Development and Utilization of Remote Sensing Technology in Africa

BY ADIGUN ADE ABIODUN

In spite of the infusion of much foreign assistance, mostly in support of training that could result in the application of remote sensing technology in many African countries, the continent remains in need of a much wider application of this technology. This paper analizes the state of the development and utilization of remote sensing and related technologies in Africa. Given that these technologies continue to benefit from advances in electronics, digital technology, the information age and the attendant information revolution, one of the challenges facing most of the African countries is how to enhance their fundamental understanding and appreciation of remote sensing and related technologies. The greater challenge is how Africa can place more emphasis on its scientific, technological, and monetary contributions to the progressive development of these technologies and their effective utilization to solve its problems and advance its own future. Unflinching commitment to political leadership level is critical to the attainment of such an objective.

Introduction

Balloons of the late 1700s, which were pioneered by the Montgolfiers Brothers and served as testimonies to Socrates' earlier postulation, "Humankind must rise above the Earth - to the top of the atmosphere and beyond - for only thus will he fully understand the world in which he lives (Socrates 500 B.C.)" have now given way to the satellites and space vehicles of the second half of the 20th century. In 1948, Fred Hoyle, a British astrophysicist, wrote that, ". . . once a photograph of the Earth, taken from the outside is available - once the sheer isolation of the Earth becomes plain - a new idea as powerful as any in history would be let loose." His prediction has since become a reality. Earth observation systems now in operation, and those planned for the future, include a variety of satellites and high-resolution sensor systems meant for collecting data for use in such activities as meteorological observations, Earth resources surveys and management, environmental assessment, coastal studies, marine observations, disaster mitigation, national security, and various civil works. Ongoing demonstration and operational projects on the application of different aspects of space technology to food security, forestry and water resources assessment, fisheries and marine resources, mitigation of natural and anthropogenic disasters, environmental pollution control, communications and information exchange, education and healthcare and transportation are a clear testament to the contributions of the technology in meeting Africa's development needs. In spite of this realisation, only a very limited number of African countries such as Egypt, Morocco and South Africa are moving ahead, while there is the possibility of a renewed commitment in Nigeria. With the support of a number of international entities, several other African countries are making use of remote sensing technology in their development efforts. But why should African countries actively participate in remote sensing, and what should be the manner of their participation?

Images used in this article courtesy of Art Today. These images were not provided by the author and are not intended to illustrate specific text.

Remote Sensing in the Service of Africa

The contribution of remote sensing, Geographic Information Systems (GIS), and Global Positioning Systems (GPS) to mineral exploration in Africa by foreign companies, is a story that will one day be told, albeit, in the positive. In addition, there are a number of problems that are peculiar to the tropical world, including Africa,

for which these technologies can make significant contributions to their solution. For example, Africa needs to understand its ever-present tropical clouds, their formation and their characteristics, as well as the extent and distribution of its natural resources. Achieving such an understanding requires a significant measure of local research and development efforts in microwave technology. This knowledge is also essential for the determination of stratified atmospheric composition, temperature and humidity soundings. These elements are needed for accurate weather forecasting and, if necessary, cloud seeding, particularly for the benefit of Africa's farmers. The roles remote sensing can play in the management of Africa's natural resources and environment are addressed below.

Agriculture, forestry and water resources: For more than two decades, African scientists have been calling attention to the urgent need for Africa to develop and apply the most practical tools possible to tackle the challenge of boosting sustainable food production, and of assessing the extent and rates of desertification and deforestation which have had an impact on both crop and livestock production. Today, reliable space-acquired multi-temporal and multi-spectral data are being used globally to up-date inventories of agricultural resources through the production of relevant maps and charts on water resources, soil characteristics, land-use practices and deforestation. Copious data on most of Africa's territory have been acquired over the years by several satellites, and capable African scientists are available to make productive use of such data in the interest of their respective countries and the continent as a whole. At present, however, such data are only finding application, mostly through donor supported projects.

Fisheries and marine resources: Phytoplankton is a major element in the food chain of most fish types, and it is found to be associated with upwelling systems. Coastal upwelling areas are among the most productive regions of the world's oceans. Such upwelling regions include the coastal zones of Peru and Ecuador, the west coast of North America, and the northwest, west, south, and northeast coasts of Africa. At present, a number of space-faring countries are using several aspects of space technology such as the Coastal Zone Color Scanner (CZCS) on board NASA's Nimbus satellites and the sensors on board the European Space Agency's METEOSAT and ORBIMAGE's satellites to monitor and harvest the fishery resources from these productive regions of the world, including those near Africa's shores.

"Humankind must rise above the Earth – to the top of the atmosphere and beyond – for only thus will he fully understand the world in which he lives"

– Socrates 500 B.C.

There is a need for Africa to better understand upwelling characteristics along its coastlines, its impact on marine stocks, and how to enhance the exploitation of its marine resources to guarantee their conservation and protection. Satellite remote sensing can be of assistance in such an effort.

