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Committee on the Peaceful
Uses of Outer Space

Space for agriculture and food security

Special report of the Inter-Agency Meeting on Outer Space Activities on the use of space technology within the United Nations system for agriculture development and food security

I. Introduction

1. The General Assembly, in its resolution 67/113 of 18 December 2012 on international cooperation in the peaceful uses of outer space urged entities of the United Nations system, particularly those participating in the Inter-Agency Meeting, to continue to examine, in cooperation with the Committee on the Peaceful Uses of Outer Space, how space science and technology and their applications could contribute to implementing the United Nations Millennium Declaration on the development agenda, particularly in the areas relating to, inter alia, food security.

2. The Inter-Agency Meeting on Outer Space Activities serves as the focal point for inter-agency coordination and cooperation in space-related activities within the United Nations system. At its thirty-second session, held in Rome on 7-9 March 2012, the Meeting agreed that a special report to be issued in 2013 should address the use of space technology for agriculture and food security.

3. Over the past years, thematic reports produced by the Inter-Agency Meeting, include the note by the Secretariat entitled "Space benefits for Africa: contribution of the United Nations system" (A/AC.105/941), prepared in cooperation with the Economic Commission for Africa and in consultation with members of the Inter-Agency Meeting on Outer Space Activities, and the special report of the Inter-Agency Meeting entitled "Use of space technology within the United Nations system to address climate change issues" (A/AC.105/991), prepared under the leadership of the World Meteorological Organization in cooperation with the Office for Outer Space Affairs of the Secretariat and with contributions from the secretariat of the United Nations Framework Convention on Climate Change and other United Nations entities.

4. The present report was compiled under the leadership of the Office for Outer Space Affairs and on the basis of submissions from the following United Nations entities: the secretariat of the United Nations Convention on Biological Diversity (CBD), the secretariat of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa (CCD), the Economic Commission for Africa (ECA), the Economic and Social Commission for Asia and the Pacific (ESCAP), the Economic Commission for Latin America and the Caribbean (ECLAC), the Food and Agriculture Organisation (FAO), the International Atomic Energy Agency (IAEA), the United Nations Environment Programme (UNEP), the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations Institute for Training and Research (UNITAR) Operational Satellite Applications Programme (UNOSAT), and the World Meteorological Organization (WMO). The present report was endorsed by the Meeting at its thirty-third session held on 12-14 March 2013 in Geneva for submission to the Committee on the Peaceful Uses of Outer Space at its fifty-sixth session, on 12-21 June 2013.

Harnessing the use of space-derived geospatial data for sustainable development – the food security component

5. The Committee on the Peaceful Uses of Outer Space, in its contribution to Rio+20 on the topic of harnessing the use of space-derived geospatial data for sustainable development, provided a set of recommendations on ways and means of strengthening the use of space-derived geospatial data for the purpose of supporting sustainable development policies (A/AC.105/993). Among those recommendations the Committee pointed to the need for establishing sustainable national spatial data infrastructure; enhancing autonomous national capabilities in the area of space-derived geospatial data, including the development of associated infrastructure and institutional arrangements; engaging in or expanding international cooperation in the area of space-derived geospatial data and increasing awareness of existing initiatives and data sources; and supporting the United Nations in its efforts to access and use geospatial information in its mandated programmes to assist all Member States. The recommendations, if implemented, would strengthen decision making in many sectors, including in agriculture and food security.

6. To promote the use of space-derived geospatial data by United Nations entities, the Inter-Agency Meeting on Outer Space Activities developed a set of recommendation, as contained in the Report of the Secretary-General on Coordination of space-related activities within the United Nations system: directions and anticipated results for the period 2012-2013 — the use of space-derived geospatial data for sustainable development (A/AC.105/1014). The recommendations include, among others, addressing gaps and bottlenecks through raising United Nations system-wide awareness of the benefits of space-derived geospatial data; meeting the requirements of United Nations entities in terms of data discovery, data access and technical capabilities for information processing; using existing and establishing, if necessary, new coordination mechanisms for streamlining the use of space-derived geospatial data; and promoting partnerships with the private sector, academia and Government agencies.

7. The United Nations Conference on Sustainable Development (Rio+20) held in Rio de Janeiro, Brazil on 20-22 June 2012, in its outcome document entitled “The

future we want", annexed to the General Assembly resolution 66/288, acknowledged that food security and nutrition has become a pressing global challenge and reaffirmed its commitment to enhancing food security and access to adequate, safe and nutritious food for present and future.

8. The Conference further reaffirmed the necessity to promote, enhance and support more sustainable agriculture, including crops, livestock, forestry, fisheries and aquaculture, while conserving land, water, plant and animal genetic resources, biodiversity and ecosystems and enhancing resilience to climate change and natural disasters. In this connection, the Conference resolved to improve access to information, technical knowledge and know-how, including through new information and communications technologies that empower farmers, fisherfolk and foresters to choose among diverse methods of achieving sustainable agricultural production.

9. The Conference specifically acknowledged the use of space-technology-based data and information for sustainable development. In paragraph 274 of its outcome document, the Conference recognized the importance of space-technology-based data, in situ monitoring and reliable geospatial information for sustainable development policymaking, programming and project operations, and noted the relevance of global mapping in that regard.

The Post-2015 UN Development Agenda perspective

10. The United Nations System Task Team, established by the UN Secretary-General in September 2011 to support UN system-wide preparations for the post-2015 UN development agenda in consultation with all stakeholders, in its report to the Secretary-General entitled "Realising the future we want for all" provided key recommendations and suggestions on a new vision for development, the possible contours of such an agenda and options for moving forward and recognized, inter alia, that bold, comprehensive efforts to eradicate hunger and guarantee food and nutrition security for all, including access to sufficient nutritious food, were both feasible and essential.

