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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Kenya/European Space Agency Regional Workshop on the Use of Integrated Space Technology Applications in Monitoring the Impact of Climate Change on Agricultural Development and Food Security

(Nairobi, 1-5 December 2008)

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I. Introduction

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in its resolution entitled "The Space Millennium: Vienna Declaration on Space and Human Development",[1] recommended that activities of the United Nations Programme on Space Applications should promote collaborative participation among Member States at the regional and international levels, emphasizing the development of knowledge and skills in developing countries.[2]

2. At its fiftieth session, in 2007, the Committee on the Peaceful Uses of Outer Space endorsed the programme of workshops, training courses, symposiums and conferences of the United Nations Programme on Space Applications for 2008. Subsequently, the General Assembly, in its resolution 62/217, endorsed the United Nations Programme on Space Applications for 2008.

3. Pursuant to General Assembly resolution 62/217 and in accordance with the recommendations of UNISPACE III, the United Nations/Kenya/European Space Agency Regional Workshop on the Use of Integrated Space Technology Applications in Monitoring the Impact of Climate Change on Agricultural Development and Food Security was held in Nairobi from 1 to 5 December 2008.

4. The Workshop was organized by the Office for Outer Space Affairs of the Secretariat, as part of the activities of the United Nations Programme on Space Applications for 2008. It was hosted by the Kenya Meteorological Department and the Department of Resource Survey and Remote Sensing of Kenya, in collaboration with the Climate Prediction and Applications Centre of the Intergovernmental Authority on Development (IGAD) and the Regional Centre for Mapping of Resources for Development. The Workshop was co-sponsored by the European Space Agency (ESA).

5. The present report contains information on the background, objectives, programme, working groups, follow-up actions, conclusions and recommendations of the Workshop.

A. Background and objectives

6. In the Plan of Implementation of the World Summit on Sustainable Development,[3] Heads of State and Government strongly reaffirmed their commitment to the full implementation of Agenda 21[4] and committed themselves to achieving the internationally agreed development goals, including those contained

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[1] *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.

[2] Ibid., chap. II, para. 409 (d) (i).

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

[4] *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.

in the United Nations Millennium Declaration (General Assembly resolution 55/2). At the World Summit on Sustainable Development, the Johannesburg Declaration on Sustainable Development[5] was also adopted.

7. In its resolution 54/68, the General Assembly endorsed the Vienna Declaration on Space and Human Development, which had been formulated by UNISPACE III as the nucleus of a strategy to address future global challenges using space applications. In particular, in the Vienna Declaration on Space and Human Development, States participating in UNISPACE III noted the benefits and applications of space technologies in addressing the challenges to sustainable development and noted also the effectiveness of space instruments for dealing with the challenges posed by the pollution of the environment, the depletion of natural resources, the loss of biodiversity and the effects of natural and anthropogenic disasters.

8. The implementation of the recommendations contained in the Vienna Declaration on Space and Human Development could support many of the actions called for in the Johannesburg Plan of Implementation. In particular, the existing space-based tools could contribute and strengthen the capacities of developing countries to improve the management of natural resources by increasing and facilitating the use of data acquired with space technologies. In addition, the United Nations/Kenya/European Space Agency Regional Workshop on the Use of Integrated Space Technology Applications in Monitoring the Impact of Climate Change on Agricultural Development and Food Security supported the work of the Commission on Sustainable Development for the thematic cluster 2008-2009 and dealt with topics on the interaction between land cover and the atmosphere, including with regard to agriculture, rural development, land, drought, desertification and Africa.

9. The Commission on Sustainable Development is pursuing a multi-year programme of work covering the period 2004-2017, divided into two-year cycles, each of which is dedicated to a thematic cluster and a number of cross-cutting issues. Each two-year cycle comprises a review year, during which the Commission seeks to identify obstacles and constraints to implementation, and a policy year, during which the Commission decides on measures to accelerate implementation and mobilize action with the aim of overcoming the obstacles and constraints identified during the review year.

10. The thematic cluster 2008-2009 includes the issues of agriculture, rural development, land, drought, desertification and Africa. Thus, the conclusions and recommendations arising from the Workshop also represent a contribution by the Committee on the Peaceful Uses of Outer Space to the work of the Commission on Sustainable Development for the thematic cluster 2008-2009 (see A/AC.105/872 and A/AC.105/892).

