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Report on the United Nations/India Workshop on the Use of Earth Observation Data in Disaster Management and Risk Reduction: Sharing the Asian Experience

(Hyderabad, India, 8-10 March 2016)

I. Introduction

1. The present report contains a summary of the United Nations/India Workshop on the Use of Earth Observation Data in Disaster Management and Risk Reduction: Sharing the Asian Experience, held in Hyderabad, India, from 8 to 10 March 2016.

2. The main objective of the Workshop was to share experiences on disaster management using Earth observation data and geospatial technologies for the implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030.[1] The Workshop built upon the outcomes of the Third World Conference on Disaster Risk Reduction and the related commitments of the Office for Outer Space Affairs of the Secretariat, in particular in fulfilling its mandates towards the fiftieth anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space[2] (UNISPACE+50) in 2018 and aligning its work and deliverables with the global development agendas: the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction and the Paris Agreement on climate change.

3. The Workshop focused its objectives and outcomes towards several Sustainable Development Goals of the 2030 Agenda for Sustainable Development. Space tools can make a significant contribution to assisting nations in the attainment of those Goals — in particular Goal 6, which is aimed at ensuring availability and

[1] For more information, see www.unisdr.org/we/coordinate/sendai-framework.
[2] For more information, see www.unoosa.org/oosa/en/ourwork/unispaceplus50/index.html.

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sustainable management of water and sanitation for all. Remote sensing applications for water management purposes are vital to the attainment of this goal. Furthermore, floods account for 15 per cent of all deaths related to natural disasters. The use of space technologies for disaster risk reduction, especially for supporting resilience to disasters and emergency relief efforts, is closely related to the attainment of Goal 9, which is aimed partly at the building of resilient infrastructures. Furthermore, Earth observation is critical to ensuring sustainable growth, particularly in disaster-prone areas, which is one of the focuses of Goal 8.

II. Background and partners

4. The Programme on Space Applications of the Office for Outer Space Affairs was established in 1971 upon the recommendation of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE I), held in Vienna in 1968. The Programme is aimed at promoting, through international cooperation, the use of space technologies and data for sustainable economic and social development in developing countries, by raising the awareness of decision makers on the cost-effectiveness and additional benefits to be obtained; establishing or furthering capacities in developing countries to use space technology; and strengthening outreach activities to disseminate awareness of the benefits obtained. Among other priorities, the programme has put special emphasis on remote sensing and its applications for disaster management.

5. The United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) was established in 2006 as one of the recommendations of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III). UN-SPIDER is the programme of the Office for Outer Space Affairs aimed at providing universal access to all types of space-based information and services relevant to disaster management to all countries and relevant international and regional organizations, in support of the full disaster management cycle (see General Assembly resolution 61/110).

6. The Department of Space of the Government of India leads the Disaster Management Support Programme[3] in order to take advantage of the benefits of aerospace technology for its application on disaster management in the country. Various centres of the Indian Space Research Organization (ISRO) are involved in implementing components of the Disaster Management Support Programme, which is centrally coordinated by its Programme office located at ISRO headquarters. The Decision Support Centre established at the National Remote Sensing Centre is the single-window delivery point for aerial and space-based data, as well as other important data, for use in all phases of the disaster management cycle. For online transfer of space-based data to end users of state and central government departments, a satellite communication network based on a very small aperture terminal (VSAT) has been put in place. This space-based information is also available through the ISRO Bhuvan portal,[4] under the “disaster services” section.

[3] For more information, see www.isro.gov.in/applications/disaster-management-support-programme.

[4] For more information, see bhuvan.nrsc.gov.in/bhuvan_links.php.

7. UN-SPIDER has offered technical advisory support to several countries in Africa, Asia and the Pacific, and Latin America and the Caribbean. After in-depth interactions and assessments undertaken with a wide range of stakeholders in those countries, it was noted that improving disaster risk management and emergency response through the effective use of space technology applications involves not only having the technology in place, but also tackling several other issues related to policies, institutional coordination, data-sharing, national spatial data infrastructure and capacity-building.