11. The Task Team outlined that such efforts would include adopting national strategies to support faster food productivity growth, greater food security, less food price volatility, strengthening resilience through the implementation of inclusive social protection systems, and empowering people through land tenure security, provision of information, technology and better access to credits and markets to better manage price shocks and climate risks. The Task Team further recognized that in areas such as climate monitoring, land use planning, water management, and food security, improving access to geographical information and geospatial data, and building capacities to use scientific information, will allow for more accurate environmental and social impact assessments and more informed decision-making at all levels.

II. Selected areas where United Nations entities use space technology for agriculture development and food security

12. United Nations entities employ space technology in their routine operations aimed at enhancing food security and sustainable food production, and also support

Member States in advancing their capacities, promoting the policy-science dialogues, developing institutional frameworks, and bridging the gap between knowledge, governance and capacity to use such technology to enable early detection of threats to agriculture and food security and informed decision making in preventing and mitigating the effects of those threats.

13. For example satellite imagery obtained from Earth observation systems informs decision making in agriculture, aquaculture and forestry, and further provides inputs for yield forecasting and risk assessments of pest, disease and other threats in those sectors. In addition to space-derived geospatial data and information, space technology and its applications provide other solutions that could be effectively employed to address the global supply uncertainty and improve the productivity and resilience of food production, in combination with other sources of data and information from terrestrial applications. Effective use of existing Earth observation information, in combination with data gathered in the field, provide tools that enhance the collection, storage, analysis and dissemination of food security information.

14. Furthermore, the availability of historical remote sensing data also allows the analysis of past trends leading to the current situation – and in particular assist in the assessment of areas where agriculture can be recognised as unsustainable and the factors leading to this, for example how agricultural development might have led to land degradation, desertification, salinization etc. Assessing changes in agricultural practice that lead to improved sustainability can also be assessed. There is also the opportunity for real time assessment of the broader impacts of agriculture on land and water – for example, correlating current agriculture (including by location and by agricultural practice) with associated ecosystem change.

Monitoring agricultural production

15. Monitoring crop growth and production of early forecasts of planted crops is of immense importance for food security, planners and policy makers at national scale. Reliable, timely and credible information enables planners and decision makers to handle deficits or surpluses of food crops in a given year in an optimum manner. Timely and reliable national agricultural statistics can be obtained through the establishment of an adequate, periodic, national agricultural survey based on probability sampling methods, image classification and adhering to well defined and reproducible techniques.

16. The use of a number of ancillary data including the integral use of remotely sensed data is a key component in effective monitoring of agricultural production. Earth Observation data is now used regularly to monitor the cropping season in some areas/countries. Satellite imagery coverage integrated by field surveys allows the quantification of area planted and to be harvested during cropping seasons. United Nations entities continue to provide support to its Member States in enhancing their national capacities for improved crop forecasts and production estimates.

17. In 2012 FAO in collaboration with IIASA launched the Global Agro-Ecological Zoning Data portal[1] which provides geospatial and tabular information

[1] www.fao.org/nr/gaez

and reporting for better understanding the potential and actual production of the major production areas, including mapping the extent of cropland areas, making improved seasonal forecasts, and improving area and yield estimates to be used at regional, sub-regional, national and sub-national level. An example of crop estimate and forecasting at a national level is a process put in place by Pakistan through its national space agency (SUPARCO) and in close collaboration with FAO. The process aims at quantifying planted areas through SPOT satellite imagery acquired twice a year complemented by field surveys.

18. To support improved crop estimates, FAO is implementing and assisting with technical advice, development of standards for land cover mapping through ISO TC 211 for the production of standardized and harmonized land cover baseline. These standardized databases created using the interpretation of the remote sensing imagery combined with in-situ data serve as the bases of assessing percent cultivation and are used for the preparation of improved sample allocation for the area frame analysis. The high resolution land cover databases improve the area frame statistical analysis, and sample allocation through discontinuous stratification. The sampling strategy has proved very successful in improving the efficiency of the approach and accuracies.

19. Recognizing the need for adequate resourcing of the agricultural monitoring activities of member countries to support sustainable agriculture development, addressing food security and climate variability, FAO fosters use of medium and high resolution Earth Observation agricultural monitoring and technology combined with in-situ observation to provide reliable information as decision support products.

20. Available high-resolution satellite remote sensing data combined with satellite navigation data also contribute to the development of precision farming techniques for monitoring crops on individual farms. Those techniques help to gather data such as soil condition, humidity, temperature, intensity of planting, and other variables in order to precisely identify water, fertilizer and pesticides requirements. Accurate targeting of such areas contributes to an optimal distribution of water and fertilizers, which not only improves crop yields but also saves money and reduces the environmental impact of agricultural activities. Applications of GNSS technology help in positioning and operating of robotic equipment.

Biodiversity

21. Biodiversity for food and agriculture includes the variety of crop, farm animals, aquatic organisms, forest trees, micro-organisms and invertebrates that are directly or indirectly responsible for the production of food for the human population. It is represented by many thousands of species and their genetic variability that are at the heart of healthy ecosystems and is among the earth’s most important resources. Space technologies, especially in terms of systems for Earth observation and characterization of agro-ecological zones and ecosystems could prove an important asset for assessing the state of conservation of biodiversity for food and agriculture, to estimate the status of health of ecosystems, to predict threats such as from climate change, from invasive alien species and others. Space technologies can also provide an additional value through the integration of images

and mapping abilities to existing information systems on genetic resources for food and agriculture.