11. The primary objective of the Workshop was to use integrated space technologies such as remote sensing and geographic information systems, navigation and positioning, telecommunications, satellite meteorology and Earth observations in ways that could contribute to the prevention and mitigation of problems caused by changes in the global climate. In particular, participants in the

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

Workshop focused on the following: prediction, monitoring and early warning of climate-related disasters and environmental hazards such as floods, droughts and desertification, and improvement of food security at the regional level through sustainable agricultural development, sustainable land use and monitoring of land-cover change.

12. The Workshop also provided an opportunity to raise awareness among national and regional decision makers and professionals about the potential of space technology applications, to exchange experiences and to initiate practical pilot projects. At the Workshop, attention was paid, inter alia, to ways in which space technology could contribute to sustainable development programmes in developing countries.

B. Programme

13. Participants in the Workshop focused on the use of integrated space technology in monitoring the impact of climate change on agricultural development and food security in support of sustainable development, with the aim of enabling and supporting the development and implementation of relevant projects and of providing reliable data and information for framing policies and making decisions on the subject.

14. During the opening ceremony of the Workshop, introductory and welcoming statements were made by representatives of the Institute of Meteorological Training and Research of Kenya, IGAD, the Kenya Meteorological Department (also the permanent representative of Kenya to the World Meteorological Organization), the Regional Centre for Mapping of Resources for Development, ESA and the Office for Outer Space Affairs. The Minister for Environment and Mineral Resources of Kenya participated as guest of honour.

15. Keynote addresses were made by the head of the international relations department of ESA and the director of the Department of Resource Surveys and Remote Sensing of Kenya.

16. The programme of the Workshop included a series of technical presentations of successful applications of tools based on space technology that provide cost-effective solutions or essential information for planning and implementing programmes or projects related to monitoring the impact of climate change on agricultural development and food security. The Workshop featured presentations on the needs of end-users engaged in monitoring the impact of climate change and changing weather patterns and in managing monitoring and early warning systems for climate-related disasters and environmental hazards such as floods, droughts and desertification that could affect agricultural development and food security in Africa.

17. Participants who received funding from the United Nations and the co-sponsors were asked to prepare short presentations on their professional work related to the issues dealt with at the Workshop. Those presentations were delivered as an integral part of the Workshop programme.

18. The Workshop programme comprised six technical sessions on the following themes: (a) integrated application of space technologies to address Earth

observations, satellite applications and atmospheric monitoring; (b) global and regional collaborations and initiatives; (c) agriculture, land and rural development using space technologies; (d) interactions between atmosphere, environment, agriculture and food security; (e) space-related technologies and informational resources for addressing environmental sustainability and natural resource management; and (f) education, training and institutional capacity-building.

19. One day was devoted to technical visits and a field trip to the Kenya Meteorological Department, the IGAD Climate Prediction and Applications Centre, the Department of Resource Surveys and Remote Sensing of Kenya and the Regional Centre for Mapping of Resources for Development.

20. Sufficient time was set aside for participants to give presentations on their relevant activities and discuss priority areas for follow-up and the possibility of establishing or strengthening partnerships. Two working group sessions were conducted during the Workshop.

21. Three working groups were formed to analyse the following topics of interest to participants: water resources mapping and analysis; land use/land cover and agricultural development for poverty reduction; and environmental degradation in urban and rural settings. The meetings held by the working groups provided opportunities for participants to discuss issues concerning regional and international cooperative mechanisms and resources for implementing projects. Working group participants also met to outline project proposals.

22. A total of 36 presentations were delivered by invited speakers from both developing and developed countries and comprehensive discussions were held at the conclusion of each presentation session.

C. Attendance

23. A total of 65 participants attended the workshop from the following countries: Austria, Ethiopia, Gambia, Germany, Guinea-Bissau, Kenya, Malawi, Mauritius, Netherlands, Niger, Poland, Seychelles, South Africa, Swaziland, Togo and the United States of America. Representatives from the following intergovernmental, international and national organizations also participated: International Institute for Applied Systems Analysis, IGAD, IGAD Climate Prediction and Applications Centre, Kenya Meteorological Department, Regional Centre for Mapping of Resources for Development, International Institute for Geo-Information Science and Earth Observation, Secure World Foundation, International Livestock Research Institute, National Commission on Space Activities (CONAE) of Argentina, ESA and the Office for Outer Space Affairs.

24. Funds allocated by the United Nations and by the Workshop co-sponsors were used to defray the cost of air travel, daily subsistence allowance and accommodation of 14 participants. The co-sponsors also provided funds for local organization, facilities and the transportation of participants.

