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Space benefits for Africa: contribution of the United Nations system*

Note by the Secretariat

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I. Introduction

1. The United Nations Inter-Agency Meeting on Outer Space Activities serves as the focal point for inter-agency coordination and cooperation in space-related activities.[1] Over the past five years, at the annual sessions of the United Nations Inter-Agency Meeting on Outer Space Activities, 25 entities of the United Nations system have reported on their space-related activities. Those activities typically focus on the following issues: the protection of the environment and the management of natural resources; the use of space applications for human security, humanitarian assistance, development and human well-being; technologies for development, including information and communications technology and global navigation satellite systems; and capacity-building and education in space applications for sustainable development.

2. The annual report of the Secretary-General on the coordination of space-related activities within the United Nations system, which is reviewed by the Inter-Agency Meeting, plays an important role in fostering new inter-agency partnerships and promoting synergies. The report serves as a strategic tool for preventing duplication of effort in the United Nations system in the use of space applications and space-related activities. The report also provides a useful source of information on activities of entities of the United Nations system that use space technology to promote sustainable development, including in Africa.

3. At its twenty-eighth session, in 2008, the Meeting agreed that the Office for Outer Space Affairs of the Secretariat, in cooperation with the Economic Commission for Africa (ECA) and in consultation with other United Nations entities, should prepare a report on the benefits of space science and technology for sustainable development in Africa. The present report underlines the importance of promoting cooperation and finding synergies, as well as contributing to regional cooperation in raising the awareness of decision makers and key stakeholders of the role of space science and technology in achieving sustainable development in Africa.

4. The present report was endorsed by the Meeting at its twenty-ninth session, in March 2009, and will be presented, in late 2009, to the third African Leadership Conference on Space Science and Technology for Sustainable Development (see www.space.gov.za/conferences/alc2007). The Conference is an important regional forum aimed at raising awareness among African leaders of the importance of space science and technology, providing a regular forum for the exchange of relevant information among African countries and enhancing cooperation within Africa in the development and application of space technology. The first Conference was held in Abuja in 2005, the second Conference was held in Pretoria in 2007, and the third Conference will be held in Algiers in 2009.

5. The report describes space technologies, applications and initiatives that have a role in achieving sustainable development in Africa. The United Nations is actively involved in bringing space benefits to Africa. Most of those activities are

[1] Further information on the Inter-Agency Meeting, its reports and the reports of the Secretary-General on the coordination of space-related activities within the United Nations system can be found at www.uncosa.unvienna.org.

being implemented through cooperation among various United Nations entities and could be strengthened through further inter-agency cooperation.

6. The report was prepared by the Office for Outer Space Affairs, in cooperation with ECA, on the basis of the reports of sessions of the Inter-Agency Meeting and the reports of the Secretary-General on the coordination of space-related activities within the United Nations system, as well as submissions from the following entities of the United Nations system: the United Nations Office on Drugs and Crime (UNODC), the Department of Field Support, the Department of Peacekeeping Operations, the Office of the United Nations High Commissioner for Refugees, the United Nations Institute for Training and Research (UNITAR) and the International Telecommunication Union.

II. Overview of space solutions for sustainable development in Africa

7. Since the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, from 3 to 14 June 1992, sustainable development has remained elusive for many African countries. Poverty is still a major challenge: 41 per cent of the population of sub-Saharan Africa (approximately 300 million people) were living on one dollar per day or less in 2004. Multiple armed conflicts, insufficient access to education and widespread pandemics such as HIV and malaria have undermined Africa's efforts to achieve sustainable development. The region is also challenged by serious environmental threats, including desertification, deforestation and climate change.[2] Africa has thus been a priority area for the activities of the United Nations, and the Plan of Implementation of the World Summit on Sustainable Development[3] refers to Africa's sustainable development as a cross-cutting issue.

8. Space technology and its applications, such as Earth observation systems, meteorological satellites, communication satellites and global navigation systems, provide strong support for the implementation of the actions called for at the World Summit on Sustainable Development and make a significant contribution to achieving sustainable development in Africa. The use of space technology benefits Africa and its peoples in various ways. Space applications offer effective tools for connecting people around the world, monitoring and conducting assessments of the environment, managing the use of natural resources, managing responses to natural disasters and providing education and health services in remote areas.

9. Space applications are widely used in agriculture, which is an important but fragile economic sector in many parts of Africa. Low soil fertility, scarce irrigation, poor rural infrastructure, insufficient financing for rural areas and recurrent droughts are among the major challenges for agriculture in sub-Saharan Africa. Soils in Africa are diverse but characterized by limited fertility. Only 45 per cent of the land is arable, 16 per cent of the land mass has soil of high quality, and about

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[2] More information on the efforts of the United Nations to promote sustainable development in Africa can be found at www.un.org/esa/dsd/susdevtopics/sdt_africa.shtml.

[3] *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26 August–4 September 2002* (United Nations publication, Sales No. E.03.II.A.1 and corrigendum), chap. I, resolution 2, annex.

13 per cent has soil of medium quality (see E/CN.17/2008/8). In that regard, Earth observation technology enables quick responses using timely information to predict the production expected in an agricultural season.

10. Space technology also provides a better understanding of global weather and climate change. Satellite systems now monitor temperature, rainfall, cyclones and vegetation cover even in areas where few or no weather stations or other means of scientific observation exist. Regional monitoring mechanisms in Africa based on satellite-derived data provide early warning of drought and extreme weather events, as well as predictions of rainfall amounts and locust invasions. Instruments installed in remote areas without telecommunication infrastructure use satellite-based communication systems to transmit data to central processing hubs.

