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**Implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III)**

# Implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III): final report of the Action Team on Sustainable Development

## Note by the Secretariat

1. At its forty-fifth session, the Committee on the Peaceful Uses of Outer Space considered the implementation of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). The Committee recalled that, at its forty-fourth session, it had established 11 action teams to implement those recommendations which had been assigned highest priority by Member States or those for which offers to be leaders of the activities had been received.[1] As requested by the Committee, all action teams reported on their work and submitted their work plans to the Scientific and Technical Subcommittee at its thirty-ninth session and to the Committee at its forty-fifth session.

2. The annex to the present document contains the final report submitted by the Action Team on Sustainable Development with a view to implementation of recommendation 11 of UNISPACE III, in accordance with the work plan submitted by the Action Team to the Scientific and Technical Subcommittee.

*Notes*

[1] *Official Records of the General Assembly, Fifty-seventh Session, Supplement No. 20* (A/57/20), para. 42.

* A/AC.105/C.1/L.253 and Corr.1.

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# Annex

## Final report of the Action Team on Sustainable Development

## I. Introduction

1. Space technology is contributing significantly to sustainable development efforts in many societies of the world. Such contributions include not only the invaluable information being provided by a number of Earth-observation satellites, but also that provided by space- and Earth-based instruments: this is critical information on the myriad natural and man-made dangers that are lurking in outer space that, if not countered or addressed, could endanger the existence of planet Earth and all its life-support systems. Here on Earth, each country is confronted by challenges that must be addressed if it is to succeed in contributing effectively to its own development and growth. The present report examines those features which single out space technology as an indispensable component of any viable sustainable development agenda. It also reviews, with examples, the contribution of space technology to the broadening of human understanding of the key elements of sustainable development, including the assessment and management of natural resources (air, land, water and minerals), agriculture and food security and safety, environment, education, transportation, health care and disaster mitigation. Given that not all countries of the world are "space-capable", the report sets out a number of critical steps that each country should take in order to achieve the space capability necessary to support its sustainable development goals.

## II. Mandate and background

2. At its forty-fourth session, held in Vienna in June 2001, the Committee on the Peaceful Uses of Outer Space mandated its African member States to coordinate, under the leadership of Nigeria, the implementation of recommendation 11 of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), to promote sustainable development by applying the results of space research.

3. To respond to that request, Nigeria organized a national meeting on the promotion of sustainable development by applying the results of space research, in conjunction with the African regional workshop on sustainability science, which was hosted by the Nigerian Sustainability Science Committee and held from 13 to 15 November 2001 in Abuja.

4. The report of the meeting was circulated among the African member States of the Committee for their comments and input. The report that resulted was subsequently submitted to the Scientific and Technical Subcommittee at its thirty-ninth session and the Committee at its forty-fifth session in 2002 (A/AC.105/2002/CRP.17). The present, final report represents the input of all member States interested in recommendation 11 of UNISPACE III and includes the responses of a number of States to a questionnaire developed for the report (see appendix I). It also reflects the issues relevant to the applications of the results of

space research, as discussed at the World Summit on Sustainable Development, held from 26 August to 4 September 2002 in Johannesburg, South Africa (see appendix II).

## III. Definition of sustainable development

5. A careful study of the existing literature shows that a consensus has emerged that sustainable development is the meeting of fundamental human needs while preserving the life-support systems of planet Earth, with the understanding that regional and local needs differ globally.

## IV. Space research and sustainable development

6. Space science and technology can be a major sustainable development tool in:

(a) Providing a better understanding of the interactions between environment and society;

(b) Linking knowledge to action in pursuit of a sustainable transition;

(c) Serving as part of today's operational systems for monitoring and reporting on environmental and social conditions, data from which can be integrated with data from other sources to provide useful guidance for efforts to navigate a transition towards sustainability:

(i) Long-term trends in environment and development, including the consumption of natural resources and population growth and demography, as well as the reshaping of "nature-society" interactions;

(ii) Determination of the vulnerability or resilience of the nature-society system;

(iii) Effective warning of conditions beyond which the nature-society systems incur significantly increased risks of serious degradation.

## V. Sustainable development challenges[a]

7. The fundamental life-support systems include air, water and food; to these should be added shelter, a wholesome environment and access to health and education. As a consequence of the human detrimental impact on the Earth's environment, the leaders of the world have become preoccupied with the problem of how best to preserve these life-support systems, to the extent feasible, for the benefit of current and future generations. Accordingly, most societies around the globe are embarking on initiatives and development agendas that could address the problems of poverty, food security, protection from natural disasters and affordable health and housing. For example, the African Union recently launched the New Partnership for Africa's Development (NEPAD) to address the urgent need to develop and apply the most practical tools possible to tackle the challenge of boosting sustainable food production and of assessing the extent and rate of desertification and deforestation, as well as their impact on food and livestock production.

8. The need to understand the nature and distribution of Earth-based natural resources in order to manage them and ensure their sustainable exploitation cannot be overstated. For example, phytoplankton is a major element in the food chain of most fish types and is found to be associated with up-welling systems. Coastal up-welling areas are among the most productive regions of the world's oceans. Such up-welling regions include the coastal zones of Ecuador and Peru, the west coast of North America, and the north-west, west, south and north-east coasts of Africa. Over-fishing by the high-tech, large fishing vessels in those up-welling zones and the failure to restock have caused a gradual depletion of the fishery resources of countries that are contiguous to the up-welling zones and whose economic fortunes have been tied to those fishery resources. The net result has been the crippling of the local fishing industry and the attendant negative impact on local economies and the life-support systems of local populations.

9. Among the key contributing factors to environmental degradation in the world today are the following:

(a) The unregulated discharge of domestic and industrial wastes, which contributes to poor sanitation, polluted and non-potable water and related water-borne diseases, toxicity of the soil of and poor agricultural productivity in the affected areas and the destruction of aquatic living resources;

(b) Emissions from the exhaust systems of motor vehicles, in particular in the urban centres of such megacities as Beijing, Hong Kong Special Administrative Region of China, Lagos, Mexico City and Tokyo, with attendant lung and other diseases;

(c) Deforestation in Brazil, South-East Asia and Central and West Africa owing to unregulated logging, resulting in the reduction of evapotranspiration and associated rainfall, exposure of the soil to landslide and soil erosion and loss of biodiversity, including living organisms and wild animals;

(d) Toxic emissions from the industrial plants of Asia, Europe and North America, resulting in acid rain, subsequent defoliation and destruction of the forests, the loss of forest resources and the crippling of forest-dependent industries, the loss of biodiversity and toxic run-off into the rivers feeding the reservoirs that provide water for domestic, agricultural and industrial needs;

(e) Oil-related pollution, both on land and along coastlines, in particular those of the petroleum-producing countries, resulting in the destruction of inland vegetation and coastal and marine life.

