GDEST AFRICA:
GEOSPATIAL SCIENCE AND TECHNOLOGY FOR SUSTAINABLE DEVELOPMENT

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ABSTRACT

The U.S. Department of State, through the office of the Science and Technology Adviser to the Secretary, conducts a series of bi- and multi-lateral studies to examine advanced and advancing science and technology. These studies, called the Global Dialogues on Emerging Science and Technology (GDEST), examine a specific area of emerging interest in different regions of the world. The GDEST for 2008 examines geospatial science and technology in Africa. The GDEST activities are intended to contribute to global security, address human aspects of sustainability, and advance opportunities for shared knowledge on emerging science and technology (S&T). They facilitate interactions between leading U.S. scientists and engineers and their foreign peers with special emphasis on involving young investigators. The GDEST in Africa consists of field visits to a number of African institutions to better understand their capabilities and share insights and knowledge on trends in geospatial science and technology in the United States and Africa. The GDEST also includes conducting a conference focused on geospatial capabilities in Africa. Specific areas of interest are: (1) observing Africa including examining trends and opportunities in monitoring and modeling the environment; (2) analysis of regional challenges to Africa, which examines analytical and visualization tools that bring science into the decision process; and (3) understanding opportunities, constraints, and approaches for getting valid data in a timely and affordable manner in a useful format, and how they can be shared among collaborators.

Key Words: Africa, Geographic Information, Observations, Analysis, Information Infrastructure, Sustainable Development

INTRODUCTION

Science is important to international relations and has been so throughout history. There are two fundamental interrelated views of science and international relations. The first is that science can be an instrument of international relations. That is, science can further the international policy goals of a nation in bi- or multi-lateral relations to help support, among other things, humanitarian response to natural disasters, the economic viability of the nation, or strengthening national security and homeland defense. A second view is that international relations can help further the goals of science, technology, and health (STH). In this view, foreign policy can be an instrument of, among other things, developing scientific monitoring networks that help improve understanding of the earth; developing agreements that ensure the free exchange of scientific knowledge, materials, specimens, and other items that form the raw material of scientific advances; and facilitating the interactions among scientists to conduct research and exploration.

Noting a decline in the visibility of science in the Department of State, the National Research Council of the National Academies recommended to the Department of State that it increase its activities with respect to STH (NRC 1999) because they are historically important to international relations and will be increasingly so as time goes on. To partially meet that recommendation, State established the office of the Science and Technology Adviser to the Secretary of State (STAS). That office conducts a variety of activities to help stimulate the use of science within the U.S. foreign policy apparatus and identify emerging scientific issues that will be important to foreign policy in the future. Among those activities are the Global Dialogues on Emerging Science and Technology (GDEST).

GLOBAL DIALOGUES ON EMERGING SCIENCE AND TECHNOLOGY

Although scientists from many nations come to the United States to do work, far fewer U.S. scientists participate in activities in other countries. GDEST activities are designed to help scientists in the United States increase their interactions with scientists from other parts of the world on emerging scientific topics and are expected to develop rapidly and to have important implications for global economics, sustainable development, humanitarian intervention, national security, and other issues of importance to international relations. The overall GDEST activity has the following objectives (DOS 2005):

- "To provide leading U.S. and foreign science and engineering researchers in cutting edge fields an opportunity to explore research directions and challenges with their counterparts having outstanding capacity in those disciplines;"
- "To provide U.S. researchers with exposure to a broad cross-cutting sample including the most promising junior investigators in the country or region in order to facilitate future international collaborations; and"
- "To identify common interests between current and future U.S. and foreign research leaders in selected emerging fields."

The GDEST activities were first established cooperatively between the U.S. Department of State and the National Academies of Science in 2005 to conduct bilateral meetings among scientists of two nations. In 2006 the meetings were organized by the Department of State on a multilateral basis. Table 1 shows the nations involved and the topics that were discussed. The 2008 GDEST took place in Africa.

Table 1. GDEST activities from 2005 to 2008.

Year	Participant Nations	Topic
2005	Japan	The future of sensors and sensor systems
2005	Germany	Quantum information and coherence
2005	India	Agricultural biotechnology
2006	China	Genomics: new tools for combating infectious diseases
2007	South America (Brazil, Argentina, Peru, Chile)	Bioinformatics
2008	Africa (Botswana, Burkina Faso, Kenya, Niger, Nigeria, Rwanda, Senegal, South Africa, Uganda)	Geospatial science and technology for sustainable development

GDEST 2008: GEOSPATIAL SCIENCE AND TECHNOLOGY IN AFRICA

Africa, at more than three times the area of the United States, is a highly complex biophysical environment. Its population, more than 922,000,000 in 2005 and expected to grow to 1,394,000,000 by 2025 (UN 2006), currently ranges in annual per capita income (PCI) from $600 in Malawi to $13,300 in South Africa. For comparison, the world average is $10,200 and the United States PCI is $43,800 (CIA 2007). Population growth will make some small countries more populous than much larger ones; for instance, Ethiopia will have a larger population than Russia by 2030 (FP 2007) if current population trends continue. Africa, which contains some of the world's most unstable countries and some of its poorest people, will experience this rapid population growth in most areas. Cohen (2003) points out that Africa's population density will increase from 0.8 times that of Europe in 2000 to 2.2 times that of Europe by 2050. More than half of Africa's population will live in urban areas by 2025 (UN 2002). Urbanization will likely cause increase in communicable and vector borne diseases (Keiser and others 2004). This will occur at the same time that Africa's rural population grows, but at a much slower rate. This increase in population will put intense pressure on the environment. However, in some areas Africa will also experience a large drag on its economic growth caused by a loss of working age population due to AIDS and other diseases and political strife. Yet, in spite of all these problems, Africa is a continent of enormous natural beauty and wealth.

