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Enabling environment for geospatial information technology uptake in Africa

By

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Abstract

1. The Committee on Development Information (CODI) strove to provide an enabling environment for sustainable development through the work of its subcommittees on information and communications technology (ICT), knowledge, libraries and information services, geoinformation and statistics, in recognition of the rapid advances in technology, and particularly in ICT, culminating in the emergence of various innovation systems since the beginning of the twenty-first century.

2. The Innovation in the field of geospatial technology has contributed immensely to decision-making and the knowledge-based economy. The use of web-based geographical information systems (GIS) is growing. Google Earth and Virtual Earth have improved the availability of geospatial information (GI), with the expectation that the resolution of the data will continually improve. Mobile technologies are playing, and will be expected to play, a big role in the use of GI. The number of people who own a mobile phone is increasing rapidly in Africa, and many of these phones are now coming with geospatial solutions such as GPS (Global Positioning System) applications and street maps. This will make mobile devices an increasingly important medium for communication, emergency management and location-based services. Efforts should therefore be intensified to provide an enabling environment for the uptake of GI technology (GIT) in Africa by promoting the development of such technologies as ICT and spatial data infrastructure (SDI) in African countries.

3. To make geospatial data sets available, discoverable, more accessible, shareable, interoperable and reusable, much attention has been paid to the development of SDI in Africa through the efforts of the CODI Subcommittee on Geoinformation. And within the SDI initiative, 10 themes of fundamental data sets have been defined, an inventory of existing ones is in the pipeline, a metadata profile for Africa has been developed, commendable strides have been taken with the implementation of the African Geodetic Reference Frame (AFREF), and human capacity-building is improving, to highlight just a few areas of progress. However, SDI development is progressing very slowly at the national level, and appears to suffer from poor political support and inadequate participation by stakeholders. Moreover, the fundamental data sets are either not available at all or are largely not available in the form and currency required to contribute to the fundamental data sets of the national or regional SDI.

4. The main primary data source for mapping is earth observation (EO) satellite images, with numerous EO satellites (EOS) available globally, but access to satellite images when needed in Africa is still difficult. Hence the contribution of EOS to the uptake of geospatial technology in Africa presents a formidable challenge. Apart from the long revisit period of the majority of the satellites, Africa faces many challenges in the use of the existing systems, including difficulties in obtaining archived and current images in African countries owing to the archiving policy of image producers; difficulties in acquiring cloud-free optical satellite images, especially over forests, coasts and mountains, and limited access to radar images; the absence of permanent receiving stations in the region for the commercial high-resolution and medium-resolution sensors

(such as Ikonos, Quickbird, SPOT and Landsat), except for the African-owned satellites (Algeria, Egypt, Nigeria and South Africa) and Landsat-5 in South Africa; rigid data pricing policy; the lack of continent-wide coverage; and the inadequacy of geodetic reference points.

5. The paper examines some building blocks that are essential for GIT uptake in Africa. These include the provision of AFREF-compliant national and geodetic reference frames; the management of geoinformation archives; the development of national mapping and geoinformation policies; funding issues; human capacity-building; infrastructure and access; and private sector stimulation. A number of recommendations are made designed to promote the rapid uptake of GIT in Africa.

A. Introduction

1. An innovation system has been defined as "… that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies". [5] As pointed out in the concept note prepared for the first session of the Committee on Development Information, Science and Technology (CODIST) (E/ECA/CODIST/I/INF/4), for innovation to occur, scientific, business and institutional knowledge is required from different sources. Thus, an efficient innovation system requires an equally efficient enabling environment.

2. It is axiomatic to state that the goal of an innovation system is to attain national sustainable development. Sustainable development itself was defined by the World Commission on Environment and Development in its 1987 report entitled Our Common Future as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Thus, sustainable development can be explained in terms of intergenerational equity – the principle of equity between people alive today and future generations – and intragenerational equity – implying that production and consumption in one community should not undermine the ecological, social and economic foundations enabling other communities to maintain or improve their own quality of life. Global efforts have been and are continually being made to ensure the attainment of sustainable development in all parts of the world. These include the setting of collective goals such as the Millennium Development Goals.