10. The global community is certainly not immune to disasters, whether natural or anthropogenic. The devastating Sahelian drought and famine that began at the end of the 1960s and continued until the early 1980s affected Ethiopia in particular and the countries of the Sahel region. Forest fires are today more frequent and are occurring on a wide scale, exacerbated by major climate change and prolonged dry spells in many countries, in particular Australia, Canada, China, Indonesia, the Philippines and the United States of America. Humankind is adjusting to floods and landslides, especially in areas of the world that have lost their forest cover, such as the Himalayas. Records show that earthquakes, tsunamis, cyclones, hurricanes and volcanic eruptions create repercussions far beyond the immediate environment of their occurrence. Space technology cannot prevent disasters that are detrimental to

life-support systems; it can, however, contribute to a better understanding of such problems and assist in limiting their impact on populations and on the Earth's environment.

## VI. Data in support of sustainable development

11. Reliable space-acquired data, with synoptic, multi-temporal and multi-spectral characteristics, are now widely available in both low- and high-resolution formats and are being used, globally and on a continuous basis, to address all the problems enumerated above. Such data, in a geographically referenced format, are also becoming widely used in the production of maps and charts on the state of every aspect of human life-support systems. According to Brooner,[b] the collection, analysis and use of geographical information is a starting point on the path towards sustainable development because the inability of many societies to undertake development efforts that are sustainable is rooted in poor-quality data collection, organization and management. It is thus imperative that maps and geospatial data be recognized as just as necessary a part of a nation's infrastructure as are a transportation network, health care, education, telecommunications and water supply systems.

12. Development plans and decisions made in the absence of facts or accurate maps amount to guesswork and could result in wrong decisions, loss of life and property, a waste of time and financial resources and unfulfilled expectations. The failure to recognize the indispensable role and use of accurate maps in the development process has resulted and continues to result in the wrong location of roads, housing estates and agricultural plantations in swamps, on flood plains and in earthquake zones with consequent loss of life and limb.

13. With the aid of the computer, it is now possible to reference geographically a large array of data, including those obtained by Earth-observation satellites, using a base map and, in the process, capture, store, check, integrate, manipulate, analyse, display and deliver the information generated on time in order to ensure its usefulness to the consumer, be he or she farmer, forester or transportation engineer. Examples include maps of river basins and watersheds, coastal and marine ecosystems and related resources, coastal and marine environments, soil characteristics, land use and land cover, forest cover, mineral deposits, risk assessment and transportation and communication networks. For effective implementation, sustainable development programmes require such organized information.

14. The contemporary use of data acquired by Earth observation satellites such as the land remote sensing satellite Landsat of the United States, the environmental satellite Envisat of the European Space Agency, the Indian Remote Sensing Satellite, the Satellite pour l'observation de la Terre (SPOT) of France, Ikonos and QuickBird of the United States and the computer is revolutionizing the development and production of maps. Maps developed using satellite data are much more detailed, accurate and easier to produce than traditional and conventional ones and can be readily and effectively used in national development efforts. Satellite radar data recently contributed to the production of a map of the Amazon river basin in Brazil and adjacent countries, which revealed that the wetlands in the basin were

17 per cent bigger than had previously been thought, resulting in a considerable improvement in the model estimates of methane fluxes for the basin.[c]

## VII. Space technology and sustainable development

15. Space technology offers decision makers valuable tools for weather-forecasting, climate prediction, the assessment and management of the water, land and ocean, forest and fishery resources that are key elements of life-support systems and for activities relating to agriculture and the Earth's environment. For example, the increased use of satellite data, such as those collected by the Tropical Rainfall Measuring Mission (TRMM) satellite,[d] the National Oceanic and Atmospheric Administration (NOAA) of the United States Geostationary Operational Environmental Satellite and polar-orbiting satellites, is improving weather and rainfall prediction through well-developed climate models and rainfall-estimation techniques. Such predictions are very useful for crop- and flood-forecasting, for assisting in the making of agricultural development decisions and improving understanding of the hydrological cycle, a parameter needed for the planning of water resource projects. Australia, Brazil and India are participating in the validation of data from TRMM, while simultaneously gaining more knowledge of rainfall precipitation over their respective territories. In Brazil, for example, the Large Scale Biosphere-Atmosphere Experiment in Amazonia (LBA) carried out jointly by the National Institute for Space Research (INPE) of Brazil and the National Aeronautics and Space Administration (NASA) is using TRMM data to gain a better understanding of and to quantify tropical continental precipitation. The ecological focus of LBA is the effect of tropical forest conversion, regrowth and selective logging on carbon storage, nutrient dynamics, trace-gas fluxes and the prospect for sustainable land use in Amazonia.

16. In many parts of Africa, international entities such as the Food and Agriculture Organization of the United Nations (FAO), the World Meteorological Organization (WMO), the United Nations Development Programme (UNDP) and the World Bank are using satellite-derived information to implement their programmes. Examples include the collection and dissemination of agro-meteorological data, the detection of areas that are prone to soil erosion, locust-breeding and assault by worms and the provision of the early-warning information needed for the prediction of droughts and desertification. Among such satellite-based activities are FAO projects on food security and the early warning of droughts carried out for the Southern African Development Community countries and on land-cover assessment based on remote sensing and geographic information system (GIS) techniques. The latter project, called "AFRICOVER" and carried out with the support of the Government of Italy, is initially concentrating on Central and East Africa. The overall goal of AFRICOVER is the development of a multi-purpose, digital, geo-referenced database on land cover and environmental information for use in early warning systems, forest and rangeland monitoring, catchment management, biodiversity and climate change studies at national and regional levels.

17. With Benin, Cameroon, Côte d'Ivoire, Ghana and Nigeria as beneficiaries, the United Nations Environment Programme (UNEP) and the United Nations Industrial Development Organization, with UNDP funding and data from NOAA weather satellites, are currently assessing the Gulf of Guinea large marine ecosystem on the

Atlantic coast of West Africa. The objectives of the project include the assessment and mitigation of ecosystem pollution, the protection of human health, redressing the loss of biodiversity and capacity-building for marine resource and environmental management. In the long term, the project should enhance the opportunities for the sustainable development of the marine resources of the countries contiguous to the Gulf of Guinea.

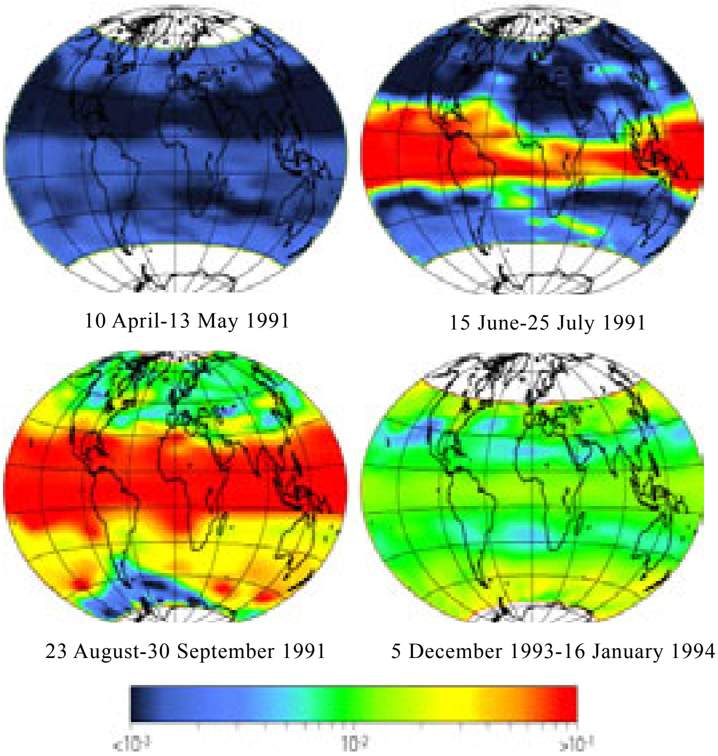
18. The region of Asia and the Pacific is believed to experience more than half of the world's natural disasters, such as tropical cyclones, typhoons and their accompanying storm surges and floods, droughts, forest fires and earthquakes. The effects of such natural disasters are especially damaging to the agricultural productivity of countries of the region and to their input to the local, regional and global food supplies. Space-related early warning systems are now playing a crucial role in facilitating the collection, dissemination, integration and analysis of information at the various stages of disaster management. Such early warning systems were effective during flooding along the Yangtze and Yellow Rivers in China and during the hurricane seasons in the Caribbean, the latter being managed by individual national disaster management units in cooperation with the Caribbean Disaster Emergency Response Agency.

