United Nations A/AC.105/1223

General Assembly

Distr.: General
28 November 2019

Original: English

Committee on the Peaceful Uses of Outer Space

Report on the Bonn international conference on the theme “Space-based solutions for disaster management in Africa: challenges, applications, partnerships”

(Bonn, Germany, 6–8 November 2019)

Note by the Secretariat

I. Introduction

1. The present document contains the outcome summary of the international conference on the theme “Space-based solutions for disaster management in Africa: challenges, applications, partnerships”, held in Bonn, Germany, from 6 to 8 November 2019, and organized by the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) and the Centre for Remote Sensing of Land Surfaces of the University of Bonn, with the support of the German Aerospace Centre.

2. Disasters triggered by natural, industrial and technological hazards cause tremendous damage to societies around the world. They lead to loss of life and property, displace people from their homes, destroy livelihoods and disrupt sustainable development efforts. Developing countries are particularly susceptible to the impact of those hazards, as their societies are more vulnerable and less resilient when disasters strike.

3. In recent years, there has been a significant improvement in the quality of satellite sensors and an increase in access to and the use of satellite imagery and Earth observation services, with a growing number of space agencies embracing open data policies that facilitate access to both archived and up-to-date imagery. Such remotely sensed data can be combined with in situ information from a variety of sensors and with other data, such as geolocated crowdsourced data, in order to generate relevant information. Furthermore, the space and geospatial communities are implementing a variety of cloud-based applications that facilitate access to policy-relevant information useful in disaster risk reduction, response and recovery applications.

4. In 2006, convinced that space technology could play a vital role in supporting disaster management, the General Assembly established, by resolution 61/110, UN-SPIDER as a programme to be implemented by the Office for Outer Space Affairs. The General Assembly mandated UN-SPIDER to provide universal access to all countries and all relevant international and regional organizations to all types of

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space-based information and services relevant to disaster management to support the full disaster management cycle.

5. In June 2019, during the annual session of the Committee on the Peaceful Uses of Outer Space, the Office for Outer Space Affairs and the University of Bonn signed a cooperation agreement to continue the efforts initiated by UN-SPIDER in Africa in the following five years. The agreement includes the provision of technical advisory support to African countries and the conduct of international conferences and expert meetings in Bonn and regional expert meetings in African countries.

6. The objective of the conference was to promote the increased use of big data from space approaches and satellite-based applications in African countries. The present note describes the background, objectives and programme of the conference and provides a summary of the observations and recommendations made by participants.

II. Background and objectives

7. In recent decades, communities in Africa have experienced disasters triggered by floods, droughts, landslides, Ebola pandemics and locust plagues that have eroded hard-won development gains. Taking note of advances in space technologies and other technological innovations, the African Union indicated in its 2017 African Space Policy that space represented a unique opportunity for cooperation in using and sharing enabling infrastructure and data towards the proactive management of, inter alia, responses to natural hazards and disasters. In that respect, the African Union aims to promote the use of space applications to improve weather forecasts and to develop a range of early warning systems, as Africa is subject to various extreme weather, climate, ecosystem and geological events.

8. Since 2008, UN-SPIDER has been strengthening technical skills and promoting the establishment of inter-institutional structures in several African countries in order to facilitate the use of space-based information by civil protection agencies and other actors involved in disaster management activities.

9. To contribute to the implementation of the UN-SPIDER mandate, the African Space Policy and the Sendai Framework for Disaster Risk Reduction 2015–2030, UN-SPIDER and the Centre for Remote Sensing of Land Surfaces of the University of Bonn joined forces to organize the Bonn international conference, on the theme “Space-based solutions for disaster management in Africa: challenges, applications, partnerships”, with the support of the German Aerospace Centre.

10. The conference brought together more than 100 participants from 22 countries, including representatives of government agencies, research institutions, regional and international organizations, private sector companies and non-governmental organizations. It benefited from the generous financial support provided by the German Federal Ministry for Economic Affairs and Energy.