To tap that wealth for the sake of the people of both Africa and the rest of the world will require a cooperative effort between Africans and the rest of the global community. Part of that effort involves participating to the maximum extent possible in the world's scientific community. Doing so will help Africans and their international partners address the complex of issues facing the continent as it strives for sustainable development. These include extreme climatic events and climate change, natural hazards and disaster response, health and disease, food production and access to nutrition, urban planning, management of vast and imperiled biodiversity, and governance and conflict resolution.

Geospatial science and technology are incredibly valuable to sustainable development. There are numerous excellent examples. In the United States, for instance, economic sectors relying on geospatial information and technology accounted for $3.56 trillion in 1998 (NAPA 1998) which meant that 40% of the U.S. economy in 1998 depended on geospatial science and technology (Kelmelis 2001). That was before the advent of commercial offerings such as Google Earth and Google Maps and before locational services such as GPS became common place in cell phones and automobiles.

Geospatial science and technology have been important in the development of Africa. In both the more and less developed areas of fourteen African nations, such geospatial capabilities as the Famine Early Warning System Network (FESWNET) integrate biophysical environmental information with knowledge of cultural conditions to help reduce the potential for famine due to drought, flood, pestilence, social unrest, and infrastructure capacity. Other geospatial data, information, tools, and analyses have been used to help develop resources, maintain and improve health, locate and monitor water resources, and develop infrastructure, along with numerous other tasks. Nonetheless, with the vast expanse of Africa and the highly variable nature of its social and engineered infrastructure, learning more about the strengths, opportunities, and difficulties of using geospatial science and technology for the betterment of the population is important for this developing continent. From a geospatial

technology viewpoint, Africa presents a unique challenge because of its relatively poor integration into the digital world. For instance, the penetration of the Internet into Africa is only 4.7% compared to 21.5% in the rest of the world (IWS 2007).

The United States presented a highly successful project, Geographic Information for Sustainable Development (GISD), at the World Summit for Sustainable Development (WSSD) in Johannesburg, South Africa, in 2002. GISD demonstrated the value of using a variety of data and analyses from numerous natural and social science disciplines in a geospatial information science context to address important sustainable development problems. GISD also formed the basis for a training course in remote sensing for sustainable development at WSSD university; supported production of "Down to Earth," a report written in textbook form on using geospatial science and technology (GST) for sustainable development (NRC 2002); and acted as a springboard for a training program for young people called "My Community Our Earth" (AAG 2002). GISD clearly demonstrated how information from the then nascent Global Earth Observing System of Systems could support sustainable development. Still, it is important to understand the current status, opportunities and impediments for using GST in Africa and the possibilities for cooperation.

To better understand geospatial science and technology in Africa and to meet the objectives of the program, the GDEST 2008 activity established two groups of government and academic scientists and engineers. One group visited government and non-government institutions in selected countries in western Africa, while the other did the same in selected countries in eastern and southern Africa. The groups came together in South Africa to compare observations and convene a workshop of participants from the United States and throughout Africa. The teams focused their efforts on three areas of geospatial science and technology:

- **Observing Africa:** documenting how Africa and the world are currently obtaining information about Africa's physical, biological, and cultural environments, including examining trends and opportunities in existing and potential monitoring techniques, systems, networks, and other capabilities;
- **Analysis of regional challenges to Africa:** identifying the analytical capabilities in and for Africa and learning how decisions and policies have been directly influenced by modeling, analysis, and visualization tools; and
- **The African data stream:** defining constraints and approaches for accessing valid data in a timely and affordable manner in a useful format and how those data can be shared among collaborators.

The teams consisted of members from government agencies (State, USAID, National Geospatial-Intelligence Agency, U.S. Geological Survey, and Bureau of the Census) and the academic community. The teams spent two weeks visiting organizations and individuals to discuss geospatial science and technology. After visiting the host countries, the teams held a conference in Cape Town, South Africa. Participants from throughout Africa, the United States, and other parts of the world came together to present current research and discuss opportunities and challenges to advancing geospatial science and technology in Africa.

THE GEOSPATIAL SCIENCE AND TECHNOLOGY SITUATION IN AFRICA

Although Africa has vast resources with high economic potential, that potential has been realized only in some select areas. Likewise, the potential exists for the successful use of geospatial science and technology (GST) in Africa, and, indeed, there are sound examples of Africans successfully using and advancing GST. However, there are a number of factors that limit the broad and general use of GST throughout Africa.

