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Committee on the Peaceful Uses of Outer Space

Report on the United Nations/Pakistan International Workshop on Integrated Use of Space Technologies for Food and Water Security

(Islamabad, 11-15 March 2013)

I. Introduction

A. Background and objectives

1. The Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III), in particular through 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 fifty-fifth session, in 2012, 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 2013. Subsequently, the General Assembly, in its resolution 67/113, endorsed the activities of the United Nations Programme on Space Applications in 2013.

3. Pursuant to General Assembly resolution 67/113 and in accordance with the recommendations of UNISPACE III, the United Nations/Pakistan International Workshop on Integrated Use of Space Technologies for Food and Water Security was held in Islamabad from 11 to 15 March 2013.

[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).

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4. The Workshop was jointly organized by the Office for Outer Space Affairs of the Secretariat, as part of the activities of the United Nations Programme on Space Applications in 2013, and by the Space and Upper Atmosphere Research Commission (SUPARCO) of Pakistan. It was co-sponsored by the Inter-Islamic Network on Space Sciences and Technology (ISNET) of Pakistan. SUPARCO hosted the meeting on behalf of the Government of Pakistan.

5. At the Workshop, participants discussed a wide range of space technologies, applications and services that contributed to sustainable economic and social development programmes supporting agricultural and water security, primarily in developing countries.

6. The main objectives of the Workshop included the following: (a) to enhance capabilities of countries in the use of space-related technologies, applications, services and information for identifying and managing water resources, and addressing food security concerns; (b) to examine low-cost space-related technologies and information resources available for addressing water and food security needs in developing countries; (c) to promote educational and public awareness initiatives in the area of water and food security, and to contribute to capacity-building processes in those areas; (d) to increase awareness among decision makers and the research and academic community of space technology applications for addressing water- and food-related issues, primarily in developing countries; and (e) to strengthen international and regional cooperation in those areas.

7. The discussion held in the Workshop and its working groups also provided an opportunity for direct dialogue between space technology experts, policymakers and decision makers and representatives of the academic community and private industry from both developing and industrialized countries. All participants were encouraged to share their experiences and to examine opportunities for better cooperation.

8. The present report describes the background, objectives and programme of the Workshop. It has been prepared for submission to the Committee on the Peaceful Uses of Outer Space at its fifty-seventh session and to its Scientific and Technical Subcommittee at its fifty-first session, both in 2014.

B. Programme

9. The programme of the Workshop was developed jointly by the Office for Outer Space Affairs and the programme committee of the Workshop, which included representatives of SUPARCO and ISNET. Substantial input to the programme was also received from Interim Secretariat of the Carpathian Convention of the United Nations Environment Programme (UNEP) and from the International Centre for Integrated Mountain Development (ICIMOD).

10. The programme of the Workshop focused on technologies, applications and services that can help to maximize the benefits of using space-related tools to address agricultural and water security and to enhance the capacity of developing countries in that area by developing human and technical resources at various

levels, improving regional and international cooperation, increasing public awareness and developing appropriate infrastructures.

11. The programme of the Workshop included four technical sessions focusing on the following themes: (a) space applications for water security and water management; (b) space applications for agriculture and food security; (c) remote sensing and geospatial technologies for improved agriculture; and (d) benefits of space applications and planning for water and food security. The Workshop had two special sessions (see sect. III below) and included discussion sessions of the working groups and a one-day technical tour of SUPARCO facilities.

12. At the opening of the Workshop, introductory and welcoming statements were made by representatives of SUPARCO, the Office for Outer Space Affairs and ISNET. A keynote address was made by the Minister of State for National Food Security and Research of the Government of Pakistan.

13. A total of 36 oral technical presentations were made during the technical and special sessions of the Workshop, and 26 papers were presented at the poster session. All presentations focused on successful applications of space technologies and space-related information resources providing cost-effective solutions or essential information for planning and implementing programmes or projects in the areas of food and water security, including case studies by participants. The Workshop also featured presentations on the needs of end users engaged in managing water and agricultural resources, as well as on international and regional cooperation and capacity-building initiatives required for the successful implementation of sustainable development programmes in developing countries.