22. FAO and its Commission on Genetic Resources for Food and Agriculture are undertaking a number of major initiatives to assess the state of the world's biodiversity for food and agriculture. FAO has produced two reports on the state of the world's plant genetic resources for food and agriculture, one on animal genetic resources for food and agriculture and is presently finalizing one on forest genetic resources. The report on aquatic genetic resources for food and agriculture is presently under preparation and the Commission is also initiating the process for the preparation of the State of the World's Biodiversity for Food and Agriculture. On the basis of these Reports on the state of resources, Countries members of the Commission have adopted specific Global Plan of Actions (GPAs) for the conservation and sustainable use their genetic resources for food and agriculture.

Water and irrigation

23. Space technology provides spatial information regarding water and food production used for assessing water productivity and evapotranspiration, and identifying irrigated areas. Assessing water productivity, in terms of yield per cubic meter of water transpired, of irrigated and rainfed agriculture, allows to benchmark the performance of different agricultural systems and identify possibilities to improve this performance. Data on evapotranspiration is useful in water accounting frameworks, and to assess, under irrigated circumstances, the amount of water used beneficially for crop growth in comparison to the amount of water withdrawn for irrigation.

24. Information and statistics related to the mapping of irrigated areas is used for the Global Map of Irrigation Areas that is distributed by FAO and the University of Bonn. The global map of irrigated areas is one of the major input layers for global water balance studies carried out by FAO to assess the amount of water used for food production under current circumstances and in the future (in the framework of FAO's "World Agriculture towards 2030 and 2050" studies).

Oceans and mariculture

25. Marine fisheries around the world remain seriously threatened from fishing overcapacity plus a range of environmental problems. As a result, the rising demand for fish products is largely being supported from increased aquaculture output. Changes in the sourcing of fish will continue to cause significant spatially variable effects on the marine and other aquatic environments, effects that are best managed through the application of geographic information systems and remote sensing methods. Furthermore, changes need to take into account wider approaches to addressing aquatic problems, i.e. via marine spatial planning and/or ecosystem approaches to both fisheries and to aquaculture.

26. FAO has been active in promoting the use of GIS and remote sensing in fisheries (both inland and marine) and aquaculture since 1985, aiming to demonstrate the capabilities of GIS and remote sensing to address aquaculture and fisheries issues, mainly for strategic planning. The FAO publication on *Advances in geographic information systems and remote sensing for fisheries and aquaculture* serves as a guide to understanding the role of spatial analysis in the sustainable

development and management of fisheries and aquaculture, and outlines current issues, status and applications of GIS and remote sensing to aquaculture, inland fisheries and marine fisheries to illustrate the capabilities of these technologies for management, assessment of potential, and zoning and site selection in mariculture.

27. In recognition of a growing need to increasingly transfer land-based/coastal aquaculture production systems further offshore as a result of the expected increases in human population, competition for access to land and clean water needed to increase the availability of fish and fishery products for human consumption, FAO has produced a publication on global assessment of potential for offshore mariculture development from a spatial perspective. The publication provides, for the first time, measures of the status and potential for offshore mariculture development from a spatial perspective that are comprehensive of all maritime nations and comparable among them.

28. As part of its activities, FAO has also developed two information systems, the GISFish Web site[2], and National Aquaculture Sector Overview (NASO) map collection. The GISFish, a "one stop" site to provide the global experience on Geographic Information Systems (GIS), Remote Sensing and Mapping as applied to Fisheries and Aquaculture, sets out the issues in Fisheries and Aquaculture, and demonstrates the benefits of using GIS, remote sensing and mapping to resolve them. The NASO map collection[3] contains Google maps showing the location of aquaculture sites and their characteristics at an administrative level (state, province, district, etc.) and in some cases even at an individual farm level depending on the degree of aquaculture development and the resources available to complete data collection form, and the level of clearance provided by the country experts.

Land use mapping

29. Land use and land cover maps are essential tools for decision makers in formulating policies for sustainable rural development. Remote sensing data are a source of information used to map the risk of desertification, soil erosion, over-salinization and acidification. There are over 50 other Earth observation satellites, including Landsat and the Sentinel 2 series, which are used for monitoring land cover. Some of these are high resolution (sub-meter) imagery platforms that assist to enhance sustainable land use and land resources management across the range of agro-ecological zones and production systems, such as rain fed and irrigated cropping, intensive and extensive livestock production, agroforestry and sustainable forest management. The resulting data and maps of status and trends, combined with best practices and lessons learnt, are intended to allow decision makers to identify areas at risk and to better plan, and later to monitor and assess the effectiveness of their implementation/investment strategies and supporting policies in regard to improving sustainable land management.

30. Promoting participatory process with land users and service providers at sub-national level improves their inputs and access to information, technical knowledge and know-how and thereby facilitates the empowerment of farmers, livestock keepers and foresters to implement sustainable production systems. The combined use of geospatial information and participatory assessments provide an effective

[2] www.fao.org/fishery/gisfish/index.jsp
[3] www.fao.org/fishery/naso-maps/en/

decision making process for enhanced spatial planning (land use/territorial) and sustainable land resources management among the various sectors and actors.

31. Through the recently established Global Soil Partnership, FAO is helping countries to improve the quality and availability of soils data and information at national and sub-national levels which will improve technical capacities for enhancing soil protection and productivity across the range of production systems and will also strengthen modelling tools and capacities for land resources, climate mitigation and adaptation, food security and disaster reduction at national, regional and global levels.

Forestry and forest monitoring

32. As part of international efforts to address climate change through the UNFCCC, developing countries are encouraged by the Cancun Agreements to undertake REDD+. The UN REDD Programme supports the use of remote sensing as part of national forest monitoring systems for climate change reporting and forest management. This includes promotion of South – South cooperation in monitoring forest area changes.