25. The Workshop was followed by 16 media representatives at the local and regional levels.

II. Summary of presentations

26. A summary of the main issues addressed by participants through their presentations in the technical sessions is provided below (paras. 27-41). Details of the programme of the Workshop, the background materials and the presentations may be obtained from the website of the Office for Outer Space Affairs (http://www.unoosa.org).

A. Technical session on integrated application of space technologies to address Earth observations, satellite applications and atmospheric monitoring

27. Four presentations were made on the following themes to highlight the integrated application of space technologies to address Earth observations, satellite applications and atmospheric monitoring: (a) ESA integrated applications promotion initiative; (b) overview of the United Nations Programme on Space Applications; (c) the African Monitoring of the Environment for Sustainable Development programme; and (d) decision support systems: dynamic sensor systems and the potential for utilizing them in Africa.

28. The presentations provided a great deal of information on the opportunities available, at the regional and global levels, for the integrated application of space technology, including research, in various socio-economic sectors such as health, agriculture, water resources, energy and transport (with emphasis on aviation and maritime transport). Collaboration and data-sharing were emphasized as key elements in most of those efforts. Examples of successful pilot projects that made use of space science in a number of sectors and the human capacity built in different parts of Africa were discussed. Initiatives to be pursued under future programmes were presented, with emphasis on applications in Africa and, at the local level, to benefit end-users.

B. Technical session on global and regional collaboration and initiatives

29. Six presentations were made on the following themes to highlight some of the collaborative efforts being made at the regional and global levels in the utilization of space technology: (a) application of space science technology in weather and climate monitoring over the greater Horn of Africa; (b) the San Marco satellite tracking and launching project: an Italian-Kenyan cooperation initiative; (c) TIGER Initiative: utilizing Earth observation technology for integrated water resource management; (d) development of national adaptation programmes of action and agro-meteorological experience in Ethiopia; (e) applications of space science technology in integrated disaster risk reduction: climate change and agriculture; and (f) use of the Meteosat Second Generation spacecraft and related products by Swaziland Meteorological Services.

30. Most of the presentations highlighted various space technology programmes, some of which aimed at improving the day-to-day operations that were being implemented in various parts of Africa. Some examples of how space technology

was being used in regional and national institutions were provided. Those applications included the monitoring of the climate and environment, the generation of rainfall estimates and the use of the Normalized Difference Vegetation Index. An illustrative collaborative effort was the San Marco satellite tracking and launching project, which is a joint project between the Governments of Italy and Kenya. The TIGER Initiative was another collaborative initiative, launched by ESA to assist African States in overcoming problems faced in the collection, analysis and dissemination of water-related geoinformation in order to contribute to the implementation of the recommendations identified at the World Summit on Sustainable Development.

31. The critical role that space science plays in integrated disaster risk management was stressed during the session. From discussions, it emerged that space-based information was being used in all phases of disaster management, from preparedness, relief and rehabilitation, to recovery.

C. Technical session on agriculture, land and rural development using space technologies

32. Seven presentations were made on the following topics to address various issues related to agriculture, land and rural development using space science: (a) collaborative mapping via geo-web services: opportunities for agricultural development and food security; (b) the Nzoia river basin flood early warning system; (c) impact of climate change on fisheries in Kenya; (d) Zar (areas at risk), an important tool in prediction, monitoring and early warning for food security in the Niger; (e) utilization of media strategies for sustainable agricultural productivity and enhanced food security in Kakamega District; (f) forest type mapping and monitoring using remote sensing; and (g) integrated space technology and land tenure reforms in Africa.

33. The presentations highlighted ongoing activities in various areas, including the provision of early warning information for disaster risk reduction, the dissemination of such early warning information, the assessment of the impact of climate change on some sectors (for example, fisheries and agriculture) and on food security, and the mapping and monitoring of land use/land cover using remote sensing technologies. The land tenure system adopted in various parts of Africa were compared with the successful tenure policies in the Western world. The reliability and application of remote sensing data in all those activities were clearly demonstrated. The latest technologies for assessing information, such as the emerging geo-web services, were shown to have various advantages over the earlier technologies.

D. Technical session on interactions between atmosphere, environment, agriculture and food security

34. Three presentations were made on the following themes: (a) the impact of climate change on agriculture in the Seychelles; (b) availability of cropland, citizen science and future potential hunger hot spots in sub-Saharan Africa; and (c) the role

of sweet potato (*Ipomoea batatas* (L.) Lam.) cultivar mixtures in household food security in Malawi.