8. The Sendai Framework for Disaster Reduction 2015-2030 identified the critical role of space-based technologies in disaster risk reduction. The momentum gathered as a result of that important milestone should be used to strengthen cooperation and capacity-building in the field of space-based technologies internationally. This is particularly important for emerging countries in the Asia-Pacific region as a means of contributing to their sustainable development and poverty eradication.

9. With the rapid development of the Asian economy and the growing impact of climate change, natural disasters are affecting people's livelihoods more than ever. According to the study "Disasters in Asia and the Pacific: 2014 year in review",[5] developed by the Economic and Social Commission for Asia and the Pacific (ESCAP), more than half of the world's natural disasters occurred in the Asia-Pacific region. Hydrometeorological hazards occurred most frequently and were responsible for the most fatalities and economic losses.

10. In Asia, technological capability and know-how with regard to the use of Earth observation data in disaster management varies greatly. China, India and Japan have developed excellent remote sensing-related infrastructure and have integrated Earth observation data to support disaster management and emergencies. Indonesia, the Republic of Korea, Thailand and Viet Nam have also developed good capacity and infrastructure to use remote sensing data in disaster management. Bangladesh, Pakistan and Sri Lanka have demonstrated the effective use of remote sensing data in their disaster management programmes. However, more must be done to learn from each other and establish international cooperation to help save lives and mitigate the damage caused to infrastructure and livelihoods by disasters.

III. Objectives

11. The aim of the Workshop was to: (a) demonstrate operational programmes and tools that make use of Earth observation data to address the disaster management cycle, including understanding disaster risks, responding to emergencies, assessing damage and loss, and providing inputs to mitigate disasters; (b) synthesize experiences and lessons learned from Asian countries; (c) promote the use of Earth observation in disaster-prone areas in order to prepare, mitigate and respond to natural disasters; plan and build more resilient infrastructure; and allow for a more sustained, inclusive growth, in line with the 2030 Agenda for Sustainable

[5] For more information, see www.unescap.org/resources/disasters-asia-and-pacific-2014-year-review-0.

Development; and (d) discuss the way forward in international cooperation on space technologies and disaster management, in preparation for UNISPACE+50.

12. The Workshop provided an insight into technologies, models, methods, tools and operational programmes utilizing Earth observation data in natural disaster management, covering the following important stages of the disaster management cycle, in particular: mitigation planning (hazard and risk assessment), early warning, emergency response, disaster recovery and damage assessment.

IV. Workshop

13. The Workshop, which was inaugurated by the Chairman of ISRO, A. S. Kiran Kumar, was attended by 110 participants from 32 countries. The following international organizations participated: Association of Southeast Asian Nations (ASEAN) Coordinating Centre for Humanitarian Assistance, ESCAP, International Centre for Integrated Mountain Development, International Water Management Institute, Office for Outer Space Affairs and United Nations Development Programme.

14. The following national organizations also participated: India Meteorological Department; Central Water Commission; Geological Survey of India; Indian National Centre for Ocean Information Services; and State Disaster Management Authorities of Assam, Bihar, and Odisha States of India; as well as educational institutions, including Indian Institute of Remote Sensing and Indian Institute of Technologies, participated in the Workshop.

15. The Workshop included two invited speakers and a total of seven sessions (two plenary, one technical and four parallel sessions) plus two site visits. The sessions addressed the following topics:

(a) Earth observation in disaster management: challenges (plenary session 1);

(b) Challenges in disaster management: field experiences (technical session);

(c) Disaster risk assessment: role of space technology (parallel session 1);

(d) Space technology in disasters: scenarios and trends (parallel session 2);

(e) Early warning systems and emergency response (parallel session 3);

(f) Challenges in capacity-building: disaster management (parallel session 4);

(g) Fostering international cooperation for promoting space technology (plenary session 2).

16. The two site visits, planned on the last day of the Workshop, were to the Shadnagar Earth Station of National Remote Sensing Centre and the tsunami warning system.[6]

[6] For more information, see www.tsunami.incois.gov.in.

V. Relevant issues

A. Earth observation in disaster management: challenges

17. Four presentations were given at the session on Earth observation in disaster management, covering the following topics: (a) transforming geospatial data into disaster management information; (b) the ISRO operational disaster management support programme; (c) strengthening regional cooperation on the effective use of Earth observation for disaster risk reduction; and (d) public and private collaboration. Speakers at the session came from the Saint Xavier University (United States of America), ISRO, ESCAP and DigitalGlobe.