14. Each technical and special session was followed by open discussion on specific topics of interest, with additional opportunities for participants to voice their opinions. The discussions were continued in depth and were summarized by three working groups established to prepare the observations and recommendations of the Workshop, develop proposals for follow-up projects and examine possible partnerships that could be launched. The first working group focused on issues related to space technologies for monitoring mountain ecosystems. The second working group discussed space technology for agriculture and food security. The third group considered space-related technologies for water management. Reports of the working groups were presented by their chairmen at the closing session and were discussed and adopted by the participants in the Workshop.

15. The detailed programme of the Workshop is available on the website of the Office for Outer Space Affairs (www.unoosa.org).

C. Attendance and financial support

16. Scientists, engineers and educators from developing and industrialized countries from all regions were invited by the United Nations, SUPARCO and ISNET to participate in and contribute to the Workshop. Participants were selected on the basis of their scientific, engineering and educational backgrounds and their experience in implementing programmes and projects in which space-related technology, information and services played a leading role in addressing agricultural

and water security. The participation of specialists at the decision-making level from both national and international entities was particularly encouraged.

17. Funds allocated by the United Nations, the Government of Pakistan and ISNET were used to provide financial support for the participation of 33 participants from developing countries. Thirty participants received full financial support, which included international round-trip air travel, hotel accommodation and a living allowance for the duration of the Workshop. Three participants received partial funding to cover their international air travel.

18. The hosting organization, SUPARCO, provided conference facilities, secretarial and technical support and local transportation, including transportation of all participants from and to the airport, and organized a number of social events for all participants of the Workshop.

19. The Workshop was attended by more than 100 participants from the following 30 States: Austria, Azerbaijan, Chile, Canada, Ecuador, Egypt, Ethiopia, Germany, Ghana, Indonesia, Iran (Islamic Republic of), Iraq, Kyrgyzstan, Lao People's Democratic Republic, Lebanon, Mozambique, Myanmar, Nepal, Nigeria, Pakistan, Palestine, Peru, Senegal, Sudan, Swaziland, Switzerland, Thailand, Turkey, United Kingdom of Great Britain and Northern Ireland and Uzbekistan. The following United Nations entities, international intergovernmental organizations, non-governmental organizations and other entities were also represented at the Workshop: Consortium for the Sustainable Development of the Andean Ecoregion (CONDESAN), European Academy of Bozen/Bolzano (EURAC), ICIMOD, International Committee of the Red Cross, ISNET, Group on Earth Observations (GEO) secretariat, Office for Outer Space Affairs, United Nations Development Programme, UNEP, Food and Agriculture Organization of the United Nations (FAO), World Bank and World Food Programme (WFP).

II. Overview of technical sessions

20. In the first technical session, participants discussed applications of space technology and data for water security and water management, including issues such as international and regional cooperation, capacity-building and the development of national policies and frameworks. The participants were updated on the latest developments of the Water Cycle Integrator, which was being developed by the Global Earth Observation System of Systems (GEOSS) to promote effective multisectoral and interdisciplinary collaboration based on coordinated and integrated efforts. The Water Cycle Integrator integrated Earth observation data and information, modelling, management systems and education systems in order to set up a framework in which partners could share data, information and applications in an interoperable way, exchange knowledge and experiences, enhance mutual understanding and work together effectively to respond to issues of mitigation and adaptation. In order to improve regional coordination and public awareness in support of water security and sustainable development, the GEOSS Asian Water Cycle Initiative and the GEOSS African Water Cycle Coordination Initiative had been established. In Latin America, GEOSS water-related capacity-building programmes were now under way through the community for spatial information and hydrography in Latin America and the Caribbean.