Natural and anthropogenic disasters: Africa is not immune from disasters, whether human-made or natural. The devastating Sahelian drought and famine, which began at the end of the 1960s and continued to the early 1980s, was particularly harsh on Ethiopia and the countries within the Sahel region. The drought made a mockery of the hydrological predictions and the rosy economic projections associated with the design and construction of Lake Kainji and Dam project in Nigeria. Lake Chad has also not recovered from its effect. In West, East and Southern Africa, drought and the attendant desertification and flash floods are equally common, and the vulnerability of the affected societies is often very drastic and tragic. Forest fires are also a common occurrence in most African countries, as well as floods and landslides that have occurred in those areas that have lost their forest cover. Space technology cannot prevent these disasters, but it can contribute to the lessening of the environmental vulnerability of our planet.

Environmental Pollution Control: Unregulated discharge of domestic and industrial wastes; emissions from the exhaust systems of motor vehicles, particularly in the urban centers; deforestation; and, oil-related pollution are among the key contributors to environmental degradation in the continent. Although oil has brought much wealth to a few African countries, it had been accompanied by extensive pollution of the coastal waters that are rich in living resources. The shores of Algeria, Gabon, Libya, Nigeria, Kenya and Egypt have been particularly hard hit. Gas flaring is another major environmental problem in the oil-rich African countries. These fires have been observed daily by a number of Earth observation satellites that pass over the continent. Apart from its economic loss, gas flaring is also contributing to the greenhouse effect and the corresponding global warming. Indeed, among all the petroleum producing countries of the world, those in Africa collectively flare the largest quantity of gas, that is, in excess of 30 billion cubic meters per year. All of these pollution problems can be monitored and corrective measures taken with the aid of satellite-acquired data.

The above examples indicate that Africa should commit itself to a thorough understanding of remote sensing technology, invest in developing necessary infrastructure and appropri-

CONTINUED ON PAGE 677

CONTINUED FROM PAGE 675

ately apply the technology to address its development programs, as well as solve its problems.

The Dawn of Remote Sensing in Africa

Until 1960, when the first meteorological satellite, Tiros, was launched by the United States, virtually all of sub-Sahara was an overseas possession of one colonial master after another. By the time the first civilian Earth observation satellite, ERTS-1 (later renamed Landsat) began orbiting the Earth in 1972, most of these former colonies had attained their political independence. And, as in other areas of science and technology, Africa's participation in remote sensing began as, and still remains, a technology transfer effort with 99 percent of the effort focusing on what the technology can do without a parallel devotion to an understanding of why and how the technology works the way it does.

United Nations system and intergovernmental entities: At the First United Nations Conference on the Exploration and Peaceful Uses of Outer Space, held in 1968 in Vienna, Austria, Sierra-Leone spearheaded the African drive that subsequently resulted, in 1971, in the creation, by the United Nations General Assembly (UN-GA), of what is known today as the United Nations Program on Space Applications (UN-PSA) in the Office for Outer Space Affairs (OOSA) in Vienna, Austria. This program was established upon the recommendation of that 1968 conference to assist member States, particularly the developing countries, to further their knowledge, participation, experience, and application opportunities in space science and technology. The first major training course organized by the United Nations, under the auspices of the Program, was attended by several African scientists and engineers, including the author of this paper. It focused on remote sensing and was hosted in Tarbes, France, on behalf of the Government of France, by the Centre National d'Etude Spaciales (CNES) in August-September 1973. This United Nations pioneer effort was immediately followed by similar efforts in a number of African countries. Among the follow-up activities were the UN/FAO Training Seminar on Remote Sensing of Earth Resources and Environment held in Cairo, Egypt in September 1974; the UN/WMO Training Seminar on the Interpretation, Analysis and Use of Meteorological Satellite Data held in Nairobi, Kenya in October 1974; and the Remote Sensing Conference to Monitor Desertification which was convened in Accra, Ghana, in April 1975 by the United States Information Service (USIS) and NASA, in cooperation with Ghana's Council for Scientific and Industrial Research (CSIR). These co-sponsors from the United States organized a similar conference in April 1975 in Bamako, Mali. The International Development Research Centre of Canada (IDRC), acting on behalf of the Canadian Government, sent a mission to Ghana, Sierra Leone, and Nigeria in March/April 1975 to assess the level of interest in remote sensing in these three countries and to determine the scope of support needed to establish a sub-regional remote sensing program in the three countries. The mission was undertaken by the author of this paper on behalf of IDRC. The report of the mission is available at the Headquarters of IDRC, 60 Queen Street, Ottawa, CANADA.