3. The 2002 World Summit on Sustainable Development focused on 10 strategies for the successful achievement of sustainable development. These are:

- Making globalization work for sustainable development
- Poverty eradication and sustainable livelihoods
- Changing unsustainable patterns of consumption and production
- Promoting health through sustainable development
- Access to energy and energy efficiency
- Sustainable management of ecosystems and biodiversity
- Managing the world's freshwater resources
- Finance and technology transfer
- Sustainable development initiatives for Africa
- Strengthening the system of international governance for sustainable development.

4. Within the various disciplines, action is being taken towards the same goal of sustainable development. For example, the Group on Earth Observations is working on a 10-year implementation plan for the creation of a Global Earth Observation System of Systems built around nine societal benefits:

- Reducing loss of life and property from natural and human-induced disasters;
- Understanding environmental factors affecting human health and well-being;
- Improving management of energy resources;
- Understanding, assessing, predicting, mitigating and adapting to climate variability and change;
- Improving water resource management through better understanding of the water cycle;
- Improving weather information, forecasting and warning;
- Improving the management and protection of terrestrial, coastal and marine ecosystems;
- Supporting sustainable agriculture and combating desertification; and
- Understanding, monitoring and conserving biodiversity.

5. At the African level, the New Partnership for Africa's Development (NEPAD) instituted by the Organization of African Unity is in part a response to the repeated calls of Africa's scientists for urgent efforts to develop and apply the most practical tools possible to meet the global development agenda.

6. Furthermore, at its biennial meetings, CODI, now replaced by CODIST, has also striven to provide an enabling environment for sustainable development through the work of its subcommittees on information and communication technology (ICT), knowledge, libraries and information services, geoinformation and statistics.

7. Since the beginning of the twenty-first century in particular, we have been witnessing rapid advances in technology, particularly in ICT, culminating in the emergence of various innovation systems. Innovation within geospatial technology has contributed immensely to decision-making and the knowledge-based economy. The use of Web-based GIS is growing. Google Earth and Virtual Earth have improved the availability of GI, with the expectation that the resolution of the data will continually improve. Mobile technologies are playing, and will be expected to play, a big role in the use of GI. The number of people who own a mobile phone is increasing rapidly in Africa, and many of these phones are now coming with geospatial solutions such as GPS applications and street maps. This will make mobile devices an increasingly important medium for communication, emergency management and location-based services.

8. However, concerted efforts are still required to enable countries to build efficient innovation systems through investment in research and development, education, ICT infrastructure and geo-infrastructure. This paper focuses on the creation of the necessary enabling environment for the uptake of GIT in Africa in order "to ensure that spatial data permeate every aspect of society and that they are available to people who need them, when they need them, and in a form that they can use to make decisions with minimal pre-processing".[8]

B. Overview of the status of geospatial information in Africa

9. We must note the commendable efforts made in past years through CODI to provide an enabling environment for the uptake of GIT in Africa through promotion of the development of such technologies as ICT and SDI in African countries, including the integration of national information and communication infrastructure and GI policies in national information policy. To make geospatial data sets available, discoverable, more accessible, shareable, interoperable and reusable, much attention has been paid to the development of SDI in Africa through the efforts of the CODI Subcommittee on Geoinformation. And within the SDI initiative, 10 themes of fundamental data sets have been defined, an inventory of existing ones is in the pipeline, a metadata profile for Africa has been developed, commendable strides have been taken with the implementation of AFREF, and human capacity-building is improving, to highlight just a few areas of progress.

10. However, SDI development is progressing very slowly at the national level, and appears to suffer from poor political support and inadequate participation by stakeholders. [2]

11. Through the efforts of the Subcommittee's working group on fundamental data sets, 10 themes of fundamental data sets have been defined, but these data sets are either not available at all or are largely not available in the form and currency required to contribute to the fundamental data sets of the national or regional SDI. For example, in many countries, 1:50,000 topographic maps that serve as base maps are out of date and non-digital; cadastral maps and databases are mostly not available; while in most cases geodetic control points are not yet unified and adjusted and are not sufficiently densely distributed. The 2008 United States Geological Survey Africa Remote Sensing Study [9] indicated that about 60 per cent of respondents mentioned inadequacy of ground control points as a major stumbling block to geospatial data production. About the same number reported that elevation data are not adequate in many African countries. The situation is similar with respect to the other fundamental data sets. These issues need to be addressed in order to create an enabling environment for efficient innovation systems.