11. Access to natural resources is worsening in the region, owing to the continuing rise in demand for natural resources, a rapidly growing population, processes of deforestation and desertification, the impact of climate change and resource mismanagement. Earth observation is the tool most frequently used to monitor the environmental impact of human activities on a local scale and manage natural resources such as forests and water resources, which are crucial for livelihoods and economic development in Africa.

12. Space-based information systems play a significant role in risk reduction and disaster management on the African continent, which is heavily affected by meteor-hydrological disasters such as droughts, floods, storms and cyclones. Natural and man-made disasters result in damage of ground-based infrastructures such as communication cables and access roads. Thus, space technology is vital to disaster management. The potential benefits of space information in disaster management can be grouped into two main phases of a disaster: the “hot phase”, dealing with the emergency response, which includes warning and crisis management; and the “cold phase”, which is the period preceding or following the disaster and which includes risk reduction and damage assessment.

13. To increase the use of space technology in disaster management, a number of global initiatives have been established to make use of space technology in disaster management. Those initiatives include the activities of the Charter to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters (also called the International Charter on Space and Major Disasters) (see www.disasterscharter.org), the Committee on Earth Observation Satellites (see www.ceos.org), the Global Earth Observation System of Systems (see www.earthobservations.org), the Disaster Monitoring Constellation (see www.dmcii.com), the Integrated Global Observing Strategy partnership (see www.igospartners.org) and the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (see www.unoosa.org/oosa/unspider/index.html).

14. Through tele-epidemiology, a field heavily based on satellite imagery, areas at risk of a disease outbreak are identified, for example, by first identifying those areas where climatic conditions are conducive to the rapid increase of malaria-transmitting mosquitoes. Satellites are also used to monitor air quality, which has benefits for public health, environmental protection and monitoring compliance with air quality standards. Air pollution not only poses a health hazard but also has a harmful impact on precipitation.

15. Space-related applications are increasingly employed in transportation services, which are an essential field contributing to sustainable development in Africa. Access to transport provides mobility, promotes commerce and fosters education and health. In many African countries, transport access rates are low and the quality of transport networks is poor. In order to improve transportation, many African countries have reformed the management of their infrastructure, including by utilizing global navigation satellites to precisely determine positions in space and time. Although initially designed as navigation tools, global navigation satellite systems have developed into a multidisciplinary tool for navigation, geodesy, surveying and cartography, agriculture, atmospheric science and disaster management.

III. Space-related activities of United Nations entities in Africa

A. Human security

16. The United Nations uses satellite and aerial imagery for the development of large-scale maps to support the movements, operations and planning of peacekeeping forces and to improve staff security and emergency preparedness in the field. Maps, often derived from satellite imagery, also inform the deliberations of the Security Council on crises worldwide. Search and rescue activities worldwide benefit from space applications (see box 1).

Box 1
International Satellite System for Search and Rescue

The International Satellite System for Search and Rescue (COSPAS-SARSAT) is an international satellite-based search and rescue system for distress alert detection and information distribution. In the framework of COSPAS-SARSAT, five African countries (Algeria, Madagascar, Nigeria, South Africa and Tunisia) currently provide location-related space-based search and rescue services, particularly for people and transportation systems in danger, for example, on aircraft crashes, shipwrecks and motor vehicle accidents. The search and rescue activities are carried out worldwide, providing accurate, timely and reliable alert and location data to the international community on a non-discriminatory basis (see www.cospas-sarsat.org/).

17. Peacekeeping operations are usually deployed in areas for which up-to-date geospatial information is not available. The United Nations has established geographic information system (GIS) units in 11 United Nations peacekeeping missions, as well as a GIS centre to support field units, which is located at the United Nations Logistics Base in Brindisi, Italy. Those units combine information from various sources with digital maps of the theatre of peacekeeping operations, thus enhancing the operational readiness and capabilities of peacekeeping missions. Satellite images and data are crucial in planning and operations to support terrain and situational awareness, thematic and analytical mapping for military and police deployments, mine action, mapping the movements of internally displaced persons and refugees and the investigation of underground water resources.

18. The Cartographic Section of the Department of Field Support provides support to various special projects of the United Nations, such as assistance and advice on

the delimitation of international boundaries (through the intensive use of satellite imagery as well), and project management for GIS units of peacekeeping missions and the GIS centre in Brindisi, Italy, which prepares topographic base mapping. The United Nations International Boundary Evidence project, carried out in collaboration with the World Health Organization (WHO), is aimed at creating and maintaining a geographical database of international boundaries.

19. The Department of Peacekeeping Operations and the Office for the Coordination of Humanitarian Affairs (OCHA) have established the Sudan Interagency Mapping Group, which, in cooperation with local authorities, promotes and facilitates the sharing of standardized geospatial information and satellite imagery so that all members can develop compatible and reliable products of use in their operations. The members of the Sudan Inter-Agency Mapping Group include the Humanitarian Information Centre for Darfur, OCHA, the United Nations Joint Logistics Centre, the United Nations Mine Action Service, the United Nations Mission in the Sudan, the United Nations Children's Fund, the United Nations Development Programme (UNDP), the World Food Programme (WFP), WHO, the European Union Satellite Centre, the Sudan Central Bureau of Statistics and the New Sudan Centre for Statistics and Evaluation (see www.unsudanig.org/sim/).