National initiatives: At the national level, particularly in the mid-1970s, a number of African countries began to take what appeared to be promising steps in the development of the technology. For example, with overseas aid from Canada, Sweden, and United States, Kenya established the Kenya Range-land Ecological Monitoring Unit (KREMU) within its Department of Resources Surveys and Remote Sensing, where the application of remote sensing became prominent. At that same time, Kenya also began to nurture the idea of converting its Italian-developed rocket launching station, off San Marco Island, into a remote sensing ground receiving station. In Kinshasa, Zaire, in January 1975, NASA and Zaire signed a Memorandum of Understanding (MOU) which called for the establishment of a ground receiving and data processing station in Kinshasa. A similar agreement was entered into by Upper Volta and France. At a tripartite (Canadian International Development Agency (CIDA) and CCRS represented Canada, USAID and NASA represented the United States, and both CNES and the French Foreign Ministry of Cooperation represented France) meeting held at the Canada Centre for Remote Sensing (CCRS) in Ottawa, January 26-29, 1977, the parties agreed to establish a basic remote sensing ground receiving and data processing station in Upper Volta, and a training and user assistance center at the French communications facilities in Ouagadougou. While the training and user assistance center was developed, the ground receiving station never materialized.

With financial support from the United States Agency for International Development (USAID) and technical support from the University of Kansas, Egypt, under the leadership of its National Academy of Scientific Research, established and equipped a remote sensing center in Cairo at a cost of $1 million US. Ghanaians within the government and the universities were sufficiently satisfied with the manner in which their CSIR handled the 1974 USIS/NASA-sponsored conference and subsequently looked upon the council for leadership and guidance on remote sensing development in the country. In Nigeria, a national proposal, developed in 1973 by the University of Ife (now known as Obafemi Awolowo University), was submitted by the government to NASA, requesting NASA to repeti-

CONTINUED ON PAGE 678

CONTINUED FROM PAGE 677

tively monitor Nigeria's geographical area with the aid of its Earth observation satellites. While an agreement to this effect was signed by both parties in late 1975, a Nigerian delegation visited Brazil, Canada, and the United States in late 1976 to observe the remote sensing activities in those countries. In order to translate the mission's outcome into a viable program, the government of Nigeria allocated N10 million Naira (worth $17.5 million US at that time), to establish, within its 1976-80 Development Plan, a complete national remote center, including an appropriate ground receiving station and related data processing facilities. In South Africa, the prevailing political situation in the country at that time foreclosed any interaction with other African countries.

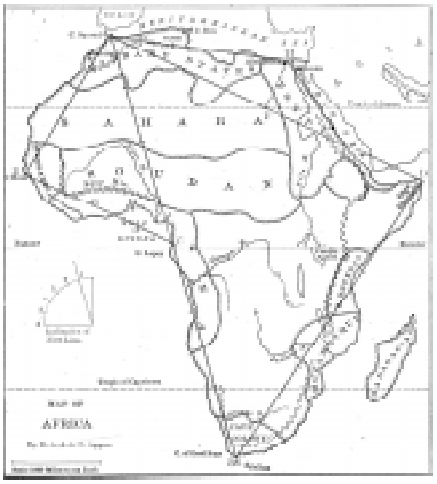
Regional approach: In parallel with these development efforts and national initiatives, there were other initiatives, particularly the 1974 United Nations Economic Commission for Africa (ECA) proposal that the aforementioned national remote sensing development programs should also benefit the entire continent, particularly those countries that were not able to launch similar independent national projects of their own. At its 12th session held on February 28, 1975, the ECA Conference of Ministers decided that, "a center be established in Africa to receive data directly from LANDSAT." This decision received varying degrees of support from the ECA and the international community, and resulted in an ECA-convened Inter-Agency Meeting, held in Addis Ababa on October 23, 1975. Although the Executive Secretary of ECA admonished his audience, at the aforementioned Inter-Agency Meeting, to, "base their choice of the location of the centre on purely technical grounds to avoid difficulties which might arise if other criteria were adopted," the meeting concluded with a recommendation that the proposed national stations in Upper Volta (now Burkina Faso) and Zaire (now Republic of Congo) be adopted as Africa's two main ground receiving stations. The meeting also proposed a rider to the above recommendation to the effect that an appropriate third station could be established to cater to other parts of Africa left uncovered by these two stations.

It was against the above background that the ECA Executive Secretary dispatched a mission to a number of African countries in February 1976, to determine the location of the center agreed to by the 1975 ECA Conference of Ministers. Members of the mission included the representatives of those entities that participated in the Inter-Agency Meeting of October 23-24, 1975. The recommendation contained

in the mission report called for the establishment of not one but five training and user centers to be located in Nairobi, Kenya; Cairo, Egypt; Ile-Ife, Nigeria; Kinshasa, Zaire; and, Ouagadougou, Upper Volta. ECA accepted this recommendation and subsequently convened a series of intergovernmental meetings for the establishment of a remote sensing organization. These meetings finally agreed on the structure of the organization which included:

- The African Remote Sensing Council (ARSC) with a working constitution (The African Remote Sensing Council was formally inaugurated at the September 20-24, 1977 First Conference of Plenipotentiaries of the African Remote Sensing Council held in Ouagadougou, Upper Volta.);
- A Remote Sensing Secretariat;
- A five-year budget of US$12.775 million for the two ground receiving stations; and
- A five-year budget of US$69.548 million for the five training and user assistance centers.