35. The presentations emphasized the vulnerability of countries in sub-Saharan Africa to the impact of climate change. Land constraints due to population pressure were emphasized and future risks explained. The kinds of impact on various sectors that had been demonstrated in other sessions were reiterated. It was noted that States needed to implement measures that would make them more food secure and provide alternative sources of energy and water for their growing populations. The case study carried out in Malawi, where sweet potatoes were chosen, was presented as a success story.

36. It was made clear that urgent measures, particularly in identified hot spots, needed to be taken quickly in order to improve the situation with regard to food security in sub-Saharan Africa. Some such measures included improving crop varieties, optimizing crop types, extending the areas under crop cultivation and increasing crop yield through better water and fertilizer management. The need to carry out collaborative research in those initiatives, with the involvement of farmers (in part to capture existing indigenous knowledge), was emphasized.

E. Technical session on space-related technologies and informational resources for addressing environmental sustainability and natural resources management

37. Eight presentations were made on the following themes: (a) use of tools for forecasting food crises in the Sahel; (b) climate change in Togo: consequences and solutions; (c) building appropriate institutions to support the use of Earth observation for human security; (d) SERVIR Africa: Earth observation, monitoring and visualization system; (e) overview of geoinformation applications in the International Livestock Research Institute; (f) the perspectives of South African space applications; (g) comparing derived cloud height with observed rainfall over African tropical regions by using data provided by the Meteosat Second Generation satellite; and (h) mitigating the effects of climate change in the arid and semi-arid lands of Kenya through community-based livestock early warning systems for food security.

38. Most of the presenters demonstrated some of the tools that used satellite data and that were being used for providing early warning information to decision makers. Decisions made included instituting measures to minimize the impact of extreme weather conditions on sectors such as agriculture and livestock, among others. However, some institutions in developing countries encountered difficulties in using some of those tools. Strengthening the capacity of such institutions to improve the management of natural resources by increasing and facilitating the use of data acquired from space technologies was proposed as one of many solutions to address some of the difficulties. The evolution of space science in the communications industry was also demonstrated.

39. It was pointed out that a lot of progress had been made in the use of remote sensing for responding to disasters. For example, more and better data could easily be accessed. In addition, the results of a great deal of important research still needed to be applied. Despite having made progress, challenges remained, such as the

uncoordinated use of data, the lack of comprehension of what users needed, the lack of data formatting standards for integration in geographic information system application packages and the slowness with which the results of research were applied.

F. Technical session on education, training and institutional capacity-building

40. Four presentations were made on the following themes: (a) space activities in Argentina and international cooperation; (b) capacity-building in space science and technology: the regional centres for space science and technology education affiliated to the United Nations; (c) introduction to an education programme (delivered as a video recording); and (d) capacity-building activities of the Regional Centre for Mapping of Resources for Development.

41. The presenters shed light on some of the regional activities related to capacity-building (both in terms of human resources and infrastructure) in space science. Most of those activities took place in the regional centres that had been established through an international effort aimed at ensuring that education in space science existed at national and regional educational institutions in developing countries. The main objective of such centres was to develop national and regional capacities through the provision of in-depth education and training in the core disciplines for research and application of space science. In Africa, two such centres had been established, one in Morocco (for the French-speaking countries) and the other in Nigeria (for the English-speaking countries). Those centres had continued to develop, at different levels, the human resource capacity of participating countries. In addition, a number of regional centres not affiliated to the United Nations existed and carried out activities with strong support from the Office of Outer Space Affairs and ESA.

III. Working groups and follow-up actions

42. Three working groups were established to consider the following themes and to develop proposals for possible follow-up projects and to discuss issues concerning regional and international cooperative mechanisms and resources for implementing projects: (a) water resources mapping and analysis; (b) land use/land cover and agricultural development for poverty reduction; and (c) environmental degradation in urban and rural settings.

43. The three working groups conducted two discussion sessions, which were held on 2 and 4 December, and prepared reports, which were presented on 5 December. The report of each working group is summarized below.

A. Working group on water resource mapping and analysis

44. The working group on water resource mapping and analysis comprised 13 participants from the following six countries: Gambia, Germany, Kenya, Seychelles, South Africa and Swaziland.