12. Thanks to the increasing development of geospatial web portals in Africa such as SERVIR-Africa and the Africa Geo Information Research Network, access to GI through the Internet is improving. However, according to the World Bank, [10] only 2 per cent of the population of Africa has Internet access, and there is a need to increase this number either by huge investment in communication satellites or by improving the undersea cable infrastructure. Other initiatives like GEONETCast and PUMA/AMESD, focusing on connectivity to transfer geospatial data sets to users, are also noteworthy.

13. The use of EOS data to generate development information is rapidly improving in Africa, as the United States Geological Survey study shows. This is especially so following the launching of EOS by African countries – Algeria, Egypt, Nigeria and South Africa - which led to increased awareness on the part of decision makers and civil society in the applications of EOS and GIS. The availability of free archived Landsat data and SRTM DEMs and cheap alternatives like ASTER data are making satellite data more

affordable, thereby contributing to an increase in the uptake of geospatial technology in Africa, while users are also eagerly awaiting the CBERS-2B images (20m resolution) which will be made available free of charge.

14. Recognition of the immense opportunities offered by EO systems for regional cooperation and development has led to the encouraging evolution of the concept of an African Resource Management Satellite (ARMS) constellation programme that includes Algeria, Nigeria and South Africa and is expected to welcome other African countries that are interested in joining the venture in the future. The ARMS initiative is a very encouraging development which NEPAD should capitalize on and strengthen within the framework of its own space science and technology agenda.

15. The United States Geological Survey study indicated that about 79 per cent of GI users in the academic, government and commercial sectors are currently using multispectral EOS data (mainly Landsat), with ESRI software products being the most widely used (about 63 per cent), followed at a distance by Erdas Imagine (14 per cent). One factor that must have definitely contributed to this is the donation of free Landsat archived data and ESRI software, which indicates that data and software accessibility are key to the uptake of GIT in Africa.

16. Even though Landsat and SPOT are the two most popular satellite images used, the study indicated that the most desired spatial resolution for satellite images was 1m - 5m, followed by 63cm - 90cm and then 5m - 120m. Consequently, access to the high-resolution images needs to be given adequate attention.

17. Again, a Geo-Africa satellite with 25m resolution XS and 75m SWIR, a 300km swath and a daily revisit being proposed [1] will play a very useful role in the generation of fundamental data sets for SDI in Africa.

18. Commendable as the current efforts are towards providing an enabling environment for the uptake of GIT in Africa, we need to identify the existing challenges and provide solutions to them. Some of these challenges are indicated below.

C. Factors responsible for slow progress in the uptake of geospatial information technology in Africa

19. The main primary data source for mapping is EO satellite images; although numerous EO satellites are now available globally, access to satellite images when needed in Africa is still difficult. This is a formidable challenge to the uptake of geospatial technology in Africa. Apart from the long revisit period of most of the satellites, Africa faces a lot of challenges in the use of the existing systems; these include:

- The difficulty of getting archived and current images in African countries owing to the archiving policy of image producers: images are most often acquired only following a commercial request, which means that there will not be any image in the archive for any area for which there has never been a request. Consequently, even for

new development programmes that can make do with images captured within the past five years, such images will still not be available because of the aforementioned archiving policy. As a result, study of change detection over the years, such as that of land use changes, is hampered in many African countries;