11. The conference was used to showcase the most recent developments in the use of space technologies to address the challenges posed by natural hazards and climate change and to contribute to sustainable development efforts in Africa. It provided a setting in which to discuss ways that space technologies could contribute to disaster risk reduction efforts. The aims of the conference were:

(a) To showcase recent advances in and identify challenges to the use of space-based information, big data approaches and artificial intelligence techniques such as machine learning in disaster management in Africa;

(b) To present and provide hands-on experience of space-based applications through tutorials on technical solutions ranging from stand-alone desktop packages to cloud computing environments that facilitate access to and the use of space-based data and information products for disaster management;

(c) To build on the outcomes of international conferences and symposiums held by the Office for Outer Space Affairs to identify capacity-building needs and opportunities relating to optimum use of the increasing amount of space-based information and new techniques to access, combine, process, analyse and present data.

12. The conference programme included two keynote presentations, two panel discussions, four parallel sessions and a final plenary session. In addition, a hands-on segment allowed participants to divide into smaller groups to learn about cloud-based solutions developed by the space community and UN-SPIDER.

13. The conference also included a one-day training event for project managers, organized jointly by the Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters and UN-SPIDER. The training day allowed participants from Belarus, Brazil, Ethiopia, France, Germany, Ghana, Greece, Kenya, Mexico, South Africa, the Sudan and Tunisia to learn about the internal procedures employed by the Charter to support disaster management agencies through the provision of space-based information free of charge.

14. UN-SPIDER hosted the annual autumn meeting of the International Working Group on Satellite-based Emergency Mapping in parallel with the conference. The Working Group comprises a voluntary group of organizations involved in satellite-based emergency mapping and supports disaster response by improving international cooperation in such mapping activities. At the Group's spring meeting, held in Bonn, particular emphasis was placed on the topic of collaborative mapping, including crowdsourcing and distributed analysis/computing and aspects of social media for satellite-based disaster mapping.

III. Attendance

15. The conference was attended by 101 participants. The following 22 Member States were represented: Bangladesh, Belarus, Brazil, Cameroon, Ethiopia, France, Germany, Ghana, Greece, India, Kenya, Mexico, Netherlands, Nigeria, Pakistan, Romania, Slovenia, Spain, South Africa, Sudan, Tunisia and United States of America.

16. Funds provided by the German Federal Ministry for Economic Affairs and Energy were used to cover the travel, accommodation and other costs of 17 participants from eight developing countries.

17. The space community was represented by the German Aerospace Centre, the Global Monitoring for Environment and Security and Africa Support Programme of the African Union Commission, the Ethiopian Space Science and Technology Institute, the Copernicus Programme of the European Commission, the European Space Agency, the National Space Research and Development Agency of Nigeria, the Romanian Space Agency, the South African National Space Agency, the National Cartography and Remote Sensing Centre of Tunisia and the National Aeronautics and Space Administration of the United States, and by the following private companies: Airbus Defence and Space, ARGANS, Deep Blue Globe, EFTAS Fernerkundung Technologietransfer GmbH, e.RAY Europa GmbH, EXXETA AG, IAB GmbH, isardSAT, LuxSpace, OPT/NET B.V., Remote Sensing Solutions GmbH, SERTIT, Sinergise, Telespazio-VEGA and UE Geoinformation Systems.

18. The disaster management community was represented by the Disaster Risk Reduction Unit of the African Union Commission, the Department of Civil Protection of Cameroon, the Federal Agency for Technical Relief of Germany, the National Disaster Management Organization of Ghana, the National Disaster Management Centre of South Africa, the Ministry of Agriculture and Forestry of Sudan and the National Civil Protection Office of Tunisia.

19. Representatives of the secretariat of the United Nations Convention to Combat Desertification in Those Countries Experiencing Serious Drought and/or

Desertification, Particularly in Africa, the United Nations University and the Office for Outer Space Affairs also attended the conference.

IV. Programme

20. The conference programme included two keynote presentations, two panel discussions, four parallel sessions, a hands-on segment and a final plenary session.

21. The four parallel sessions addressed the following topics:

(a) Solutions: recent initiatives in Africa;

(b) Solutions: capacity-building in innovative solutions for disaster management;

(c) Partnerships and initiatives supporting disaster management in Africa;

(d) Advances in space technology applications.

22. The hands-on segment included 10 cloud-and web-based solutions developed by different institutions, including UN-SPIDER.

V. Summary of conference activities

A. Opening session and panel on space technologies for disaster management in Africa

23. The conference was opened by the Vice Rector of the University of Bonn, the Deputy Mayor of the City of Bonn, the Head of the Directorate of Space Programmes of the German Aerospace Centre and the Head of the UN-SPIDER Office in Bonn on behalf of the Office for Outer Space Affairs.

