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Report on the United Nations/Indonesia International Conference on Integrated Space Technology Applications to Climate Change

(Jakarta, 2-4 September 2013)

I. Introduction

1. Climate change has been recognized as a process which may deter sustainable development throughout the world. As a global phenomenon, it represents a threat to the economic, social and environmental dimensions of sustainable development.

2. At its fifty-fifth session, in 2012, the Committee on the Peaceful Uses of Outer Space endorsed the programme of conferences, training courses and symposiums of the United Nations Programme on Space Applications for 2013. That programme included the United Nations/Indonesia International Conference on Integrated Space Technology Applications to Climate Change, which was held in Jakarta from 2 to 4 September 2013. The Conference was co-organized by the Office for Outer Space Affairs of the United Nations and the National Institute of Aeronautics and Space (LAPAN) of Indonesia, and benefited from support provided by the European Space Agency (ESA).

3. The present report describes the background, objectives and programme of the Conference and contains observations and recommendations made by the participants during plenary sessions and in working groups. 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. The report is prepared pursuant to General Assembly resolution 67/113.

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A. Background and objectives

4. In the context of the peaceful uses of outer space, Governments have reiterated the need to protect the Earth's environment and to promote international cooperation on the use of integrated satellite technology applications for such issues as climate change. Satellites offer a unique way of observing at the global level climate change-related variables and features, such as sea-level rise, deforestation trends and carbon emissions, and of measuring on a permanent basis other parameters which may be too difficult or costly to observe from the ground, such as the melting of polar ice caps and glaciers, and social trends, such as the increasing exposure of vulnerable communities to phenomena related to climate change.

5. While remote sensing applications are already used to track some of the manifestations of climate change, there is a need to assess how such space applications could contribute to adaptation efforts worldwide. To that end, the Conference was convened to achieve the following objectives: (a) to facilitate discussions regarding ways in which countries affected by climate change can make better use of integrated space technology applications to assess vulnerability to climate change; (b) to identify potential alternatives in the context of adaption to and mitigation of climate change; (c) to improve synergies among space agencies and organizations, targeting efforts relating to climate change; (d) to strengthen international and regional cooperation in that area; and (e) to raise awareness on the recent advances in space-related technologies, services and information resources which can be used to assess the impacts of climate change and the effects of measures implemented to reduce such impacts.

B. Programme

6. The programme of the Conference was developed jointly by the Office for Outer Space Affairs and LAPAN and benefited from inputs provided by the Secretariat of the United Nations Framework Convention on Climate Change and ESA. The programme focused on integrated space technology applications used to address the challenges posed by climate change in coastal and mountain environments, in urban and rural areas and to health and agriculture, and on specific themes, such as the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (REDD Programme). It also included discussions on academic research, data policies and strategies to enhance the capacity of developing countries to take advantage of space applications to identify ways to adapt to and to mitigate the effects of climate change at various levels.

7. The Conference comprised an opening ceremony, the meetings of nine working groups, a plenary wrap-up meeting and 38 technical presentations on examples, case studies and methods of utilizing space technologies in the areas of adaptation to and mitigation of climate change. Introductory statements were made by the Chairman of LAPAN, by the United Nations Resident Coordinator in Indonesia and by representatives of the Office for Outer Space Affairs, the Ministry of National Development Planning of Indonesia, the Ministry of Environment of Indonesia and the Ministry of Research and Technology of Indonesia.

8. The nine working groups each began their work with three or four presentations on their respective topics and continued with discussions on key questions elaborated and shared with the participants before the beginning of the Conference. The following topics were addressed:

(a) Mitigation/REDD;

(b) Climate change and disasters;

(c) Adaptation in coastal areas;

(d) Climate change and the environment;

(e) The role of research in climate change issues;

(f) Data policy;

(g) Mitigation and adaptation in mountains;

(h) Adaptation in agriculture;

(i) Weather and climate.

9. The programme also included a cultural event on the first evening of the Conference, which allowed participants and organizers to interact in a more informal setting.