33. FAO provides support to member countries in developing their own forest monitoring systems, where the use of remote sensing is an important component. In particular, the Open Foris Geospatial Toolkit, developed at the Forestry Department based on open source software, provides a set of advanced tools for processing of remote sensing and other geospatial data. The Geospatial Toolkit is now used in many countries for the establishment of forest monitoring systems linked with national forest inventories.

34. The Global Forest Resources Assessment (FRA), produced by FAO every five years, has been using satellite data since 1980. In FRA 2010, a global survey of forest land use change used a global systematic grid of Landsat imagery to demonstrate forest land use change from 1990-2005. The FRA has also produced two global forest maps (2000 and 2010) using satellite imagery and is also using satellite data for forest area projections, forest fire area estimates, and forest canopy change detection.

Vegetation fires

35. Globally, vegetation fires affect an estimated 350 million ha of land each year. The control of these fires has become an issue of high importance, not only because of the increasing number of casualties and the huge amounts of area burned but also because of the relations with issues of global interest, like climate change and food security. The Global Fire Information Management System (GFIMS[4]) addresses these issues by delivering global near real-time fire information to users to support fire managers around the World.

36. GFIMS is a web-based integrated tool which uses remote sensing and GIS technologies to deliver global MODIS hotspot/fire locations (from MOD14/MYD14 standard products) and burned areas (from MCD45 standard product) to natural resource managers and other stakeholders around the World. National and regional

[4] www.fao.org/nr/gfims

historical fire statistics and frequency by major land cover types (when, where and what) are produced in support of projects and programmes. GFIMS was implemented operationally by FAO Natural Resources Department in 2010, based on a research project financed by NASA and conducted by the University of Maryland (FIRMS). It is intended to be one of the components of an operational monitoring system of FAO that deliver near real time information to on-going monitoring and emergency projects.

Desertification

37. Sustainable land use is a prerequisite for lifting billions of people from poverty, enabling food and nutrition security, and safeguarding water supplies. Building on the recognition of the need for urgent action to reverse land degradation by the Rio+20 outcomes document, the observance of the World Day to Combat Desertification in 2012 culminated in the commitments to achieve a land degradation neutral world in the context of sustainable development.

38. Further to the adoption of its ten-year strategic plan (2008-2018), the United Nations Convention to Combat Desertification (UNCCD) has been implementing a new approach towards planning, monitoring and reporting, moving from a qualitative to a quantitative measurement system of its outputs, outcomes and impact. Quantitative data on the conditions of the dry-land ecosystems and of the livelihood of its population are required to support policymaking and environmental management at all scales.

39. In the biennium 2012-2013, the concentrated effort will be on the measurement land’s productivity and rural poverty rate, the two impact indicators identified as mandatory for reporting by affected country Parties. However, being desertification a complex cross-sector environmental problem promoted by multiple drivers, its monitoring requires the integration of human- and environmental-based variables and should include the collection of information relating to climate change and biodiversity. As reported by countries participating in the recently concluded pilot impact indicator tracking exercise, availability of and access to data and information remains a critical issue.

40. In support of UNCCD, FAO has developed, built capacity and validated with several countries and partners a set of tools and methods for assessing, mapping and monitoring the status and trends of land use and land resources (i.e. degradation, conservation and restoration of soil, water and biological resources), their drivers (for example demographics, poverty, governance and so forth) and their impacts on the range of ecosystem services and on livelihoods. The resulting LADA-WOCAT toolbox and process uses available geospatial information at global, national and sub-national levels and participatory, multi-sector expert assessment to assess degradation type, extent and severity as well as the extent and effectiveness of existing and new land management practices.

Drought

41. Drought is one of the main causes of food insecurity on the world. In 2011, the horn of Africa has faced the worst drought in 60 years. An estimated 12.4 million people suffered from a massive food shortage. In the region, water scarcity is exacerbated by the lack of information on groundwater. Most data are incomplete,

fragmented or outdated, and scientists in the area lack the tools to assess groundwater to rapidly improve water supplies. Furthermore, effective management of groundwater needs to be complemented by relevant policies to enable actors in the region to build long-term preparedness to drought.

42. Established in 2012 by UNESCO, the Groundwater Resources Investigation for Drought Mitigation in Africa Programme (GRIDMAP) aims to combat climate change in water-scarce areas of Africa by identifying emergency and sustainable water supplies and delivering measures to mitigate against long-term drought and famine. GRIDMAP assesses the availability of groundwater resources of target areas through the use of remote-sensing data, in combination with ground penetrating radar and information from geological, hydrogeological, geographical, hydrological and climate data and, when dealing with deep aquifers, seismological data, and determines which resources can be utilized safely for emergency and long-term development situations.

43. The initiative also strengthens the drought preparedness of local, national and regional actors by building the capacity to sustainably manage groundwater resources, and aims to build the resilience of populations vulnerable to drought and famine. The project is expected to increase access to water for thousands of vulnerable populations; enhance understanding of where safe groundwater resources exist and how much can be used for emergency and long-term development needs; and build sustainable skills in groundwater assessment and management. In its first phase (2012-2013) the Programme focuses on the Horn of Africa region.

44. UNITAR/UNOSAT is working in collaboration with the Government of Chad and the Government of Switzerland to improve water management in Chad through the use of remote sensing, GIS analysis and geological surveys. The initiative includes remote assessments, field surveys, technical training, capacity development and production of maps and GIS database for informed territorial water management decisions.

45. To mitigate the impact of agricultural drought, it is of high importance to dispose of timely and reliable information on the condition of food crops in all regions and countries in the world. The Global Information and Early Warning System and Climate, Energy and Tenure Division of FAO aims to develop an "Agricultural Stress Index System" (ASIS), based on METOP-AVHRR imagery 10-day step and 1km resolution, for detecting agricultural areas with a high likelihood of water stress (drought) on a global scale. This system is being implemented on behalf of FAO by the Flemish Institute for Technological Research with the technical support of the Monitoring Agricultural Resources unit of the Joint Research Centre of the European Commission.

