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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Austria/European Space Agency Symposium on Space Tools and Solutions for Monitoring the Atmosphere and Land Cover (Graz, Austria, 9-12 September 2008)

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I. Introduction

1. Since 1994, the Office for Outer Space Affairs of the Secretariat, the Government of Austria and the European Space Agency (ESA) have jointly organized symposiums on space science and technology and their applications. The symposiums, held in Graz, Austria, have addressed a broad range of themes, including the economic and social benefits of space activities for developing countries, space industry cooperation with the developing world and enhancing the participation of youth in space activities. Information on the symposiums is available on the website of the Office for Outer Space Affairs (http://www.unoosa.org/oosa/SAP/graz/index.html).

2. Since 2003, the symposiums have been dedicated to promoting the benefits of using space science and technology and their applications to carry out the Plan of Implementation of the World Summit on Sustainable Development.[1] The initial series of three consecutive symposiums, held from 2003 to 2005, focused on water resources and sustainable water management (see A/AC.105/844).

3. The second series of three symposiums, held from 2006 to 2008, has focused on atmosphere-related issues. The first symposium of that series, held in September 2006, addressed the benefits of using space technologies for monitoring air pollution and energy production (see A/AC.105/877). Building on that event, and pursuant to General Assembly resolution 61/111 of 14 December 2006, the symposium held in 2007 dealt with space tools and solutions for monitoring the atmosphere in support of sustainable development, focusing on issues such as air quality, climate change and weather, ozone depletion and ultraviolet monitoring (see A/AC.105/904).

4. The 2008 United Nations/Austria/European Space Agency Symposium on Space Tools and Solutions for Monitoring the Atmosphere and Land Cover,[2] which was the third and concluding symposium of the present series on atmosphere-related issues, promoted the use of demonstrated capabilities of space technologies and their applications to support the actions called for in the Plan of Implementation of the World Summit on Sustainable Development. The 2008 symposium also served as a transition to issues related to the monitoring of land cover, with a focus on the interactions between land cover and the atmosphere, including issues such as agriculture, rural development, land use and drought and desertification, which have been identified as issues to be considered as part of the thematic cluster of the Commission on Sustainable Development for the two-year cycle 2008-2009.

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[1] *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.

[2] The documents and presentations of the 2008 symposium are available on the website of the Office (http://www.unoosa.org/oosa/SAP/act2008/graz/index.html), which also serves as a portal by providing links to useful reference and tutorial materials, including links to atmosphere-related data and websites.

A. Background and objectives

5. At the World Summit on Sustainable Development, held in Johannesburg, South Africa, from 26 August to 4 September 2002, Heads of State and Government reaffirmed their strong commitment to the full implementation of Agenda 21,[3] which had been adopted at the United Nations Conference on Environment and Development, held in Rio de Janeiro, Brazil, from 3 to 14 June 1992. They also committed themselves to achieving the internationally agreed development goals, including those contained in the United Nations Millennium Declaration (General Assembly resolution 55/2 of 8 September 2000). The Summit adopted the Johannesburg Declaration on Sustainable Development[4] and the Plan of Implementation of the World Summit on Sustainable Development.

6. In its resolution 54/68 of 6 December 1999, the General Assembly endorsed the resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development",[5] which had been adopted by the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999. UNISPACE III had formulated the Vienna Declaration as the nucleus of a strategy to address future global challenges using space applications. In particular, the Vienna Declaration noted the benefits and applications of space technologies in addressing the challenges to sustainable development, as well as the effectiveness of space instruments for dealing with the challenges posed by the pollution of the environment and the depletion of natural resources.

7. Space science and technology and their applications can provide important information in support of policy- and decision-making for sustainable development. In some cases, space-based solutions are essential or afford the only or most cost-efficient means of collecting specific data. For example, the gathering and assessment of global environmental information often can be accomplished only by means of space-based sensors.

8. Implementation of the recommendations contained in the Vienna Declaration supports the actions called for in the Plan of Implementation of the Word Summit on Sustainable Development. Consequently, in 2002, the Office for Outer Space Affairs organized a symposium in Stellenbosch, South Africa, immediately prior to the World Summit on Sustainable Development in order to consider steps to carry out actions proposed for inclusion in the Summit Plan of Implementation. That symposium recommended that pilot projects should be launched to demonstrate operational capabilities of space technologies to support sustainable development. In follow-up to that recommendation, the Office for Outer Space Affairs, with the sponsorship of the Government of Austria and ESA, held the series of symposiums from 2003 to 2005 to examine how such projects could be initiated, in particular in water resource management. Details of that series of symposiums, including the

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[3] *Report of the United Nations Conference on Environment and Development, Rio de Janeiro, 3-14 June 1992, vol. I, Resolutions Adopted by the Conference* (United Nations publication, Sales No. E.93.I.8 and corrigendum), resolution 1, annex II.

[4] *Report of the World Summit on Sustainable Development*, chap. I, resolution 1, annex.

[5] *Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space, Vienna, 19-30 July 1999* (United Nations publication, Sales No. E.00.I.3), chap. I, resolution 1.

programme and background materials, are available on the website of the Office (http://www.unoosa.org/oosa/en/SAP/act2005/graz/index.html).