20. Since 2004, on multiple occasions OCHA has leveraged the resources made available through the geographic information support team,[4] bilateral agreements with major companies and other mechanisms to service the geospatial data requirements of the humanitarian community, especially by channelling satellite imagery obtained from the Government of the United States of America during major disasters and related responses.

21. The Office of the United Nations High Commissioner for Refugees has developed a geographic information system using satellite imagery, global positioning system (GPS) receivers, existing maps and refugee registration data. Refugee camps have been mapped in Chad, Kenya, Liberia, Namibia, Sierra Leone, the Sudan and the United Republic of Tanzania. The mapping of refugee camps in the area of Dadaab, Kenya, near the Kenyan/Somali border, is planned in order to assess the impact of refugee camps on the environment and the environmental conditions of refugee camps. In the context of collaborative platforms for inter-agency activities in areas with limited Internet access, it is crucial to improve access to global navigation systems in remote areas and establish long-term partnerships for the shared use of remote sensing data and for the customized interpretation of high-resolution imagery.

22. The United Nations Geographic Information Working Group, in collaboration with partner entities of the United Nations system such as ECA and several regional and global initiatives, supports the development of the Second Administrative-level Boundaries project, which provides up-to-date contact information for national

[4] The geographic information support team consists of United Nations agencies with humanitarian operations, including the Department of Peacekeeping Operations, the Office of the High Commissioner for Refugees, the World Food Programme and the World Health Organization and the Food and Agriculture Organization of the United Nations, as well as agencies of the United States of America, representatives of donor countries, non-governmental organizations and academic institutions, with the Office for the Coordination of Humanitarian Affairs providing secretariat services (see https://gist.itos.uga.edu/index.asp).

mapping agencies (for further information, see www.unsalb.org). The Working Group's members have worked to define and gradually implement the United Nations Spatial Data Infrastructure project, which is aimed primarily at improving the ability of the United Nations system to deliver as one in the area of space technology benefits for sustainable development. The project, which will be instrumental in creating the geospatial standard environment and data framework required for the greater efficiency of the United Nations system, will first focus on improving the availability of data on Africa and access to relevant shared satellite imagery, in order to respond better to the challenges faced on the African continent due to recent developments related to climate change and food security.

B. Food security and agriculture

23. Space technology and applications play a crucial role in agriculture and food security. Farming relies on weather forecasts derived from monitoring satellites. Crop irrigation is dependent on rainfall and evaporation measurements from satellites. Satellite imagery informs risk assessments of pest and disease threats to crops, and mapping crops from space helps forecast agricultural yield. Thus, effective use of existing Earth observation information provides tools that enhance the collection, storage, analysis and dissemination of food security information. Remote sensing data, in combination with data gathered in the field, are essential for carrying out comprehensive studies on food security and vulnerability.

24. United Nations programmes and agencies, such as the United Nations Environment Programme (UNEP), WFP and the Food and Agriculture Organization of the United Nations (FAO), collaborate with various governmental and non-governmental entities to strengthen information systems to manage food security. WFP and FAO have carried out various initiatives in the framework of the Global Monitoring for Food Security project of the European Space Agency (ESA) that make use of agricultural meteorology for food security in Africa. Ethiopia, the Sudan and Uganda were selected for pilot projects applying a new methodology to estimate cultivated area using radar data at the beginning of the growing season.

25. In 2006, WFP, FAO and the Global Monitoring for Food Security project of ESA installed the GeoNetwork spatial information environment for the Southern African Development Community, the Regional Centre for Mapping of Resources for Development and the Regional Training Centre for Agrometeorology and Operational Hydrology (see box 2). Following the set-up of the spatial information environment in six WFP regional bureaux and several countries, including Ethiopia and the Sudan, WFP developed a model for setting-up mapping task forces, composed of GIS practitioners at the country level, to complement the mandate of each agency or local institution by sharing knowledge, data and capacity in order to gain a better understanding of the situation of the respective country.

Box 2
Regional Training Centre for Agrometeorology and Operational Hydrology

UNDP, UNEP, UNITAR, the United Nations Educational, Scientific and Cultural Organization (UNESCO), FAO and the World Meteorological Organization are supporting the Regional Training Centre for Agrometeorology and Operational Hydrology (AGRHYMET), an institution of the Permanent Interstate Committee on Drought Control in the Sahel. AGRHYMET works to increase agricultural production in the States members of the Committee and to improve the management of natural resources in the Sahel region by, among other things, producing and disseminating information and providing training in the field of agricultural ecology (see www.agrhymet.ne).

26. The use of integrated space technology applications for monitoring the impact of climate change on agricultural development and food security was a subject of a regional workshop organized by the Office for Outer Space Affairs, the Government of Kenya and ESA and held in Nairobi in December 2008. The workshop addressed the prediction, monitoring and early warning of climate-related disasters and environmental hazards, the improvement of regional food security including sustainable agricultural development, land use and land cover change.

C. Health and sanitation

27. Satellite communications are also be used to provide high-quality and cost-efficient health services and medical care to people in areas with non-existent or underdeveloped healthcare infrastructure, in particular in rural areas (see A/AC.105/892). Space-related technology is also useful for strengthening health information management at the district level in Africa, for example, through the Africa health Infoway (see box 3).