21. Participants were also briefed on the use of advanced space-borne synthetic aperture radar (SAR) systems for food and water security, including missions such as the German TerraSAR-X and the Canadian RADARSAT-2. The TerraSAR-X (launched on 15 June 2007) and the RADARSAT-2 (launched on 14 December 2007) satellite missions were capable of fully polarimetric SAR observation of the Earth's surface. The satellites contained polarimetric SAR instruments designed to transmit and receive both horizontally and vertically polarized signals, providing high-resolution information about the radar target in two spectral bands. New missions with advanced instruments of compact/hybrid polarimetric SAR would soon be launched. The Japan Aerospace Exploration Agency and the Canadian Space Agency were working on new missions with a compact/hybrid SAR mode: the Advanced Land Observing Satellite (ALOS-2) and the Radar Constellation Mission, respectively. In addition to the fully polarimetric SAR capabilities, those SAR instruments would be able to transmit a circular polarized signal and coherently receive the backscattered signal in a linear basis. Thus, those instruments would provide more information than the classical dual-polarized SAR and would at the same time still have the advantage of a large swath range. Participants were shown the advantages of new SAR missions for all-weather Earth observations and the cost-effective and accurate monitoring of water resources, flood mapping, soil moisture estimation and crop monitoring. Other papers presented at the session demonstrated the effectiveness of the application of remote sensing for water management and food security and discussed challenges of developing national public policy on the use of space technology for the assessment of water resources and of extending such policies to a regional scale.

22. In the second technical session, participants discussed space applications for agriculture and food security. A case study on mapping crop types using hyperspectral and multispectral data sets was presented by SUPARCO as a good example of the potential of space technology. Given the importance of the agricultural sector, which constituted 24 per cent of the total gross domestic product of Pakistan, there was a need for crop discrimination using remote sensing to provide timely information for the authorities concerned. Multispectral remote sensing data were widely used for crop discrimination and yield estimation. The presented study compared crop parameter retrieval using hyperspectral data acquired by the Hyperion sensor with multispectral data from the Landsat Thematic Mapper (TM). Hyperion and Landsat TM were selected for the study because of their similar spatial resolution (30 metres). As a first step, both data sets were geometrically registered using Universal Transverse Mercator projection for spatial reference. Next, an atmospheric correction of both data sets was performed using Fast Line-of-Sight Atmospheric Analysis of Spectral Hypercubes (FLAASH) software. Then, image-based spectral libraries of the same area for multispectral and hyperspectral data sets were developed to extract end-members for the Spectral Angle Mapper (SAM) classification technique. Prior to final comparison, the two satellite data sets were categorized using the SAM classification method. Owing to less detailed end-member spectra, multispectral data sets led to generalized results in which there was a mixing of classes, such as a waterlogged area that had wrongly been categorized as a canal. Using detailed end-member spectra, hyperspectral image classification resulted in precise classification output. The study concluded that crop discrimination using the SAM technique is more accurate when using hyperspectral data sets than when using multispectral data sets.

23. The participants were also introduced to the intelligent decision support system that was under development in Malaysia, aimed at enhancing the existing computer-aided river management system. A variety of data sets were generated using remote sensing data and geographic information systems (GIS), integrated with global positioning system-aided field surveys, in order to create reliable models and provide decision makers with the information required for the sustainable management of water and land resources. Other presentations at the session demonstrated ways to apply space technology and information to agriculture monitoring in mountainous areas of Pakistan, the development of a satellite-based crop intelligence system, the evaluation of changes in land cover for efficient land management in Ecuador and the development of a drought prediction system for the more effective mitigation of climate change. The participants were shown examples of the use of Earth observation data for food security monitoring in the Sudan, which had been initiated in 2003 in cooperation with the European Space Agency (ESA) and the German company EFTAS as part of the ESA Global Monitoring for Food Security programme in order to provide a crop estimation service to food security decision makers.