9. Based on the positive experience of that series of symposiums, the Office for Outer Space Affairs, with the support of the Government of Austria and ESA, organized the following series of symposiums, from 2006 to 2008, to consider how existing space technology-based tools and solutions could contribute to and strengthen the capacities of developed and developing countries and countries with economies in transition to measure and assess, and take steps to reduce, the impact of air pollution, climate change and changing weather patterns, as well as ozone depletion, ultraviolet radiation and the associated health risks.

10. The themes for the series of symposiums from 2006 to 2008 are closely linked to the work of the Commission on Sustainable Development, which was established in 1992 to consider the implementation of the recommendations on sustainable development made at major global conferences such as the United Nations Conference on Environment and Development and the World Summit on Sustainable Development.

11. The Commission on Sustainable Development is pursuing a multi-year programme of work covering the period 2004-2017. That time period is split into two-year cycles, with each cycle focusing on a thematic cluster and a number of cross-cutting issues. Each cycle consists of a review year, in which the Commission seeks to identify obstacles and constraints to implementation, and a policy year, in which the Commission decides on measures to accelerate implementation and to mobilize action to overcome the obstacles and constraints identified in the course of the review year.

12. The thematic cluster for the period 2008-2009 includes the issues of agriculture, land use and rural development, interaction between climate change and agriculture, particularly in developing countries, improved management of land resources and combating drought and desertification, which coincide with the focus of the current series of symposiums. The recommendations and conclusions of the symposiums thus also form part of the contribution of the Committee on the Peaceful Uses of Outer Space to the work of the Commission (see A/AC.105/872 and A/AC.105/892).

13. Pursuant to General Assembly resolution 62/217 of 22 December 2007, the 2008 United Nations/Austria/European Space Agency Symposium on Space Tools and Solutions for Monitoring the Atmosphere in support of sustainable development was co-sponsored by the Office for Outer Space Affairs, the Federal Ministry for European and International Affairs and the Federal Ministry for Transport, Innovation and Technology of Austria, the state of Styria, the city of Graz and ESA and supported by the National Aeronautics and Space Administration (NASA) of the United States of America. The symposium was held at the Institute for Space Research of the Austrian Academy of Sciences, Graz, Austria, from 9 to 12 September 2008. It was the fifteenth in the series of symposiums organized as part of the United Nations Programme on Space Applications in cooperation with those co-sponsors.

14. The 2008 symposium had the following specific objectives:

(a) To inform about the World Summit on Sustainable Development framework and the work of the Commission on Sustainable Development and to provide a comprehensive introduction to the context and role of atmosphere monitoring in support of sustainable development;

(b) To promote and inform about ongoing relevant national, regional and global initiatives (such as the programmes of the Committee on Earth Observation Satellites (CEOS), the Group on Earth Observations (GEO) and the Global Earth Observation System of Systems (GEOSS), Global Monitoring for Environment and Security (GMES), the United Nations Programme on Space Applications and the World Meteorological Organization (WMO)) and the uses of the demonstrated capabilities of space technology and their applications related to monitoring the interaction between the atmosphere and land cover, including issues such as agriculture, land use and rural development and drought and desertification;

(c) To examine available space technology-based tools, solutions and information resources (for example, operational meteorological satellites, research satellites, data dissemination using systems such as the GEONETCast and the WMO Integrated Global Data Dissemination Service (IGDDS)) to address issues related to the monitoring of the atmosphere and land cover and how such information can be accessed and utilized;

(d) To examine possibilities and strategies for including space technology-based tools, solutions and informational resources in decision-making processes on issues requiring information on the state of the atmosphere and land cover;

(e) To identify the type and level of available and desirable training for using the relevant tools, solutions and resources;

(f) To examine existing functional partnerships and cooperation opportunities and consider the possible necessity of establishing new frameworks for cooperation through voluntary action, including by Governments, international organizations or other relevant stakeholders, to promote the use of space technologies for monitoring the atmosphere and land cover.

15. Participants were expected to gain the following from the symposium:

(a) An understanding of the World Summit on Sustainable Development framework, the context of sustainable development, the role of atmosphere and land cover monitoring in that context and the capabilities of the relevant space technology-based tools, solutions and information resources, as well as strategies for including such tools in the relevant decision-making processes;

(b) Knowledge of space technology-based tools, solutions and informational resources for monitoring the atmosphere and land cover and knowledge of ways to utilize existing partnerships or establish new functional partnerships to promote the operational use of space technologies;

(c) An understanding of national, regional and international strategies, programmes and projects to promote sustainable development, in particular with regard to issues related to the atmosphere and land cover.

B. Programme

16. This year's symposium was the fifteenth in the series of annual symposiums held in Graz since 1994. A special session to celebrate that anniversary, held on 9 September, provided an appropriate and special opportunity to review and celebrate the achievements of the series of symposiums.

