and global environmental problems in SSA requires multidisciplinary approaches that address

linkages among biological, physical, and socio-economic components of the environment. Research on coupled human-natural systems (socio-ecological systems) is central.

2) A key to facilitating enhanced collaboration between the U.S. and the developing SSA region is the recognition among the U.S. scientific community that the direct value of the research in addressing key societal needs is of primary importance to African countries and a primary criterion for their support of research.

Other factors such as institutional disincentives, bureaucratic hurdles, cultural

differences, and other regional socio-economic issues have also hindered progress. The HIV-AIDS epidemic currently represents a major barrier to capacity building within the region. The lack of networking and coordination among SSA countries also hinders progress in addressing important trans-boundary environmental issues such as water resources, animal population dynamics and management, invasive species, and effects of regional climate change. The lack of Internet resources and inadequate IT infrastructure in African institutions has resulted in many SSA researchers being essentially invisible to the broader international scientific community.



**Unique human-wildlife-livestock-disease interactions in SSA provide excellent opportunities for increased understanding of human and animal disease.**

## Recommendations

A summary of general recommendations of the workshop with regard to scientific issues such as priority research areas, training, and enhancing multi-disciplinary approaches is provided below. In addition, a summary of recommendations regarding operational issues such as IT, infrastructure improvement, and mechanisms to strengthen intellectual collaboration, support, and capacity building are also provided. Further details and specific recommendations are included in the full report.

Scientific Research Needs and Opportunities - The workshop identified 5 important scientific issues and themes of high regional and global scientific importance and relevant to the environment and

societal needs of SSA (Table 1). These include: 1) climate, 2) biodiversity dynamics, 3) animal and human disease, 4) land-use and land cover change, including ecosystem responses to anthropogenic environmental change, and 5) water. Savannas, grasslands, and forests are the most important ecosystems supporting human livelihoods, and are the most extensive, understudied, and rapidly changing terrestrial ecosystems in SSA. Thus, significant research attention to environmental transformations of savannas and forests and their ecological and societal consequences is needed. Water issues are also of high importance, and water distribution, quantity and quality are identified as areas with high potential for application of hydrological engineering.

Given the regional and global importance of these issues, as well as the unique opportunities that the SSA region presents to address them, these are specific areas where research investment in the SSA region is most likely to yield significant new scientific understanding of key environmental processes and problems. It is recommended that NSF enhance support for collaborative U.S.-Africa research and training proposals in the research areas listed in Table 1. More detailed descriptions and examples of specific research needs or recommendations under each area are provided in the full report.

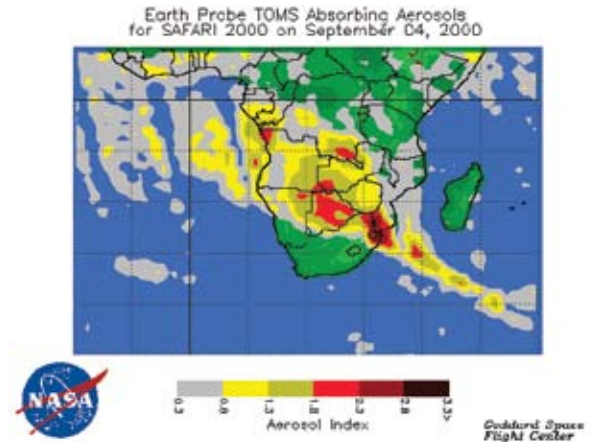


**Anthropogenic alterations in fire and grazing regimes, land use, hydrological regimes and water use, and urbanization represent important environmental transformations in SSA.**

**Table 1. Recommended Areas of Scientific Research on the Environment in SSA**

<b>1. Atmospheric Processes, Climate Modeling, and Climate Change</b>	Studies of key processes influencing regional and global climate, and the patterns and consequences of climate change
	Research addressing changing atmosphere-biosphere interactions in SSA and their role in climate change
	Projects and programs to rescue meteorological and geological data at risk of being lost over time
	Research leading to a better mechanistic and predictive understanding of impacts of climate change on human health, disease, and food security
<b>2. Biodiversity Dynamics</b>	Basic inventories, distributions, and dynamics of the biota of the region, including micro- and macro-flora and fauna
	Research on biodiversity dynamics and conservation in SSA, including loss of biodiversity, invasion of exotic species, and processes regulating diversity
	Studies of relationships between biodiversity and ecosystem functioning, focusing on different levels from top predators to soil microbial communities
	Studies of the relationships between geomorphology and biodiversity distribution
<b>3. Animal and Human Disease</b>	Studies of the causes, epidemiology, and consequences of animal and human disease in a multi-disciplinary context (ecological and human consequences)
	Studies of the role of human-wildlife-livestock interactions as they pertain to disease
	Studies of the impact of zoonotic disease on human resources
<b>4. Land-use and Land-cover Change (LULCC)</b>	Quantification of current LULCC patterns and prediction of future changes
	Studies addressing the implications of LULCC for biodiversity, ecosystem functioning, and human livelihoods
	Local, regional and global impacts of mineral resource extraction and processing
	Impacts of urbanization on human and natural ecosystems
	Environmental change and transformations in savanna/forest ecosystems
	Research focusing on synthesis of LULCC studies, and analyses that scale-up from the local to regional level
<b>5. Water Resources</b>	Research addressing the variability, predictability, ecosystem functioning, and preservation of river basins and wetlands, focusing on complex system-based analysis and effects on human development
	Studies on the human implications of climate change for the future availability of water for humans
	Engineering research aimed at improving water distribution, quality and quantity
	Multi-disciplinary research addressing trans-boundary water issues of lake and river basin systems
	Long-term monitoring of water quality and quantity within the SSA region based on watershed units of analysis
	Research on water and human health, including emerging contaminants, water based infectious diseases, and the socio-cultural dynamics of health and disease