24. The opening session included two keynote presentations. The first keynote presentation, delivered by representatives of the Centre for Remote Sensing of Land Surfaces and UN-SPIDER, provided information about the efforts being made by the two bodies to advocate and facilitate the use of space technologies in Africa. Reference was made to the SPEAR initiative, a five-year plan that was launched in June 2019 with a view to providing technical advisory support to several African countries between 2019 and 2023 and conducting international conferences and expert meetings in Bonn and regional expert meetings in Africa. The aims of the initiative are:

(a) To raise awareness of solutions offered by the space and geospatial communities in disaster risk and response and recovery efforts;

(b) To work with partners to develop solutions that address user needs in early warning systems, disaster response and recovery efforts, and disaster risk management applications (such as hazard mapping for land-use planning and exposure for risk assessment);

(c) To establish an international community of practice or a partnership of active stakeholders from the disaster management community, space agencies, other ministries and government agencies, geospatial institutions and universities in order to increase the capacities and capabilities of end users and to encourage the use of big data and other information technology innovations.

25. The second keynote presentation, delivered by the Coordinator of the Global Monitoring for Environment and Security and Africa Support Programme, provided information on how the African Space Policy aimed to address the challenges faced by African nations. The speaker noted that the Policy was aligned with the Agenda 2063 of the African Union and that one of its goals was to implement an African space programme that was responsive to the social, political, economic and environmental needs of the continent and was based on a regulatory framework.

26. The speaker highlighted several digital challenges that must be addressed, including limited connectivity, inadequate data access and sharing, weak digital infrastructure and the low levels of engagement of the African private sector in space-related activities. He also drew attention to the following needs:

(a) To align space solutions with the priorities and policies defined by decision makers in African countries, and for such solutions to provide policy-relevant information that decision makers can use to implement policies;

(b) To change the focus from the facilitation of access to data to the provision of services, and to promote the use of web- and cloud-based solutions;

(c) To facilitate synergies between the international space community and African users, and to encourage the participation of the African private sector;

(d) To encourage cooperation in order to avoid duplication of efforts and the practice of working in silos, including in the area of capacity-building and institutional strengthening.

27. The Coordinator of the Global Monitoring for Environment and Security and Africa Support Programme indicated that efforts were under way to launch the African Space Agency as a regional organization, and that African nations should continue their efforts to launch satellites, the aim being to have 64 satellites in orbit by 2024.

28. In addition, he informed participants of the implementation of the Global Monitoring for Environment and Security and Africa Support Programme, which was coordinated by the African Union Commission. It included efforts in four key areas: data and infrastructure, products and services, communication and awareness-raising, and training and capacity-building. He noted that the Programme was being implemented through 13 regional consortiums that brought together 122 institutions in 45 African countries, and benefited from the engagement of six European countries.

29. The introductory presentation by an expert from the German Aerospace Centre, on the theme “Africa from space and space technologies for Africa”, highlighted the Centre’s efforts in the areas of space, aerospace, energy, transportation, security and digitalization, including the specific efforts of the Centre’s Space Administration and Project Management Agency. The Centre is conducting research on the use of Earth observation to improve understanding of the Earth and contribute to environmental sciences, meteorology, sustainable development, security, mobility, resource management, civil engineering and urban planning.

30. Of key relevance to the conference was the presentation of the Earth Observation Atlas of Africa being developed by the German Aerospace Centre. It provides a continent-wide view of Earth observation time series to highlight change across Africa. The Atlas provides information on vegetation (such as the start of the growing season, vegetation status and the effects of drought on the growing season), water bodies and floods (flood extent and duration), and the development of urban areas.

31. The expert from the German Aerospace Centre concluded her presentation by providing information on the Centre’s Humanitarian Technology Initiative and the recently conducted Office for Outer Space Affairs/German Aerospace Centre International Teachers’ Workshop, which was attended by 14 teachers from nine African countries.

32. The first panel, on the theme “Space technologies for disaster management in Africa”, was chaired by another expert from the German Aerospace Centre. Panellists included the Coordinator of the Global Monitoring for Environment and Security and Africa Support Programme, the Executive Director of the Ethiopian Space Science and Technology Institute and high-ranking officers from the National Space Research and Development Agency of Nigeria, the South African National Space Agency and the National Cartography and Remote Sensing Centre of Tunisia. Panellists were

asked to comment on challenges and opportunities relating to the use of space technologies in disaster management.