The establishment of ARSC led to the expansion of the mandates of the two existing regional centers, RCSSMRS in Nairobi and RECTAS in Ile-Ife (The center in Nairobi is now known as The Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS). The center at Ile-Ife is now known as The Regional Centre for Training in Aerospace Surveys (RECTAS). According to their new mandates, both centers were to provide remote sensing training, research, data collection, and technical advisory services to member States and their nationals. While the two centers continue to carry out their respective mandates, their ability to do so has depended largely on direct financial support from donors and funding institutions through externally funded projects. Entities, such as WMO and FAO and occasionally, the United Nations Program on Space Applications, continue to work with the centers in the fields of remote sensing and satellite meteorology. Both centers also depend on assessed contributions from their member States for their operating revenue. In an attempt to shape their own financial future and be revenue generating, both centers have also embarked on sale of products, by carrying out contractual obligations for member States through the execution of projects and by organizing training courses at the national level. And, in an effort to speed up the use of remote sensing in



Africa, the United States, through USAID, gave much support in financial resources and equipment, including a donation of all of the negatives and positives of images of Africa acquired by Landsat-1 to RCSSMRS.

The Net Results of the Earlier Remote Sensing Initiatives

The above national and regional initiatives were quite challenging, given the circumstances of that era. If each of the proposals had been carried out as planned, Africa today would have become an envy of the developing world in the field of remote sensing. However, at both RCSSMRS and RECTAS, contributions from member states remain far below assessments. Furthermore, managerial malpractice and the attendant lowering of staff morale also have plagued RCSSMRS. Except for some successes registered by RCSSMRS and RECTAS at the regional level and by Morocco, South Africa, and a few other countries at the national level, the development of remote sensing technology has not been accorded its rightful place of pride in the development process. In the case of Zaire and Upper Volta, the programs envisioned were too ambitious for both countries to undertake and successfully execute, and thus would have financially strangled them. Furthermore, attempts to introduce remote sensing in Africa have remained at the professional and academic levels. The appreciation and understanding of the technology by political leaders, heads of ministries, state governors, and local council chairpersons are inadequate.

Furthermore, there have been problems related to special interests among the members of the Inter-Agency group that was made up of representatives of countries that had other agendas beyond an honest transfer of remote sensing technology to Africa. For example, France wanted one of its former colonies, Upper Volta, to be in charge of the Earth resources data that would be acquired by its own SPOT satellite (which at that time was under construction) instead of a Landsat station in Kinshasa. Accordingly, France proposed to use its communications infrastructure in Ouagadougou at that time as the justification for citing a ground receiving station there, despite the fact that this was not the most technically advantageous location. Also, in 1975 the high price of copper, a major export commodity of Zaire, encouraged the United States to lend its support to the establishment of a second ground receiving station in Kinshasa, Zaire. But, by 1977 the price of copper fell sharply, political equations began to change, and both the African countries involved and their donors became more realistic about their expectations. Neither Upper Volta nor Zaire, the two countries aspiring to host ground receiving stations, pos-

CONTINUED ON PAGE 680

CONTINUED FROM PAGE 679
sessed the required infrastructure, such as uninterrupted electric power supply, reliable communications systems, highly skilled technology-oriented manpower, and financial resources.

The Second Conference of Plenipotentiaries of the African Remote Sensing Council was held in Addis Ababa, Ethiopia, August 11-15, 1980. The donor countries at that Second Plenipotentiary Conference included Canada, France, Germany, the United Kingdom and the United States of America. (The author of this paper represented the United Nations at the Second Conference of Plenipotentiaries of the African Remote Sensing Council.) At that time, it became clearer that the representatives of the donor countries and the African representatives were not on the same wavelength on the issue of developing remote sensing technology in Africa. One of the contentious issues was the authority of both the Governing Board and the Director-General of ARSC over the training and user assistance centers. While the constitution of ARSC called for the five training and user assistance centers to be under the umbrella of the Governing Board of ARSC, the donors disagreed and wanted each center to be independent of the council. The ARSC constitution also called for the establishment of one technical advisory board, but the donors demanded that each center must have its own independent technical advisory board. In fact, the donors warned the African countries at this meeting that if they insisted on the authority of ARSC over all the five centers, they, the donors, would have to reconsider their financial support for remote sensing activities on the continent. On that memorable day, remote sensing development certainly went into reverse gear in Africa. The multiplicity of offices and boards and the infighting among African member States along the anglophone and francophone divide subsequently paralyzed ARSC which today exists only in name in Algiers and with practically no responsibility or financial backing.

In Nigeria, the story was equally discouraging. In late 1976, the Nigerian Government withdrew the N10 million Naira allocation it had made in 1974 to the then National Council for Science and Technology (NCST) for the establishment of a National Remote Sensing Programme including the installation of a satellite Earth observation data receiving station and a data processing center in Jos, Plateau State. The Government took this drastic action because those at NCST that were charged with the responsibility to implement this program had little knowledge of the subject matter and could not move the project forward. They also did not seek any input from

competent Nigerians who would have willingly shared their knowledge and given their input.