**Urbanization, biomass burning, energy production, and mineral mining and processing are all important sources of anthropogenic atmospheric alterations in the SSA region.**

## **Enhancing Multi-disciplinary Approaches: Integration of Biological, Physical, and Social Sciences**

A clear consensus of the workshop is that there is a critical need for increased support for multi-disciplinary SSA research that effectively integrates the social sciences with the biological and physical sciences to solve important regional and global environmental problems. To promote such inter-disciplinary integration, increased support for research aimed at the following is recommended:

1. Understanding linkages between biodiversity, ecosystem function and sustainability, and human societies, and their implications for global change, biodiversity dynamics, and human livelihoods.
2. Multi-disciplinary research on the land-water-atmosphere interface and biosphere-atmosphere interactions.
3. Research that seeks not only mechanistic understanding of ecological patterns and processes, but also contributes to developing solutions to regional and global environmental problems, including key regional needs for sustainable land-based human livelihoods.
4. Multidisciplinary international collaborative research on trans-boundary environmental issues in the SSA region.

5. Development of new interdisciplinary networks (e.g. support the formation of a network around each of the following topics: water, LULCC, climate change and atmosphere-biosphere interactions, biodiversity/conservation), each emphasizing integration of the human dimension and social sciences

6. The development of models and the strengthening of modeling capability in several areas (outlined in

the full report, e.g. regional climate change, LULCC, social sciences).

The challenge is to build on successful disciplinary and interdisciplinary model projects, some of which are fully or partially funded by NSF. The workshop recommends expanded support for programs such as the Biocomplexity Program and Coupled Human-Natural Systems, and/or new programs with similar goals and focus. In particular, the development of a new NSF program for SSA Environmental Research and Training (SSA-ERT) to fund collaborative research and training activities in the region would be an effective means to strengthen scholarly collaboration between U.S. and African scientists and help to build effective and sustainable scientific partnerships.



**The majority of Africa's people are engaged in land-based livelihoods. Land use and land cover change (LULCC) is a central aspect of rapid environmental change in SSA, with regional and global implications.**

## Operational Issues & Recommendations

The workshop identified need for significant investment in the crosscutting areas required to promote effective multidisciplinary research integration and thereby ensure a successful outcome. These areas include networking, training, capacity building, data, and IT technologies.

Concerning research networking it was proposed that primary activity should occur at the academic institutions level, and driven primarily from within the SSA region, but of course recognizing that assistance from the international community is needed and vital. These partnerships/collaborations should include scientists, policy makers, and the communities that are potential beneficiaries of the research, and ways should be explored for encouraging broader participation of scientists from many SSA countries and multiple disciplines. A specific recommendation to enhance communication and connectivity is to support the development of a web-based database/directory of researchers, projects, institutions, and organizations involved in environmental research and training in SSA.

For training it was recommended that mechanisms should be devised that exploit country-to-country alliances as well as post-doc/post-grad/sabbatical scientists visiting SSA institutions, and similar opportunities to maximize SSA regional resources/expertise for training and research. For a more balanced collabor-

ative US-SSA environment in training, it was recommended that partnership should evolve more towards equal partnership traineeships where SSA scientists are engaged not only as trainees but also as trainers, and in longer-term continuous training programs. Table 2 summarizes the workshop recommendations for mechanisms to enhance training collaborations (see full report for details).

Data issues consumed considerable proportion of the discussions at the workshop because of their critical role in conducting interdisciplinary research. The need for enhanced investment in data rescue/digitization programs, promotion of a culture of free sharing of data through policies and incentives, development of long-term observations, clear-

inghouse databases for archiving data for supporting interdisciplinary collaborative research, and expansion of digital libraries (Table 2) was emphasized. There was consensus that improved IT infrastructure and greater use of IT is required to support interdisciplinary collaboration in the key areas of training, literature and data management, computing, and distance learning. Future efforts should focus on enabling network infrastructure, ready access to new technologies, well-trained local support and ongoing educational opportunities for local engineers and technical and support staff. In addition to training scientists, enhanced training programs for technical and support staff are recommended as crucial for the success and advancement of science and engineering in the SSA region. Details on specific needs or recommendations under each area are indicated in the full report.