46. The Agricultural Stress Index System is based on the Vegetation Health Index (VHI), derived from NDVI (Normalized Difference Vegetation Index) and developed by the Center for Satellite Applications and Research of the National Environmental Satellite, Data and Information Service. This index was successfully applied in many different environmental conditions around the globe, including Asia, Africa, Europe, North America and South America. VHI can detect drought conditions at any time of the year. For agriculture, however, only the period most sensitive for crop growth (temporal integration) is of interest, so the analysis is performed only between the start and end of the crop season.

47. ASIS assess the severity (intensity, duration and spatial extent) of the agricultural drought and express the final results at administrative level given the possibility to compare it with the agricultural statistics of the country. From the global version of ASIS that was designed for detecting agricultural hot spots on the globe, it is possible to develop a standalone version for monitoring the agricultural drought at country or regional level. The standalone version would be calibrated with local agricultural statistics and it would run using specific parameters, coefficients and mask of the main crops of the country or region. This version could be used for risk management by establishing remote sensing based crop insurance.

48. A global drought detection and monitoring system being developed by WFP and the Information Technology for Humanitarian Assistance Cooperation and Action (ITHACA) in order to define thresholds and triggers suitable for early warnings is also based on the analysis of a series of drought-related variables and indices, including NDVI, a satellite-based vegetation index, and SPI (Standardized Precipitation Index), obtained from satellite data. Land cover, land use, soil moisture, soil type and other relevant information may be integrated in the system to improve its effectiveness.

49. Integration of NDVI allows to monitors over time water stress vegetation conditions. Monthly historical time-series of NOAA-AVHRR-NDVI data (1982-2007) have identified long-term vegetation dynamics and helped to produce maps about the areas that were subject to increase or reduction in vegetation greenness. The use of SPI, a meteorological drought index, provides a numerical value offering quantitative information related to the deviation from normal conditions, which can be interpreted as the intensity of a drought spell in case of negative values. It also allows studying different time scales, related to different drought conditions.

50. The impacts of the two consecutive seasonal droughts in the Horn of Africa (October 2010 – February 2011 and April – June 2011) were evaluated based on multi-year NDVI data from SPOT-VGT. The magnitude of the drought impacts were assessed through statistical indicators (standardized anomalies and ranks) for each season in turn and jointly, allowing clear identification of areas suffering dual/single/no impacts as well as a ranking of the episodes within the historical record.

51. Working closely with governments and key partners, the WFP is introducing new approaches to risk transfer by using space-based and other climate information to inform food security interventions. One such example is LEAP (Livelihood Early Assessment and Protection), a service which uses ground and satellite rainfall data to monitor the Water Requirement Satisfaction Index (WRSI) and quantify the risk of drought and excessive rainfall in different administration units of Ethiopia. LEAP is used to guide disbursements to scale up the Government’s safety net programme and protect the livelihoods of food insecure populations in the event of a climate-related shock.

52. Drought forecasting and early detection relies, inter alia, on satellite imaging systems and enables decisions to be taken to prevent and mitigate its effects. Drought monitoring built on knowledge acquired from past events and using archived imagery can help profile current trends and events so that the effects of droughts can be mitigated and famine avoided. FAO developed applications for

monitoring of the state of vegetation in cultivated and rangeland areas, rainy season and identifying areas which are likely to have suffered from or might be affected by, drought or excessive rainfall. FAO continues to monitor food supply/demand and food security at global, regional/sub-regional, national and sub-national levels using the Global Information and Early Warning System. Its main objective is to provide early warning of imminent food crises to ensure timely interventions in countries or regions affected by natural or man-made disasters.

Floods

53. In 2012, floods were the most frequent disaster occurring in Asia and had the highest human and economic impact. Pakistan suffered large-scale loss of life from floods for the third successive year, whereas floods in China affected over 17 million people and caused huge economic losses. The significant impacts of floods and storms in the region can also be seen in the Philippines when Typhoon Bopha resulted in more than 1000 deaths. Earth Observation products were used extensively to monitor these disasters and the overall impact to the economy. As an example, floods accounted for 20% of all UNITAR/UNOSAT rapid mapping activations in 2012.

54. 2011 witnessed floods impacting food supply chains that comprise Cambodia, Myanmar, Thailand, and Vietnam, which were monitored using Earth observations. The analysis of using Earth observations for food supply chains was reported in Asia Pacific Disaster Report 2012, a joint publication of ESCAP and UNISDR.

55. The mapping of flood plains and areas at risk of landslides with high resolution imagery and detailed elevation models generated from satellite imagery and precise GNSS services can reduce the vulnerability or exposure of urban and rural populations. Evidence and experience from the disasters suggest that having substantive capacity enables policy makers to use Earth observations inputs more effectively, as it was the case in countries such as China, India, Pakistan, Philippines and Thailand.

56. However, space applications continue to be underutilized because of the lack of capacity in developing countries of the region in terms of human, scientific, technological, organizational and institutional resources and expertise for operational applications of these tools. This is evidenced from the fact that floods in Cambodia and Myanmar in 2011 were captured by Earth observations only through international cooperation such as the International Charter on Space and Major Disasters, Sentinel Asia and the UNITAR/UNOSAT programme. To address these gaps, ESCAP will continue its efforts in building technical and institutional capacities in the use of space applications towards inclusive and sustainable development.