19. In response to the lack of the information needed for disaster-preparedness, -warning and -mitigation, the Society of Japanese Aerospace Companies proposed the development of a dedicated Global Disaster Observation Satellite System.[e] The project, which should be able to acquire images and data at any location on Earth regardless of weather conditions, will be integrated with conventional disaster prevention systems and is expected to be carried out through international cooperation.

20. The above proposal may have contributed to the urgency of the call, made at UNISPACE III, for space-acquired data for the management of disasters to be made available, globally and as needed, which subsequently led to the establishment of the Charter on Coopeation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters (the "International Charter 'Space and Major Disasters'") on 1 November 2000.[f] The goal of the Charter is to provide civil protection agencies, globally and on request, with various types of space services, including Earth observation data, emergency telecommunications and precise location and navigation data. Since its inception, the Charter has been activated more than 20 times. It aided disaster management efforts in the Galapagos Islands by monitoring and tracking an oil spill in January 2001; in the Democratic Republic of the Congo by plotting lava flows and developing maps for food and medical deliveries and for the rescue of the victims of the eruption of the Goma volcano in February 2002; and in France by acquiring and delivering imagery to civil protection authorities when the Meuse River flooded its basin in January 2002.

21. Space technology has also brought into sharper focus the interdependence of the world. It is now universally accepted that planet Earth is a unified system and that events in one geographical location, such as the erruption of Mount Pinatubo in the Philippines in 1991 (see figure below), or the recurring El Niño phenomenon, can have repercussions in other parts of the world. An earthquake in Chile in 1960 caused a tsunami that killed at least 114 people in Japan.[g]

Figure
**1991 global evolution and dispersion of Mount Pinatubo aerosol from April to September and from December 1993 to January 1994, as measured by the Stratospheric Aerosol and Gas Experiment (SAGE II) instrument on board the United States Earth Radiation Budget Satellite, launched in October 1984**




SAGE II 1020 nm Optical Depth

22. The recognition of that global interdependence led the General Assembly to adopt the Principles Relating to Remote Sensing of the Earth from Outer Space (General Assembly resolution 41/65, annex) in 1986. Principles X and XI established the rules on how, under the circumstances referred to above, remote sensing technology can serve humanity as a whole, by promoting the protection of the Earth's natural environment and mankind from natural disasters. The two principles were put into practice in 1986 when both the SPOT and Landsat satellites first alerted the whole world to the Chernobyl nuclear disaster with irrefutable evidence; that disaster has had a devastating impact on human life, water, agriculture, health and biodiversity in the near and far environment of the accident site.

23. Principle X also provides a basis for the practical implementation of General Assembly resolution 1721 (XVI) of 20 December 1961, in which the Assembly recommended to all Member States and to WMO and other appropriate specialized agencies the early and comprehensive study of measures to advance the state of

atmospheric science and technology so as to provide greater knowledge of basic physical forces affecting climate and the possibility of large-scale weather modification. An example of how this has been put into practice is international agreement on the Montreal Protocol on Substances that Deplete the Ozone Layer of 1987. The results of research on the stratospheric ozone layer conducted under the auspices of UNEP and WMO provided the scientific guidance for formulating the Montreal Protocol and its amendments, as well as the Kyoto Protocol to the United Nations Framework Convention on Climate Change of 1997. Such scientific guidance became a reality as a result of the ozone measurements made over the years by space-, air- and ground-based observing programmes. Prominent among these programmes are the Upper Atmosphere Research Satellite, and the array of Total Ozone Mapping Spectrometers placed on board Nimbus-7 and Earth Probe of NASA, the Russian Federation Meteor-3 and Meteor-3M and Japanese Advance Earth Observing Satellites. Through those efforts, humankind is now more aware of its own contribution to ozone depletion, the danger of such depletion to human health, as well as to crops and marine life, and the corrective steps that must be taken to avert that danger.

24. A number of spacefaring countries are currently also using space technology, such as the Coastal Zone Colour Scanner on board the Nimbus satellites of NASA, the sensors on board Meteosat and the Sea-viewing Wide-Field-of-View Sensor (SeaWiFS) on board the OrbView-2 satellite of ORBIMAGE to monitor and harvest the fishery resources of the productive regions of the world.[h] The same SeaWiFS sensor enabled scientists to monitor the concentration of the green chattonella algae that smothered and killed over 700 tons of salmon in the Atlantic Ocean in March 2001.[i] Since 1997, SeaWiFS has also enabled the measurement, globally, of abundant terrestrial and oceanic vegetation, thus providing, in a five-year period, the baseline measurement for global photosynthesis, the principal means by which carbon, a key parameter in life-support systems, enters the Earth's atmosphere. The table contains a list of the space systems that are dedicated to sustainable development.

25. With the above understanding of what can be accomplished, member States need to work at the local, national and regional levels to accomplish a number of milestones, which have been presented below.

## VIII. Necessary action plans to be implemented by Governments and intergovernmental organizations

26. Governments could take the following actions to encourage the development of space technology:

(a) Sensitize decision makers to the value and contribution of space science to human development through the organization of appropriate national and regional conferences;

(b) Develop indigenous personnel in space science and technology through participation in regional centres of excellence in space science and technology. Provide greater support for local education and training at the regional centres for space science and technology education that have been established by the United Nations in Brazil, India, Morocco and Nigeria;