- The difficulty of acquiring cloud-free optical satellite images, especially over forests, coasts and mountains, and limited access to radar images;
- The absence of permanent receiving stations in the region for the commercial high-resolution and medium-resolution sensors (such as Ikonos, Quickbird, SPOT and Landsat), except for the African-owned satellites (Algeria, Egypt, Nigeria and South Africa) and Landsat-5 in South Africa. This retards direct data reception and the processing of high-resolution satellite images in Africa, thus increasing the overall cost of satellite image acquisition;
- Data pricing policy. Various calls have been made to image providers to introduce more flexible licensing and pricing policies for their products. For example, when a government department purchases a single user-licence image for a project in a particular year and it happens that another department of the same government needs to implement another project a few years later for which the same image would be useful, the government finds it unacceptable that it may have to pay again to enable the second department to legally utilize the same image the government had earlier paid for;
- The lack of continent-wide coverage. At the moment, unless one uses NigeriaSat-1 and Alsat-1 with a large swath of 600km, obtaining recent complete coverage of Africa (about 30.2 million sq. km.) even with medium-resolution satellite imagery for a continent-wide project would impose an enormous burden, given the low foreign exchange capacity of many African countries, yet if we want to meet the objectives of NEPAD on regional integration, then it is essential to have access to such images at affordable cost; and
- The inadequacy of geodetic reference points for georeferencing of images and other survey and mapping applications, as attested to by the United States Geological Survey study, in which about 60 per cent of respondents indicated inadequacy of ground control points as a major stumbling block to geospatial data production.

D. Some essential building blocks for GIT uptake in Africa

1. National geodetic reference frame

20. As indicated above, there is a preponderance of inadequate national geodetic controls in Africa, to the extent that survey plans required for the registration of land titles are still being tied to a local origin determined by solar or stellar observations. Mere sketches are even acceptable officially in some cases. Apart from the fact that the planimetric controls may be based on different coordinate systems, they are usually not unified with the vertical control points, whereas many applications such as urban and land management in cities with multilevel buildings now require 3D geospatial data. To facilitate adequate and fit-for-use geospatial data for various applications, it is therefore necessary to intensify the implementation of AFREF as well as other national geodetic reference frames.

2. Geoinformation archives

21. Information archives are in general a critical component of any infrastructure providing the enabling environment for innovation. Much of the GI archives in Africa are still paper-based, and this limits their accessibility. In many cases, the data are so obsolete that new mapping is required, yet it is also essential to convert the obsolete maps to digital form for time series analyses. This leads to double costs that will be difficult to sell to political decision makers. We therefore need to address this issue of converting the existing analogue data and the appropriate archiving of the converted existing data and the newly produced current digital data.

3. National mapping and geoinformation policies

22. As a result of the promotion of the development of SDI in Africa, many African countries have realized the need to implement components of the infrastructure. They are also conscious of the need to adopt policies for promoting greater awareness of and public access to standard and coordinated geospatial data production, as well as their management and dissemination by all sectors, including the establishment of a geospatial data clearing house at various levels in the country (local, state and federal), with linkages with the private sector.

23. In pursuance of the above objectives, various countries have put or are putting in place procedures to produce a national GI policy, with South Africa being the first and the only country known to have enacted a national spatial information bill. The establishment of SDI backed by a national policy will certainly eliminate most of the problems experienced by GI producers and users in African countries today. An efficient functioning SDI and the associated national policy should be regarded as vital requirements for sustainable national development.

24. Moreover, it is important to consider institutional and policy issues before the introduction of GIT either at the national or at the institutional level. Policy issues must be thoroughly considered and addressed so that difficulties that may arise are dealt with and action taken in advance. Policy issues should be considered regardless of the scale of implementation of the GIS - in large or small organizations, at the national, State or local government level.

25. The importance of geospatial data and information policy has been succinctly expressed in the SDI Guide:[7]

> "….. some institutions refuse to share their data, either because of a restriction on these particular data, or because of the absence of a policy relating to provision of data altogether.
> "Even in the situation where a data policy exists, it may not have been ideally elaborated, i.e. in such a way that people apply it by consent and not by

constraint. The data policy should be initiated with a clear understanding of why, for example, some people and institutions are reluctant to share their data.