18. The applications of Earth observation in all stages of disaster management are well known. Most of the countries in the Asian subcontinent have dedicated agencies for disaster management. However, barring a few countries, namely, China, India and Japan, Earth observation data are not yet regularly used in decision-making for disaster management. The immense potential that Earth observation data hold in the field of disaster management is the ability to provide immediate support to reconstruction efforts. The session provided a platform for sharing the experiences learned and challenges in addressing recent catastrophic disasters, highlighting the role of space technology in bridging the gaps for better disaster management.

19. The role of “big data” and “rich data” in disaster management — their scope, elements and challenges — were discussed at the session. The need for cloud services and “big geo data” platforms as a service was stressed. The speakers also advocated an open-standard dissemination protocol. Given how susceptible to disaster the Asia-Pacific region is, the need for operational procedure manuals for rapid assessment and recovery was discussed. The important elements to be considered in that regard are developing institutional capacity, mapping risk hotspots, assessing multi-hazard risks and strengthening early warning.

B. Challenges in disaster management: field experiences

20. Three presentations were given at the session on challenges in disaster management, covering the topics of monitoring and assessment of floods and drought, disaster mitigation and operational marine environmental disaster monitoring. Speakers at the session represented the following organizations: MacDonald, Dettwiler and Associates (MDA) (Canada), the National Satellite Ocean Application Service (China) and the International Water Management Institute (Sri Lanka).

21. The presentations highlighted the need for countries to set up operational systems and discussed tools to support disaster management. Setting up such systems requires cooperation on the part of disaster management agencies and providers of Earth observation information. A successful support system requires an in-depth understanding of disaster management needs and appropriate map products and information that cater to the requirements of preparedness, early warning, emergency response, and damage and loss assessment.

22. The speakers shared success stories by demonstrating operational systems and tools for disaster management. The utilization of Interferometric Synthetic Aperture Radar data in monitoring urban infrastructure and the mitigation of land deformation risks by using the capabilities of Synthetic Aperature Radar satellites were discussed. The experiences and challenges of operational marine environmental disaster monitoring using remote sensing data were also discussed. Experiences related to the use of remote sensing applications for the monitoring of oil spills, green tides, sea ice, typhoons and pipeline explosions were shared. In addition, the use of global and open-source satellite images in assessing and monitoring floods and drought risks was addressed.

C. Disaster risk assessment: role of space technology

23. Six presentations were given at the session on the role of space technology in disaster risk assessment. The topics covered were landslide susceptibility mapping, active sand dune hazards, crowdsourcing and disaster response, monitoring weather phenomena, crisis management of land subsidence and groundwater level, disaster risk reduction and virtual reality tools. Speakers at the session represented the Geological Survey of India, the National Authority for Remote Sensing and Space Sciences (Egypt), the Kerman Disaster Management Centre (Islamic Republic of Iran), the National Institute for Disaster Management (Mozambique), the Alborz Regional Water Authority (Islamic Republic of Iran), the Odisha State Disaster Management Authority (India) and the Indian Institute of Space Science and Technology.

24. The session focused on national missions, programmes and methodologies involving the use of Earth observation for assessing the risks of major disasters in Asia. As set out in the Sendai Framework for Disaster Risk Reduction 2015-2030, policies and practices for disaster risk management should be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment. A pre-disaster risk assessment is therefore necessary to provide inputs for disaster prevention and mitigation. Earth observation is one of the key sources of information required to prepare the hazard, risk and vulnerability maps needed for pre-disaster risk assessment.

25. The methodology and outcomes of medium-scale, national landslide susceptibility mapping, being implemented in India using Earth observation data, were shared. The experience of India stressed the value of landslide hazard and risk mapping, as well as early warning, in the prevention of damage caused by landslides. Emphasis was placed on the urgent need for legislation to help mitigate landslides caused by human activity. The use of satellite images for the assessment of active hazards related to sand dunes in Egypt was highlighted. In the same presentation, the challenges of collecting data from crowdsourcing, especially in terms of maintaining quality and confidentiality, were discussed. Another example of crowdsourcing (the Tomnod platform by DigitalGlobe[7]), utilized during the Nepal 2015 earthquake, was also discussed, further highlighting the need for more in-depth analysis on accuracy, reliability and timeliness in using crowdsourced data.