Box 3
Africa Health Infoway

The Africa Health Infoway initiative, led by WHO in close partnership with ECA, the International Telecommunication Union and the African Union Commission, aims to strengthen health information management in Africa at the district level. Covering 53 African countries, it is focused on district-level health data collection and processing and on evidence-based decision-making in health care. Satellite-based communication and long-distance wireless connectivity are among the space-based applications planned to be launched in the participating countries (see www.who.int/africahealthinfoway/).

28. Diseases such as malaria afflict millions of people each year, especially in Africa. Geospatial science and technology are used by United Nations entities to contribute to the international efforts in monitoring, evaluation and response management and to understand and characterize the various environmental and climatic factors known to perpetuate or exacerbate such diseases, including temperature, precipitation, moisture, vegetation and land-cover types. WHO and the World Meteorological Organization share data from the monitoring of rainfall,

temperature, humidity and flooding during the rainy season with the Southern Africa Malaria Control Programme and assist in the early detection of and response to malaria epidemics.

29. WHO uses GPS devices to collect data on the location of households and health facilities in various countries. In the malaria control programme conducted in Botswana, Malawi, Mozambique, Namibia, Swaziland, Zambia and Zimbabwe, the location of households and health facilities are identified and integrated in a geographic information system to monitor and map the spatial distribution of a number of malaria and other health indicators, providing a better understanding of the malaria situation in those countries and assisting in cross-border malaria control. WHO also uses global navigation technology in the context of the Service Availability Mapping initiative to assess and monitor the availability and coverage of health services (see www.who.int/healthinfo/systems/serviceavailabilitymapping/).

30. In Zambia, a project initiated by WHO, the Research for Equity and Community Health Trust of Malawi and the Network on Equity in Health in Southern Africa has now developed into a capacity-building exercise aimed at addressing the needs in terms of geographic information and GIS capacities to support HIV/AIDS monitoring, evaluation and response (see www.unsalb.org/SDI/ZMB/GIS_HIV_ZMB.htm). Seventeen local and international institutions, including WHO and ECA, are now part of a working group that was created to fill the existing gaps. A similar process is under way in Malawi (see www.unsalb.org/SDI/MWI/GIS_HIV_AIDS_MWI.htm).

31. The Telemedicine Task Force for sub-Saharan Africa[5] published a report entitled "e-Health for sub-Saharan Africa: opportunities for enhancing the contribution of ICT to improve health services" in July 2007. The recommendations contained in the report were endorsed by the European Commission in the context of implementing two pilot projects – "Medical e-content via satellite for the African health work force" and "Satellite-based teleconsultation service for rural areas" – the results of which will form the basis for long-term actions to support the gradual development of an e-health network covering sub-Saharan Africa.

32. A regional workshop on using space technologies for tele-health to benefit Africa was organized by the Office for Outer Space Affairs in partnership with WHO, ESA, the Centre national d'études spatiales of France and the Government of Burkina Faso and was held in Ouagadougou in May 2008. The workshop was used to raise awareness of the benefits of using space technologies in tele-health, exchange information on the current status of tele-health practices in Africa and discuss issues, concerns and approaches in developing tele-health for the region.

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[5] The Telemedicine Task Force comprises representatives of the European Commission, ESA, WHO, the African Union Commission, the New Partnership for Africa's Development, the African Development Bank, the Central African Economic and Monetary Community, the Organization of Coordination for the Control of Endemic Diseases in Central Africa, the East African Community, the Economic Community of West African States and the secretariat of the African, Caribbean and Pacific Group of States (see www.esa.int/esaTE/SEM2UREFWOE_index_0.html).

D. Protecting and managing national resource bases

33. The impact of climate change is one of the most challenging issues faced in Africa. ECA aims to use geospatial technology to determine relevant indicators for the evaluation of the impact of climate change, assess the level and the magnitude of the risk in vulnerable zones and map African vulnerability. Satellites provide a global view of dynamic processes on land, in oceans and in the atmosphere. The satellite imagery collected over many years is a vital resource permitting the detection and monitoring of environmental changes. Satellites provide hard evidence that supports the enforcement of environmental legislation and serves as a powerful tool in communicating environmental issues to the general public and decision makers (see box 4).

Box 4
Africa Environmental Information Network

UNEP coordinates the technical implementation of the Africa Environmental Information Network in response to the request from the African Ministerial Conference on the Environment. The Network focuses on developing infrastructure and a support mechanism for collating and storing geospatial and bibliographic data and for harnessing professional skills and expertise to analyse and generate policy-oriented information to be communicated to decision makers (see www.unep.org/dewa/africa/aeoprocess/aein/aein.asp).

34. Many entities of the United Nations system, including UNDP, UNEP, UNESCO, FAO, WHO and the secretariats of the United Nations Framework Convention on Climate Change,[6] the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa[7] and the Convention on Biological Diversity[8] are involved in the Millennium Ecosystem Assessment (see www.millenniumassessment.org), a project that helps meet ecosystem assessment needs by, inter alia, providing tools for planning, filling data gaps using additional remote sensing information and assisting in building individual and institutional capacity to undertake integrated assessments of ecosystems and act on the findings.

35. Satellite-based techniques have proved to be a key source of information for water resource management at the local, national and regional levels. ECA uses geospatial technology to address issues related to water resources (quantity, quality and balance among the various uses), monitor surface water bodies, assess seasonal hydrological characteristics and forecast floods.