C. Attendance

10. The Conference brought together experts, decision makers and representatives of academia, government agencies and regional and international organizations involved in climate change activities to discuss methods for using integrated space technology applications to support the identification and implementation of adaptation measures, as well as to share experiences and lessons learned on the use of such applications in mitigation. A total of 161 participants (50 female and 111 male) from the following 29 Member States attended the Conference: Algeria, Australia, Azerbaijan, Bangladesh, Belarus, Bhutan, China, Egypt, Ethiopia, Finland, Germany, Ghana, Guatemala, Indonesia, Jamaica, Kenya, Lebanon, Mauritius, Morocco, Nigeria, Pakistan, the Philippines, Saudi Arabia, Sri Lanka, the Sudan, Thailand, the United Kingdom of Great Britain and Northern Ireland, the United States of America and Viet Nam. Representatives of the Office for Outer Space Affairs, the Office of the United Nations Resident Coordinator in Indonesia, the United Nations University and the World Bank also participated. Some participants represented regional organizations, such as the Regional Centre for Mapping of Resources for Development (RCMRD) which is based in Kenya and supports most African countries, and the Asian Disaster Preparedness Centre in Bangkok.

11. Funds allocated by the United Nations, LAPAN and ESA were used to defray the cost of air travel, daily subsistence allowances and accommodation for 22 participants. LAPAN also provided lunch, coffee breaks and a cultural event and mobilized participants from Indonesia to attend the Conference.

II. Summary of plenary meeting presentations and discussions of the working groups

A. Plenary meeting presentations

12. The plenary meetings on the first and last days of the Conference provided participants with an opportunity to become aware of the use of space-based applications to address adaptation and mitigation efforts in Algeria, Bangladesh, Egypt, Indonesia, Nigeria and the Philippines. Those two meetings also provided insights into the work of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER), the Asian Disaster Preparedness Centre and the private sector.

13. During the plenary meetings, the representative of the Algerian Space Agency and the National Authority for Remote Sensing and Space Sciences of Egypt briefed participants on the need to address the manifestations of climate change in the Mediterranean basin, including sea-level rise and subsequent salinity intrusion and shoreline erosion; flooding, drought, desertification and loss of biodiversity; and temperature extremes, including heatwaves in urban areas. The representative of the National Council on Climate Change of Indonesia noted the effects of inadequate land use, land use changes and deforestation as drivers of greenhouse gas emissions and commented on the use of space applications to track mitigation measures. The representative of the Ministry of Home Affairs of Bangladesh provided an overview of the impacts of climate change across Bangladesh and on the contributions of geographic information systems and satellite technology to assessing vulnerability to climate change. The representative of the National Hydrological Services Agency of Nigeria made a presentation on the use of satellite technology for effective data collection and to facilitate the sharing of data and information as a way to contribute to negotiations and agreements on the joint use of water resources in transboundary basins and to develop future climate change projections and early warning systems for sustainable development in such transboundary basins. The representative of the EADS Astrium briefed participants on the use of satellite imagery in the context of REDD and on the role of such imagery to provide baselines and registries, and to support the measurement, reporting and verification of mitigation activities.

B. Working group 1: Mitigation and reducing emissions from deforestation and forest degradation

14. Space agencies have positioned satellites that track the concentration of gases in the atmosphere, and ministries of the environment continually use remote sensing applications to track emissions of such greenhouse gases. Other uses of such applications include tracking emissions from forest fires, industry, vehicles, ships and aircraft.

15. The three presentations in the working group 1 provided participants with examples of the use of satellite imagery. LAPAN uses it to monitor forest cover changes in Indonesia and highlighted the need to validate medium resolution data with high resolution data. The National Centre for Remote Sensing of Lebanon uses SPOT imagery to track snow cover changes in Lebanon that trigger floods and

landslides, and proposes the use of hyperspectral sensors to track forest cover changes and carbon dioxide sequestration. The representative of RapidEye presented examples of the use of imagery to support the REDD programme and of the relevance of the red-edge band to monitoring the health of vegetation which is relevant to carbon sequestration.