[7] For more information, see www.tomnod.com.

Such tools integrate geospatial content with satellite images and ensure sustainability in the use of those images. Several examples of risk assessment for floods and cyclones in India were also presented, with an emphasis on the role of space technology in disaster risk assessment.

D. Space technology in disasters: scenarios and trends

26. Seven presentations were given at the session on scenarios and trends in space technology in disasters, covering the topics of online geographic information systems (Web-GIS), the Bhuvan portal for disaster management in India, the National Database for Emergency Management[8] in India, crowdsourced damage mapping and hyperspectral small-satellite missions. Speakers at the session represented institutes including King Abdulaziz University (Saudi Arabia), the South China Sea Institute of Oceanology, the National Remote Sensing Centre (India), the Chinese Academy of Sciences, Beihang University (China), the Assam State Disaster Management Authority (India) and Berlin Space Technologies (Germany).

27. Many advanced technologies, such as crowdsourced mapping, mobile technologies and unmanned aerial vehicles, are becoming an integral part of disaster management. The session addressed advances in Earth observation technologies, research, innovations, emerging technologies, open-source data and tools that can help plan a better response during a disaster.

28. Numerous factors, including information-driven approaches and mechanisms and policy-related considerations, affect the ability to create and investigate multi-agency "what-if" simulation models. The foundation of having technology-driven frameworks for effective advancement related to geographic information system interoperability was highlighted. The challenges faced at the operational and decision-making levels of having efficient and interoperable systems, operational policies and data-sharing protocols to provide emergency managers with the requirements for effective interoperability were discussed.

29. Seven experiences from Asia were shared at the session. The Bhuvan portal could be effectively used for better disaster management within the South Asian Association for Regional Cooperation. A study carried out in China on the temperature change response to typhoons, which quantitatively evaluated the extent of the sea surface temperature cooling caused by typhoons, was discussed. ISRO proposed the use of the National Database for Emergency Management as a prototype in Asia and other areas for managing disaster emergencies. The use of the Tomnod crowdsourcing platform during the 2015 Nepal earthquake was demonstrated by DigitalGlobe. The need to improve accuracy, reliability and timeliness in using crowdsourced data was discussed. An experience of the use of space-based inputs for operational use to manage floods in the Brahmaputra River in India was shared. Inundation maps are routinely used for identifying severely affected regions, planning airdrops and relief rescue operations and carrying out post-disaster mitigation activities. The joint work of Berlin Space Technologies and the National University of Singapore provided an excellent example of how industry

[8] For more information, see www.isro.gov.in/national-database-emergency-management-ndem-services-tackling-disasters.

can help academia to build sustainable small-satellite missions needed for disaster monitoring.

E. Early warning systems and emergency response

30. Nine presentations were given at the session on early warning systems and emergency response. The topics covered included tsunami warnings, flood forecasting and modelling, oil spill detection, quantification earthquake response and meteorological hazards. Speakers at the session came from the following institutions: Malaysian National Space Agency, Indian National Centre for Ocean Information Services, Sudan Remote Sensing Authority, Dresden University of Technology (Germany), International Centre for Integrated Mountain Development, National Land Commission of Bhutan, Indian Meteorological Department, North Eastern Space Application Centre (India) and Central Water Commission (India).

31. The session focused on the lessons learned from experiences of mega-disasters, including the recent earthquake in Nepal and cyclones in India. The session provided guidance on how to integrate Earth observation data to provide precise early warning, generate the products needed for effective response, and address issues such as information preparedness, access to Earth observation images, preparation of emergency mapping products and product dissemination. Through the use of cases studies, the session highlighted methods for utilizing Earth observation for damage assessment.