36. The Division of Water Sciences of UNESCO developed a regional strategy for the implementation of national projects in Africa as part of the ESA/UNESCO Earth Observation for Integrated Water Resources Management in Africa (TIGER)/Space Hydrology International Partnership (SHIP) project, which is based on the recommendations of the World Summit on Sustainable Development and aimed at building national capacities in water resource management (see www.tiger.esa.int).

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[6] United Nations, *Treaty Series*, vol. 1771, No. 30822.
[7] Ibid., vol. 1954, No. 33480.
[8] Ibid., vol. 1760, No. 30619.

Other UNESCO initiatives and programmes contributing to the goals of the World Summit on Sustainable Development and, in particular, the New Partnership for Africa's Development (NEPAD), include the system-wide World Water Assessment Programme (see www.unesco.org/water/wwap/publications/), a cross-cutting project on the application of remote sensing for integrated management of ecosystems and water resources in Africa; the open initiative on the use of space technology for the monitoring of World Heritage sites; and the Regional Ocean Observing and Forecasting System for Africa of the Intergovernmental Oceanographic Commission.

37. The FAO African Water Resource Database was set up under the guidance of the Inland Water Resources and Aquaculture Service in collaboration with the Land and Water Development Division and the Environment and Natural Resources Service, all of FAO. The database is a GIS-based analytical platform that allows users to visualize and analyse complex hydrological and ecological relationships of specific river reaches, larger-scale river basins and entire mega-basins (see www.fao.org/fishery/collection/awrd/).

38. Under the Technical Cooperation Programme of the World Meteorological Organization (see www.wmo.int/pages/prog/tco/), satellite receiving ground equipment in 47 African countries was replaced in order to collect meteorological and hydrological data on Africa from geostationary meteorological satellites (Meteosat satellites).

39. UNEP has issued a number of publications on sustainable development in Africa. Among them is the 2008 publication "*Africa: Atlas of Our Changing Environment*", which describes environmental change at more than 100 locations in all countries of Africa. More specific issues in the field of environmental change in Africa are addressed in the UNEP publication *Africa's Lakes: Atlas of Our Changing Environment*, which presents an overview of the location of the lake resources of Africa and the impact of human activity on them. UNEP/GRID-Sioux Falls (United States) carried out an analysis of the rapid environmental changes in Lake Chad in West Africa, reported in its publication *Analysing Environmental Trends Using Satellite Data: Selected Cases*, in which satellite data from various periods are examined and scientific evidence is provided, sounding an early warning of the potential long-term consequences of development decisions.

40. UNEP, ECA and WFP assist the African Ministerial Conference on the Environment in preparing the report entitled *Africa Environment Outlook*, which highlights the potential of the region's natural resource base to support the development agenda of NEPAD (see www.grida.no/publications/other/aeo/?src=/aeo/).

41. The UNITAR Operational Satellite Applications Programme continues its participation in the process, initiated in Lisbon in 2007, leading to a Global Monitoring for Environment and Security programme for Africa (see www.gmes.info/). In 2008, the Operational Satellite Applications Programme worked towards completion of its research, carried out with partners, in the area of integrated applications combining Earth observation with telecommunications and navigation systems.

E. Land use and management

42. Land use and management are important factors for development in rural areas. Accurate land-use data of the correct spatial resolution is a primary source of information for decision makers. Remote sensing products have wide coverage and are therefore used to produce land-use and land-cover maps as the first step in various applications. Those data are used, among other things, to establish rural land registers that help to identify the potential and the limitations of those land areas (see A/AC.105/892).

43. Land-use products using Earth surface classification methods provide many benefits through the use of specific absorption rate images. For example, low-resolution satellite data, moderate-resolution imaging spectrometer data, advanced very-high-resolution radiometer data and ancillary data (such as data on precipitation and temperature, climatic maps, land-use maps, topographic and soil maps, life zone maps, vegetation maps and the historical record of droughts) are useful to predict land surface changes and to make recommendations for appropriate and effective interventions for sustainable land management. Satellite imagery can be used to make an inventory of past landslides and to collect data on relevant parameters concerning, among other things, soil, geology, slope, geomorphology, land use, hydrology and geological faults. High-resolution satellite imagery is essential for obtaining such land surface information.

44. More than 1 billion hectares in Africa is affected by land degradation, resulting in a loss calculated to be more than $9 billion per year for the continent. ECA uses geospatial technology to highlight and assess the related trends and effects and the interrelationships of the various factors causing land degradation.

45. Since 2003, UNODC and the Government of Morocco have collaborated in conducting surveys of cannabis cultivation and the production of cannabis resin in the country. The surveys are aimed at measuring the evolution of cannabis cultivation in Morocco, defining the geographical boundaries of the cultivation of that crop, estimating the production of cannabis and cannabis resin and the corresponding revenues of cannabis producers, and collecting socio-economic parameters. Information collected using space technology is essential for the sustainable development of areas where illicit crops continue to provide a major reliable and profitable source of livelihood. Policymakers can use that information to design alternative development strategies for those areas.

46. UNODC will continue to monitor cannabis cultivation and the production of cannabis resin in Morocco. The challenge is to explore the use of new sensors that can differentiate crops through the use of the appropriate spectral and spatial resolutions, with sufficient revisiting time and at a lower cost, and to find necessary resources to carry out a global survey on cannabis, including in Africa.

47. The Global Land Cover Network, established by UNEP and FAO, among other entities, is a global collaborative project to develop a fully harmonized approach for making reliable and comparable baseline land-cover data available, especially for the users in developing countries. Regional collaborative networks have already been established for subregions of Africa (see box 5), the Americas, the Middle East, South-East Asia and Central Asia (see www.glcn.org/index_en.jsp).