33. The panellists commented that disaster risk management and emergency response efforts in Africa could benefit from the use of space technologies. They noted that the potential was there but that there were many relevant stakeholders; therefore, collaboration was necessary to avoid duplication of efforts. They also stressed the need to avoid a top-down approach from the space community, but rather to adopt an approach where end users and representatives of the space community engaged in a discussion on how to shape solutions.

34. They highlighted a number of challenges, including limited access to the Internet in several African countries, particularly in rural regions; limited skills in the use of space-based products and information; inadequate information technology infrastructure; and a disconnect between the space and disaster management communities in some African countries.

35. With regard to opportunities, panellists noted the establishment of the Global Monitoring for Environment and Security and Africa Support Programme; the upcoming establishment of the African Space Agency; the incorporation of open data policies by several space agencies in Europe and the United States, which facilitated access to vast amounts of both up-to-date and archived satellite imagery of different types and resolutions; the objectivity and lack of bias regarding data collection; the possibility of accessing data covering large areas if needed; and the possibility of collecting data from remote, often inaccessible areas.

36. Panellists also noted the need for additional capacity-building efforts, awareness-raising among decision makers of the benefits of the use of space-based technologies in disaster risk management, data exchanges and ways to address the challenges caused by natural hazards, which were exacerbated by climate change.

B. Session 1. Solutions: recent initiatives in Africa

37. Session 1 included four presentations, in which representatives of African institutions and a German non-governmental organization discussed advances they had made in the use of space technologies to deal with natural hazards, and a presentation by the Convention to Combat Desertification on its Drought Toolbox.

38. The representative of the National Disaster Management Organization of Ghana gave a presentation on the Ghana remote-sensing application team and its role as an inter-institutional emergency response and risk mitigation team. The team was established in 2018 in response to a recommendation made by UN-SPIDER during its Institutional Strengthening Mission conducted in Ghana in October 2018. The team is composed of 30 members from eight national institutions in Ghana, and its role is to facilitate knowledge-sharing among all responsible remote sensing agencies in Ghana and to effectively communicate that knowledge to responders during an emergency.

39. The representative of the Ethiopian Space Science and Technology Institute informed participants that in recent years, Ethiopia had experienced more frequent and intense droughts, impacting livelihoods and resulting in a reduction in its gross domestic product of approximately 10 per cent. The representative presented a study of the Rift Valley lakes basin, a heavily populated, often drought-stricken area, to show how satellite data could be used to fill gaps in the country's institutional knowledge of droughts. Rainfall data were used to create maps that provided estimates of water reserves in the basin for every drought since 1981. The results were consistent with historical drought records and therefore showed that satellite data could be used to provide near real-time information to respond to current and future droughts, even providing insights into underground water reserves.

40. The representative of the non-governmental organization German Agro Action informed participants of its forecast-based financing model and current

implementation in Madagascar. He commented that forecast-based aid was based on the idea that the current framework of providing humanitarian aid after disasters had occurred failed to prevent destruction and, therefore, there was a need to replace that framework with one of taking action before a disaster struck. He also informed participants of the efforts of his organization to implement such a forecast-based model in Madagascar, working with the national disaster prevention authority and with international partners such as the World Food Programme and the Food and Agriculture Organization of the United Nations.

41. The representative of the National Cartography and Remote Sensing Centre of Tunisia presented a retrospective view of the experiences of the Centre in flood disaster response and management. The Centre's role is to, inter alia, act as a focal point for the United Nations and other international agencies for remote sensing aid. She noted that on 22 September 2018, the Nabeul region of Tunisia had been hit with extreme rainfall, totalling nearly a third of the annual average in only a matter of hours. Flash floods had reached 1.7 meters in urban areas and six people had been killed. The Centre had provided maps and data to the national disaster agency and local authorities. On the basis of an internal assessment of disaster response efforts, the Centre had identified the need for training programmes to ensure that the necessary institutional knowledge was available on the ground. The Centre had also highlighted the importance of radar imagery for flood monitoring as cloudy weather conditions made optical data less useful during a crisis.