16. The participants in working group 1 stressed the high value of space applications for tracking and measuring mitigation efforts owing to the fact that satellites can cover large areas with comparatively low time and cost investments and that they allow for near real-time reporting. They also highlighted the use of hyperspectral images to achieve good results, especially on bare and dry surfaces. However, the participants also identified constraints when using coarse spatial resolution images, which inhibit the detection of small variations. When deciding which types of imagery work best to measure the amount of greenhouse gases absorbed in forests, the participants concluded that there is no uniform approach, since forests can be quite diverse. However, in general, optical data were identified as the most useful, particularly when cloud cover can be avoided. Additionally, the participants stressed the usefulness of indices as a way of capturing biomasses relevant in the context of mitigation, vegetation cover maps and real-time systems in order to visualize changes and to report to decision makers.

C. Working group 2: Climate change and disasters

17. The experts of the Intergovernmental Panel on Climate Change have stated that, as a result of climate change, more frequent and more intense hydro-meteorological events can be expected: storms or droughts, both of which can have a severe impact on agriculture, livestock farming and water resources. Storms directly trigger landslides and debris flows in mountainous areas and floods in flood plains.

18. The three presentations illustrated the adverse effects of climate change in the form of natural disasters and how space-based information can be used to monitor hydro-meteorological hazards. The Philippine Atmospheric, Geophysic and Astronomical Services Administration uses satellite imagery to elaborate cloud masks and cloud classifications, to track cyclones and to fill in gaps in observational data used to generate flood maps. LAPAN uses such imagery to assess coastal vulnerability in Indonesia and the Space and Upper Atmosphere Research Commission uses it to monitor snow cover and glacial lake outbursts in Pakistan and to map landslides, floods, droughts and storms.

19. The participants recognized the need to combine ground-based surveys and data acquired via satellites as a way to assess the socioeconomic dimension of the vulnerability of communities to climate change-induced disasters. They highlighted that satellite data can be very useful to identify the exposure of assets and suggested that archived and up-to-date imagery be used to track changes over time.

20. In the context of potential losses and damage caused by sea-level rise, the participants suggested that satellite altimetry be used in combination with satellite imagery to design coastal zone protection measures. While LIDAR was found to be the most suitable technology to develop digital elevation models for coastal areas, very high resolution satellite imagery could be used to assess coastal erosion. In the

case of drought, participants suggested the use of low-resolution imagery to track the large areas that can be affected by drought.

D. Working group 3: Climate change and the environment

21. Natural ecosystems play a vital role in human subsistence through the provision of a variety of services. Ministries of the environment are already making use of remote sensing applications and global navigation and satellite services (GNSS) to assess the different manifestations of climate change in the environment and the impacts of climate change, and to track ways to control such impacts.

22. The Blue Nile National Institute for Communicable Diseases uses satellite imagery to track the effect of climate change on vector-borne diseases in the Sudan and adaptation efforts targeting such diseases, while the Ministry of the Environment and Natural Resources of Guatemala uses such imagery in adaptation and mitigation efforts in Guatemala. RCMRD in Kenya uses satellite imagery to monitor water resources, vegetation and land use change which are relevant to REDD, as well as for index-based insurance products and greenhouse gas inventories.

23. The participants in working group 2 concluded that ministries of the environment and natural resources are already using remote sensing applications and GNSS to assess the various manifestations and impacts of climate change in the environment and to track the effect of specific measures to control such impacts. They suggested that the vulnerability of ecosystems was best assessed when space data were calibrated and checked for accuracy through ground referencing and focused group discussions with communities. The participants concluded that it was possible to use space applications to measure or quantify the services provided by forests through forest health assessments based on vegetation and species density indices, forest fire assessments and forest degradation mapping.

E. Working group 4: The role of research

24. Academia and research centres play an important role by establishing the theoretical frameworks and developing tools and instruments to support the practical work of decision makers and implementers of climate change adaptation and mitigation efforts. The challenge is to ensure that researchers and other stakeholders complement each other.