"By nature, human beings tend to be suspicious about the quality of what comes from their neighbours, and, in the opposite, have confidence in the quality of their own produce. This feeling is not limited to individuals. Institutions too develop the same feeling with regard to the outside world. It is understandable to be cautious about every relationship or partnership that could present a risk for one's own image, be it individual or institutional. This is particularly true when data exchange is involved.

"From an institutional point of view, risks, virtual or real, are generally associated with the principle of sharing data:

"1. As mentioned above, an a priori suspicion of the quality of third-party data is common. This generates a cautious attitude due to the false risk of deriving questionable information from the third-party data;

"2. Another virtual risk arises from an a priori presumption that the institutions' own data (generally deemed of high quality by the latter) may be "wrongly" used if shared with a third party, or even that ownership thereof may be lost. This ends up in a paternalistic attitude characterized by attempts to find out in advance what the data will be used for by the third party;

"3. Some institutions may fear that other users will discover the poor quality of their data by sharing them. Such a fear is likely to dictate a protectionist attitude with regard to sharing data, in an attempt to avoid the risk of deteriorating the image of the data-owning institution.

"The purpose of developing an SDI being merely to provide easy access to development information through data-sharing, a sound data policy should look carefully at ways to remove the potential risks summarized above, so that the data producers will be happy and confident in sharing their data.

"All this shows how important the data policy is in achieving full participation by all stakeholders and their involvement in and commitment to the SDI process."

26. In some countries, maps and map products are seen as highly sensitive and classified information and are sometimes controlled by the military. A national GI policy will facilitate access and make the information available to commercial organizations, allowing government agencies such as the national surveying and mapping agency to share fundamental data sets with other public-sector organizations and industry. This will in turn enhance opportunities for the private sector to develop more innovative applications. Concomitant with the fact that GI needs to be open and shared is the need for each organization to maintain control of its data, which calls for well-managed and executed data security protocols. [6]

27. While not discouraging the development of an overarching national information and communication infrastructure policy that integrates the needs of ICT and geoinformation, it is essential to have a separate national GI policy that will address the following GI-specific issues of (a) geospatial data sets (focusing on policy on the production, ownership, custodianship, archiving and maintenance of fundamental and

thematic geospatial data sets); (b) standards (for data production, transfer and exchange, and hardware and software); (c) metadata (provision, standardization and maintenance of metadata for every geospatial data holding in the GI community); (d) legal issues (pertaining to ownership and custodianship of data sets, intellectual property and copyright, confidentiality, privacy and liability); (e) data access and data security; (f) organizational aspects; (g) funding (which should address, in clear terms, means of funding all aspects of SDI, including data production); (h) commercial aspects (including data pricing, with provision and guidelines for access and data fees, on a differential basis, for research and educational, government-to-government, and commercial and private use of community, private and value-added data sets); (i) capacity-building (human, institutional and technological); and (j) related national policies and legislation, international treaties, protocols and cooperation, etc.

28. In addition to having a national GI policy, it is also necessary to put in place a national mapping policy to address in detail the activities of national topographic mapping and the provision of a geodetic framework as well as cadastral mapping, including funding arrangements. These cannot be treated in depth within the national GI policy, and the absence of a national mapping policy can deter production of these vital fundamental data sets.

4. Funding issues

29. The United States Geological Survey study indicated that on average, less than $US 200,000 was budgeted for GIT by the responding organizations. This is not surprising considering the fact that many governments have failed to yield to the consistent call to properly fund survey and mapping activities nationally. Not less than 2.5 per cent of the national budget each year has been generally advocated, but the amount allocated is often typically a far cry from this percentage.

30. Beyond this, some of the national mapping organizations do generate some income, which by law is paid directly into the government treasury, but which the organization has no access to and in fact is not permitted to spend even for its own operations, except through the budgetary provision of the following year. Unfortunately such budgetary provision often does not take into consideration the amount generated by the agency; a high-income-generating agency may still attract inadequate budgetary provision. This situation can be substantially alleviated by granting autonomy to the agencies. In the absence of full autonomy, a better arrangement could be found by allowing the agency to spend a certain percentage of its internally generated income on its mapping activities. The percentage could be determined by evaluating the cost of production in the previous five years, for example, and comparing this with the yearly allocation in the national budget. This will allow the agency to be properly funded and thus be in a position to implement new innovation systems in its production strategies.