Table
**Space systems dedicated to sustainable development**[a]

| *Name of instrument or satellite* | *Mission objective* | *Key function* | *Year of launch* | *Owner* |
|---|---|---|---|---|
| Cloud satellite<br>CloudSat | To monitor a large fraction of clouds and precipitation ranging from very thin cirrus clouds to thunderstorms that produce heavy rain. | To furnish the data needed to predict clouds and a complete knowledge of their role in climate change and the cloud-climate feedback. | 2004 | Canadian Space Agency (CSA) and National Aeronautics and Space Administration (NASA) of the United States |
| European Remote Sensing satellites ERS-1 and ERS-2 | To collect data on Earth's land surfaces, oceans, sea ice and polar regions. | To enhance understanding of the interaction between the oceans and the atmosphere, ocean currents and changes in Arctic and Antarctic ice. | 1991 and 1995 | European Space Agency (ESA) |
| Terra/Measurement of Pollution in the Troposphere (MOPITT) | To scan the Earth's atmosphere in order to measure pollution (carbon dioxide and methane) from space. | To predict the long-term effects of pollution, to understand the increase of ozone in the atmosphere and to guide the evaluation and application of short-term pollution controls. | 1999 | CSA and NASA |
| Environmental satellite<br>ENVISAT | To monitor the land, oceans, atmosphere and ice caps. | To provide information on the state of the rain forests, the state of the El Niño current, the concentration of greenhouse gases and the state of the hole in the ozone layer. | 2002 | ESA |
| Meteorological operational polar satellites<br>METOP | Metop-1 will be Europe's first operational polar-orbiting weather satellite. When it is launched in 2005, it will replace one of two satellite services operated by NOAA. Metop will carry a set of "heritage" instruments provided by the United States of America and a new generation of European instruments offering improved sensing capabilities to both meteorologists and climatologists. | To augment the accuracy of temperature and humidity measurements, and wind speed and wind direction measurements, especially over the ocean, and to provide a more accurate profile of ozone in the atmosphere. | Metop-1, 2005,<br>Metop-2, 2010,<br>Metop-3, 2015 | ESA |
| Shuttle Radar Topography Mission (SRTM) | To produce the most complete near-global, high-resolution database of the topography of the Earth. | To produce topographical maps of Earth 30 times more precise than the best global maps previously available. | 2000 | German Aerospace Center, Italian Space Agency and the United States National Imagery and Mapping Agency and NASA |

| *Name of instrument or satellite* | *Mission objective* | *Key function* | *Year of launch* | *Owner* |
|---|---|---|---|---|
| Topographical Explorer (TOPEX)/Poseidon | To monitor global circulation and to understand the role of oceans in the climate of the Earth. | To measure sea levels and global ocean topography; to map year-to-year changes in heat stored in the ocean. | 1992 | Centre national d'études spatiales (CNES) of France and NASA |
| High Resolution Dynamics Limb Sounder (HIRDLS) on board the Aura satellite | To sound the upper troposphere, stratosphere and mesosphere to determine the concentration of ozone, water, methane, greenhouse and other gases. | To provide observations of temperature and trace gases that are superior to those obtained in the past. Instruments will obtain profiles over the entire globe, including the poles, by day and by night. | 2003 | British National Space Centre (BNSC) and NASA |
| Synthetic Aperture Radar Satellite (RADARSAT) | To monitor environmental change and to support resource sustainability. | To provide useful information to both commercial and scientific users in the fields of agriculture, cartography, hydrology, forestry, oceanography, ice studies and coastal monitoring and natural disaster mitigation and response. | RADARSAT-1, 1995<br>RADARSAT-2, 2003 | CSA |
| Humidity Sounder for Brazil on board the Aqua satellite (NASA) | To obtain humidity measurements under cloudy and hazy conditions. | To obtain atmospheric water vapour (humidity) profiles near the Earth's surface (within 10 kilometres) by measuring radiation from the atmosphere. | 2002 | National Institute for Space Research (INPE) of Brazil |
| Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) | To provide data that can be used to improve predictions of the regional impacts of long-term climate change. | To provide a capability to monitor volcanic plumes and the long-range transport of the pollutants that affect air quality and visibility. | 2004 | CNES and NASA |
| Advanced Microwave Scanning Radiometer on board the Aqua satellite (NASA) | To provide information on atmospheric water vapour, cloud water, precipitation, soil moisture, snow cover and sea ice properties. | To measure atmospheric water vapour, the Earth's primary greenhouse gas, wind speed that controls evaporation, precipitation that replenishes water supplies and soil moisture, which enables the study of photosynthesis. | 2002 | National Space Development Agency of Japan and NASA |

[a] A large part of the information in the table has been extracted from "Global Reach: A view of international cooperation in NASA's Earth Science Enterprise" (Washington, D.C., National Aeronautics and Space Administration, 2002).

(c) Establish networks among national and regional institutions in order to facilitate and enhance collaborative research opportunities. The cooperative information network linking scientists, educators, professionals and decision makers in Africa, known as COPINE, a space-based information network, is one example of such a network. In addition, scientists would need to take advantage of other facilities and networks, such as the Integrated Global Observing Strategy, the Center for International Earth Science Information Network of Columbia University, United States, the African Earth Observatory network of the University of Cape Town, and the Sustainability Geoscope, an initiative of the Potsdam Institute of Climate Research sponsored by the Government of Germany;

(d) Access to data and information has also been recognized as a necessary complement of the knowledge development effort, in particular in space applications. In that regard, entities of the United Nations system, in particular the Office for Outer Space Affairs, FAO and WMO, prevailed upon the Committee on Earth Observation Satellites (CEOS) to launch, in 1997, CEOS Information Locator Service (CILS). The objective of CILS is the improvement of access mechanisms, especially by the developing countries, to relevant data and databases. With the aid of a personal computer, users can use CILS web pages (cils.dlr.de or cils.ceo.org or cils.unep.org or cils.eoc.cisro.au) to find information about Earth observation data;

(e) Coordinate, at the highest level of government, all space-related activities in order to make space data available to scientists in many areas of research and application;

(f) Participate in the generation and use of scientific and technical knowledge and the making of adjustments in existing institutional arrangements. In addition to producing the needed manpower, institutions must see themselves as productive entities that can serve as incubators for new enterprises;

(g) Address globally the disparity between the considerable efforts being devoted to the design and launch of hardware into space and the insufficient attention and resources that have been dedicated, inter alia, to: (i) the issue of effectively translating the radiance measurements made by satellites into information that can be used in practical applications; and (ii) the stimulation of basic and applied research in support of the development of this economic sector in the coming decade;

(h) Promote methodological research and development. The demonstration of the feasibility and value of remote sensing and satellite meteorological data would go a long way to closing the knowledge gap between the scientists and engineers who are developing the space platforms and sensor systems on the one hand and the end users of Earth-observation information on the other;

(i) Involve national academies of science in national decision-making by inviting them to advise on science and technology issues;

(j) In order to be able to provide active coordination in environmental activities, international institutions such as UNEP and FAO should provide intellectual leadership that is built on a strong scientific and technical foundation. Such a transition would include monitoring and assessing trends, harmonizing measurements and developing standards in environmental, census/population, agricultural productivity, urbanization, energy and material development and utilization;

(k) In order to provide a reliable basis for decision-making, existing sustainable development conventions such as the United Nations Framework Convention on Climate Change, the Convention on Biological Diversity and the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa should forge stronger links with other science-based institutions worldwide, and their scientific advisory bodies should be expanded to include experts in the fields of space science and technology. The work of those bodies will be greatly strengthened by forging close cooperation with the space science and technology community, particularly with such entities as the Committee on Space Research (COSPAR), the International Astronautical Federation and the International Society for Photogrammetry and Remote Sensing, which have permanent observer status with the Committee on the Peaceful Uses of Outer Space.