24. In the third technical session, participants considered issues related to the use of remote sensing and geospatial technologies for improved agriculture. A number of case studies on successful applications of space technology were presented to participants in the Workshop. Low resolution satellite data, such as Moderate Resolution Imaging Spectroradiometer (MODIS) data, were used in the joint project carried out by the Remote Sensing Authority of the Sudan and FAO to develop a set of maps of land cover and land use. The project resulted in improved agricultural land management and more accurate crop yield forecasts. Integration of satellite data, aerial photography and topographic maps in various available scales, along with GIS technologies, were used in the Islamic Republic of Iran to produce soil erosion maps. That work helped planners and decision makers to safeguard the country's river basins and to optimize management of agricultural resources on a national scale. Participants were also briefed on the results of the joint United Kingdom-Pakistan project on the modelling of floods and erosion and their impact on agriculture. A pilot study site in Chashma, Pakistan, had been badly affected by the 2010 floods that damaged irrigation structures and the area's main agricultural infrastructure. Optical remote sensing data and GIS were used in the study for erosion and land loss modelling and for the development of local flood relief and early recovery response plans. Remote sensing and GIS data and modern geospatial modelling techniques had also been successfully used by WFP to assess how the population had been affected by floods and estimate the extent of food insecurity caused by natural disasters. Those techniques had also been used by SUPARCO to assess long-term land use/land cover changes in Pakistan.

25. The participants were shown examples of the use of geoinformatics in agricultural practice and in the development of an agricultural effectiveness and efficiency management system in Thailand, where farming was the most important sector of economy, accounting for 70 per cent of the national labour force. Advanced cultivation technology, agronomic research and environmental impact assessments were necessary to support the sustainable agricultural development in Thailand. In the project carried out by Geo-Informatics and Space Technology Development Agency of Thailand, agricultural areas were extracted from high-spatial resolution satellite images using visual interpretation. By integrating that

information with other data, including those on land use, agricultural land topology and zoning, soil suitability, irrigated zone, meteorological conditions, land parcels and households and the crop cultivation calendar, the country's agricultural effectiveness and efficiency management system was able to provide reliable information for five subsystems: the crop monitoring system, the pest and plant diseases monitoring system, the agricultural technology transfer system, the weather forecast system and the productivity estimation system. Full-scale implementation of that project would provide the central government and local agricultural organizations with valuable information needed for improving the welfare of farmers and leading towards sustainable agriculture in the country. Other papers presented at the session demonstrated the effectiveness of the use of Earth observation data to estimate wheat yields in Pakistan and to measure soil moisture in Iraq.

26. In the fourth technical session, participants discussed benefits of space applications and planning for water and food security. Presentations made during that session provided participants with an update on the status of the African Risk Capacity project which had been initiated by African heads of State in 2010 with the objective of establishing a pan-African risk pooling facility for improving the efficiency of current natural disaster emergency response on the continent. A technical engine of the African Risk Capacity project was the Africa RiskView software application to quantify and monitor weather-related food security risks in Africa. Africa RiskView used real-time and historical weather data and spatial information to calculate current and potential food security needs and operational response costs, generating information that could help countries and their partners prepare for and respond to weather shocks more efficiently. In that process, Africa RiskView combined four well-established disciplines: crop monitoring and early warning; vulnerability assessment and mapping; humanitarian operational response; and financial planning and risk management. Africa RiskView was designed to absorb and interpret different types of weather data and remote sensing products such as rainfall estimates, potential evapotranspiration and information about crops, soils and cropping calendars. Those data were then converted into meaningful indicators for agricultural production and for the vulnerable populations who depended on rainfall for crops and rangeland. Currently, Africa RiskView used the water requirement satisfaction index as a drought indicator. The water requirement satisfaction index provided a significant indicator of how a rainfall shortage might impact yields and the availability of pasture by monitoring water deficits throughout the growing season, capturing the impact of the timing, amount and distribution of rainfall on annual rain-fed staple crops.