17. The opening ceremony of the symposium included introductory statements by representatives of the Austrian Academy of Sciences, Joanneum Research, the city of Graz, the Federal Ministry for Transport, Innovation and Technology of Austria and the Office for Outer Space Affairs. In their statements, the Federal Ministry for Transport, Innovation and Technology and the Office For Outer Space Affairs highlighted the importance of space tools and technologies for the benefit of society and the achievements of the Graz symposiums of the past 15 years.

18. Representatives of NASA presented a video marking the occasion of the fifteenth anniversary of the symposiums, covering their history, background and achievements.

19. Representatives of the International Institute for Applied Systems Analysis and the United Nations Environment Programme gave keynote speeches, and participants in the 2007 symposium reviewed the highlights, outcome and follow-up activities of that symposium.

20. The 2008 symposium programme included a series of technical presentations on successful applications of space technology-based tools that provided cost-effective solutions or essential information for planning and implementing programmes and projects related to the monitoring of the atmosphere and land cover.

21. Participants receiving funding support from the United Nations and the co-sponsors gave short presentations on their work related to the symposium.

22. The symposium consisted of six thematic sessions: global and regional initiatives; overview of Earth observations, satellite applications and atmosphere monitoring; agriculture, land and rural development; interactions between the atmosphere and agriculture, particularly in developing countries; space tools and solutions for combating drought and desertification; and education, training and institutional capacity-building.

23. NASA sponsored and organized a half-day interactive training session on space tools and applications for monitoring the atmosphere and land cover.

24. On the fourth day of the symposium, two working groups were formed to analyse the following two topics: training and capacity-building; and the availability and use of data and tools for atmosphere and land cover monitoring. The working group splinter meetings provided opportunities for participants to discuss issues concerning regional and international cooperative mechanisms and resources for implementing projects. The working groups also met to outline project proposals.

25. At the symposium, a total of 40 presentations were delivered by invited speakers from both developing and industrialized countries, and a comprehensive discussion session was held at the conclusion of each presentation session.

C. Attendance

26. A total of 52 participants from the following States attended the symposium: Algeria, Austria, Azerbaijan, Bangladesh, Belarus, Brazil, Cambodia, Canada, Costa Rica, France, Germany, Ghana, India, Indonesia, Lebanon, Lesotho, Malaysia, Nepal, Nigeria, Pakistan, Paraguay, Romania, Russian Federation, Sri Lanka, Suriname, Syrian Arab Republic, Ukraine, United States and Zambia. Representatives of the following national, international and intergovernmental organizations were among the participants: United Nations Environment Programme, German Aerospace Center (DLR), GMES, International Institute for Applied Systems Analysis, National Academy of Sciences of Ukraine Scientific Centre for Aerospace Research of the Earth, Max-Planck-Institute for Meteorology and United States Geological Survey.

27. Funds allocated by the United Nations and the co-sponsors were used to defray the cost of the air travel, daily subsistence allowance and accommodation of 23 participants. The co-sponsors also provided funds for local organization, facilities and the transportation of participants.

28. Funding support from the United Nations and the co-sponsors was made available to participants in managerial or decision-making positions in governmental and research institutions with responsibilities for carrying out programmes and projects in areas related to the theme of the symposium or who worked in institutions related to space or meteorology, environmental agencies or companies conducting activities related to the monitoring of the atmosphere and land cover. Individuals who had started or were involved in atmosphere- and land cover-related application projects or outreach activities in their institutions, as well as women carrying out any of the above-mentioned responsibilities, were particularly encouraged to apply.

II. Summary of thematic presentations

A. Global and regional initiatives

29. GMES, a European initiative for implementing information services dealing with the environment and security, made use of Earth observation satellites and other observation sources, in support of European environment and security policies. Those services covered the land, marine, emergency response, atmosphere and security fields. The purpose of GMES was to build a European capacity by consolidating, structuring and coordinating existing capacities. Representatives of GMES described that initiative's contribution to monitoring land cover and atmosphere and its atmosphere-related service.

30. GMES would build upon existing bases and operational activities such as the Coordination of Information on the Environment (CORINE) Land Cover project. Four principal themes were included in the scope of the atmosphere service: climate forcing, air quality, stratospheric ozone and solar radiation. The land monitoring core service addressed a wide range of resources and policies (in areas such as soils, water, agriculture, forestry, biodiversity, transport and regional policies) involving diverse user communities at the local, national, European and global levels

requiring diverse information, ranging from common multi-purpose information to information specific to the thematic or geographical area.

31. The land monitoring core service would offer a portfolio of data and products with different levels of elaboration, from pre-processed images to elaborated information, with multi-purpose products such as the following: (a) pre-processed space data such as orthorectified images, image mosaics and daily or weekly image composites; (b) reference data consisting of existing reference data complemented by the production of specific data as required, for example, the digital elevation model of Europe, orthorectified photographs and thematic data such as soil maps; (c) bio-geophysical parameters, such as dynamic vegetation and surface parameters in real-time and at the global level; and (d) a set of land use/land cover and land-cover-change products offering combinations of various scales (global land cover, European continental land cover and national or local land use/land cover), time resolutions (daily, weekly, monthly or seasonal periods or with a periodicity of 1-5 years) and layers (general land cover or thematic land use/land cover, such as forest classes and agriculture classes). The portfolio would later be extended with a set of thematic products at the European or international level (based on modelling and spatial analysis) in areas such as crop forecasts, early warning on food security, water models (water quality and irrigation), environmental and agri-environmental indicators, carbon fluxes, soil degradation and desertification models.