32. India shared its experiences regarding a framework and mechanisms for disaster response for decision-making at the district, state and national levels. Presentations were given on the role of the National Security Council of Malaysia in regulating and making policies and the role of the National Space Agency (ANGKASA) — a part of the Ministry of Science, Technology and Innovation — in monitoring and disseminating information related to disaster management. Presentations were also given on the Indian approach to dealing with causative factors and risk assessments related to disasters caused by tsunamis and the tsunami warning system developed for the Indian Ocean, which is an international observation network for detecting and sharing information related to earthquakes and tsunamis. The importance of run-off inundation maps as they related to urban emergency management was discussed, with an emphasis on appropriate urban planning for low elevation regions. A methodology for identifying oil spills in the petroleum and gas extraction areas in the Caspian Sea using radar and optical satellite data was presented. The approach involved the use of object-based image segmentation in identifying and mapping the effects of recurrent oil spills in a selected study area.

33. A presentation was made on the issues related to mapping and zoning hazard risk areas associated with the Nepal earthquake in the context of the efforts of the International Centre for Integrated Mountain Development. The presentation explained operational challenges linked to the use of Earth observation and related tools and shared lessons learned in coping with major disasters in the country.

34. The session also included a presentation on the expanded meteorological network of weather stations and the process of numerical weather prediction at the regional and global levels in India, as well as forecast models and the role of the

Indian Meteorological Department in providing effective forecasting. A brief account of various flood forecasting models was presented, including three-hourly numerical weather predictions, cloud growth potential, the Weather Research and Forecasting numerical weather prediction model for rainfall and run-off and the use of the Hydrologic Modeling System and other hydraulics models for pilot studies. The role of the Central Water Commission in supporting international cooperation through the sharing of flood forecasting information was explained. The Central Water Commission also presented the models used for flood forecasting, including the MIKE 11 software and other mathematical models, and explained the ways in which information is transmitted in real time to end users.

F. Challenges in capacity-building: disaster management

35. Seven presentations were given at the session on challenges in capacity-building in disaster management. The topics covered included disaster risk reduction and capacity-building and lessons learned from the UN-SPIDER technical advisory missions. Speakers at the session came from various institutions including the Bihar State Disaster Management Authority (India); the United Nations-affiliated Regional Centres For Space Science and Technology Education[9] in Asia and the Pacific, in China and India; the National Space Secretariat of Kenya; the Ministry of Science and Technology of the Lao People's Democratic Republic; the Indian Institute of Technology; and the Centre for Development of Advanced Computing (India).

36. Although various advanced technologies are emerging and access to Earth observation data is less limited nowadays, the availability of trained manpower to make use of these technologies remains a big challenge. Until planners know how to precisely interpret and use hazard maps, the challenge will remain. The session provided access to opportunities for capacity-building in the field of disaster management. For example, a presentation on the disaster scenario in Bihar State, India, stressed that awareness of the use of satellite-derived map products should trickle down to district and village levels. The Regional Centres for Space Science and Technology Education in Asia and the Pacific — affiliated to the United Nations and based in China (Beihang University) and India (Indian Institute of Remote Sensing) — gave a presentation on the capacity-building activities and training programmes conducted in their respective centres. Courses are available in the areas of remote sensing and geographical information systems, satellite navigation, satellite meteorology, space law, small satellites and several other short or tailor-made courses on the applications of remote sensing technology.

37. Representatives from Kenya and the Lao People's Democratic Republic shared their experiences as part of the UN-SPIDER Technical Advisory Mission and the lessons learned in developing a space programme to support disaster management. The methods of integrating space science and technology inputs for effective disaster management and the needs of capacity-building at the country level, through international cooperation, were highlighted.

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[9] For more information, see www.unoosa.org/oosa/en/ourwork/psa/regional-centres/index.html.

G. Fostering international cooperation for promoting space technology

38. Four presentations were given at the session on fostering international cooperation for promoting space technology, covering experiences and challenges in disaster management, including small satellite-based sensor technology, universal access to the International Charter "Space and Major Disasters"[10] and disaster risk reduction. Speakers at the session came from various institutions, including the ASEAN Coordinating Centre for Humanitarian Assistance, Lockheed Martin Space Systems (United States), the National Remote Sensing Centre and the United Nations Development Programme.