Adverse weather conditions

57. Monitoring and forecasting weather by satellites is of crucial importance to farmers. Satellites are an important complement to the ground-based weather stations for predicting storms, flooding and frost. Weather observations are performed by a constellation of geostationary meteorological satellites for permanent monitoring, and a constellation of Low-Earth orbit satellites, generally near-polar sun-synchronous, for global coverage with a comprehensive suite of

active or passive instruments. Both types of observations are extensively assimilated in Numerical Weather Prediction models to support short to medium range weather forecasts. Rainfall estimations derived from infrared and/or microwave satellite imagery help farmers plan the timing and amount of irrigation for their crops. Land surface temperature and soil moisture products are starting to be operationally available. Of course, ground-based measurements of air and soil temperature and soil moisture are needed for verification.

58. WMO, ECA, UNEP and FAO provide support to the African Monitoring of Environment for Sustainable Development (AMESD) project of the African Union Commission, being implemented from 2007 to 2013. AMESD aims to provide decision-makers with full access to the environmental data and products needed to improve policy and decision-making processes, focusing on crop and rangeland management in Western Africa; water resources management in Central Africa; agricultural and environmental resource management in Southern Africa; land degradation, desertification mitigation, and natural habitat conservation in Eastern Africa; and marine and coastal management in the Indian Ocean sub-region. AMESD has paved the way for the Monitoring of Environment and Security in Africa (MESA) which is implemented since 2013 and addresses environment, climate, food security in enhancing access to and exploitation of relevant Earth observation applications in Africa.

59. Aiming at enhancing capacities in using space-derived information for informed decision making, WMO, EUMETSAT and the AGRHYMET Centre organized a Land SAF/Satellite Products Training Course on Applications in Agro Meteorology in November 2012 in Niamey, Niger. A similar workshop will be held for English speaking participants in Ghana in June 2013.

60. WMO and the George Mason University are involved in the Agromet and Soil Moisture Applications Pilot Projects in Africa, which aim to build an integrated soil moisture/vegetation moisture observation system utilizing remote sensing and in situ soil moisture network measurements, and crop models to quantify crop vigour, crop health, and vegetation indices in a comprehensive agro-meteorological monitoring program in Africa. The projects will also develop a methodology for integrating these analyses into a decision support system for assessing the impacts of extreme events on crop productivity and the agro-ecosystem, utilizing a user-friendly, knowledge based interactive resource sharing system.

61. 2011 and 2012 were marked with adverse winter conditions in many parts of the world. WFP, for the purposes of defining the type, scale and zoning of its interventions, worked to identify the areas subject to a recent exceptional shock and areas subject to recurrent seasonal shocks. This was achieved by analysis of multi-year datasets of rainfall estimates and NDVI, identifying seasons when shocks occurred, and summarizing the information on its frequency and magnitude in easy to interpret maps for stakeholder discussions. Using a multi-year data set of MODIS NDVI 250m resolution, the temporal development of the winter wheat crop in Afghanistan was followed and a seasonal assessment was made, identifying the provinces that had undergone the most severe impact as well as providing assessments on a comparative basis with previous years.

62. WFP also works with governments, local partners and key scientific institutions to use spatial information to identify key livelihood and food security

vulnerabilities. As part of an initiative within CCAFS (Climate Change, Agriculture and Food Security, a CGIAR research programme), which analyses linkages between climate variables and food security indicators, climate data from weather stations and remote sensing imagery is being assessed for Nepal looking for recent changes in climate patterns and how it may impact food security in the country.

Disasters, food security, and humanitarian operations

63. In the case of natural disasters and complex humanitarian emergencies, space technology is crucial to the effectiveness of response and relief operations on ensuring food security for affected population. They facilitate data collection and transmission and the recent progress shown in using crowdsource communities and social networks when relevant and validated data can more easily be shared. As communications capabilities are often limited by emergency-related destructions, satellite communications facilitate smooth and expedient coordination critical to prompt understanding of the extent of damage and complex planning of food, water, and other necessities without the need for costly ground-base infrastructures. Satellite navigation and positioning technology is indispensable for tracking and tracing food security efforts during such devastating events and for fleet management related to food delivery.

64. WFP has been using analysis from remote sensing provided by ITHACA Centre (a joint venture between WFP and Politecnico of Turin) in targeting its food aid and logistic support operation in several major humanitarian crises i.e. Mozambique, Pakistan, and Myanmar. These operations have provided direct support to several million of civilians affected by natural disasters and have greatly taken advantage of information on affected areas derived from remote sensing. The main aim is to rapidly produce geo-referenced information on the impact of disasters, especially data on affected areas and population. The rapid mapping activities aimed at supporting the first stage of disaster management are generally based on satellite remote sensing data.

65. In conjunction with the Global Facility for Disaster Reduction and Recovery (GFDRR) of the World Bank and ITHACA, WFP has developed a data exchange platform to exchange geo data, including remote sensing derived ones. The aim of the project is to develop, implement, and optimize web infrastructures dedicated to geographical data sharing and management, based on Open Source components. The architecture is mainly involved in data sharing both for the early impact and early warning activities having outputs through WebGis applications accessible through a common web browser from anywhere.

66. WFP and UNITAR/UNOSAT have been proactive in defining the type of products and services that best support humanitarian operations. As part of its mandate, WFP has requested to activate the European Commission emergency services to provide support in emergencies in Algeria, Iran (Islamic Republic of), Libya, Pakistan, Yemen, and the Horn of Africa. The products have been widely disseminated to partners and the humanitarian community.

67. The UN-SPIDER programme of the Office for Outer Space Affairs, established by the General Assembly in its resolution 61/110, continues to work to ensure that all countries and international and regional organizations have access to, and develop the capacity to use, all types of space-based information to support the

full disaster management cycle. In particular, UN-SPIDER is taking a leading role in harnessing the potential of crowdsource mapping for the benefit of countries in need. The UN-SPIDER workplan for the biennium 2012-2013 envisages the programme's role as a gateway to space-based information for disaster management, a bridge to connect the disaster management and space communities and a facilitator of capacity-building and strengthening institutions.