Within the international community, all issues dealing with the exploration and peaceful uses of outer space are addressed by the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS). However, out of Africa's 13 member States in this committee, only five are very active in its deliberations; these include Egypt, Morocco, Nigeria, South Africa, and Sudan. The other eight that gained their admission into COPUOS, through the backing of the Organization of African Unity (OAU), from as far back as 1964, have marginalized the interest of Africa within this committee by their non-attendance at its meetings and non-participation in its sponsored activities. However, in spite of a variety of efforts in the form of correspondence, campaigns, and briefings at the highest levels, Africa takes the least advantage of the opportunities inherent in the United Nation Program on Space Applications, whose creation it championed, and the continent benefits the least from the activities of the Program, in comparison with other regions of the world.

One of the factors that could have also contributed to the inactive participation in remote sensing, particularly at the national level, in sub-Sahara Africa, was the rivalry between the traditional surveyors who control government funding for virtually all mapping activities in each country. The new remote sensing community is often regarded as a collection of upstarts by the latter. Of course, there are exceptions. The Ethiopian Mapping Agency, for example, has successfully integrated traditional surveying, remote sensing and geographic information system activities to the benefit of Ethiopia. This author has proposed that the International Training Centre in Aerospace Surveys (ITC) in Enschede, The Netherlands, the organization responsible for training many of Africa's surveyors and Earth scientists, to seriously consider the re-education of Africa's traditional land surveyors in all facets of these new technologies.

Second Phase of Remote Sensing Development and Utilization in Africa

The above developments in Africa, notwithstanding, remote sensing development and utilization are moving ahead rapidly in other parts of the world. For example, public access to 5-meter spatial resolution imagery has been buttressed by the declassification, by both Russia and the United States, of high-resolution imagery of the Earth obtained from satellite altitudes. The commercial sector has responded with great enthusiasm to these developments. These advanced

high resolution sensor systems, many of them with spatial resolution of 1-meter or less, and which were not commercially imagined over a decade ago, will be mounted in over 100 Earth observation satellites destined for launch in the next decade.

Today, many people base their hopes for education, profit, and competitiveness in the abilities of information technologies; remote sensing is one of these technologies. Specifically, the remote sensing information market, particularly in the sales of satellite imagery alone, is expected to reach US$2 billion in a few years. There are also the technology transfer and value-added companies, software developers, image processing work station builders, image analysts, and map makers whose contributions to the growth of the economy depends solely on how successfully they are able to translate the satellite-acquired imagery data into useful information for weather forecasting, for settling flood insurance claims, for guaranteeing food sufficiency in a given society, and for the millions of end-users whose livelihoods depend on such information. Within the next decade it has been predicted that the market value of commercial remote sensing and spatial information industry has the potential to grow from over US$1 billion today to over US$10 billion. The latter is predicated on the fact that new uses continuously are being found for remote sensing-based information and associated technologies.

At the national level: To prepare Africa for the aforementioned future of remote sensing, national and international efforts are in progress on many fronts on the continent. At the national level, while remote sensing courses are now routinely taught in many of Africa's universities, the majority of these institutions are still in need of qualified educators, appropriate infrastructure, and equipment. On data acquisition, the only functioning Earth observation satellite ground receiving station on the African soil today is located outside of Johannesburg in South Africa. During the year 2000, Egypt plans to establish a satellite ground receiving station for the acquisition of Earth observation data. Both Morocco (with the support of CNES and ESA) and the Republic of South Africa have the most up-to-date national image interpretation facilities in the field of Earth observation systems on the African continent. In the field of meteorology and weather forecasting, a few African countries, particularly Egypt, Kenya, Morocco, Nigeria, Senegal, South Africa, and Tunisia have functional High Resolution Picture Transmitting (HRPT) stations for

CONTINUED ON PAGE 682

CONTINUED FROM PAGE 681
the acquisition of data from meteorological satellites, including related data interpretation facilities. A number of budding indigenous value-added companies, with emphasis on remote sensing and GIS, have also taken root on the continent, and can be found in Abidjan, Accra, Cairo, Cape Town, Harare, Ibadan, Johannesburg, Lagos, and Nairobi.

At the regional level: Many application specialists from African countries continue to receive training at both RECTAS and RCSSMRS in the interpretation and utilization of Earth observation data in the development process. RCSSMRS is receiving much support from both the European Space Agency and the FAO. In 1986, RECTAS developed a post-graduate program in remote sensing and subsequently received a six million ECU grant from the European Community to implement the project. It is also receiving support from the French Government. The urban mapping project of the city of Ibadan in Nigeria, which RECTAS recently completed successfully for the World Bank, is a manifestation of the center's current capabilities.