32. A presentation was made of the Protocol Monitoring for the GMES Service Element (PROMOTE) project of ESA. More than 20 service providers from Europe and Canada had teamed up to directly provide end users targeted information related to atmospheric conditions (stratospheric ozone, surface ultraviolet radiation, air quality, climate change and volcanic activity). The main objective of the project was to construct and deliver sustainable and reliable operational services to support informed decisions on atmospheric policy issues. Users of the services included more than 50 administrations and organizations in Europe and Canada, ranging from city administrations to volcanic ash advisory centres and European citizens in general.

33. Presentations were made on the following topics: present status of Nepal in the area of space tools for sustainable development (Nepal); integration of remotely sensed data into a geographical information system for soil resources (Romania); satellite applications in aerosol and glacier monitoring in Pakistan (Pakistan); monitoring land cover changes in the Arab region using high temporal resolution Normalized Difference Vegetation Index (NDVI) time series images (Lebanon); measuring the impact of urban growth on urban travel and the implications for air quality (Canada); concept of a space system for global radio occultation monitoring of the lower atmosphere and the ionosphere based on super-small satellites with Global Navigation Satellite System (GLONASS)/global positioning system (GPS) navigational signal receivers (Russian Federation); and a proposal for the establishment of a centre of data excellence (Zambia).

B. Earth observations, satellite applications and atmosphere monitoring

34. Introductory presentations familiarized participants with the latest developments in global Earth observation systems, satellite applications and the principles of satellite remote sensing and their applications for atmosphere monitoring.

35. A presentation was made on the monitoring of climate change from space, emphasizing the contribution of satellite data to forecasting abilities and trend analysis using satellites. An overview of the European perspective on Earth observation systems was given. Earth observations from space contributed to the following areas: the detection and exploitation of windows of predictability; warning of geohazards and the mitigation of their impact; and monitoring of compliance with international law.

36. Satellite remote sensing data are a powerful and convenient means of monitoring atmospheric air quality and land use/land cover. Several satellite data sets, including true colour images, aerosol optical depth and normalized difference vegetation index were of particular use to analysts and researchers working in those fields. Such data with global coverage were available on a daily basis from various Internet resources. Users could download data in a hierarchical data format and process images themselves or, if they had limited time and resources, could access pre-processed images. Examples of true colour, aerosol optical depth and normalized difference vegetation index images were shown, with an emphasis on how to interpret their key features and their relation to air quality and land use/land cover. Several websites from which images and data could be downloaded free of charge were reviewed. The strengths and limitations of satellite remote sensing data sets in the context of the research requirements of participants were also discussed. A recent successful application of satellite remote sensing data in Mesoamerica and the Caribbean through the Regional Visualization and Monitoring System (SERVIR)/Air project was presented, entitled “Earth observations for air quality and land applications”.

37. A presentation was made giving a comprehensive overview of Earth observations, including principles of satellite remote sensing, and applications related to particulate matter and air quality. Satellites provided repeated, reliable and daily global coverage, and satellite data were used for assessing global weather, climate, environmental issues and for understanding the Earth-atmosphere system. Since very few ground monitors were available, satellites were the only viable tools for monitoring air pollution, from space.

38. Representatives of the United States Geological Survey made a presentation on the Centre for Earth Resources Observation and Science (EROS) and its activities in remote sensing and monitoring of the land surface for achieving sustainable development, including for addressing issues such as desertification, carbon sequestration and a range of other sustainable development interventions. The presentation also provided information on the regional centres and on continent-wide capacity-building efforts in Africa. The West Africa Land Use and Land Cover Trends project was an effort to document and quantify the impact of environmental and land resource trends in West Africa. The project was being

carried out through the agrometeorological and hydrometeorological (AGRHYMET) Regional Centre in Niger, with partners from 12 participating countries and support from the United States Agency for International Development. The project had provided each country with Corona and Landsat satellite imagery for four periods: the 1960s, 1970s, 1980s and 2000s. The project had trained environmental scientists from those countries in the analysis and mapping of land use and land cover changes that had occurred across the region in the past 40 years. The goal of the project was to promote the awareness of trends and the use of spatial information about natural resource trends among national and regional decision makers. That heightened level of awareness would help them formulate sound and sustainable policy responses, leading to better natural resource management, conservation, food security and human well-being.

39. An overview of the approach to map land use and land cover over time using diverse sources of satellite imagery was presented, with an introduction to the Rapid Land Cover Mapping Tool.

40. Presentations by participants in the session addressed the following topics: monitoring land cover in the interest of an agriculture with use of the remote-sensed data (Belarus); capacity-building for sustainable agriculture development in Cambodia (Cambodia); space tools and solutions for monitoring the atmosphere and land cover for rural development projects—geospatial technology processes and application models (India); multitemporal analysis of the urban growth of the city of Sapucaí (Paraguay); and environmental risks and social dissimilarities—facing the challenges of global changes in the Baixada Santista metropolitan region (Brazil).