5. Human capacity-building

31. In GI production and management, advances in space and information technologies have impacted positively on human capacity globally through the availability of GIT tools. In order to be fully utilized, however, the acquisition of GIT must be complemented by readily available skilled manpower and an enabling infrastructure. The regional GIT capacity is improving in Africa, with many countries participating in a variety of notable space technology initiatives. For example:

- Many African countries have established national remote sensing centres and/or mapping agencies, and many universities on the continent are offering remote sensing programmes;
- As earlier indicated, four African countries (Algeria, Egypt, Nigeria and South Africa) have developed or acquired micro earth observation satellites; and
- Two African countries - Egypt and South Africa - have active programmes in astronomy.

32. It is therefore certain that some indigenous EO capacity now exists in Africa, especially by virtue of the capacity-building aspects of the satellite programmes of African countries that can and should be built upon. As countries that already have satellites plan to launch additional ones, while other countries (including Morocco) plan to launch new ones, in addition to the proposed Geo-Africa satellite, building on the existing capacity, will rapidly enhance the ability to master space technology, reinforce science and technology education, create a sustainable human resources base and stimulate high-tech spin-offs.

33. It should also be acknowledged that many GI professionals, technologists and technicians in various organizations were trained in the obsolete methods of map production, whereas the introduction of GIT demands a critical mass of well-trained staff at all levels in a reasonable time frame. Yet another identified problem is the difficulty of retaining skilled GIT staff in public institutions.

34. Given that many organizations in African countries cannot afford to send their staff abroad for training or retraining programmes, except using external funding support from donor countries and agencies, and considering the number of persons to be trained before full capacity utilization is achieved, it is necessary to provide alternative solutions through networking among educational institutions in developed and African countries, i.e., through cross-border education and Web-based education/e-learning. International organizations such as the International Society for Photogrammetry and Remote Sensing, the Group on Earth Observations and the International Federation of Surveyors have put in place working groups and committees to evolve the necessary arrangements and frameworks for effective cross-border education. Participation by the CODIST Subcommittee on Geoinformation through its working group on capacity-building in the capacity-building activities and tasks of these organizations will facilitate the quick uptake of capacity-building innovations that may emanate from the activities.

35. Moreover, we need to strengthen institutions of higher learning and national and regional institutions to provide each country with the capacity to carry out research and developmental efforts in its national institutions. Overall, the goal should be to build on existing capacity to enable each country to enhance its scientific and technical knowledge and experience in the applications of geodesy, photogrammetry, remote sensing and spatial information sciences in addressing Africa's needs.

6. Infrastructure and access

36. Against the background of the need to carefully sequence and prioritize infrastructure roll-out and universal access in the light of capacity and resource constraints, the successful uptake of innovation systems in African countries is largely constrained by the lack of efficient national infrastructure. Adequate and appropriate infrastructure, from communications networks to power, and widespread access to it, particularly in rural areas, are essential for building the knowledge economy. Thus there is a strong economic justification for national investment in national infrastructure. This view has been corroborated by the World Bank's African privatization expert, [4] who blamed the inability of African countries to compete in the international market on their lack of infrastructure in spite of the huge resources at their disposal. He noted that the provision of infrastructure is one of the biggest challenges to be met to realize the Millennium Development Goals in Africa, adding that "Africa would need $15 billion a year in infrastructure financing to achieve 7 per cent economic growth in order to halve extreme poverty by 2015 and reach the Millennium Development Goals". Unfortunately, the infrastructure situation is still practically the same in 2009 as in 2004.

37. Since most of the countries find it difficult to provide efficient infrastructure at home, it stands to reason that regional infrastructure is almost non-existent, and thus regional integration as envisaged by the African Union and NEPAD seems to me a long way off.