Contributions from the United Nations system and other international entities: Remote sensing is also being nurtured in Africa by many elements within the United Nations system. For example, between 1979 and 1997 the United Nations Program on Space Applications organized 20 activities in Africa that were dedicated to remote sensing, and 37 similar ones globally in which African scientists and engineers took part. On the whole, virtually every African country has participated in these activities. In addition, the Program has spearheaded the establishment of United Nations Affiliated Regional Centers on Space Science and Technology Education for imparting in-depth knowledge on various aspects of the discipline to research and application scientists. African countries have also benefited significantly from a number of key remote sensing activities of the Program, including: * the annual course series, since 1990, on Remote Sensing Education for Educators, hosted by Stockholm University and funded in large part by the Government of Sweden, * the two-week course on microwave remote sensing at the European Space Agency (ESA) facility in Frascati, Italy, and * the three annual

long-term (12 months) ESA fellowships on remote sensing instrumentation and applications and satellite meteorology which are tenable at ESA's establishments in The Netherlands. Through the activities of the Program, the African Association of Remote Sensing of the Environment (AARSE), a professional body that has since gained international recognition, has been established for the benefit of Africa's remote sensing specialists. Its objective is to promote remote sensing technology development and utilization on the continent. At an AARSE/ISPRS-sponsored international symposium on Promoting Space Technology Transfer and Geomatics Education in Africa, held in Cotonou, Republic of Benin, December 6-9, 1999, AARSE successfully launched its first major publication - a 21-chapter book on *Geoinformation Technology Applications for Resource and Environmental Management in Africa*.

The Food and Agriculture Organization of the United Nations (FAO) has undertaken more remote sensing activities in Africa, particularly at the national level, than any other entity of the United Nations system. The latest in its efforts is the Italian Government-funded forestry project known as Africover, a project in which FAO is using the satellite data acquired over the continent to prepare a forest map of Africa. Africa also relies daily on the meteorological data acquired over the continent by Meteosat satellite, which is owned and operated by the European Meteorological Satellite Organization (EUMETSAT). In collaboration with the World Bank, the World Meteorological Organization (WMO) has drawn up plans to set up an advanced hydrological and environmental monitoring system in Africa using Meteosat data. And the AGRHYMET Centre in Niamey is currently assisting nine west African countries, using Inmarsat-A portable satellite communication terminals, to disseminate meteorological data that are used in planning disaster mitigation programs, particularly in agriculture and forestry activities.

Three agencies within the United Nations system, UNEP, UNIDO and UNDP, are currently assessing, with the aid of satellite acquired data, the Gulf of Guinea Large Marine Ecosystem on the Atlantic coast of West Africa, with Benin, Cameroon, Côte d'Ivoire, Ghana and Nigeria as beneficiaries. The objectives of the project include assessment and mitigation of ecosystem pollution, protection of human health, redressing loss of bio-diversity, and capacity-building for marine resource and environmental management. This is a laudable project, but the capabilities of the many remote sensing specialists in the countries covered by the project remain untapped and unutilized, since such specialists that are needed for the project were recruited from outside Africa. While one would also strongly advocate that African countries should urgently put their human and other resources to work in order to protect their economic and related interests along their biologically rich

coastlines, some African coastline states are actually granting fishing rights and licenses to foreign fishing fleets with larger fishing vessels, equipped with the latest elements of information and satellite technologies, to operate in Africa's coastal waters. Hopefully, the lessons learned from the on-going UNEP/UNIDO/UNDP project cited above will rub off on marine resources development and conservation in the region.

With the support of German aid, satellite data are being used in Zimbabwe to undertake land-use planning, vegetation monitoring, and drought mitigation with encouraging results.

Similarly in Tanzania, with the assistance of the United Nations Institute for Training and Research (UNITAR), satellite data have been used in conjunction with ground surveys to combat forest fires. The SCC Satellitebid of Sweden and Stockholm University are cooperating with the University of Botswana in the application of remote sensing for the ecological management of Okavango Valley in that country.

Enhancing Africa's Capability

As one reflects on the role of science and technology, including remote sensing, in Africa's future development efforts, one is reminded of its past and on-going preoccupation with technology applications, without a corresponding commitment to technology development. In this connection, it is pertinent to recall and consider whatever lessons Africa has learned from its over-dependence on technology transfer relative to the views contained in the 1990 Report of the South Commission1 which states, "Unlike the standard industrial technologies . . . , mastery over new sciences and technologies requires high expertise in the relevant basic sciences. Experience has shown that high technologies cannot simply be transferred; the notion that it would be possible for the South [including all of Africa] to obtain them from abroad without the development of an indigenous broad-based scientific and technological infrastructure is mistaken."

Simply stated, an essential prerequisite for a successful technology program is the building of various indigenous capabilities, particularly human resources. In the past decade, achieving such a goal in Africa has been the main focus of the United Nations Program on Space Applications (UN-PSA), that is, to assist the developing countries, including the African countries, to understand, master, and make use of space technology in their social and economic development activities. Through the UN-PSA, the UN has embarked on establishing five United Nations Affiliated Regional Centers for Space Science and Technology Education in the developing countries. Two of these centers were established in Africa in November 1998, one in Morocco (in French), in October 1998, and the other in Nigeria (in English).

"The principal goal of each Centre is the development of skills and knowledge of university educators and research and applications scientists, through rigorous theory, research, applications, field exercise and pilot projects in those aspects of space science and technology that can enhance social and economic development in each country."