45. The objective identified by the working group was related to the use of space technology for analysing and mapping changes in the availability of water resources, in particular as a consequence of floods, droughts and desertification. It was decided that three aspects of water resources, namely atmospheric water, surface water and groundwater, would be integrated. The overall objective was to build capacity in rainfall estimation and mapping of extreme events using space technologies.

46. Specifically, the working group considered the following: (a) mapping flooded areas and areas at risk of flooding; (b) rainfall estimation using satellite imagery to augment conventional observations, especially in sparsely gauged areas; (c) surface and groundwater assessment and monitoring; (d) establishment of an early warning system for floods; and (e) tracking tropical cyclones in the Indian Ocean.

47. The expected outcomes of the working group were the establishment of a spatial data infrastructure for supporting decision-making in the areas of water resource management, flood and drought risk early warning and information dissemination, and the building of capacity to implement such a spatial data infrastructure at the national, regional and basin-wide levels.

48. The working group generated information on the following: the scope of the tasks required to achieve the objective; the expected outcome; the products; the main tasks to be carried out for the establishment of the spatial data infrastructure; and the approaches to be adopted.

49. Some participants in the working group were assigned responsibility for carrying out specific tasks. It was agreed that the implementation of the proposals would be implemented at the national level in all six of the countries represented by participants in the working group.

50. Implementation of the outcome of the Workshop would be carried out in two phases. The first phase would involve the provision of a template for the spatial data infrastructure, to be provided by the participant from Technical University of Berlin, in Germany, to all the members of the working group. Tasks to be carried out following provision of the template and timelines for completion were set. The second phase of implementation would involve applying for a grant for integrating the spatial data infrastructure at the national or regional level and adding the spatial data infrastructure into the training curriculum of the Regional Institute for Meteorological Training and Research.

B. Working group on land use/land cover and agricultural development for poverty reduction

51. The working group on land use/land cover and agricultural development for poverty reduction comprised 12 participants from the following eight countries: Ethiopia, Germany, Guinea-Bissau, Kenya, Mauritius, Niger, South Africa and Togo.

52. The objective identified by the participants in the working group was related to the performance of natural resource mapping and monitoring using space technologies, aiming at providing information for the planning of land use/land cover and agricultural development for poverty reduction.

53. The working group generated information on the following: expected outcomes; the main tasks to be carried out for the establishment of the spatial data infrastructure; constraints and a workplan.

54. Participants created an implementation matrix that clearly laid out the main objective, specific objectives, main tasks to be carried out in order to achieve the objective, the expected results and the resources required. The matrix also included information on which countries would be responsible for which tasks.

55. The proposals would be implemented in two phases. The first phase would include a number of activities, such as the generation of the baseline data at the national level, most of which were expected to be carried out in conjunction with the normal duties of the participants and, therefore, to have no financial implications. Most of the activities were scheduled to be completed by June 2009, while a few were to be completed by the end of 2009.

56. The second phase included many activities, whose time of implementation ranged from one to three years. Some of the activities would be carried out at the same time as some of those in the first phase, but the majority were scheduled to commence in July 2009. Most of the activities in the second phase would require financial support.

C. Working group on environmental degradation in urban and rural settings

57. The working group on environmental degradation in urban and rural settings comprised seven participants from three countries: Kenya, Malawi and South Africa.

58. From the outset, participants in the working group enumerated the issues that caused urban and rural degradation as background information to understand the subject matter. The objectives identified by the working group were to identify major contributing factors to environmental degradation, to identify mitigation strategies and to prepare response and coping mechanisms.

59. The major factors contributing to environmental degradation were listed, and mitigation strategies were identified for tackling problems such as degraded health, pollution and agriculture and food insecurity and in areas such as policymaking. The products or outputs of the mitigation measures related to those challenges were also identified. An outline was generated of the activities that the working group would carry out.

60. The activities would be implemented in two phases. It was noted that the activities in the first phase were already being carried out in the course of participants' professional duties and would, therefore, be carried out without the need for additional funding. However, the second phase would require some funding, especially for facilitating the attendance of participants in workshops and conferences.

61. Participants in the working group were assigned responsibility for specific tasks. An implementation workplan was developed for undertaking the activities in the first phase.

IV. Conclusions and recommendations

62. The Workshop provided a unique opportunity to bring together decision makers and professionals working at the national and regional levels to discuss the potential of space technology applications, to exchange experiences and to initiate practical pilot projects through working groups established during the Workshop. The Workshop also provided a forum for scientists, policymakers and resource managers operating in that area, from the public and private sectors, to use for networking.