27. Participants were informed that the tool used the above-mentioned information to define and assess how weather hazards affected people vulnerable to food insecurity and used information about the magnitude and spatial extent of weather shocks to calculate, in a standardized way, an estimate of the potential number of people to be directly affected by such shocks across sub-Saharan Africa. Africa RiskView linked to data extracted from the WFP Comprehensive Food Security and Vulnerability Analysis surveys or, if the WFP surveys were not available, used proxy data from the United Nations Children's Fund Multiple Indicator Cluster Survey (MICS) or the Demographic and Health Surveys. Once the number of people potentially affected by a drought shock had been estimated and the appropriate food assistance response identified, Africa RiskView could estimate the potential

operational costs for a given situation. Users of the tool could vary the operational response costs entered to reflect current conditions and the appropriate assistance required. The water requirement satisfaction index component of the tool had been developed in cooperation with FAO and the United States Geological Survey, working with the Famine Early Warning Systems Network, using rainfall estimate data from the United States National Oceanic and Atmospheric Administration.

28. Other technical papers at the session demonstrated the contribution space technology could make to the development of national water management programmes, the assessment of agricultural water demand and the monitoring of lake water quality and aquaculture activity. Case studies in that regard from Indonesia, Myanmar and Swaziland were presented to participants. Participants were also given a prognosis of the state of water and food security in Pakistan through 2050. It was recognized by participants that many critical issues stressed in those case studies were common to all geographic regions and should be addressed at both the national and international levels.

III. Overview of the special sessions

29. The first special session, entitled “Mountains under review: experience exchange on remote sensing-based monitoring of natural resources in mountain regions”, was organized by the Interim Secretariat of the Carpathian Convention of UNEP in collaboration with EURAC, ICIMOD and the Office for Outer Space Affairs. The session highlighted the various opportunities provided by satellite-based Earth observation for monitoring changes and trends in various mountain regions worldwide and the need for a comprehensive mountain information system for a better understanding of the impacts of climate change and human activities. Experiences, planned joint initiatives and best practices for the mountain regions of the Alps, the Andes, the Carpathians, Central Asia and the Hindu Kush-Himalayas were presented, with the aim of seeking possible strategic partnerships with other relevant actors, including actors of the space community.

30. Mountains covered approximately one quarter of the world’s land surface and were home to approximately 12 per cent of the global population. Mountains provided freshwater to half the world’s population and were home to half of all global biodiversity hotspots. On the other hand, mountains were among the regions most sensitive to climate change and human impact. To date, there was no appropriate comprehensive mechanism to monitor mountain environments and exchange up-to-date environmental information between different mountain regions. Such a mechanism would be important for providing accurate information, in particular to the local community and decision makers.

31. Presentations at the session demonstrated the capacity of remote sensing for monitoring on various levels (regional, national and across different mountain ranges) in terms of applications to monitor the cryosphere and snow, water, ecosystems and biodiversity, disasters and natural hazards. Following the presentations, an in-depth interactive discussion was carried out resulting in a number of findings and recommendations on opportunities and challenges in using space-based monitoring technologies in mountain regions. The recommendations were summarized as follows:

(a) Participants called for organizing follow-up actions following the session, with a view to continuing the process and analysing ways and opportunities to enhance capabilities for monitoring the natural resources of mountains and mountain ecosystems and exploring opportunities for the establishment of a global mountain information-sharing and network system, which would include space-based technologies;

(b) Participants called for enhanced inter-agency cooperation in the field of mountain monitoring and invited relevant organizations such as the Office for Outer Space Affairs and UNEP and regional organizations such as CONDESAN, EURAC and ICIMOD to explore potential fields of cooperation with a view to sharing and exchanging information, experiences and best practices with respect to the various mountain regions, and to look into opportunities to strengthen capacity-building, including the facilitation of common products and results such as communication and outreach tools and the development of a global mountain atlas;

(c) Participants agreed to continue to strengthen efforts to mainstream mountain issues into other relevant global processes and invited, in particular, the organizers to explore possibilities to mainstream mountain monitoring and relevant activities into GEOSS activities. One possible example would be for ICIMOD to take the lead on initiating GEOSS-Himalaya, for mountain-focused applications with societal benefits in the Hindu Kush-Himalayan region.