"The principal goal of each Centre is the development of skills and knowledge of university educators and research and applications scientists, through rigorous theory, research, applications, field exercise and pilot projects in those aspects of space science and technology that can enhance social and economic development in each country." In so doing, each center aims at building up, in each participating country, a number of capacities, which include the following:

- A capacity to enhance scientific and technological knowledge and experience at the local level, particularly in those application areas (air/land/water including atmospheric studies and mitigation of disasters) that have the potential for a greater impact on each country's economic and social development including the preservation of its environment;
- A capacity to strengthen institutions of higher learning at both national and regional levels in order to support research and development efforts especially those dealing with the understanding and application of environmental information systems. The centers should also prepare educators to develop environmental and atmospheric sciences curricula which they can readily demonstrate and teach in the high schools and universities in their own country; and,
- A capacity to effectively participate in regional and international programs and contribute to the understanding and support of international actions on such issues as climate change and global warming, ozone layer depletion, global deforestation and reforestation, land degradation and management of marine environment.

The success of these centers will depend on the active support and commitment of all African member States, as well as the commitment of the Governing Board of each center, to high quality performance that can earn each of the centers both the regional and international badges that would acclaim it as a Centre of Excellence.

In order for Africa to reap the benefits inherent in remote sensing technology, it is critical that it complements the aforementioned efforts with others that can enhance and broaden Africa's participation in, and contribution to, the development and appli-

CONTINUED ON PAGE 685

CONTINUED FROM PAGE 683

cation of the technology. To achieve such an objective, a number of concerns demand attention and corrective measures among which are the following:

- The need to enhance the knowledge and understanding of political leadership and decision makers, at both the national and regional levels, on the roles of space science and technology in the development process;
- The inadequate articulation of, and commitment to, national policies on science and technology, including elements of space science and technology (remote sensing, satellite communications, satellite meteorology and basic space science) in the development process;
- The inadequate commitment to national capacity-building, particularly in research and development programs, which are pre-requisites to the effective contribution of each nation to the solution of national, regional, and global problems;
- Under-prioritizing and under-funding of infrastructure and skilled manpower development and related facilities, all of which impede the implementation of appropriate space-related activities;
- The untapped application potentials of satellite technology at the national and regional levels, particularly for communication to rural areas for education and healthcare delivery, for disaster monitoring, mitigation and relief, for sustained environmental monitoring and natural resources management, and for search and rescue operations;
- The need for the government, the universities and research institutions, and the private industries in African countries to be co-partners in cost-effective space systems projects including small satellites as well as in translating spin-off benefits of space exploration into viable commercial products;
- The need to recognize that maps and geospatial data are part of a nation's infrastructure, as much as a network of transportation, health care, education, telecommunications, and water supply systems; to gain access to essential information, including affordable, space-acquired data that are applicable to these and other aspects of human endeavor; to use such information to develop necessary data bases that can communicate with one another; and,
- The need to recognize the immense opportunities for regional cooperation, in spite of different national policies and priorities, through the implementation of joint programs and projects that can be mutually beneficial to all.

An assessment of the efforts undertaken to date to develop and utilize remote sensing in Africa clearly shows that much work has been done at the professional level and, to some extent, in developing the necessary human resources.

The Next Step – Leadership Commitment

An assessment of the efforts undertaken to date to develop and utilize remote sensing in Africa clearly shows that much work has been done at the professional level and, to some extent, in developing the necessary human resources. The most important ingredient that appears to be missing is national and regional commitment at the political leadership and decision-making levels. There are many examples of the absence of such a commitment. These include the non-effective utilization of the Landsat-1 data donated by the United States to RCSSMRS and the eventual dismantling of the portable Earth observation ground receiving station at RCSSMRS in Nairobi. The station was installed by TELEOS as a joint venture between Nuovo Telespazio of Italy and EOSAT of the United States. After a period of nine months of operation (September 1994 to May 1995), there were no purchases of the data acquired by the station by the African countries within its footprint. Foreign entities operating in Africa were the only ones that purchased data acquired by this station. The same situation has repeated itself in Libreville, Gabon where, with the support of European Space Agency, the Government of Germany set up a receiving Earth station for acquiring ERS-1 and ERS-2 data over Africa. In the absence of the usage of its data, the station is now in a shut-down mode. The above examples demonstrate that Africa's political leaders and decision makers have neither the understanding nor an appreciation of the role of remote sensing technology in the development process.

The important role of political leadership in moving the frontier of remote sensing forward in Africa was clearly demonstrated at a seminar held at the University of Botswana in October 1998. The seminar was co-sponsored by the Government of Sweden and the United Nations to assess the impact, on the participating African countries, of the Remote Sensing Education for Educator course series held at Stockholm University. From the presentations and contributions by the over 40 participants from 27 African countries present at the seminar, it was apparent that the course series made the greatest impact in the Cameroon where a course participant had become a city councilman and mayor and was able to use his understanding of the subject matter and his political leadership to bring remote sensing to bear on local development activities.