38. Despite the appreciable growth recorded in ICT infrastructure within the last five years, a recent report indicated that currently only 2 per cent of the population in Africa have Internet access. [10] Even then the bandwidth is often too low to support image and GI transfer. One of the factors responsible for the low bandwidth is the cost, as Internet service providers within the countries require huge amounts of foreign exchange to pay for the Internet backbones located outside Africa. Since a few African countries including Egypt, Morocco and Nigeria have communication satellites (though Nigeria's has stopped functioning and has not been replaced at the time of writing), the services of these satellites should be maximized to promote regional development through a special pan-African price regime that will help to appreciably increase the density as well as the bandwidth of Internet services. Efforts should also be made to improve the undersea cable infrastructure. The GEONETCast facility, with its relatively low cost, also promises to be a key player in image data transfer and distance learning, and its use is highly recommended.

7. Private sector stimulation

39. Globally, the private sector has driven technological innovation and the growth of the knowledge economy. It is therefore necessary to ensure effective indigenous private-sector involvement in the production and management of geospatial data through job outsourcing and public-private partnerships. It is common in many countries to find that mapping jobs are outsourced to foreign countries even when the country has indigenous private companies with the capacity to do the job. Worse still, the foreign companies often execute the greater percentage of the job outside the country, usually without the participation of the client's staff, only to bring back the results in CPUs or DVDs to simply install with perhaps a few days' training. After a few years, the systems and the data are unusable and un-updatable, leading to huge waste of revenue. This calls for the inclusion of a "local content" clause in national mapping and geoinformation policies to nurture indigenous talent and expand skill transfer.

E. Recommendations and concluding remarks

40. It is clear that EO satellites have been playing and will continue to play a vital role in the sustainable development of any country towards meeting the Millenium Development Goals and other developmental goals. Informal feedback has shown that both the awareness and the uptake of GI have increased in the continent since the launching of EO satellites by Algeria and Nigeria, and further since Egypt and South Africa launched theirs. The possibility of having the ARMS constellation has also been received with much enthusiasm. The ARMS initiative is indeed a very encouraging development which NEPAD should capitalize on and strengthen within the framework of its own space science and technology agenda, in close collaboration with the CODIST Subcommittee on Geoinformation.

41. The regional space programme would be better realized if a coordinating agency in form of an African space agency, akin to the European Space Agency, could be put in place, as recommended by the High-level Scientific Workshop on the Critical Role of Satellite Remote Sensing Applications for Africa's Sustainable Development organized by the United Nations Educational, Scientific and Cultural Organization and the African Union. This proposal was strongly supported by the African Association of Remote Sensing of the Environment in its Accra Declaration of 2008. This can be realized by ensuring that African space policy and programmes are incorporated in NEPAD's programme. An African space agency would then be an effective platform for the implementation of the ARMS programme and those featuring other future regional African satellites such as the proposed GEO-Africa satellite.

42. Still in the area of EO, the Subcommittee needs to promote a more flexible data provision policy for Africa on the part of commercial image suppliers to accommodate the reuse of data by government organizations, as well as the free provision of data for education and research. We also need to support the ongoing efforts to establish additional ground receiving stations for CBERS to allow complete coverage of Africa. Furthermore, to enhance the uptake of EO systems, it is recommended that, through country representatives, the Subcommittee should encourage effective country

participation in the Group on Earth Observations and the implementation of the Global Earth Observation System of Systems.

43. To rapidly boost African EO skills, efforts are recommended to build on existing capacity through a joint educational network (cross-border education) and e-learning, including the use of the GEONETCast facility for Web-based education and mass data transfer.

44. In order to enhance the uptake of GIT in Africa, developments in the ICT sector need to take into consideration the special requirements of the geoinformation community for high-speed and high-bandwidth Internet connections to facilitate efficient data transfer, processing and other geoportal applications.

45. It is also essential to ensure the realization of national and regional SDI backed by national geoinformation policy as well as national mapping policy in each country. Of key importance in this initiative is the provision of a dense regional geodetic reference frame to facilitate accurate spatial referencing including georeferencing of satellite images. In this regard, the ongoing implementation of AFREF being coordinated by ECA requires regional and international funding support. Public-private partnerships should also be explored for effective funding of the national SDI process.

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