## IX. Projected results of government actions on these recommendations

27. The following could result from the implementation of the action plans:

(a) National space policies and programmes that stipulate the integration of space-related activities within all national government establishments and development activities;

(b) The availability of skilled manpower, at each national level, that can generate and use scientific knowledge, as well as implement each nation’s space programme at a level commensurate with its needs and available resources;

(c) Regional and international agreements focusing on areas of cooperation in space activities that could support sustainable development efforts, including the establishment of appropriate networks;

(d) Space-related advisory panels to support the various existing international conventions on sustainable development;

(e) Agreements between each country and funding entities, such as UNDP, the World Bank and the International Monetary Fund, focusing on providing support for those aspects of the country’s development agenda which emphasize sustainable development.

*Notes*

[a] Sections V, VI and VII are based on Adigun Ade Abiodun, “Space technology and its roles in sustainable development”, lecture delivered at the 2002 annual meeting of the British Association for the Advancement of Science, University of Leicester, United Kingdom, 11 September 2002.

[b] W. G. Brooner (2002), “Promoting sustainable development with advanced geospatial technologies”, *Photogrammetric Engineering and Remote Sensing*, vol. 68, No. 3, pp. 198-205.

[c] National Aeronautics and Space Administration, *Global Reach: A View of International Cooperation in NASA’s Earth Science Enterprise* (Washington, D.C., 2002).

[d] The Tropical Rainfall Measuring Mission satellite was jointly developed by NASA and the National Space Development Agency of Japan and launched in 1997. It is a research satellite designed to study tropical rainfall and the associated release of energy that helps power the global atmospheric circulation that shapes both weather and climate around the globe.

[e] T. Kuroda, T. Orii and S. Koizumi (1997), *Concept of Global Disaster Observation Satellite System (GDOS) and measures for its realization*, Acta Astronautica, vol. 41, Nos. 4-10, pp. 537-549.

[f] The initial signatories to the Charter were the European, French and Canadian space agencies followed by the Indian Space Research Organization and NOAA of the United States. Other States, including Argentina, Brazil, China, Japan and the Russian Federation, have expressed an interest in joining.

[g] British National Space Centre, *Report of the Task Force on Potentially Hazardous Near Earth Objects* (2002).

[h] Satellite observation of sea state can be useful for both (a) identification of coastal up-welling systems, where phytoplankton, a major element in the food chain of most fish types, is found and thus a likely area of fish concentration; and (b) assessing the potential working conditions for fishing vessels. It can also provide opportunities for better weather-forecasting and a better knowledge of the salinity within the various estuaries and its influence on the fish population and distribution.

[i] NASA, "SeaWiFS Sensor marks five years documenting Earth's dynamic biosphere" (31 July 2002). Available at earthobservatory.nasa.gov/Newsroom/NasaNews/2002/2002073110324.html

# Appendix I

## Responses of Member States to questionnaires on sustainable development

| *Country/ question* | *Azerbaijan* | *Morocco* | *Nigeria* | *Philippines* | *Russian Federation* | *South Africa* | *Syrian Arab Republic* |
|---|---|---|---|---|---|---|---|
| 1. Kindly provide at least two examples, in your country and region, of successful development projects (type, location, etc.) where the results of space research constituted a major input. | 1. Strengthening capacity in inventory of land cover/land use by remote sensing.<br>2. Development of a multi-purpose environmental monitoring system for Azerbaijan. | 1. The integration of remote sensing techniques in natural resource management. (www.crts.gov.ma/)<br>2. A microsatellite project that provides support and operational applications such as telemetry collection and the transmission of meteorological data from the remote station to the central units. | 1. Natural resource inventory, thematic mapping and map updating (for example, forest inventory, 1980, land use and land-cover mapping, 1985, weather forecasting, 1990s).<br>2. Low-Earth orbit microsatellite disaster monitoring constellation of six countries with a daily revisit | | 1. Weather forecast system based on Meteor-type. satellites.<br>2. Navigation system based on GLONASS-type satellite constellation.<br>3. Multifunctional telecommunication system based on Ekran satellite and other types. | 1. Mapping, map updating, thematic maps. (Examples: population estimates, urban growth, land-cover mapping.)<br>2. Agriculture/food security, geology and geo-exploration, weather forecasting. | 1. Land and forest study: the study covers the coastal area of the country, where Landsat thematic mapper images were used to provide information on soil types, land use, land cover and land suitability.<br>2. Thermal survey of Syrian coast. |
| 2. What factors contributed to the successful implementation of projects you have described above? | 1. Technical potential.<br>2. Trained staff.<br>3. Existing database and archived materials.<br>4. Wide experience in the area indicated. | 1. The awareness and commitment of decision makers.<br>2. The investment made to train and educate staff .<br>3. Budgetary resources made available by the Government.<br>4. International cooperation: experts, training and so forth.<br>5. A national policy to access data regularly and the establishment of a national archiving facility. | 1. Investment in skilled manpower.<br>2. Consistent government policy on space applications.<br>3. Inter-agency collaboration. | | Existing developed industry, science and education systems. | 1. Availability of remote sensing imagery locally, rapidly, sustainably.<br>2. Portfolio of sensors.<br>3. Local knowledge of problems.<br>4. Training in remote sensing applications.<br>5. Willingness and ability to respond to emerging market needs.<br>6. Continued exposure to what is being tried and achieved elsewhere in the world. | 1. Availability of trained manpower.<br>2. Availability of needed images.<br>3. Availability of needed hardware and software.<br>4. Cooperation between the national institutions concerned. |

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| 3. What are the resources, operational support systems and tools that are critical to the successful application of the results of space research in the development process? | 1. Computers of a IBM PC-4-20 and 5th breed (Pentium III equivalent).<br>2. Digitizer (New Sketch 1812 HR).<br>3. Canon copier (Xerox).<br>4. Scanners.<br>5. Printers (laser and ink).<br>6. Plotter. | 1. Infrastructure: adequate equipment and facilities.<br>2. Telecommunication means (network) to be able to inform and to be informed.<br>3. The role of universities through participation in space research. | 1. Availability of local experts in aerial photo interpretation.<br>2. Simultaneous investments in capacity-building and satellite infrastructure development, with attendant availability of trained manpower in image interpretation, requisite image interpretation hardware and software, including image-printing laboratory, local knowledge of problems and scientists/engineers trained in Earth observation.<br>3. Availability of institutions such as the Regional Centre for Training in Aerospace Surveys. | 1. Funding.<br>2. Integration of key players.<br>3. Government support.<br>4. Expertise. | 1. Sufficient developed industry, science and education systems.<br>2. Availability of an education system; delivery through a highly educated group of people capable of understanding decision-making. | 1. Human resources and capacity.<br>2. Rapid and reliable access to fresh and archived imagery.<br>3. Good software and hardware/output support.<br>4. Teamwork and awareness of local conditions and problems. | 1. Ongoing training of technical staff to supply the needed human resources.<br>2. Updating of hardware and software.<br>3. Capacity-building and awareness-creation. |
| 4. What are the potential limitations to the realization of such a successful application? | 1. The absence of permanent source of space information.<br>2. The absence of a ground-receiving station.<br>3. The source of finance. | 1. Space research does not always take into consideration the needs of developing countries.<br>2. Limited resources dedicated to space activities.<br>3. Limited awareness of the benefits of space research. | 1. Low morale of trained scientists/ engineers due to poor incentives and remuneration.<br>2. Poor maintenance of facilities due to poor management and funding.<br>3. Attendant brain drain due to 1 and 2 above. | 1. Funding.<br>2. Bureaucratic red tape.<br>3. Resistance of clientele to technology. | Lack of the above-mentioned factor and initial financial resources. | 1. Inadequate and erratic investments in imagery.<br>2. Inability to fully understand real market needs.<br>3. Insufficient training.<br>4. Erratic coverage of the area of interest.<br>5. Lack of awareness among policy | 1. Insufficient financial resources.<br>2. Lack of awareness activities for decision makers.<br>3. Erratic imagery coverage. |