African Leadership Conference: The recognition of the role of political leadership in the development process

CONTINUED ON PAGE 686

CONTINUED FROM PAGE 685

resulted in the convening of the biannual Space Conference of the Americas in Latin America. The fourth in this series was organised after UNISPACE III last year. Similarly, the 2nd Asia-Pacific Ministerial Conference on Space Technology Applications was held in India in November last year, also after UNISPACE III. These two series of regional conferences at the political leadership levels achieved their objectives of strengthening regional cooperation in both the Asia-Pacific and the Latin America and Caribbean regions, two parts of the developing world where the understanding, appreciation, and participation in space activities, including remote sensing, are highest.

Concerned with inaction at the decision-making level at home, and stimulated by the above examples in other regions of the world, the African delegates at the United Nations Regional Conference on Space Technology for Sustainable Development, held in Pretoria in November 1996, called for an African Leadership Conference on Space Science and Technology. This call was also unanimously echoed by the delegates at the Africa-Middle East Regional Preparatory Conference on UNISPACE III, held in Rabat in October 1998. According to its proponents, such an African Leadership Conference should provide the appropriate political guidance and commitment needed if Africa is to take necessary participatory steps and benefit from the opportunities inherent in the different phases of space science and technology. Hopefully, an African country that is capable of championing the cause of the technology will soon offer to host such a conference on the continent, and thus provide the critical missing link in moving Africa forward in remote sensing and in other aspects of space science and technology.

Conclusion

Remote sensing technology is here to stay. It is no longer a preoccupation of only governments in industrialised countries. Today, the private sector is more active and has become the determining factor in the rate of development and progress of the technology, principally by developing cheaper space vehicles, a variety of sensor systems, and launching capabilities as well as by finding many more applications for remote sensing data. The list of developing countries that are staking their interests in the technology is also growing steadily and several of them are becoming space-capable beginning with their investments in specific applications-dedicated micro satellites. The known benefits of active participation in space are many and fully justify the investment and risk. And, because of the high cost of such participation, bilateral, multilateral, and regional cooperative programs have become the norm rather than the exception. Those that are fully benefiting today in remote sensing and other aspects of space technology have acquired the knowledge, understanding, and appreciation of the technology and are investing in its development and growth. They are applying it in their social, economic, and strategic development programs and have the full commitment of the political leadership in their respective societies to move ahead. Africa cannot do less. If it expects to partake in the opportunities, it must, out of necessity, also faithfully address the challenges.

References

Abiodun, A. A., 1998. Remote sensing in the information age, *Journal of SPACE POLICY*, 14: 229-238, Elsevier Sciences Ltd., UK.

Abiodun, A. A., 1997. SPACE EDUCATION, Advances in Space Research (COSPAR), Vol. 20, No.7, pp. 1341-1349, Elsevier Sciences Ltd.

Abiodun, A. A., 1973. Waters of Lake Kainji - Hydrological predictions and performance, *Hydrological Sciences Bulletin*, XVIII (39): 321-326.

Adeniyi, P. O., 1999. *Geoinformation Technology Applications for Resource and Environmental Management in Africa.*

Adeniyi, P. O., 1981. Urban Land Use Mapping. Commissioned Paper read at the Third Annual Conference of the African Cartography Association, Reas Hall, Kaduna Polytechnic, 11-14 November 1981.

Buckley, S., 1997. Senegalese fish for a living in seas teaming with industrial rivals, *International Herald Tribune*, November 4,1997, p. 4.

Doyle, F., 1978. The next decade of satellite remote sensing, *Photogrammetric Engineering and Remote Sensing*, 44 (2).

Fritz, L. W., 1998. Commercial aspects of space remote sensing including spin-off benefits, A contribution to the preparation of UNISPACE-III Background Papers, United Nations Office for Outer Space Affairs, Vienna, Austria.

Makambwe, M., 1979. Evaluation of LANDSAT imagery for geographical research in Africa, *African Geographer Journal*, 22: 77.

Report of the 12th Session of ECA Conference of Ministers held at ECA Hdqtrs., Addis Ababa, ETHIOPIA on 28 February 1975.

Final ECA Report (No. 1975-2132) of the Inter-Agency Meeting on the Establishment of Remote Sensing Satellite Ground Receiving and Data Processing Centre in Africa, 23-24 October 1975.

Remote Sensing in Africa (1976). Report of the ECA Technical Mission on Remote Sensing in Africa, ECA Hdqtrs., Addis Ababa, Ethiopia.

Report of the Fact-Finding Mission to the Regional Centre for Services in Surveying, Mapping and Remote Sensing (RCSSMRS), Nairobi, Kenya, 25-31 July, 1990, prepared for and submitted to Prof. A. Adedeji, Executive Secretary of ECA and Chairman, Governing Council of RCSSMRS.

http://www.crsp.ssc.nasa.gov/CRS/WORKFORC.HTM

The Challenge to the South (1990). The Report of the South Commission, Oxford University Press, New York.

Dr. Abiodun was the United Nations Expert on Space Applications from November 1981 to September 1999. He is presently serving in the administration of President Olusegun Obasanjo of Nigeria as Senior Special Assistant on Space Science and Technology. He can be reached at aaabiodun@cs.com