25. The participants took note of the remote sensing efforts conducted by the Belarusian State University, focused on ecology and climate monitoring, flood and fire modelling, soil nuclide migration forecasting, land cover changes, forest classifications and heat anomaly identification in Belarus. They were also briefed on the capacity of the University of New South Wales in Australia to design spacecraft payloads and sensors for novel satellite applications, as well as on the distance education courses it offers in space technology and on its interest in useful collaborative research. They were also made aware of the role that international institutions such as the World Bank can play in accelerating innovations for development and poverty reduction in Asia through the Asia Knowledge and Innovation Lab. The Centre for Coastal and Marine Resources Studies of Bogor

Agricultural University in Indonesia uses satellite imagery to track sea grass and mangroves, given their high potential for carbon storage (referred to as blue carbon).

26. The participants reiterated that academia and research institutions could complement practical steps implemented by government agencies and suggested that academia could contribute by providing ex-post assessments regarding which methods had worked and which had not worked.

F. Working group 5: Adaptation in coastal areas

27. Coastal areas include coral reefs, beaches, estuaries and portions of land which are heavily interlinked with the seas and oceans. Adaptation would cover coral and mangrove forest ecosystems and ecosystems associated with sand dunes; livelihoods, such as fishing and shrimp, oyster and mollusc farming; agriculture in coastal areas; and coastal settlements (urban and rural).

28. The presentations to working group 5 highlighted the special circumstances of countries with coastal areas and small island developing States, and the challenges they face. Mauritius uses space-based data to gather information on land suitability, to create flood risk maps and to carry out agricultural planning, and for early warning purposes. The Ministry of Water, Land, Environment and Climate Change in Jamaica uses space technologies for environmental monitoring, land use management and disaster management, to assess coastal erosion and sea level rise and to map risks and vulnerabilities in coastal ecosystems, including mangroves, coral reefs and sea grasses. The Royal Centre for Remote Sensing of Morocco uses space technology applications to draw up land cover and land use change maps on various spatial and temporal scales, and for drought early warning, through the use of various space-based indexes, such as the Normalized Difference Vegetation Index, the Standardized Vegetation Index, the Vegetation Condition Index, the Temperature Compensating Index, the index related to the health condition of vegetation and the Standardized Precipitation Index. In addition, the Research and Development Centre for Marine and Coastal Resources of Indonesia uses those applications to assess the impacts of climate change on the marine and fisheries sectors and to contribute to fisheries management.

29. The participants in working group 5 agreed that small island developing States and other developing countries with coastal areas are vulnerable to the effects of climate change, such as sea level rise, coastal erosion, environmental deterioration, for example coral bleaching, and increasingly intense storm surges and floods. They also agreed that space-based information can play an important role in monitoring shipping traffic and in measuring shoreline erosion and coral bleaching, land subsidence and sea level rise. However, cost is usually an obstacle to access high resolution imagery and some participants argued that even when satellite data are used, it is not always possible to separate the effects of climate change from the effects of human activity.

G. Working group 6: Data policy

30. Access to space- or ground-based data that are necessary for both assessments and decision-making can be a challenge owing to lack of resources and lack of expertise in interpreting and processing such data. In several countries geospatial data policies have been successfully put in place as a way of facilitating access to geospatial data and information for such assessments and decision-making.

31. The participants took note of the satellite remote sensing data policy of Indonesia, enacted through Presidential Decree No. 6/2012, which puts LAPAN at the centre of the National Geospatial Data Network and mandates LAPAN to provide high resolution imagery to other governmental institutions. They also took note of the Indonesia Space Act, a national legal framework protecting national interests but complying with international treaties and laws. That Act includes regulations for effective integrated data collection, archiving, and distribution among stakeholders and users. The participants were also briefed on the land reforms carried out in Azerbaijan in 1996, which included satellite-based georeferencing of all parcels of land and free access to such information via the Internet, including information on land ownership and soil quality. The participants also took note of the views of the private sector regarding data policies covering legal frameworks, sharing/distribution methodologies and the provision of accessible and reliable data.