Box 5
Africover

Entities of the United Nations system have been involved in the Africover project, a component of the Global Land Cover Network aimed at establishing a digital geo-referenced database on land cover and a geographic referential framework (a type of reference map that includes place names, roads and watercourses and bodies). Africover is based on Landsat Thematic Mapper (TM) and ancillary data for 10 African countries: Burundi, Democratic Republic of the Congo, Egypt, Eritrea, Kenya, Rwanda, Somalia, Sudan, Uganda and United Republic of Tanzania (see www.africover.org).

48. The UNITAR Operational Satellite Applications Programme has implemented training and capacity development activities in Chad, Namibia, Nigeria, Senegal and the Sudan. Those activities included on-site training and capacity development aimed at achieving direct tangible results by using local and national data to support local and regional land planning and management, including the aspects of biodiversity, infrastructure and agriculture development.

F. Infrastructure, transport and energy

49. Infrastructure, transport and energy are important elements in achieving sustainable development. Many African countries face recurring, deepening energy shortages, partly owing to the lack of rigorous assessments of energy potential on the continent. ECA uses geospatial technology to map potential sources of energy in Africa (biofuel production, wind energy, solar exposure etc.) and assist in planning energy supply and demand. ECA helps Member States to develop and utilize their geo-information resources (production, management and distribution of geospatial data and products) and promote policies, standards and legal frameworks for spatial information-based decisions. ECA carries out activities in the following areas: policies and coordination (assign custodianship responsibilities as appropriate); data (building fundamental core data sets and thematic data); capacity-building and retention (critical mass of individuals with the required skills); standards and interoperability (a common geodetic framework and a metadata standard); and electronic services (development of online applications and streamlined electronic delivery of products and services in order to make more informed decisions). Other information and communications technology initiatives contribute to greater efficiency in these and other areas (see box 6).

Box 6
Connect Africa

The Connect Africa initiative, launched at a summit of leaders in Kigali in October 2007, is a global multi-stakeholder partnership to mobilize the human, financial and technical resources required to bridge major gaps in information and communications technology infrastructure across the region, with the aim of supporting affordable connectivity and applications and services to stimulate economic growth, employment and development throughout Africa. The Connect Africa Summit was organized by the Global Alliance for Information and Communication Technologies and Development, ECA, the International Telecommunication Union, the World Bank Group and the African Union in partnership with the African Development Bank, the African Telecommunications Union and the Global Digital Solidarity Fund (see www.itu.int/ITU-D/connect/africa/2007).

50. As part of the GPS Africa project, the Office for Outer Space Affairs contributed to the deployment of a GPS receiver network in Africa so that developing countries could participate in studies of the Sun-Earth system in the framework of the International Heliophysical Year 2007. The network included the International Heliophysical Year instrument array of the International Geodesy System (IGS), Analyse multidisciplinaire de la mousson africaine (AMMA), Scintillation Network Decision Aid (SCINDA) and the African GPS Receivers for Equatorial Electrodynamics Studies (AGREES).

51. The African continent is directly involved in global navigation satellite systems through the African Geodetic Reference Frame (AFREF) project (see http://geoinfo.uneca.org/afref/), a geodetic project aimed at unifying the coordinate reference frames of Africa and which serves as the basis for national three-dimensional reference networks and is fully consistent and homogeneous with the International Terrestrial Reference Frame. AFREF, based on current satellite positioning technologies, is the geodetic infrastructure for multinational projects requiring precise geo-referencing (e.g. three-dimensional and time-dependent positioning, geodynamics, precise navigation and geo-information). Like other continental geodetic reference frames, it will be part of the global geodetic infrastructure and is being implemented in close cooperation with international partners with expertise in geodetic reference frames, notably the International Association of Geodesy, the International Committee on Global Navigation Satellite Systems and the Office for Outer Space Affairs. When fully implemented, it will be key to infrastructure, planning and development projects and will include a continuous network of permanent GPS stations to which users anywhere in Africa will have free access.

52. Through the AFREF project, ECA works to develop a unified geodetic reference frame for Africa so that maps and other geo-information products can be represented on the same datum. ECA is also collaborating with the African Union to prepare a transport infrastructure master plan for Africa. The main objective of the programme of activities is to produce an optimum, integrated all-mode transport infrastructure master plan for Africa. Producing such a master plan requires access to data on all existing and planned networks and corridors of development,

including railways, airports, roads, ports, harbours and waterways, and related social economic information. Those transport components must be depicted in their correct spatial locations and cross-referenced with one another in order to perform a full analysis of all relevant factors. Since currently there is no database containing those necessary data sets, another major objective of the project is to create a database (using remote sensing and GPS techniques) in a geographic information system in order to support the proper planning, design, operation and maintenance of infrastructure facilities.

53. In line with the support by ECA for the regional priorities defined by NEPAD, several regional geospatial databases have been developed to support regional initiatives. The Programme of Infrastructure Development in Africa (PIDA) geospatial database covers all existing and planned infrastructure facilities in Africa, including all networks and development corridors for transport infrastructure, as well as power plant and power system interconnection networks for the power sector. The Agricultural Commodity Value-Chain Database and Interface is an inventory of available data and information resources compiled through an extensive survey involving international and regional partners. Primary databases on ecological and crop production zones, optimum processing locations, markets and infrastructure continue to be established.