32. The second special session, entitled “SERVIR-Himalaya: enhancing use of Earth observation and geospatial technologies in the Hindu Kush-Himalayan region”, was organized by ICIMOD in collaboration with the Office for Outer Space Affairs. The session aimed at bringing together the contributors and potential users of the SERVIR geospatial applications for mutual sharing and learning of the use of Earth observation and geospatial tools and technologies for improved scientific knowledge and understanding of climate change in order to support climate policy and actions in the Himalayas.

33. Climate change had placed the Himalayan region at the centre of international attention as one of the most vulnerable ecosystems in the world, as climate change was leading to severe impacts on mountain and downstream communities and their environments. As a result, the dynamics of the life support systems that relied on the mountain ecosystems were threatened, and the traditional adaptation and coping mechanisms of the local people were losing their effectiveness. Earth observation combined with modern geospatial tools were proving to be vital for an improved understanding of climate change, and its trends and impacts, and for predicting future scenarios. ICIMOD, through its Mountain Environment Regional Information System (MENRIS) programme, had been promoting access to and use of Earth observation in the region through various capacity-building and application development initiatives. In cooperation with the National Aeronautics and Space Administration of the United States, the United States Agency for International Development (USAID) and regional partners, ICIMOD had established SERVIR-Himalaya, the third regional node of SERVIR (a regional visualization and monitoring system integrating Earth observation data such as satellite imagery and forecast models together with in situ data and other knowledge for timely decision-making), to complement the initiatives that were already operational in Mesoamerica and East Africa.

34. Presentations at the session introduced the SERVIR initiative and gave an overview of SERVIR-Himalaya activities, focusing on the thematic areas of the cryosphere and water, ecosystems and biodiversity, agriculture and food security, disaster and natural hazards, and air and the atmosphere. Those areas were targeted also to contribute to GEOSS societal benefit areas. A number of existing applications were presented, including multiscale biomass modelling, land cover change analysis, forest fire monitoring, and crop growth monitoring and production assessment. All applications were made available through the ICIMOD mountain geoportal (http://geoportal.icimod.org) and the SERVIR portal (http://www.servirglobal.net). Other presentations covered agriculture monitoring and food security analysis in the Hindu Kush-Himalayan region, a study on the dynamics of the upper Indus basin rangelands in relation to climate variability, and a status and change assessment of glaciers in the Hindu Kush-Himalayan region. Participants were also given an update on the status of development of the decision support tools for the management of protected areas in Pakistan.

35. A discussion following the presentations led to a number of recommendations made by participants, summarized as follows:

(a) SERVIR science applications demonstrated how information could be derived from Earth observation and packaged for use by decision makers and the general public. Efforts were required to establish institutional mechanisms to make those science applications operational on a sustainable basis;

(b) There were great opportunities for creating networks of international and regional partners and initiatives such as SERVIR; such networks and initiatives, which provided platforms for collaboration and cross-agency coordination, should be encouraged;

(c) Capacity-building at different levels (such as for individuals and institutions) and an enabling environment were key to ensuring that Earth observation information provided long-term benefits for society;

(d) Monitoring of glaciers was an important task in order to better understand climate change in the Hindu Kush-Himalayan region. The work on mapping decadal changes should be taken further with the use of better quality satellite images in order to identify hot spot areas and to carry out regular monitoring;

(e) Research on the development of quick methods for mapping glaciers would be very useful as the tools currently available were labour intensive.

IV. Conclusions of the Workshop

36. Following the deliberations in the technical sessions, three working groups were convened to consider thematic issues and concerns, discuss potential solutions using space technology, formulate the observations and recommendations of the Workshop and develop project ideas for possible follow-up action.

37. Discussions of the first working group on space technologies for monitoring mountain ecosystems centred on the importance of mountain ecosystems for agricultural, water and food security. It was commonly agreed that in mountain

regions local farmers and industry were not always aware of that importance or of the efforts being made to protect those ecosystems. In that context, the gap between the academic community and local users should be bridged using traditional and social media or through workshops and specific events such as mountain information days.