68. The Horn of Africa drought, which forced millions of people in the region to face severe shortages of drinking water and food, and made those living in refugee camps particularly vulnerable, will impose extension of existing camps or the creation of new ones. The mapping of camps of refugees or sites of internally displaced populations will remain a priority for the United Nations High Commissioner for Refugees (UNHCR) and access to affordable, adapted and timely remote sensing products will be further used. Remote sensing analysis through technical partnerships facilitates site planning and camp management. UNITAR/UNOSAT and UNHCR collaborates through a joint Memorandum of understanding on ensuring satellite imagery and mapping is available to United Nations field staff and implementing partners.

69. UNITAR/UNOSAT continues to develop its HumaNav service. This vehicle fleet management system is a Public Private Partnership (PPP) with Novacom Services. The system has been used by UNHCR, WFP, WHO and continues to expand to the benefit of more cost-efficient fleet management, improved driver security and reduced environmental impact of several hundred vehicles operated by humanitarian and development actors. The UNITAR/UNOSAT humanitarian rapid mapping service was activated 35 times in 2012. Satellite imagery provided by commercial actors, public websites and the International Charter on Space and Major Disasters was used by UNOSAT to derive information on for example flood extent and duration agricultural areas had under water, thus contributing to assessments of food production capacity following floods.

III. Regional Outlook: Examples of initiatives of United Nations Regional Commissions

Economic Commission for Africa

70. The Comprehensive Africa Agriculture Development Programme (CAADP) and the Sirte Declaration on Agriculture and Water are at the heart of efforts by African Governments under the AU/NEPAD initiative to accelerate growth and eliminate poverty and hunger on the continent. To achieve the main goal of CAADP of eliminating hunger and reducing poverty and food insecurity through agriculture, African leaders have set a target to increase agricultural output by 6 per cent a year for the next 20 years. Without technological upgrading and adoption, even large-scale investment would not be sufficient for Africa to succeed this target.

71. ECA, working with the African Union Commission to support the CAADP programme, had built a primary database, "Agricultural Commodity Value-Chain Database", on ecological and crop production zones; optimum processing locations; markets and infrastructure with a related tool developed for accessing and querying the data. This spatially enabled database system will assist the Agricultural Marketing and Support Section at ECA to perform analyses on the regional trends of

agriculture production and marketing in Africa. The System will also enable decision makers to analyze and model the relationships between suitable agro-ecological zones for the priority crops identified in the CAADP. The use of space-based information is indispensable in supplementing and sustaining the policy research in the agriculture sector.

Economic and Social Commission for Asia and the Pacific

72. Under the framework of the ESCAP Regional Space Applications Programme for Sustainable Development in Asia and the Pacific (RESAP), the Regional Cooperative Mechanism on Disaster Monitoring and Early Warning, Particularly Drought, was launched in September 2010 with the aim to provide substantive technical support, including satellite information products and services, an information portal and capacity building activities, to the region for development of national (agricultural) drought disaster monitoring and early warning capacities and services. It was established as part of a project to strengthen regional cooperation mechanisms for sharing and analysis of information on disaster risk reduction and management.

73. Subsequent meetings held by ESCAP for stakeholders of the Mechanism had seen countries and organizations committed their existing satellite and technical resources and relevant services that could be considered as in-kind contribution to support the work of the Mechanism. The meetings also identified institutional, financial, and technical service modalities, with the latter encompassing: standards for data sharing; multi-satellite and multiplatform approaches and integration of data; standard harmonization of modelling systems for drought monitoring; drought vulnerability maps; and capacity-building, for discussion/consideration towards implementation.

74. As the logistical arrangements for request and fulfilment of space-based products and services is an important part of the Mechanism, with significant implications on other aspects of providing satellite imagery for other major disasters as well, the ESCAP secretariat proposed at the 16th Session of the Intergovernmental Consultative Committee on RESAP that Service Nodes be established in different regions serving their respective sub-regions to perform these duties in lieu of a functional secretariat. The service node modality is more suited to the Mechanism as the nodes could provide regionally and sub-regionally localized modelling through the use of space-based products to achieve more effective drought monitoring and early warning, making it possible for the Mechanism to become operational within the year. The first service node is expected to be hosted in China, with subsequent ones established based on the success and modalities of the first one, with support from all stakeholders of the Mechanism.

Economic Commission for Latin America and the Caribbean

75. In the course of last years the Agricultural Development Unit (ADU) of ECLAC has been engaged in two work areas linked in some sense to the uses of outer space for agriculture and food security: Information and Communication Technologies for agriculture and the impacts of Climate Change on agriculture. The main activities carried out in these areas have been, on the one hand, the identification of best practices (in Latin America and in other regions) in the use of

space imagery and satellite remote sensing data to enhance agricultural productivity and sustainability and to mitigate the effects of climate change and, on the other hand, the regional dissemination of such experiences through publications, seminars, workshops and technical assistance activities.

76. An international conference on the impact of climate change on agriculture and the use of new technologies to mitigate these effects and to help farmers adapt to forecasted scenarios has been organized every year by the ADU since 2009. Some contributions to these seminars have analyzed the feasible uses of satellite data to predict changes in farming conditions and to advise farmers how to make a better use of agricultural inputs. The main results of each conference have been compiled in a series of publications available on the ECLAC website.