63. Workshop participants observed that the presentations provided a great deal of information on national, regional and global initiatives in remote sensing and on the application of remote sensing technology in various economic sectors, including agriculture and food security, water resources, disaster management and health. Participants agreed that climate change was a reality and that such change was already affecting various socio-economic sectors, such as agriculture and food security.

64. The human and infrastructural capacities of many countries were, however, still insufficient for taking advantage of the available space science information to minimize the impact of climate change. The Workshop made the following recommendations:

(a) Various data formats currently being used in remote sensing data sets should be harmonized;

(b) Open-source tools and software should be made available and utilized;

(c) Networking and data-sharing should be embraced;

(d) Community-based projects and research aimed at alleviating the welfare of the common person should be enhanced;

(e) African partners should be assisted in launching projects in collaboration with development partners and donors (e.g. African Development Bank) in order to support the transition from pre-operational to operational;

(f) Partnerships and synergies among all existing early warning systems and the participatory development of intervention options and contingency plans for disaster management should be encouraged;

(g) Scientific collaboration in the exploitation of space science and its applications should be strengthened;

(h) Capacity should be built to enhance the generation and validation of rainfall estimations to improve the climate observing network over most areas;

(i) Adequate technology should be promoted by purchasing infrastructure and by building human capacity to assist developing countries in mitigating the impact of climate change;

(j) Human capacity should be built so that remote sensing data can be integrated into early warning systems;

(k) Collaborative and participatory research and development initiatives that deliberately include end-users should be encouraged;

(l) Dramatic adaptive measures, such as improving crop varieties, optimizing crop types, extending the areas under crop cultivation and increasing crop yield though better water and fertilizer management, should be taken soon to improve the situation with regard to food security in sub-Saharan Africa;

(m) Potential users should be sensitized to the value of the products generated;

(n) Policymakers should be sensitized to the value of Earth observation for disaster management.

65. Participants concluded that global food shortages posed a serious problem for food security, in particular given the declining quality of land under agriculture. Managing water and soil resources, reducing wasteland, making productive use of land resources and adopting precision agriculture methods were some ways in which the food security scenario in the world could be improved, if addressed urgently. Training and building capacity on those issues needed to be promoted immediately if food security was to be ensured.

66. It was noted that signals of climate change had been observed in East Africa: some diseases such as highland malaria, meningitis and Rift Valley fever had re-emerged; some plant and animal species had become extinct; the rivers had become more seasonal or disappeared altogether; lake sizes and levels had shrunk; conflicts over limited resources had occurred, especially at watering points and pastures; and mountain glaciers had declined.

67. As mentioned during the Workshop, most socio-economic sectors in Africa were sensitive to climate variability and change. A warmer environment could facilitate the spread of malaria, infectious diseases caused by flooding and drought and respiratory illnesses, such as asthma and bronchitis, resulting from poor air quality and, in general, could increase weather-related mortality.

68. In the tourism industry, the extinction of some species of fauna and flora had been observed. Frequent and prolonged droughts and/or reduction in rainfall had been projected; should such projections become reality, they would devastate wildlife and reduce the attractiveness of some natural reserves.

69. With regard to freshwater resources, variable climate conditions might render water resource management more difficult. A drop in the water levels of dams and rivers would adversely affect the quality of fresh water by increasing the concentrations of sewage waste and industrial effluents, thereby increasing the possibility of an outbreak of waterborne diseases and a reduction in the quality and quantity of fresh water available for domestic use.

70. It was noted that space technology could be indispensable for addressing climate change, food security and health. Space applications provided the kinds of innovative technologies that, in turn, provide effective mechanisms for conducting environmental assessments, managing natural resources and providing early warning and disaster management tools, as well as supporting education, health services and food security in marginal areas.

71. It was also noted that deforestation was responsible for 20 per cent of global greenhouse gas emissions but that, if managed effectively, forests could become net carbon sinks owing to their ability to absorb about one tenth of global carbon

dioxide emissions in biomass, soil and forest products. Curbing deforestation, promoting forestation programmes and reforesting damaged areas were seen as cost-effective ways to mitigate climate change while enhancing the security of forest-dependent communities and households. Space technology could be used to effectively monitor such activities.

72. The Workshop served to raise awareness and reach out to the public on space technology applications with the extensive support and interest of media in the region.

73. Participants expressed their appreciation to the Government of Kenya, ESA, all the host institutions and the United Nations for organizing the Workshop and providing significant support.