**Table 2. Recommended Mechanisms for Enhancing Training and IT in SSA**

Training	IT and Data
Exchange scholar programs	Data rescue programs
Student peer-mentoring	Data sharing policies and incentives
Distance learning	On-line data registries and clearinghouses
“Teach in Africa” program	Technical and support staff training programs
Outreach training programs	Strengthen Government-sponsored national information centers
African field schools	Support IM policies and standardization
Directory of SSA training opportunities	Expansion of digital libraries

## Strengthening and Balancing US-SSA Scholarly Collaboration

The workshop yielded several general recommendations regarding operational strategies for strengthening and balancing scholarly collaboration between U.S. and SSA and enhancing the communication and networking of researchers within and between regions. These include establishment and maintenance of a web-based directory/database of SSA scientific personnel, institutions, and programs; establishment of formal inter-agency partnerships with NSF; forging formal NSF-SSA regional al-

liances, and other measures. In addition, the workshop recommended several specific mechanisms regarding NSF policies for proposal evaluation to insure that U.S. scientists fully engage their SSA counterparts (both local scientists and local communities where appropriate) in all phases of the research planning and implementation, and that U.S. scientists demonstrate broader impacts of proposals relevant to SSA. These recommended proposal criteria include demonstrating the following:

1. Relevance and benefits to the host country
2. Scientific merit
3. Potential for developing sustainable collaborative training and research partnerships and/or capacity building opportunities beyond the period of support
4. Appropriate consideration and compliance with laws, regulations, customs and values of the host country and institution
5. How African collaborators will be fully engaged as partners, and sufficient support for their participation

It was concluded that the NSF and other U.S. funding agencies in general lack sufficient information and awareness about

the importance and needs for environmental research and training in Africa, and how these issues are relevant for citizens of the U.S. and across the globe. Thus, it is recommended that these agencies consider specific efforts to highlight environmental research in Africa to a greater degree.

The workshop recommended specific approaches to strengthen U.S.-SSA scholarly collaboration and foster evenly balanced scholarly exchange, including establishment of formal interagency partnerships and co-funding arrangements and establishment of formal NSF-Africa regional alliances

• **Interagency Partnerships** – The establishment of formal programs for co-funding of collaborative U.S.-SSA research projects by NSF and other agencies whose missions allow support for African scientists based in African institutions would help to create a more mutually sustainable partnership between U.S. and African scientists. It is strongly recommended that the NSF seek formal partnership with other agencies and foundations (both U.S. and international) that have strong and complementary commitments to African science and development (e.g. USAID, CIES/Fulbright Program, Kellogg Foundation, Ford Foundation, Rockefeller Foundation, Carnegie Foundation, Mellon Foundation). Development agencies are transforming the African landscape through multimillion-dollar programs, thus they have a central

role in determining outcomes of human interactions with their environments. Development efforts should be informed by good ecological research. Conversely, science-funding agencies such as NSF could have broader impacts by leveraging development funds. NSF and other science agencies should work with development agencies in institution-building for long-term sustainability. The lack of coordination between NSF and other research or development agencies in supporting environmental research as a foundation for sustainable development is currently a significant barrier. Specifically, a formal partnership between NSF and USAID would be logical and synergistic, as USAID aims to improve human well-being and environmental sustainability, and NSF can most effectively provide the needed sound scientific basis for accomplishing that mission.

• **NSF-Africa Regional Alliances** - It is recommended that the NSF, as well as U.S. institutions, should formally and fully engage with regional networks such as the New Programme for African Development (NEPAD) as an effective means to enhance support for collaborating African researchers and institutions and building capacity within the region.

The workshop concluded that the implementation of these recommendations, outlined above and detailed in the full report, will accomplish much toward the goals of strengthening scholarly collaboration in science and engineering between the U.S. and SSA, building and trianing a new community of scholars, and promoting the multi-disciplinary collaboration, partnerships, and capacity-building needed to address important regional and global environmental issues.

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**References:**

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**Photographs:**

Cover: Biomass burning in SSA 09/25/00 – image courtesy NASA, TOMS; Fig. 1: steep precipitation gradient over southern Africa; p.2: photo courtesy D. C. Hartnett; p.5 left: photo courtesy S. Macko; p. 5 right: image courtesy NASA, TOMS; p. 6 photos courtesy D.C. Hartnett.

**Credits:**

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## Enhancing Collaborative Research on the Environment in Sub-Saharan Africa (SSA)

### KEY ISSUES & CHALLENGES

- Rapid Economic & Environmental Change
- Unique Scientific Opportunities
- Key role in global environment
- Limited capacity and research infrastructure
- Weak US-SSA scientific collaboration & networking

### RECOMMENDATIONS TO NSF

- Key SSA Research Needs and Opportunities
- Policies & Proposal Criteria
- Programs to support collaborative research & training
- Partnerships w/ international agencies and regional organizations