C. Interactions between the atmosphere and agriculture, particularly in developing countries

41. The session's introductory presentation entitled "Mountains as early indicators of climate change: the role of space technologies in monitoring our changing climate" underlined the fact that climate change is a global challenge and focused on the importance of mountains as an early indicator of that change.

42. Another presentation described an approach for considering local environmental conditions characterizing the spatial distribution of plant communities in wetlands and forests. A variety of land cover classification systems based on space imagery had been proposed as an important source of updatable spatial data for monitoring the environment, in particular wetlands and forests. Results of land cover contextual classification using space imagery provided detailed spatial information for monitoring wetlands and forests and could be useful for analysis of changes caused by human activity.

43. Within a twinning framework supported by the European Commission research project BRAHMATWINN (Twinning European and South Asian River Basins to enhance capacity and implement adaptive management approaches), an approach had been developed to effectively model and map vulnerability to floods in Assam, India, and the Salzach river catchment in Austria. The objective of the research was to assess, in the broader context of environmental and physical hazards, the socio-economic component of risk through a joint vulnerability approach. The approach reflected the broader objective and concepts of the Intergovernmental

Panel on Climate Change framework, in which vulnerability was characterized as a component of overall risk.

44. Presentations by participants in that session addressed the following topics: spatial variability of soil properties of the kame field of the Poznań Lakeland, Poland (Syrian Arab Republic); variability of atmospheric and land surface biophysical parameters retrieved using satellite-based measurements over India (India); geographic information system (GIS) technology for dynamic monitoring land cover/land use changes for all of Azerbaijan using high resolution space images (Azerbaijan); land cover and environmental hazards—satellite remote sensing approach and solutions in Bangladesh (Bangladesh); challenges of obtaining land use data using conventional methods—opportunities for remote sensing (Lesotho); utilization of remote sensing and GIS technology in various applications for sustainable development in Malaysia (Malaysia).

D. Space tools and solutions for combating drought and desertification

45. At the first meeting of the Parties to the Kyoto Protocol and the eleventh session of the Conference of the Parties to the United Nations Framework Convention on Climate Change, held in Montreal, Canada, in November and December 2005, the Governments of Papua New Guinea and Costa Rica, supported by Latin American and African States, submitted a proposal for the consideration of reducing emissions from deforestation and degradation in developing countries under the United Nations Framework Convention on Climate Change.[6] The Conference of the Parties agreed to a two-year process of evaluation of the issue, beginning with negotiations of the Subsidiary Body for Scientific and Technological Advice. The goal of many States supporting that proposal was to initiate a programme through which countries that reduced emissions from deforestation could be compensated for those reductions, perhaps through linkages with the carbon market. Avoiding deforestation was considered to be a contribution to the reduction of greenhouse gas emissions. However, uncertainties existed about the quantifiable influence of the reduction of forest areas on the carbon balance. For example, there were uncertainties about how forest loss and degradation should be defined and the forest areas regularly inventoried (area and the related greenhouse gases).

46. It was reported that as the reducing emissions from deforestation and degradation (REDD) process was endorsed at the thirteenth session of the Conference of the Parties held in Bali, Indonesia, Conference decision 2/CP.13, entitled “Reducing emissions from deforestation in developing countries: approaches to stimulate action”, encouraged States parties to explore a range of actions, identify options and undertake efforts to address the drivers of deforestation relevant to their national circumstances. The role of Earth observation was considered indispensable as a technology and tool for carbon stock assessment. In order to demonstrate the feasibility of the REDD process, countries could take action to increase their capacity to conduct national forest inventories and maintain those inventories over time using available technologies such as remote sensing,

[6] United Nations, *Treaty Series*, vol. 1771, No. 30822.

identify deforestation hotspots and calculate deforestation rates and the resulting greenhouse gas emissions, establish emission baseline reference levels with reference to forest cover changes over a time period, and assess and monitor emissions related to forest degradation.

47. The GMES Service Element Forest Monitoring, financed by ESA, offered European users a specific service in the area of the United Nations Framework Convention on Climate Change, providing required information on forests for 1990, which was the reference year for the Kyoto Protocol to the United Nations Framework Convention on Climate Change,[7] as well as for successive years. Maps detailing forest cover and forest cover change, together with appropriate statistical data, were also provided. Based on that experience and the positive user feedback, in 2006, the Institute of Digital Image Processing, Joanneum Research and GAF AG participated in the development of REDD pilot projects in Cameroon and Bolivia, in consultation with user organizations. The aim of the pilot projects was to establish projections of emissions caused by deforestation for the baseline years 1990, 2000 and 2005, combined with regional projections of degradation. The Cameroon case presented was of special importance as the Central African Forestry Commission (COMIFAC) of the Congo basin, which was mandated by treaty to coordinate the implementation of all forestry programmes including international conventions such as the Framework Convention on Climate Change, had supported the programme as a prototype for the region.