38. The working group also identified a need for better and more accurate up-to-date geospatial data. In that area, great importance was attached to the availability of higher-resolution digital elevation models, to be generated possibly by utilizing unmanned aerial vehicles for data collection. Participants stressed the need for more studies in using radar data in mountain areas to obtain detailed geospatial information, given the frequent cloud cover in mountain regions. Equally important was access to archived satellite imagery data, as well as in situ meteorological observations and measurement data, especially for higher altitudes. All that naturally led to requirements for better models and modelling of data to improve prediction and early warning in the future.

39. The working group also emphasized the importance of commonly agreed standards for data exchange and reporting, national programmes for monitoring mountains, specific capacity-building efforts and related awareness-raising. In addition to the recommendations made at the first special session, entitled "Mountains under review: experience exchange on remote sensing-based monitoring of natural resources in mountain regions", the working group made the following recommendations:

(a) A common set of "essential mountain variables" should be developed and adopted;

(b) A global mountain database and portal should be designed and established. It should include metadata on projects and links to secondary data and map products, and facilitate the sharing of knowledge about space-based technologies.

40. The working group on space technology for agriculture and food security expressed its strong support for the findings and conclusions of the FAO report entitled *The State of Food Insecurity in the World 2012*, which showed that sustainable agricultural growth was often effective in reaching the poor because most of the poor and hungry lived in rural areas and depended on agriculture for a significant part of their livelihoods. However, growth would not necessarily result in better nutrition for all. Policies and programmes that would ensure nutrition-sensitive growth included supporting increased dietary diversity, improving access to safe drinking water, sanitation and health services and educating consumers. Since economic growth took time to reach the poor, and might not reach the poorest, social protection was crucial for eliminating hunger as rapidly as possible. Finally, rapid progress in reducing hunger required government action in order to provide key public goods and services within a governance system based on transparency, participation, accountability, the rule of law and human rights.

41. Converging factors had made food security one of the most important global issues. An increasing population wanted a more varied diet, but was trying to grow more food on less land, with limited access to water, while facing increased costs for fertilizer and fuel for storage and transport. Keeping in mind the

above-mentioned observations, the working group put forward the following recommendations:

(a) Food resource monitoring systems should be expanded and linked in order to establish networks to synergize the knowledge base through establishing multilateral relationships, preferably under intergovernmental and internationally authorized bodies;

(b) Easily accessible and integrated space technologies should be used for the monitoring and evaluation of agricultural lands and crops;

(c) The United Nations, in cooperation with the appropriate bodies and organizations, should continue facilitating capacity-building in developing countries, especially in the areas of agricultural crop forecasts and estimates, production and biotic/abiotic stresses;

(d) The governmental bodies and decision makers, especially in developing countries, should be encouraged to allocate sufficient financial, human and physical resources for conducting food insecurity surveys and research and for developing comprehensive plans for alleviation;

(e) The exchange of successful ideas, approaches and technologies among farmers, scientists, experts, managers and decision makers should be stimulated by extending services and holding regular scientific or professional meetings at the local, regional and global levels.

42. The third working group, on space-related technologies for water management, discussed the availability of various water-related portals and considered the ways how recommendations from such a working group or the results of the workshop could contribute to those portals. Participants agreed that the major themes to be addressed in that context were droughts and floods, crop water requirements and water quality. The working group also identified two main areas where efforts should be made: data sharing and capacity-building.

43. With respect to data sharing, the working group noted that the following data categories were the most important: water resource inventories, population and census data, soil moisture maps, water flow models, evapotranspiration data, meteorological data and land cover maps.

44. With respect to capacity-building, the working group agreed that there was a need for training in data processing and the development of applications for water resources, a need for training in data utilization at various levels, and a need for training in flood modelling and drought and ground water modelling.

45. At the closing session of the Workshop, participants discussed and approved observations and recommendations of the working groups that were presented by chairmen of the working groups. Participants also expressed their appreciation to the Government of Pakistan and the United Nations for organizing the Workshop and for the significant support provided.