32. The participants discussed how geospatial databases could best be established and shared and noted that standardized formatting was very useful. The example was highlighted of the one-map policy of Indonesia, whereby a base map format has been defined as a standard to be used by all agencies and at all levels of government. In addition to standardized data, the participants stressed the benefits of standardized software. They agreed that governmental and non-governmental actors and the private sector should work together on data issues and exchange data with one another, while respecting national regulations and privacy issues, including with regard to sensitive data. The Committee on Earth Observation Satellites was referred to as a good resource for accessing satellite data, but it was pointed out that few existing data sources provided data at the fine accuracy needed at the local level.

H. Working group 7: Mitigation and adaptation in mountains

33. Mountainous environments host specific ecosystems and provide sustainability to the livelihoods of rural communities in many regions of the world. On a very general scale, one can differentiate between two types of mountain environments: those which include glaciers and those which do not.

34. The participants from the International Centre of Insect Physiology and Ecology in Kenya commented on the effect of warmer temperatures on pollination and insect pest management in East Africa. The Royal Government of Bhutan uses space technology applications to assess vulnerabilities to climate change due to glacial lake outbursts and more intense precipitation, which trigger more intense floods and landslides that lead to land degradation. The Department of Geophysics and Meteorology of Bogor Agricultural University in Indonesia commented on the

potential use of space technologies to collect climate data, to develop climate models and to elaborate national forest inventories and integrated water resource management guidelines; and on the usefulness of integrated top-down and bottom-up approaches, as had been presented for topographical and climate-related influences.

35. The participants discussed various ways of integrating space applications with ground-based surveys in order to assess vulnerabilities in mountain communities. In order to assess the effects of the melting of glaciers on communities living in mountainous areas, the participants agreed that a regional multi-risk mapping approach would be sensible, integrating thematic maps on precipitation, soils, demography, elevation models and glacier morphology and dynamics as well as vulnerability maps that should be used to estimate the cost of potential alternatives related to adaptation.

I. Working group 8: Adaptation in agriculture

36. Agriculture is the basis for many types of livelihood around the world. When discussing how best to approach this theme, it is important to keep in mind the particular case of subsistence agriculture and the types of crops that are grown on different continents in such agriculture.

37. The participants from the Ethiopian Institute of Agricultural Research and the Ministry of Agriculture and Irrigation of the Sudan made participants aware that farmers in their region of Africa depend heavily on rain-fed agriculture and therefore are highly vulnerable to climate change-induced droughts. Since space technology is a relatively new topic in those two Member States, there is a need for institution strengthening initiatives and research programmes to identify alternatives in the context of adaptation to climate change. Participants also took note of the Ghana Technology Needs Assessment project for climate change adaptation and mitigation, which is coordinated by the Environmental Protection Agency of Ghana and is aimed at identifying and determining the mitigation and adaptation technology priorities in Ghana.

38. In many developing countries, subsistence agriculture is conducted on small plots of land and in some cases several crops are planted on the same plots. The working group discussed ways to use remote sensing methods to track the size of such plots, to assess expected yields and to determine the state of health of crops. The participants agreed that measurement of the area of such plots is possible using high-resolution imagery; however, estimation of the yield using imagery requires calibrating the method used with in situ data. When estimating the state of health of crops, very frequent assessments (every few days) would be necessary, but this might be a quite costly approach. The participants also noted that, during the recent droughts in the Horn of Africa, maps were produced by many international and regional organizations providing general overviews of the areas affected by drought. However, because of their coarse resolution, such maps were not so useful for assessing the extent of crop damage.

39. With regard to subsistence agriculture in mountainous areas, the participants noted that in Kenya, the Regional Centre for Mapping of Resources for Development makes use of Moderate Resolution Imaging Spectroradiometer

(MODIS) and Landsat imagery, digital elevation models and information provided by the Meteorological Department to predict frost conditions in high elevation areas. Furthermore, information derived from satellite imagery can be used to estimate soil moisture and the area of water bodies that are relevant for irrigation, as well as to assess the exposure of crops to landslides.