48. Soil moisture, an important parameter for understanding the water cycle and for applications concerning vegetation and plant growth, was a widely used parameter in hydrological modelling, as well as in numerical weather prediction, flood forecasting and drought monitoring. The Vienna University of Technology had experience in long-term monitoring of soil moisture data sets from several microwave satellite sensors. The presentation covered soil moisture retrieval methods, the importance of soil moisture for monitoring droughts and products using various spatial scales. The scatterometers on board the European remote sensing satellites ERS-1 and ERS-2 (Active Microwave Instrument) and the Meteorological Operational satellite (METOP) (Advanced Scatterometer Instrument) provided the opportunity to measure soil moisture in a relatively direct manner due to the high sensitivity of microwaves to the water content in the soil surface layer. The soil moisture retrieval method was based on a change-detection approach that accounted for the effects of surface roughness, vegetation and heterogeneous land cover. Moreover, that service had the advantage of operational availability and a standardized product format through use of the facilities of the European Organisation for the Exploitation of Meteorological Satellites.

49. Presentations by participants in the session addressed the following topics: spatial analysis of forest regeneration after fire in Algeria by using high spatial images resolution and GIS (Algeria); integrating remote sensing data and energy balance modelling for detection of drought, and its publication on the Internet (Indonesia); the flash flood guidance system for Central America—a useful tool to improve flash flood warnings and alerts (Costa Rica); remote sensing/GIS multicriteria zoning of 200,000 hectares of land for a detailed feasibility study and survey and design for 5,000 hectares for an irrigation project (Ghana).

[7] FCCC/CP/1997/7/Add.1, decision 1/CP.3, annex.

E. Education, training and institutional capacity-building

50. On the fourth day of the symposium, NASA organized a hands-on training session on data access and image analysis techniques and the use of relevant resources to convey the benefits and challenges of using space-based tools in assessing land changes and air quality events.

51. The training session featured scenarios, data assessment and image analysis techniques and the use of relevant online resources to convey the benefits and challenges of using space-based tools in assessing actual atmospheric events. Participants split into small teams and worked through four case studies, which included a major wildfire, a large dust storm and regional air pollution events. They used space-based image data and software that were freely available on the Internet. Trainers guided and instructed the teams through the interactive training.

52. In the following discussion session, participants discussed the training activities, their approaches and the benefits and challenges in accessing data and using space-based tools.

53. In the presentation on the work of the Office for Outer Space Affairs, it was noted that capacity-building efforts in space science and technology were a major focus of the activities of the Office. Those efforts included support to the regional centres for space science and technology education, affiliated to the United Nations. The goal of such efforts was to develop, through in-depth education, an indigenous capability for research and applications in the core disciplines: remote sensing and geographical information systems; satellite communications; satellite meteorology and global climate; and space and atmospheric sciences and data management. The regional centres for Africa are located in Morocco and Nigeria; for Latin America and the Caribbean, in Brazil and Mexico; and for Asia and the Pacific, in India.

III. Conclusions and recommendations

54. In the context of the fifteenth anniversary of the Graz symposiums, the organizers will make available on DVD-ROM a compilation of all documents issued at the past symposiums, and the Office for Outer Space Affairs will make every effort to distribute that valuable resource to Governments and space-related institutions worldwide.

55. Participants recommended that the Office for Outer Space Affairs use proposals made at the symposium as input to the “communities of practice” currently being established by GEO to identify the needs in the area of access to satellite and ground data, and share expertise by applying Earth observation products in decision-making.

56. Participants in the symposium were asked to submit project proposals relevant to the theme of the symposium and were given time after the completion of the symposium to discuss and submit the proposals after returning to their institutions or organizations. The following project proposals were submitted:

(a) “Urbanization and the urban heat island effects”, in collaboration with Natural Resources Canada, Canada, Beijing Normal University, China, and the University of Cologne, Germany;

(b) “Impact of human development on coral reefs in the Hainan Island coastal region”, in collaboration with the Earth Sciences Sector of Natural Resources Canada, Canada, and East China Normal University, China;

(c) “Satellite image processing for aerosol mapping in the Baixada Santista metropolitan region” (Brazil);

(d) Evaluation of the Global Digital Elevation Model for estimation of landscape-dependent soil properties: case study of a representative watershed” (Romania);

(e) “Space technology for vulnerability assessment of environmental/energy security” (Azerbaijan).

57. The final day of the symposium was dedicated to the discussion of follow-up activities and working group meetings.

58. Participants split into two working groups, one group focusing on training and capacity-building and the other group focusing on the availability and use of data and tools for atmosphere and land cover monitoring. Those two topics had been identified as major priority issues. The working groups made the following recommendations and conclusions.

A. Working group on training and capacity-building

59. The working group on training and capacity-building suggested a broad framework for a training and capacity-building component including objectives, focus areas, an organization structure and a plan of action.