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| 4. What are the potential limitations to the realization of such a successful application? | 1. The absence of permanent source of space information.<br>2. The absence of a ground-receiving station.<br>3. The source of finance. | 1. Space research does not always take into consideration the needs of developing countries.<br>2. Limited resources dedicated to space activities.<br>3. Limited awareness of the benefits of space research.<br>4. Lack of information concerning space activities. | 1. Low morale of trained scientists/ engineers due to poor incentives and remuneration.<br>2. Poor maintenance of facilities due to poor management and funding.<br>3. Attendant brain drain due to 1 and 2 above.<br>4. Frequent changes in government policy.<br>5. Poor funding/lack of commitment. | 1. Funding.<br>2. Bureaucratic red tape.<br>3. Resistance of clientele to technology. | Lack of the above-mentioned factor and initial financial resources. | 1. Inadequate and erratic investments in imagery.<br>2. Inability to fully understand real market needs.<br>3. Insufficient training.<br>4. Erratic coverage of the area of interest.<br>5. Lack of awareness among policy makers. | 1. Insufficient financial resources.<br>2. Lack of awareness activities for decision makers.<br>3. Erratic imagery coverage. |
| 5. What type of capacity-building programmes would you recommend for a given country or region? | 1. Forecasting of natural disasters.<br>2. Identification of climate and weather changes. | 1. Training and education are the foundations of any action to promote capacity-building.<br>2. This action should concern all levels of education, from primary to university.<br>3. Establishment of national infra-structure for opera-tional uses of results of space research. | 1. Joint project collaboration.<br>2. Advance training in space technology and space application research.<br>3. Reinforcement of existing institutions and establishment of a new regional centre of excellence through seminars, workshops and conferences. | 1. Association of South-East Asian geomatics laboratories.<br>2. Orientation and training of local government officials on geomatics.<br>3. Professional association of geomatics specialists. | 1. K. E. Tsiolkovsky Space Academy suggests developing a global space system. | 1. Academic institu-tions need to include training in the use of imagery in their courses.<br>2. Joint projects.<br>3. Support training initiatives with lead-ing organizations.<br>4. Integrate remote sensing into other priority programmes such as water and food. | 1. Advanced training programmes.<br>2. Enhance the technical cooperation between national remote sensing centres and international agencies.<br>3. Carry out joint projects between neighbouring countries. |
| 6. From your knowledge of national, regional and global develop-ment, identify existing and relevant institutions that you are aware of. | | | | | | | |

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| (a) Please supply the name, location and year of establishment of the institution. | 1. Institute for Space Research of Natural Resources, 1978.<br>2. Institute for Space Informatics, 1991.<br>3. Institute of Ecology, 1991.<br>4. Special Design Office of Space Instrumentation, 1975.<br>5. Pilot Plant of Space Instrumentation, 1981.<br>6. Shamakhy Astrophysical Observatory, 1960. | 1. Royal Centre for Remote Sensing, Morocco, 1989.<br>2. National Centre for Remote Sensing, Tunisia, 1989.<br>3. National Authority for Remote Sensing, Egypt, 1971. | 1. National Centre for Remote Sensing, Jos, Nigeria, 1996.<br>2. African Regional Centre for Space Science and Technology Education—in English language, Ile-Ife, Nigeria, 1986.<br>3. Regional Centre for Training in Aerospace Surveys, Ile-Ife, Nigeria, 1972. | 1. National Mapping and Resource Information Authority, Makati, Metro Manila, Philippines.<br>2. University of the Philippines Training Centre for Applied Geodesy and Photogrammetry, Geodetic Engineering Department.<br>3. Groupement pour le développement de la télédétection aérospatiale, Toulouse, France.<br>4. Space Technology Applications and Research Academic Programme, Asian Institute of Technology.<br>5. Centre for Environmental Geomatics, Manila Observatory, 1999. | Developing a global space system will require a coordinated effort by many Russian agencies, such as the Russian Aviation and Space Agency (Rosaviakosmos), the communications and transportation ministries, the academy of sciences and so forth. International cooperation can give significant acceleration to the project taking into account its multidisciplinary nature and complexity. | 1. Satellite Applications Centre, Hartebeeshoek, South Africa.<br>2. University of Stellenbosch, Department of Electrical Engineering and Satellite Technology.<br>3. University of Cape Town, Engineering and Survey (GPS).<br>4. South African Weather Service. | 1. Centre for Space Science and Technology Education in Asia and the Pacific, India.<br>2. International development research centre, Regional Office for the Middle East and North Africa, Cairo.<br>3. Arab Centre for the Study of Arid Zones and Dry Lands, Damascus.<br>4. International Centre for Agricultural Research in the Dry Areas, Aleppo, Syrian Arab Republic. |

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| (b) Focus of the programme(s)? | 1. Setting up of ground-receiving station.<br>2. Creation of information and analytical centre for gathering and processing remote sensing data. | 1. All these centres have similar programmes: remote sensing and space applications for natural resource management; training activities; and action to increase awareness. | 1. Training in remote sensing and geographic information system application survey, natural resource and environmental applications.<br>2. Pioneer role in training of national geospatial data infrastructure.<br>3. Regional advisers on the management and development of natural resources.<br>4. Development of application software such as the Integrated Land and Water Information System. | 1. National mapping service and support.<br>2. Graduate programmes in remote sensing and geographic information systems, short courses and training programmes.<br>3. Graduate and professional courses in applied remote sensing and geographic information systems.<br>4. Graduate programmes and short courses in remote sensing and geographic information systems.<br>5. Environmental geomatics programme. | | 1. Remote sensing and support for space missions.<br>2. Microsatellite design and construction.<br>3. Surveying, including the use of the Global Positioning System and the Global Navigation Satellite System.<br>4. Weather and climatic conditions. | 1. Remote sensing applications for natural resource development.<br>2. Land degradation monitoring using remote sensing techniques and geographic information systems.<br>3. Training and space technology education.<br>4. Natural resource mapping. |