The Existing African GST

The use of geospatial information, including remote sensing, in Africa has grown tremendously since the 1970s. Africa is now at the point where the use of geospatial information is generally accepted, though budgetary support for regional platforms, networks, and national governmental institutions remains weak and highly variable according to the vagaries of donor funding.

The community of geospatial experts in Africa has taken the initiative to establish organizations and networks to promote and develop the use of geospatial information. Some examples include the Environmental Information Systems of Africa (EIS-Africa), African Association for Remote Sensing of the Environment, Tracks 4 Africa, African Geospatial Information Research Network (a cooperative effort of EIS-Africa and Human Science Research Council), and Regional Center for Mapping of Resources for Development. However, this initiative has not always been met with an equal ability to secure funding from key clients, particularly national governments. This lack of

governmental funding has engendered a high level of dependence upon donor funding, with the result that highly imaginative and high potential initiatives wither or disappear upon the end of the grant. Some efforts have been made to achieve cost recovery for services or product developed, but these too often fall victim to the willingness and ability of national entities to pay.

The capacity to carry out geospatial analyses is quite robust within the context of Africa's abilities. Rather than building capacity *per se*, African experts have called for building upon existing capacity in a collaborative manner. With the advent of programs by the U.S. National Aeronautics and Space Administration, European Space Agency, and other space or remotely sensed data agencies to provide imagery and baseline geographic data at low or no cost, the use of these key data is becoming prevalent. However, the scientists using these data still need to develop innovative analytical algorithms, models, and analytical frameworks to directly address the decision-making process at local, national, and regional levels. Although global activities such as the Global Spatial Data Infrastructure, International Steering Committee for Global Mapping, and the Global Earth Observing System of Systems are providing important opportunities for African participation and capacity development, more needs to be done on the continent. A key challenge to sustaining this capacity is to encourage national governments to understand and appreciate the overall potential of geospatial science and institutionalize these efforts as part of the business of government. One way to demonstrate this support is to invest their own budgetary resources rather than depending upon donors. Another is to ensure that resources, regardless of their source, support GST activities and to use the results of GST analysis.

Opportunities and Challenges

Our experience with African GST has unveiled both opportunities and obstacles. Both are intertwined. For every challenge there is an opportunity; likewise, for the opportunities we identified, there are some obstacles. Six fundamental issues are listed here.

Human environment. The population of Africa is generally the poorest and least educated in the world. It also is the one with the least access to modern technology and knowledge about that technology. What is known as the digital divide – the separation between the technologically literate and endowed population and the population that is not – is the widest in Africa. Still, in Africa there are educated and interested people. Though the educated and technologically literate portion of the population is small, improved educational opportunities can help expand that cadre. Such an effort would take time and considerable resources. Without adequate support, the education system will not be able to sufficiently educate and train an expanding population literate enough to use advanced GST for sustainable development.

Natural environment. Africa has vast energy resources such as the largely untapped geothermal resources in the rift valley and petroleum deposits in western Africa and elsewhere. These resources can fuel a growing economy and growing information infrastructure and provide great opportunities. Likewise, the natural environment provides challenges. At three times the land area of the United States, there are vast areas that have no reliable communications network. In addition, there are terrain, forests and jungles, and vast arid regions that are difficult to either span or penetrate with a communications network sufficient to transfer the large files often necessary for GST analysis. Yet, these are not insurmountable obstacles. Both advancing technology and growing economies can help overcome them. To gain the advantages of the vast resources of Africa, GSTs offer indispensable capabilities for prudent land and resource management. This is particularly important as population grows, becomes increasingly urban, and expands its environmental footprint.

Intellectual capital. There is a small but increasing cadre of well qualified scientists, engineers, and technicians in some African countries who participate in GST activities, use the results of GST, and contribute to the advancement of the state of the art. The existing participants in the field are well qualified to participate in the global community of specialists. However, the current growth in numbers is not yet sufficient to expand and maintain a pipeline of educated and trained individuals if the use of GST is to meet the need for modern approaches to sustainable development. There are neither sufficient educational opportunities on the continent nor sufficient paid positions to retain trained people in the field.

Governance. Several opportunities exist to advance the development and use of GST in Africa. Given that few nations have the capacity or capability to address all concerns themselves, cooperative regional international consortia can be established to share and maximize the intellectual and technical resources. The fledgling networks that are developing could be additionally supported both by the nations of Africa and the international donor community. The information and technical resources extant within governments could be shared to the benefit of all. Existing networks of various types (geospatial, seismologic, meteorological, etc.) can form consortia both within and beyond Africa to share technical and intellectual resources and reduce the overall costs per participant.

Technological capacity. Although most African nations do not have sufficient technological capacity of their own, cooperative activities could be undertaken. African nations can work with each other to develop standards of acceptance so that the technology received is capable of interacting with the variety of commercial and open source options that exist. As more hardware and software options become available, African nations should insist that any technology that they adopt or that is provided by donors meets international interoperability standards.

Supporting infrastructure. A major limiting factor for African GST is the lack of a reliable electric grid and the very limited availability of telecommunications. Development of technologies that overcome these limitations should be a high priority of both donors and African nations.

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