60. The working group recommended the following focused areas for effective and efficient training and capacity-building for space technology applications for project managers and policy planners:

(a) *Standard curriculum*. The working group suggested establishing a standard curriculum so that those working in the field of developing applications for the space-based monitoring of air quality and land use planning could be familiarized with process methodology and data integration analysis. That requires training manual preparation, training tutorials and exercise manuals;

(b) *Language*. The training and capacity-building curriculum and instructions, manual and tutorials should be published in languages other than the official languages of the United Nations;

(c) *Training tutorials using a simple and easy methodology*. To make space-based monitoring a proven and widely used tool, the training tutorials are to be developed using simple and easy-to-use methodologies. That will make it possible to promote space-based monitoring among individuals who are not geo-informatics professionals by enhancing their skill and knowledge base;

(d) *Case studies/best practices*. To learn from successes and failures in the use of space-based monitoring systems using case studies and best practices from various countries worldwide, case studies and best practices should be documented and periodically updated, and that knowledge base should be shared in order to raise awareness of and popularize the space-based monitoring systems;

(e) *Process methodologies*. The process methodologies of space-based monitoring systems in various fields assist in understanding the data requirement methodologies and in developing applications. There are standard, proven space-based technology processes for various applications. Documentation and dissemination of knowledge of those processes contribute to the wider application of technology;

(f) *Global issues related to climate change, the atmosphere and mountainous regions*. The global issues related to climate change, the atmosphere and mountainous regions are of great significance at present. Thus, space-based monitoring systems must be studied and propagated on a continuous basis. Training and capacity-building on the application of space-based monitoring in those areas are critical for the environment, ecology and regional development;

(g) *Disaster management*. The world is facing numerous disasters. Space-based monitoring has proved to provide reliable and accurate information for the early warning, prediction and mitigation of disasters. Training in the area of capacity-building in space-based monitoring in disaster management would be very useful;

(h) *Natural resource management*. Knowledge derived from space-based systems capturing data on natural resources and the dissemination of information through training and capacity-building should be significantly upgraded in developing countries;

(i) *Climate and the environment*. The most dynamic phenomena are found in the area of climate and the environment and require continuous monitoring, in which activity space-based monitoring is of great use. Monitoring of the climate and the environment would benefit immensely from training and capacity-building;

(j) *Atmosphere*. Because space-based monitoring of aerosol, haze, smog and other phenomena is reliable, the working group suggested training and building the capacity of functionaries associated with that area;

(k) *Urban and rural planning*. Training and capacity-building on space-based monitoring for urban and rural planning are expected to benefit scientific planning for regional development;

(l) *Management of mountainous regions*. Mountainous regions are significant regions that feed water to the world's rivers. Given the landslides, earthquakes, volcanic eruptions and associated problems, in addition to forest fires, deforestation and avalanches, that occur in mountainous regions, building training capacity in space-based monitoring would be helpful;

(m) *Coastal zone management and ocean resources*. The space-based monitoring of coastal zones, oceans and marine resources can give useful information on mangrove effluent emitted to the sea, oil spills and fish catches etc. Thus, training and capacity-building in that field is of great benefit;

(n) *Food security*. With the declining area of land under agricultural cultivation and food shortages posing a serious problem for food security, the management of water and soil, wasteland reduction, the productive use of land resources and precision agriculture should be urgently addressed in order to improve

global food security. Training and capacity-building in those areas must be promoted immediately in order to ensure food security for millions of people;

(o) *Promoting pilot projects*. Pilot projects and best practices constitute an important input for the training and capacity-building of decision makers and project managers. The working group recommended the funding of pilot projects by the United Nations for sharing processes and knowledge among the Member States;

(p) *Networking and coordination among nations*. For networking and the effective sharing of the resources and infrastructure of training institutions worldwide, it would be useful to provide the appropriate training and capacity-building for policymakers and project managers in order to promote space-based monitoring systems;

(q) *Data sharing*. Space-based monitoring should be used to address global and regional problems, and the sharing of data among States should be promoted through training and capacity-building for the effective monitoring of the quality of land use planning;

(r) *Global early warning systems*. The working group suggested that a global early warning system using space-based monitoring be operated by various countries worldwide. Training and capacity-building for a global early warning system would help to generate worldwide support for addressing global problems.

61. The working group also suggested the following plan of action:

(a) *Guidelines and process methodologies*. To promote training and capacity-building, guidelines and process methodologies must be prepared on a regional basis, thus promoting skill development and knowledge enhancement. As there are proven process methodologies for monitoring air quality and land use planning, technical manuals on process documentation can disseminate knowledge and contribute to developing the capabilities of project managers and policy planners for the effective monitoring of atmosphere and land use planning;

(b) *Identify regional groups*. The Office for Outer Space Affairs should identify regional groups capable of imparting training and building the capacity in the area of space-based monitoring of air quality and land use planning, in order to coordinate efforts to promote monitoring systems using space technology applications;

(c) *Establish national groups*. After the Office for Outer Space Affairs has identified such regional groups, national groups engaged in the promotion of space technology must be identified in order to work in accordance with the aims and objectives of the space-based monitoring systems;

(d) *Establish networking among all stakeholders*. The Office for Outer Space Affairs is urged to network with all national and regional resource organizations in a coordinated effort to promote space-based monitoring systems;