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| (c) Performance of institution(s) to date in meeting established goals? | 1. Ministry of Agriculture.<br>2. Committee of Cartography and Land.<br>3. The State Commission on Disaster.<br>4. Statistical Committee. | 1. The Royal Centre for Remote Sensing: since its establishment in 1989, the Centre reached successful achievements.<br>2. Operational and regular uses of remote sensing in several sectors: agriculture, forestry, urbanism.<br>3. Establishment of a nationwide database.<br>4. Training of more than 500 persons in different fields. | The Regional Centre for Training in Aerospace Surveys has made remarkable impacts in West Africa, while the Satellite Applications Centre has made an impact in South and East Africa. The International Institute for Geo-Information Science and Earth Observation and the Groupement pour le développement de la télédétection aérospatiale have made an impact in virtually every part of the world. | | | 1. Outstanding collection of remote sensing data with support for mapping, agricultural and forestry applications and town and regional planning.<br>2. Efficient and relatively accurate short- and long-term forecasting. | 1. Enhancing natural resource management.<br>2. Thematic maps for natural resources at local and regional levels.<br>3. Creating well-trained action teams.<br>4. Integration of modern technology and traditional knowledge. |
| (d) Limitations of institution(s) in achieving established goals? | Lack of equipment, limited software and hardware facilities. | 1. The main limitation is related to limited budgetary resources to finance projects within departments.<br>2. Difficulties to have trained people. | 1. Poor funding and lack of commitment, particularly from collaborating countries, especially with the regional institutions such as the Regional Centre for Training in Aerospace Surveys and the African Regional Centres for Space Science and Technology Education.<br>2. Limited United Nations financial support. | 1. Funding, new data and equipment.<br>2. Funding and equipment.<br>3. Need software upgrades.<br>4. Brain drain. | | 1. Insufficient funding.<br>2. Lack of a body to promote research in space sciences. | 1. Lack of regional coordination.<br>2. Lack of financial and technical support. |

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| 7.1. Identify the categories of decision makers that are essential to the successful application of the results of space research in sustainable development. | (a) Engineer-technician;<br>(b) Programmer;<br>(c) Specialist in remote sensing;<br>(d) Analytic database;<br>(e) Specialist in global information system technology. | (a) The highest level of the State;<br>(b) Ministers in charge of science and technology;<br>(c) Departments in charge of resource management;<br>(d) Budget/finance department to provide support. | Government ministers and parastatals. | National line agencies such as the Department of Science and Technology, the Bureau of Fisheries and Agricultural Research, and the National Economic and Development Authority. | Assuming the global space system project is realizing the opportunities it offers more likely will not demand government interference to be marketed and used by the community because of its quite evident attractive nature. | (a) Political-level: support of cabinet ministers is essential;<br>(b) Leading figures from academic institutions;<br>(c) Curriculum planners of school education authorities;<br>(d) Senior management of government departments responsible for agriculture, education, science and technology development, disaster management, transport, land usage and regional planning and so forth. | (a) Political level: ministers of agriculture, irrigation, environment and mineral resources;<br>(b) Academic level: facilities of agriculture, geography and applied sciences;<br>(c) Technical level: directors and technical staff of natural resource management projects. |
| 2. Suggest ways of educating and influencing decision makers so that they pay due attention to space-related information and technology when making policy decisions. | Educating and influencing:<br>(a) Doctor;<br>(b) PhD;<br>(c) Master’s degree. | (a) Pilot project (operational) to demonstrate usefulness of space sciences and technologies;<br>(b) Seminars and symposiums to show spin-off benefits;<br>(c) Visits and contact with foreign experiences. | Recommend the training and involvement of bureaucrats such as deputy directors, permanent secretaries, directors and assistant directors, as well as their participation in seminars, symposiums, workshops and so forth. | (a) Make space research part of our agenda for sustainable development;<br>(b) Include fundamental environmental geomatics in curricula of educational programmes at tertiary levels of education. | It is necessary to discuss the proposal in all possible forums to achieve a common understanding of the benefits of the discuss system. Main influence on decision makers may make industrial level leaders ready to accept the proposal. | (a) Seminars, symposiums and public information work;<br>(b) Effective distribution of information by agencies with an interest in space technology. | (a) Seminars, symposiums and training courses;<br>(b) Technical exhibitions;<br>(c) Field days and demonstration activities;<br>(d) Networking and knowledge-sharing. |

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| 8. What steps should a country take if it aspires to become an effective participant in space programmes that can enhance sustainable development at the local level? | 1. Enhance international cooperation in the area of space investigations.<br>2. Provide software and hardware facilities.<br>3. Integrate with countries of region. | 1. Establish a clear strategy in techno- logy applications.<br>2. Undertake training and education of local human resources.<br>3. Establish operational structures (equipment, tools and so forth).<br>4. Allocate budgetary resources.<br>5. Encourage inter- national cooperation of knowledge and expertise exchange. | 1. Develop a national space policy.<br>2. Build capacity in space science and technology.<br>3. Strengthening national institutions.<br>4. Ensure the participation of the public and private sectors in space programmes. | 1.Establish own space programme.<br>2. Allocate funds to it.<br>3. Institutionalize and sustain a network of organizations.<br>4. Educate and train staff.<br>5. Secure professionals. | Find a way of allotting some funds to more applicable for given country space activity to join despite financial and common situation in the country. | 1. Establish a well- defined policy of education, research and application of space technologies.<br>2. Establish meaningful cooperative agreements with other countries that have the necessary technology and expertise and ensure that those agreements are made operative. | 1. Support the national institutions that apply remote sensing and space science.<br>2. Develop technical cooperation with concerned regional and international organizations.<br>3. Encourage the participation of non- governmental organizations and the private sector in space technology and space research development. |
| 9. What are your additional suggestions for ways in which space technology and research can be harnessed in the interest of sustainable development? | Increased attention by international organizations to the countries of the former Soviet Socialist Republics, including Azerbaijan. | 1. Space research programmes should take into considera- tion the needs of developing countries.<br>2. Wide diffusion of space research results.<br>3. Easy access to results and data related to space research.<br>4. Cooperation through regional projects. | 1. Investments and full participation in space technology, not only as a con- sumer nation, but also as a service provider.<br>2. Promotion of private investments in space research and technology. | 1. Integration of space-based research and development policy formulation.<br>2. Use of space technology research outputs for popular education.<br>3. Diffusion of space technology outputs for private, development- oriented enterprises.<br>4. Expansion of university-industry research linkages. | | Place emphasis firstly on skilled people and then on technology. The critical path is to train people in the applications of space technology and then to create opportuni- ties for those people to practise their careers in their home countries. This is where the technology comes in. Space applications have to be oriented to national needs and space has to figure in the national natural resource manage- ment systems of a country. | 1. Strengthen the institutional and technical capacities of national and regional specialized centres to develop the use of space technology.<br>2. Encourage the up- scaling of existing regional databases.<br>3. Survey and evaluate the methodologies used in space technologies for sustainable development.<br>4. Encourage the flow of investments to programmes of remote sensing application. |

# Appendix II

## Issues relevant to the application of the results of space research as discussed at the World Summit on Sustainable Development

1. The areas of socio-economic development in which the results of space research can be applied include globalization, the management of ecosystems and biodiversity, the management of freshwater resources, food security and sustainable health, access to energy and energy efficiency, changing unsustainable patterns of consumption and production, as well as poverty eradication, sustainable livelihoods, strengthening the system of democracy and ensuring good national governance. Studies necessary to achieve the foregoing require an integrated approach, which takes into account sound scientific methodologies, including aspects of space technology, with multiple-scale perspectives for the efficient and sustainable management of the natural resources and environment.