42. The representative of the Convention to Combat Desertification noted that one of the key objectives of the Convention was to provide technical assistance to Member States so that such States were better able to mitigate, adapt to and manage the effects of drought in order to enhance the resilience of vulnerable populations and ecosystems. One of the efforts recently implemented by the Convention in that regard is its Drought Toolbox, a cloud-based portal designed to provide drought stakeholders access to the knowledge they need to prepare for, prevent and mitigate the impacts of drought.

43. The Drought Toolbox contains three tools: (a) the drought monitoring and early warning tool, which combines over 50 water, vegetation and drought data sets for analysis, allowing stakeholders to sound the alarm in case of droughts long before they hit; (b) the drought vulnerability and risk assessment tool, which allows stakeholders to detect areas that may be at high risk now or sometime in the future in order to make disaster preparedness efforts; and (c) the drought risk mitigation tool, which provides solutions from Convention partners and outside sources for stakeholders to gain knowledge of appropriate actions to take.

C. Session 2. Solutions: capacity-building in innovative solutions for disaster management

44. Session 2, on networks, big data and integrated systems, included five plenary presentations on ongoing projects and activities designed to strengthen disaster management at both the national and international levels.

45. The representative of the Romanian Space Agency provided information on the Erasmus+ Project, entitled "GEOMAG", which is being implemented in Tunisia. The project focuses on capacity-building to improve management of the agricultural and environmental sectors using geospatial information. The project comprises several training segments, including e-learning modules for students enrolled in Master's and PhD programmes in the fields of agriculture and the environment. The GEOMAG project is increasing expertise in the Romanian geospatial sector, which should, in turn, strengthen the management of environmental resources. A collaborative platform has already been set up (http://geomag.uvt.tn/moodle/) to facilitate communication between partners from different countries such as France, Romania, Spain and Tunisia .

46. The FANFAR project on operational flood forecasting and alerts in West Africa was introduced by the representative of the Barcelona-based company, isardSAT. The project is aimed at providing hydrological forecasts and reliable and timely access to information. To achieve those aims, the following three outputs are envisaged:

(a) A visualization portal showing the current forecast situation;

(b) A non-interactive map summarizing the peak flood risk in the upcoming 10 days;

(c) Notifications for stakeholders, which they can receive via email or text message in case there is an elevated flood risk in their area of interest.

47. The geoinformation segment of the project is closely connected to the Hydrology Thematic Exploitation Platform of the European Space Agency, which aims to facilitate access by the hydrology community to Earth observation data. The project includes ongoing in situ measurements for the validation of the model-output.

48. A representative of the Friedrich-Schiller University of Jena presented the work of the Earth Observation College – an online university for Earth observation that was established in September 2017 and now has more than 11,500 registered users. The learning resources cover various topics, including a basic introduction explaining how to use synthetic aperture radar data and applications in agriculture, biomass detection and image classification. The online courses focus on the use of radar imagery, are free of charge and are available in German, English, Spanish and French. More than 5,000 students have already enrolled in the courses, which are also open to the public and for which a certificate is issued upon completion. They cover topics such as the basics of how radar systems work and the various areas in which they can be applied, including land, water and hazards, with a particular focus on flood monitoring. In the near future, the Earth Observation College will be conducting a European Space Agency massive open online course on land applications.

49. The representative of the African Regional Centre for Space Science and Technology Education in English presented information on its PhD and Master's level academic programmes. He informed participants that the Centre was also conducting several projects, including the Multi-scale Flood Monitoring and Assessment Services for West Africa project, which focuses on flood monitoring. The Centre leads the project consortium that includes partners from five West African countries, namely, Benin, Burkina Faso, Côte d'Ivoire, Ghana and Nigeria. The Centre is also participating in the Distributed Sensor Network project, which focuses on desertification monitoring in northern Nigeria and involves the observation of degradation rates and interventions to combat desertification.

50. A researcher from the United Nations University Institute for Environment and Human Security presented the outcomes of the Earth Observation-based Information for Disaster Risk Reduction at the National Level project, which was conducted in collaboration with the Centre for Remote Sensing of Land Surfaces, UN-SPIDER and two local partners in Ukraine and South Africa. The project aimed to combine space-based and in situ data in order to assess hazards, exposure and vulnerability related to droughts. Using the example of Eastern Cape Province in South Africa, the researcher showcased the use of Earth observation data to compile vegetation information and the use of socioeconomic surveys and additional statistical data to extract information on exposure and vulnerability. The combination of all the information in a geospatial manner allowed researchers to assess the risk of drought in the region and supported the identification of indicators to report to the Sendai Framework for Disaster Risk Reduction.