54. The United Nations Geographic Information Working Group (see www.ungiwg.org/unsdi.htm), an informal inter-agency coordination body comprising over 33 United Nations departments, programmes and specialized agencies, continues its efforts, through cooperative approaches, to improve access to geospatial data on African countries, including transportation infrastructure data. The Working Group works closely with various private companies and data providers to obtain direct access to geographic data captured through the use of satellite imagery and user-contributed content. To that end, licensing arrangements are being negotiated to enable access and use of such valuable and up-to-date geospatial base data for improved infrastructure mapping.

G. Disaster management and emergency response

55. When a disaster strikes, different types of satellites are employed to alleviate the suffering of the people affected. Remote sensing satellites provide the imagery to map the extent of the disaster and its impact, resulting in maps that are used to prioritize relief needs and enable relief workers to locate and reach the victims. Communications satellites are essential for information flow and relief coordination, as disasters damage or destroy the ground communications infrastructure. When a disaster renders existing maps ineffective or strikes in a remote, poorly mapped area, navigation satellites allow relief workers to determine their location, collect damage assessment data and update existing maps as needed.

56. The International Strategy for Disaster Reduction (ISDR) is aimed at making communities disaster-resilient by promoting awareness of the importance of disaster reduction as an integral component of sustainable development in order to reduce human, social, economic and environmental losses caused by disasters. To facilitate disaster risk reduction in Africa, ISDR established a regional outreach office, ISDR Africa, in Nairobi in 2002, which aims to advance the process of disaster risk

reduction in Africa in partnership with major stakeholders in the region. NEPAD, the African Union Commission, the African Development Bank, UNDP and UNEP have, with support from ISDR Africa, developed the Africa Regional Strategy for Disaster Risk Reduction, to be integrated into the development programmes of States and international organizations (see www.unisdr.org).

57. In December 2006, the General Assembly, in its resolution 61/110, established the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) as a programme to provide universal access to all types of space-based information and services relevant to disaster management. UN-SPIDER is implemented by the Office for Outer Space Affairs and is mandated to ensure that all countries and international and regional organizations have access to, and develop the capacity to use, all types of space-based information to support the full disaster management cycle. Several member States, including Algeria, Nigeria and South Africa, have offered to support the work of UN-SPIDER with regional support offices, hosted by institutions in those countries. That will promote regional expertise within Africa and foster regional networks to support disaster risk management.

58. In the context of UN-SPIDER, the Office for Outer Space Affairs has supported several awareness-raising and networking events in African countries, including those in Ghana, Morocco and Nigeria, and provides technical support to include the use of space-based information in national plans and policies. In 2008, a technical advisory mission was conducted in Burkina Faso to assess the current use of space-based information for disaster management. The expert team provided recommendations on how to improve access to and use of space-based information. A similar mission to Namibia in 2009, followed by a training session, helped to improve the use of satellite imagery for early warning of floods in the country's flood-prone northern provinces.

59. The UNITAR Operational Satellite Applications Programme continues to develop and disseminate satellite-based services and products for humanitarian relief and disaster prevention. Over the past two years, the Programme provided support for emergencies in Algeria, Angola, Chad, Comoros, Côte d'Ivoire, the Democratic Republic of Congo, Ethiopia, the Gambia, Ghana, Kenya, Madagascar, Mali, Mauritania, Morocco, Mozambique, Namibia, Senegal, Somalia, the Sudan, Togo, Uganda, Zambia and Zimbabwe.

60. ECA continues to focus on the identification of multi-hazard or composite risk hot spots and to develop vulnerability mapping and disaster monitoring applications to better understand how disasters affect people and communities, as well as their impact on the environment. In Africa, nearly all of the activations of the International Charter on Space and Major Disasters were made possible owing to close cooperation among several United Nations entities (see box 7). The Office for Outer Space Affairs and ECA work closely to ensure that the Charter and other similar opportunities are accessible to all African countries.

Box 7
International Charter on Space and Major Disasters

The International Charter on Space and Major Disasters is an international mechanism through which entities of the United Nations system and other entities can request and receive various satellite images, free of cost, to support their disaster response activities in the field. Since the signing of the Charter in 2000, there have been more than 180 activations of the Charter, including 20 activations covering African subregions. The Office for Outer Space Affairs acts, on behalf of the United Nations, as a cooperating body of the Charter (see www.disasterscharter.org).

IV. Outlook for the future

61. Space science and technology support numerous aspects of sustainable development worldwide and provide indispensible tools to achieve better management of natural resources, assess the interactions between the environment and society and provide valuable information for humanitarian and peacekeeping operations. Satellites are essential to the sustainable development of Africa: they are crucial in communication, medicine and education; since they are used to determine position in space and time, they are invaluable for land, sea and air navigation; and they are vital for Earth observation and remote sensing, in particular in such areas as environmental monitoring, mapping, urban planning, weather prediction, disaster management and relief.

62. As space technology plays an indispensable role in the development of Africa, a growing number of African countries focus on the implementation of national space programmes with a strong emphasis on development. Significant progress has been made in developing the indigenous space-related capabilities of Africa. For example, the African space assets dedicated to remote sensing include those of Algeria (AlSat-1 and AlSat-2), Egypt (EgyptSat-1), Nigeria (NigeriaSat-1 and NigeriaSat-2) and South Africa (Sunsat-1 and Sumbandila). Both Egypt (NileSat-1, NileSat-2) and Nigeria (NigComSat-1) operate communication satellites that contribute to Africa's integration with global communications. Numerous countries in Africa have established national space agencies and coordinating institutions to promote space science and technology. A growing number of spacefaring countries and countries using space technology outside Africa have recognized the importance of the African efforts and have provided support and assistance for those undertakings.