(e) *Develop specific regional programmes*. Regional programmes should promote specific training and capacity-building programmes that reflect the characteristics of the air and land features of the region, in order to produce a reliable knowledge base that is useful to the region;

(f) *Identify data requirements and sharing arrangements*. Space-based monitoring data on air quality and for land use planning are to be identified for each region, and a mechanism to share regional and global data should be established so that States can work towards regional and global solutions;

(g) *Identifying funding sources*. Funding, wherever required, should be made available by international space agencies and the United Nations, in order to promote space technology for training and capacity-building in countries and regions;

(h) *Promote pilot projects*. Pilot projects for space-based monitoring systems on air quality and land use planning need to be promoted by space agencies and the United Nations, in order to have a substantial impact and effectively promote space-based monitoring systems worldwide. Once streamlined and put into practice, data capturing and dissemination processes will be reliable and precise.

B. Working group on the availability and use of data and tools for atmosphere monitoring

62. The second working group discussed data needs, data availability, data access and data flow, infrastructure and the processes leading from training to accessing data and to implementation.

63. Participants expressed their views on different issues related to data availability, data access and data sharing mainly for land cover mapping and disaster management. The majority of group members drew attention to the lack of near-real-time satellite data when disasters occurred. The main requirement of various users was low-cost imaging radar data to overcome the effect of cloud cover. It was found that developing and developed countries had different satellite data needs. The availability of land cover maps was an issue for some countries, while other countries required data on air pollution. Because there are various application needs and terrestrial ecosystems of varying characteristics, the optimal configuration of sensors for regional/global land cover monitoring must be studied.

64. At the conclusion of their discussion, the second working group made the following conclusions and recommendations:

(a) There is a need for the creation of United Nations regional remote sensing data and service centres to respond to regional demands in the area of satellite data applications;

(b) A GIS web portal related to land cover studies and for sharing data among countries should be established;

(c) A constellation of microsatellites should be developed to obtain real-time data and for communications for disaster management;

(d) A task force should be established to study and determine the optimal sensor configuration in terms of spatial resolution, spectral capabilities and temporal resolution for mapping regional land cover and monitoring air pollution;

(e) Documentation for a reference manual describing available remote sensing applications and data should be developed.

Annex

United Nations/Austria/European Space Agency symposiums on space applications and technology for developing countries, 1994-2008

1. After a series of preparatory discussions within the Committee for Peaceful Uses of Outer Space, the proposal to organize a symposium on space applications and technology particularly for the benefit of developing countries was put forward, and a related decision was taken during the 44th Congress of the International Astronautical Federation, held in Graz, Austria, in 1993.

2. The suggestion of using the venue of Graz was positively received by the prospective sponsors, namely, the Austrian Ministry of Foreign Affairs, the government of the state of Styria, Austria, and the city of Graz. Further sponsors, including the European Space Agency (ESA) and the Austrian Ministry of Transport, Innovation and Technology, joined at a later stage.

3. The first symposium, entitled "Enhancing Social, Economic and Environmental Security through Space Technology" was held in Graz in 1994.

4. In the light of its success, it was proposed that follow-up symposiums in Graz be held again.

5. The 1995 and 1996 symposiums were dedicated to space technology and space applications, followed by the 1997 symposium dedicated to space industry cooperation with developing countries and the 1998 symposium on economic benefits of using space technology.

6. In 1999, in connection with the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), held in Vienna from 19 to 30 July 1999, the sixth United Nations/Austria/ESA symposium in Graz concentrated on the worldwide vision of youth concerning the future of space development, as expressed by the recently formed Space Generation Forum.

7. Subsequent symposiums were grouped in series of three. The first series (2000-2002) focused on enhancing the participation of youth in space activities. The next series (2003-2005) focused on space applications for sustainable development, and the following series (2006-2008) focused on space tools for monitoring air pollution, the atmosphere, energy use and land cover.

8. Graz was chosen as a venue for all those symposiums because of the longstanding experience in space research and technology accumulated by the two universities of Graz (Graz University of Technology and Karl-Franzens-University), the Institute for Space Research of the Austrian Academy of Sciences, the research institution Joanneum Research and local space industry (MAGNA-Steyr and Andritz). Those institutions still form the focal point of space research in Austria.

9. In recent years, valuable training workshops for utilizing space-based tools were organized by the National Aeronautics and Space Administration of the United States of America in the framework of the Graz symposiums.

10. The series of symposiums on sustainable development and monitoring of the atmosphere, especially with respect to water resource management and air pollution, were welcomed by the symposium participants.

11. The Government of Austria has demonstrated an open-minded attitude to space-related matters, as manifested by its continuing financial support of the Graz symposiums. Similar support has been given by the government of the state of Styria and the city of Graz.

12. Meeting facilities were provided in the early years of the symposiums by the Graz University of Technology and, since 2001, by the Institute for Space Research of the Austrian Academy of Sciences. From the beginning, Joanneum Research has acted as the local organizer. The response of the symposium participants, from many countries and a variety of cultural backgrounds, has always been very positive, and the environment of the Graz symposiums has had a stimulating effect on the creation of networks among participants, leading to a sustainable “Graz spirit”.