39. The session identified concrete needs of countries to support disaster management and promote international cooperation. Challenges such as sharing best practices, providing access to satellite images during all stages of disaster management, exchanging methodologies and contributing to capacity-building and developing infrastructure were emphasized. The session provided an opportunity to develop a dialogue and bilateral cooperation between India and other countries and intergovernmental organizations. The ASEAN Coordinating Centre for Humanitarian Assistance highlighted its work to harmonize regional efforts and provide a legal framework that binds all ASEAN member States to a unified and standardized approach to disaster management. The role of the International Charter "Space and Major Disasters" and of its universal access initiative in providing support during emergencies was presented.

VI. Recommendations and outcomes

40. Although Earth observation and geospatial technologies have matured, common mapping standards, better coordination and data interoperability are still needed at the local and regional levels, among all disaster management agencies, for effective disaster management. Those goals can be achieved through cooperation with States that have established best practices, international agencies and centres of excellence.

41. The products and services provided through Earth observation technology need to be more meaningful and user-friendly if they are to be readily understood and utilized by the public. Until Earth observation data and value-added products derived from such data are widely used by communities to contribute to risk reduction, preparedness, early warning and relief efforts during major disasters, such use will be ineffective.

42. There is an urgent need for countries to set up operational systems and portals to facilitate disaster management. Successful support systems should be based on an in-depth understanding of the needs of a disaster management team in all phases. Two operational portals were developed by the National Remote Sensing Centre to support disaster management efforts, including Earth visualization, in the country. The portals of Bhuvan and the National Database for Emergency Management could be used as models for implementation by others in the Asia-Pacific region.

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[10] For more information, see www.disasterscharter.org.

43. There is also a need for national disaster management agencies to develop closer relationships with the private sector. Such relationships will enable rapid and coordinated efforts in providing quality and timely Earth observation data, both in pre-disaster phases (using satellite image archives) and post-disaster situations (using satellite images in near-real time). This type of cooperation and coordination is necessary for planning a successful emergency response.

44. Crowdsourcing has evolved as a means of rapidly collecting information. However, a key issue that needs to be addressed is how to make that technology an integral part of the emergency response methodology. Furthermore, studies are required to improve accuracy, reliability and timeliness in the use of crowdsourced data.

45. In building disaster-resilient societies, which is an important goal of disaster risk reduction efforts, capacity-building can be one of the main ways to increase awareness among citizens. It is important to empower communities and the general public through the use of Earth observation and other geospatial technologies for disaster risk management. While communities have to increase their awareness of products derived from Earth observation and the associated benefits, providers should learn about the needs of the community and tailor their products, services and technologies to fit them.

46. An effective way to contribute to building resilience is through the use of specific applications, developed for smartphones and made available to the general public. Such applications enable local people to contribute to risk identification during normal situations, to early warning systems and to damage and loss assessment during and after disasters.

47. In order to gain access to products derived from satellite images during major disasters, the understanding of international frameworks such as the International Charter “Space and Major Disaster” needs to be improved. However, promoting collaboration within the country and with other providers in order to access Earth observation data is important for effectively addressing the disasters occurring on a routine basis.

48. The Workshop succeeded in attaining the following outcomes: (a) exchange of knowledge and lessons learned by experts and disaster managers; (b) strengthened knowledge of technology trends, including the newest satellites and sensors; (c) elaboration of ways to access advanced Earth observation data; (d) enabling a platform for countries and intergovernmental organizations to develop bilateral and multilateral cooperation; and (e) enabling opportunities for enhanced collaboration among countries in Asia and other parts of the world for the effective utilization of Earth observation technology in disaster management.

VII. Conclusion

49. Based on feedback from participants, the Workshop was successful in providing insight into the role of Earth observation in disaster risk reduction and implementing the Sendai Framework for Disaster Risk Reduction 2015-2030.

50. The issues and recommendations synthesized during the Workshop are valuable to assist in consolidating the role of Earth observation in the

implementation of the Sendai Framework for Disaster Risk Reduction 2015-2030, develop a momentum that will contribute to the UNISPACE+50 process and increase the impact of the Office through a strengthened mandate to implement its programme, thereby assisting nations in reaching their goals on disaster risk reduction and sustainable development.