63. In its efforts to take full advantage of the benefits of space technology, Africa faces various challenges of three types. The institutional challenges include the need for more coordination and synergy at the national level and among States in Africa. The technical challenges include strengthening appropriate infrastructure, including setting up archiving and processing facilities and harmonizing spatial data management through the use of common fundamental data sets and geodetic reference frames. Finally, the human challenges include the need to urgently build a critical mass of skilled human resources, which is a prerequisite for making progress in space science and technology. There is a need to leverage the space-related advances made so far and develop strategic guidance by raising the

awareness of decision makers, making geospatial and space-derived information available to them and the general public in a user-friendly format.

64. Building national and regional capacity in space science and technology, as well as space law, is crucial for the African efforts to meet the challenges outlined above. In that context, the African regional centres for space science and technology education, affiliated to the United Nations, located in Morocco and Nigeria, make a valuable contribution to capacity-building in space science and technology and offer programmes in space and atmospheric science, satellite communications, satellite meteorology and global climate, remote sensing and GIS. All regional centres for space science and technology education, affiliated to the United Nations, are involved in the development of two further model curricula in the areas of global navigation satellite systems and space law. The regional centres, in cooperation with the Office for Outer Space Affairs, are working to become centres of excellence and regional hubs for bringing socio-economic benefits to all Member States in Africa in the areas of education and training, research and policymaking and the application of space science and technology, as well as space law. In addition to those two regional centres affiliated to the United Nations, two regional training centres in satellite meteorology are operated by the World Meteorological Organization in Kenya and the Niger as part of space-related training activities of the Organization.

65. Since many of Africa's developmental challenges transcend national boundaries, the collective impact of the continent's national space programmes could be greatly enhanced through regional cooperation and coordination. Regional cooperation and partnerships among African States and international entities are essential to promoting the use of space science and technology to achieve internationally agreed sustainable development goals and provide the benefits of space technology. Strengthened cooperation within the region and with other regions would help African countries develop the capacity to utilize space applications for sustainable development.

66. The African Resource Management (ARM) system, a regional initiative that aims to make space technology more accessible to the end-user, has four pillars. The first pillar is the ARM satellite constellation, a project launched by Algeria, Kenya, Nigeria and South Africa aimed at developing a constellation of satellites for mutual benefit and cooperation in the areas of agriculture, climate, environment, land use, border monitoring, disaster monitoring, water management and health. The second pillar is the ARM application infrastructure, consisting of several software applications that can be used by each of the African countries to support initiatives in the three priority economic areas: (a) food security, agriculture and coastal zone areas; (b) environmental monitoring, conservation and tourism; and (c) government planning and security. The third pillar is constituted by the ARM information services, which distributes to end-users the information products generated by the software application infrastructure, and provides support in interpreting and using that information. The fourth pillar is raising public awareness of ARM and the relevance of space technology to people in their daily lives, in order to support the long-term success of the use of space for the benefit of Africa.

67. United Nations entities will leverage existing opportunities and work closely with disaster management agencies in Africa to address the increasing number of natural and man-made disasters. The network of UN-SPIDER regional support offices – with one office already established in Nigeria and offices to be established

in Algeria and South Africa – will play a major role in helping African countries access and use space-based information. The Office for Outer Space Affairs and ISDR will coordinate their activities in the area of risk reduction, and the Office and OCHA will coordinate their work in the area of emergency and humanitarian responses.

68. In the framework of the efforts of the United Nations system to deliver as one, the United Nations is actively involved in bringing space benefits to Africa, focusing on the following issues: the protection of the environment and the management of natural resources; the use of space applications for human security, humanitarian assistance, development and human well-being; enabling technologies for development, including information and communications technology and global navigation satellite systems; and capacity-building and education in space applications for sustainable development. The report of the Secretary-General on the coordination of space-related activities within the United Nations system plays an important role in fostering new inter-agency partnerships and promoting synergy and serves as a strategic tool for the United Nations to avoid duplication of effort in the use of space applications and space-related activities. The Inter-Agency Meeting seeks to underline the importance of promoting cooperation and finding synergies, as well as contribute to regional efforts including in the African continent in raising awareness among decision-makers and key stakeholders of the role of space science and technology in promoting sustainable development.

69. The present report on space benefits contributes to the efforts of the African Leadership Conference to raise awareness among African leaders of the importance of space science and technology, provide a regular forum for the exchange of information among African countries and enhance intra-African cooperation in the development and application of space technology.

70. The African Leadership Conference can benefit from establishing strong links with other regional space-related initiatives, such as the Asia-Pacific Regional Space Agency Forum, Asia-Pacific Space Cooperation Organization and the Space Conference of the Americas, which have already developed implementation mechanisms. The African Leadership Conference has reached out to the Committee on the Peaceful Uses of Outer Space with a view to promoting its role in shaping and strengthening the African region’s involvement in the global space community. In the context of regional cooperation, full advantage should be taken of the opportunities provided by intergovernmental forums such as the Committee on the Peaceful Uses of Outer Space in order to achieve a greater collective outcome and strengthen cooperation within Africa and among all regions.