40. In the context of locust infestations in north-western Africa, space agencies such as the Algerian Space Agency have developed methods of using satellite imagery to track potential locust swarms and the extent of the damage they cause, using the National Aeronautics and Space Administration Earth Observing-1 data.

J. Working group 9: Weather and climate

41. Climate change can strongly influence global weather and weather patterns. There is a complex interaction between oceans, the atmosphere and various weather events that result from climate change. In order to assess and monitor factors that influence climate change as well as to track its adverse effects, remotely sensed data combined with ground data provide valuable inputs.

42. The representative of the Department of Meteorology of Sri Lanka made reference to the more frequent and intense droughts, floods and landslides that that Member State is experiencing owing to climate change, as well as unpredictable rainfall patterns, increasing temperatures, sea level rise and coastline erosion. The Department uses space applications to study seasonal rainfall patterns and rainfall anomalies, to detect trends in surface temperature and to understand the interaction between the ocean and the atmosphere. LAPAN uses remote sensing applications to identify climate change-related hydrometeorological phenomena over Indonesia. The representatives of the Ateneo de Davao University and the Manila Observatory in the Philippines presented an overview of recent climate change-related events in the southern Philippines, including typhoons, floods, sea level rise and unusual rain patterns, and their effects on agriculture and livelihoods. The work of the Manila Observatory in collecting magnetic field data as part of a Magnetic Data Acquisition System (MAGDAS) project at the zero dip magnetic equator was also presented.

43. Participants identified the challenge of developing a model that is based on reliable, high resolution data and that at the same time is simple enough to be understood by all stakeholders, especially policymakers. The participants discussed in detail phenomena such as El Niño or monsoons which still need studying further using space technologies. In the context of early warning of extreme weather events, the participants considered that satellite data could contribute to better models and to a deeper scientific understanding. The participants went on to discuss the impacts of changing weather patterns due to climate change on specific ecosystem services and agreed that ecosystem monitoring from space could support government policies. However, there are still some limitations when using satellite images; for example, satellite images cannot penetrate below forest canopy. Another example is coral reef bleaching, where water clarity is a limiting factor for the use of satellite images.

III. Observations and recommendations

44. Discussions during the Conference highlighted the view that space applications are contributing to the understanding of climate change, its drivers and its manifestations. They are useful for tracking regions and livelihoods exposed to the various manifestations of climate change, as well as for tracking changes in exposure over time, especially if combined with ground data. Specific advantages of the use of space applications include the capacity to capture large areas at once, inaccessible areas and areas regardless of country boundaries, for example in coastal and mountainous regions. Space-based data also offer the advantages of different temporal and spectral resolutions. Constraints mentioned were the relatively high cost of high resolution imagery and the need to validate lower resolution imagery or to assess impacts that are only visible using high resolution images. The Conference revealed that there have been many advances around the world in methods of deducing information from space applications and that information technology methodologies can be used to facilitate its dissemination.

45. The participants agreed that academia and research institutions play an important role in facilitating and promoting the use of space technologies. They can provide feedback to Governments regarding the usefulness of measures implemented to adapt to climate change, as well as generating information for use by decision makers in designing policies regarding mitigation of and adaptation to climate change. Furthermore, they can share lessons learned on global methods and applications that are not specifically tied to national conditions.

46. In the course of the Conference, it became evident that there is a need to increase capacity at all levels so as to enable stakeholders, including local communities, decision makers, staff in ministries and other governmental actors, non-governmental organizations and academia to access and efficiently use space technology applications in the context of mitigation and adaptation. In that respect, the United Nations, in cooperation with appropriate institutions and regional training centres and universities, should conduct capacity-building and institutional strengthening activities. Regional approaches would facilitate both capacity-building and the exchange of lessons learned.