77. The ADU has also been engaged in several activities to analyze the use of ICTs in agriculture, in the framework of a broader European Union – ECLAC project (ECLAC-@lis2). These activities have included the preparation of a book to be released in the first trimester of 2013, which will also be available on the ECLAC website. Three international seminars on this issue were conducted in different Latin American countries (Chile, Ecuador and Bolivia) in the course of 2012; the idea was to present the best practices in the use of ICTs in agriculture and the possibilities to adapt these technologies to local agricultural needs and conditions. Several experiences discussed in these seminars were related to the use of spatial imagery, satellite data and satellite Internet access for agricultural purposes, including areas such as precision agriculture and precision irrigation. In any case the main objective was to discuss how to make agriculture a more productive and sustainable activity, for instance, by reducing the transaction costs of this activity and making a more efficient use of agrochemicals and water in agricultural tasks.

IV. Capacity-building, Outreach and Research in Space Technology

Capacity-building

78. Some recent activities organized by the Office for Outer Space Affairs in cooperation with Member States, specialized agencies and intergovernmental organizations in the area of agriculture and food security include the workshops focusing on the use of space technology for sustainable development towards food security (2007, India); integrated space technology applications for monitoring climate change impact on agricultural development and food security (2008, Kenya); and on integrated use of space technology for food and water security (2013, Pakistan).

79. The Workshop held in Islamabad, Pakistan, from 11 to 15 March 2013, hosted by the Pakistan Space and Upper Atmosphere Research Commission (SUPARCO) on behalf of the Government of Pakistan and cosponsored by the Inter-Islamic Network on Space Science and Technology (ISNET), explored how present-day space technologies helped to identify and monitor the relationships between mountain environment (as a source of water), sustainable water resources and how these affect food security on an international and regional scale.

80. This Workshop discussed how space technology, applications, information and services could contribute into sustainable economic and social development programmes supporting agricultural and water security, primarily in developing countries, and had the objectives of enhancing 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; examining low-cost space-related technologies and information resources available for addressing water- and food security needs in developing countries; strengthening international and regional cooperation in this area; increasing awareness among decision-makers and research and academic community of space technology applications for addressing water- and food-related issues, primarily in developing countries; and promoting educational and public awareness initiatives in the area of water- and food security, as well as contributing to capacity building efforts in these areas.

Agricultural research and development

81. Space industry has an essential role to play in agricultural research, as a microgravity environment has a great impact on plant growth and development and affects plant yield. In order to assist Member States in harnessing the benefits of human space technology and its applications, the Office for Outer Space Affairs launched in 2012 the "Zero-Gravity Instrument Project (ZGIP)" under the framework of the Human Space Technology Initiative (HSTI) of the United Nations Programme on Space Applications.

82. As part of the Project, the Office promotes space education and research in microgravity, particularly for the enhancement of relevant capacity-building activities in developing countries. The project will provide opportunities for students and researchers to study the gravitational effects on samples, such as plant seeds and small organisms, in a simulated microgravity condition with hands-on learning in classroom or research activities conducted by each institution. It is also expected that a dataset of experimental results in gravity responses would be developed and contribute to the design of future space experiments and to the advancement of microgravity research.

83. The use of the space environment in uncovering the hidden potentials in crops, commonly described as space breeding, was also a focus of project undertaken by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture. Approximately 10 kilos of the rice variety Pokkali were sent to space in 2006 for the Joint FAO/IAEA Division by a Chinese spacecraft to observe heritable alterations in the genetic blueprint of these seeds and planting materials induced by the effects of cosmic rays, microgravity and magnetic fields in space. Upon return to Earth, the seeds were planted in the glasshouse at the FAO/IAEA Agriculture & Biotechnology Laboratories in Seibersdorf Glasshouse with the objective of evaluating progeny for desirable traits such as resistance to stresses and improved quality traits.

84. Induced mutation in general is a tool for the plant breeder to access the sought after heritable variations for developing new crop varieties. So far, there was no proof that mutations induced in space would differ from those induced using physical mutagens in controlled settings. While the plants didn't grow well at

Seibersdorf and there are no results to report from this one experiment, the FAO/IAEA Joint Division supported two research contracts (CPR12610 and CPR14195) as a follow up. The overall conclusion from these experiments was that “space environment mutagenesis has widespread use potential in crop mutation breeding.” FAO encourages the application of the best scientific and technological tools in addressing the scourge of food insecurity, and expresses hope that work relating to space induced mutations will contribute to the advancement of the science of plant breeding and genetics.

Open informal sessions of the Inter-Agency Meeting on Outer Space Activities

85. To increase awareness on the applications of space technology for agricultural development and food security and to promote dialogue among United Nations entities, Member States and other stakeholders, the 9th open informal session of the Inter-Agency meeting was held on 9 March 2012 in Rome on the theme "Space for Agriculture and Food Security" under the auspices of the World Food Programme.

86. The session featured presentations on various topics such as the applications of remote sensing to food security analysis, crop monitoring, agriculture change assessment for agricultural monitoring, and enhanced risk management and resilience, delivered by representatives of WFP, FAO, European Commission, European Space Agency, national authorities, and private sector; and fostered discussion on future developments in remote sensing: implications for food security and agricultural monitoring, potential, limitations and sustainability of remote sensing technology, and on access and wider use of space-derived data and information.

87. The dialogue on the use of satellite data in addressing landslides, droughts, floods and other threats to food security and agriculture continued in the framework of the 10th open informal session, held on 12 March 2013 in Geneva under the auspices of UNISDR, and with speakers representing UN-HABITAT, UNITAR/UNOSAT, UN-SPIDER, UNISDR, World Bank, the European Commission and national research institutions. The session focused on “Space and disaster risk reduction: Planning for resilient human settlements” and covered, inter alia, urban planning, land use planning and rural development processes for effective disaster risk reduction, in applying cross sector strategies for the use of space-derived and terrestrial geospatial data and information in reducing vulnerability to natural hazards.

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