## I. Potential areas of intervention

### A. Development of low-cost satellites and Earth stations

2. The current research and development of microsatellites and minisatellites have provided the opportunity for developing countries to be major players and service providers by owning their own satellites. Microsatellites offer the opportunity for increased performance and, compared with the traditional large satellites, are inexpensive platforms for remote sensing, communication, weather and scientific observations and research. That affordability makes possible research into and the development of appropriate payloads for solving local problems. It also provides the opportunity to bridge digital divides within and across regional blocks through international cooperation and facilitates improved temporal resolution through constellations with other satellites. An example of this are the efforts of Algeria, China, Nigeria, Thailand, Turkey, the United Kingdom of Great Britain and Northern Ireland and Viet Nam to build microsatellites that will provide data, on a daily basis, that can be used by these countries to undertake disaster monitoring. A similar initiative, known as the African resource management microsatellite constellation, being proposed by Algeria, Nigeria and South Africa, aims at a joint development of satellites with high resolution and hyperspectral (sensors) payloads.

3. Affordable microsatellites or minisatellites will reduce launch cost and revolutionize information communication, which will aid rapid development even in the rural areas of the developing countries, as well as encourage the involvement of local industries and the private sector.

### B. Capacity- and institution-building

4. Capacity- and institution-building will require the establishment of adequate and effective human resource development mechanisms and the appropriate institutional framework or, where one exists, its reinforcement. Similarly, capacity-

and institution-building can be enhanced through international cooperation and pilot projects, as well as the establishment of new regional centres of excellence; the latter can serve as focal points for training and the transfer of technological know-how, data-sharing and the coordination of international cooperation.

5. For example, through cooperative research, the countries of Asia and the Pacific have established an integrated environmental monitoring system that covers the entire region. The system includes the establishment of satellite data-receiving stations with analytical systems for Moderate-Resolution Imaging Spectroradiometer (MODIS) data, a ground-truthing observation network, integrated monitoring of environmental degradation and disasters and simulation of land-atmosphere processes, with all the appropriate and associated human resource development. The monitoring system is part of the Asia-Pacific Environmental Innovation Strategy Project sustainable development strategy. African and Latin American countries should consider launching a similar initiative.

## C. Monitoring the environment

6. Observations of the Earth’s atmospheric system are essential for a better understanding of the atmosphere, ozone depletion, global warming, sea-level rise, atmospheric and water pollution, floods, droughts, land degradation and desertification, deforestation and loss of biodiversity, mitigation of natural disasters, freshwater availability, agricultural services and hazardous waste disposal. These observations constitute challenges that can be met by strengthening monitoring facilities for the observation of the Earth’s atmospheric system and the collection of reliable data, the provision of frameworks for promoting synergy among relevant national and international programmes to ensure linkage with all countries and committing all nations to pool together resources and intellectual capital in addressing these issues in support of sustainable development.

7. In this regard, the Integrated Global Observing Strategy partnership unites the major satellite and surface-based systems for global environmental observations of the atmosphere, oceans and land. Some of the observation systems within this partnership are the World Weather Watch Global Observing System (WWW/GOS), the Global Atmosphere Watch (GAW), the World Hydrological Cycle Observing System (WHYCOS), the Global Climate Observing System (GCOS), the Global Ocean Observing System (GOOS) and the Global Terrestrial Observing System (GTOS).

8. These weather watch and Earth observations will help to achieve sustainable development by:

(a) Enabling increased awareness of the usefulness of weather observations and the provision of increasingly beneficial weather, water, climate and related environmental services to the public, Governments and other customers throughout the world;

(b) Enabling the delivery of accurate and reliable warnings of severe events related to weather, water, climate and the natural environment and ensuring that warnings reach their target audience in a timely and useful manner;

(c) Enhancing the relationship between meteorological factors and the quality of agricultural output;

(d) Enabling the management of freshwater resources through hydrometeorological applications and services;

(e) Ensuring the safe and efficient conduct of flights and related aviation services, as well as coastal and marine navigation and management;

(f) Managing safe communities in urban areas.

9. For example, the aim of the Global Ocean Observing System is to establish a Regional Ocean Observing and Forecasting System for Africa (ROOFS-Africa). The ROOFS-Africa project is one of the cross-cutting projects established by the United Nations Educational, Scientific and Cultural Organization to improve the collection of data and their use in the prediction of tides and sea-level rise, the assessment of coastal erosion, coastal flooding forecasting, fishery and resource management. GOOS-Africa radio and Internet communications systems have been developed to facilitate this project.

10. Similarly, the recent launch of the first meteorological satellite in the Meteosat Second Generation series provides meteorologists with much improved imagery and data of the changing weather in Africa, part of Asia and Europe. Accordingly, all countries in Africa have agreed under a unique partnership to transform the data to useful purposes and sustainable development. To that end, a task force on preparation for the use of Meteorological Second Generation in Africa (PUMA) and African Monitoring of the Environment for Sustainable Development (AMESD) projects will provide much better network data and services for the early warning of disasters, improved food security, better health management, more efficient water and energy use and safer transport. The PUMA Task Team Project is being financed by the European Development Fund and the trust fund set up under the auspices of WMO. Similar initiatives can be established for the regions of Asia and Latin America.

## D. International charter

11. Through an initiative of the Centre national d'études spatiales of France and the European Space Agency, the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of National or Technological Disasters (the "International Charter 'Space and Major Disasters'") was established on 1 November 2000. It was later signed by the Canadian Space Agency, the Indian Space Research Organization and the National Oceanic and Atmospheric Administration of the United States. It focuses on the contribution that space technology can make in responding to natural disasters. The Charter provides for the efficient use of space technology to address major disasters involving large-scale loss of life and property caused by natural phenomena such as earthquakes, cyclones, tornadoes, volcanic eruptions, floods and fires. The central objective of the Charter is to supply data that will provide the basis for critical information and support to States or communities affected or at risk during periods of crisis.

## E. Geographic information for sustainable development

12. The application of the results of space research to sustainable development is diverse and large and creates scenarios for integration with data from other sources. The Geographic Information for Sustainable Development (GISD) initiative is being established to improve the quality, accuracy and availability of data needed to better monitor and understand the environment. The initiative is promoted by international organizations such as GISD, a United States Agency for International Development-funded institution. According to GISD, geographic information systems and database management are effective tools for (a) monitoring deforestation; (b) assessing land degradation; (c) providing early warning of famine; (d) enhancing the capacity for emergency response to disease outbreaks; (e) aiding food security; and (f) developing new strategies to manage natural resources. Geo-information sharing is also promoting greater transparency and accountability at the national level. The GISD initiative is focusing on result-oriented partnerships for applying geographic information for sustainable development challenges at the international, national and local levels. Projects have been implemented in many parts of Africa.

## F. Spatial data infrastructure

13. The space technology issues addressed at the World Summit on Sustainable Development concerned, among other things, the needs:

(a) To adopt policies that promote greater public access to geo-information;

(b) To act in concert to develop and implement geo-information standards;

(c) To document geo-information resources and publish such information widely;

(d) To invest in human capacity development to use geo-information;

(e) To invest in technical capacity to acquire, manage and provide access to geo-information;

(f) To initiate formal programmes for the development of spatial data infrastructure.

14. The opinion was expressed by Environmental Information Systems—Africa that each country should be encouraged to establish spatial data infrastructure because it has been proved to enhance socio-economic development.