47. The participants reiterated the usefulness of exchanging lessons learned, methods and results, suggesting that the Office for Outer Space Affairs should serve as a vehicle for the sharing of lessons learned and useful methods through the organization of meetings with partners and focused discussion groups, as well as through online forums and mailing lists. Such efforts should lead to a common understanding regarding how best to make use of space applications to address the challenges posed by climate change, to a “common language” and to synergies in the generation and use of space-based information to support mitigation and adaptation efforts worldwide. The Office for Outer Space Affairs might also consider establishing a dedicated section on its website to collect the needs of Governments, to showcase best practices and provide links to relevant resources and guidelines. Such a section could also provide metadata of existing and past projects as well as step-by-step methodologies on the use of integrated space technology applications to assess vulnerability and to characterize the effects of climate change. Those resources would also help to monitor the results of adaptation and mitigation measures implemented in different regions of the world.

48. In the context of facilitating the visualization of the effects of climate change on the environment, livelihoods and sectors of development, the participants agreed that space technologies could provide very valuable inputs, which should be transferred into easily understandable models that facilitated timely and precise visualizations of vulnerabilities, impacts and potential solutions. The participants recommended that the Office for Outer Space Affairs serve as a vehicle to facilitate interaction among stakeholders for the development of geoviewers to visualize relevant geospatial information, given its usefulness in supporting the decision-making process and in facilitating the design of specific policies. They suggested that specific models should be developed that incorporated the monetary dimension of the effects of climate change on livelihoods, communities and sectors of development, as well as models that assisted visualization of the cost/benefit relationship associated with different types of solutions, and their timeliness.

49. The issues of data accessibility, data sharing and data policies were discussed in depth during the Conference. Data and information standards and management policies may facilitate the sharing among institutions of data to be used to assess vulnerability and to monitor, report on and verify adaptation efforts. Geospatial data infrastructure would be of great benefit for the sharing of data and derived products among various agencies and stakeholders. Participants also suggested that the Office for Outer Space Affairs promote the establishment of data policies incorporating spatial database infrastructure, as a way of facilitating the sharing of data and information among agencies, as well as of stimulating discussion regarding data standards at the international level in order to reach a global consensus.

50. Discussions on pilot projects to foster the use of space technologies led to the identification of several potential projects, including on the use of space technologies to generate relevant and reliable information on crops for the agriculture sector; the development of vegetation maps to track changes in vegetation over time; adaptation and implementation of the method developed by LAPAN to assess vulnerability in coastal areas; the modelling of vector-borne diseases and the development of methods to assess for early warning purposes how climate change is affecting the habitats of insects responsible for such diseases; assessment and quantification of the services provided by forests and the environment and assessment of the vulnerability of such services to climate change; the elaboration of baselines regarding vulnerable livelihoods based on agriculture and aquaculture; assessment of the vulnerability of communities in mountainous areas in relation to the melting of glaciers; and improving understanding of how climate change affects regional weather processes, such as monsoons in Asia. Participants also suggested the use of integrated space applications to develop adaptation strategies for food and water security, and in early warning systems. With a view to replicating best practices in future projects, they suggested that the involvement of universities and the creation of a dedicated website could help access software, tools, methods and other relevant information.

IV. Conclusions

51. The participants confirmed that space-based applications are perceived as providing highly valuable inputs which can contribute to efforts worldwide to mitigate the effects of climate change and to adapt to its manifestations. They also

highlighted the benefits of international cooperation regarding the use of integrated space technology applications to achieve development goals for the benefit of humankind.

52. The Conference has enabled the Office for Outer Space Affairs to gather together elements to draft a plan of work for its climate change activities and to build a network of participants to advance its agenda on this topic. It has also contributed to the efforts to address climate change carried out under the umbrella of the United Nations Framework Convention on Climate Change. In this context, it can be seen as complementary to other efforts already carried out under the Convention regarding the use of space-based applications to monitor climate and to address mitigation and REDD. In the particular case of adaptation, the Conference has served as a vehicle to identify ways in which space-based information can contribute to efforts carried out worldwide under the auspices of the recently established Adaptation Committee of the United Nations Framework Convention on Climate Change.

53. At the closing meeting of the Conference, participants discussed and approved the remarks and recommendations of the working groups. They also expressed their appreciation to the Government of Indonesia, to ESA and to the United Nations for organizing the Conference and for the significant support provided.