D. Session 3. Partnerships and initiatives supporting disaster management in Africa

51. The third session included five presentations on examples of solutions provided by the development and space communities.

52. The representative of the German Aerospace Centre emphasized the importance of working towards combining Earth observation data with direct and indirect digital crisis information using analysis techniques such as machine learning, citizen science and cloud-based big data solutions.

53. According to the Centre, the development of interactive web applications and near-real-time web services offered potential in respect of early warning systems and disaster response. Cloud-based solutions were currently spread among many stakeholders and were therefore difficult for end users to access. In response to that challenge, the Centre raised the question of whether a body such as UN-SPIDER could host a global registry and inventory of satellite-based emergency mapping applications and promote the establishment of cloud systems which would enable the hosting of data, computing capacity, scripts and methods on one platform to be shared with the disaster management community.

54. Representatives of the European Space Agency and the German Aerospace Centre introduced participants to the International Charter on Space and Major Disasters. The Charter is a rush-mode mechanism that provides rapid access to space-based information products and has been activated more than 620 times in 120 countries since 2000 in order to support disaster response efforts. Participants took note that the Charter addressed sudden-onset events such as floods, storms, landslides, fires and human-made disasters, such as industrial accidents and oil spills. The Charter does not cover emergencies caused by armed conflicts.

55. Disaster management authorities from all countries are encouraged to become authorized users so that they can request the activation of the Charter directly. The Charter collaborates with UN-SPIDER, the United Nations Institute for Training and Research Operational Satellite Applications Programme, Sentinel Asia and the Copernicus Emergency Management Service with the aim of bridging the gap between spacefaring and space emerging nations.

56. The representative of the European Commission presented the Copernicus Emergency Management Service, which provides rapid mapping services to authorized users immediately following a disaster. When activated, Sentinel satellites are reassigned, images and maps are created and Copernicus shares its products with officials and emergency responders in the affected country. Nearly half of all activations of rapid mapping services have been for disasters outside of Europe, with dozens of activations in Africa. The services provide key information in the hours following floods, fires, storms and other disasters.

57. Additionally, Copernicus provides a risk and recovery mapping service, which provides not only immediate information during a disaster but also long-term, thorough analysis of possible future disasters. The service also provides detailed reports on drought monitoring, flood and fire risk and other disaster-related issues. Together, the risk and recovery mapping and rapid mapping services are designed to help not just in emergency response, but also in recovery and preparedness, to enable all countries to increase their resilience to disasters triggered by natural hazards.

58. The representative of Airbus Defence and Space presented the current and future synthetic aperture radar satellite platforms developed by the company. Launched into orbit in 2007 and expanding from 2025 onwards, the Airbus high-resolution platforms provide valuable information on the situation on the ground. The representative highlighted specific cases such as coastal flood hazard modelling in the Accra region of Ghana using the company's synthetic aperture radar data elevation model. The representative also provided information on the company's use of interferometric synthetic aperture radar to measure landslides in the United Kingdom of Great Britain and Northern Ireland to track ground instability around a dam in Brazil. With its high resolution, the company's synthetic aperture radar platform can be used to detect maritime vessels, including vessels as small as 8 metres in length. Participants were also informed that the platform allowed for the monitoring of active landslides and the tracking of oil spills, and could be used to respond to and prevent disasters, thereby supporting the Sustainable Development Goals.

59. The representative of the German Agency for International Cooperation informed participants of the Agency's international cooperation project in the Mekong Delta. The project focuses on measuring ground subsidence for urban planning and disaster risk reduction. In conjunction with local officials, the Agency uses interferometric synthetic aperture radar techniques to measure the subsidence of buildings and structures in the Delta over extended periods of time in order to forecast future problems. Subsidence is a major problem in the area, so the team carrying out the project was asked by local partners to use their research to predict the future of the region's drainage system specifically. As the ground sinks and sea waters rise, it is a real concern that the very systems meant to relieve flooding could do the opposite, channelling mass amounts of water into urban areas. The Agency's interferometric synthetic aperture radar-based ground subsidence maps provide urban planners and other stakeholders with the required information regarding such subsidence problems and their potential side effects.

E. Session 4. Advances in space technology applications

60. The fourth session included five presentations highlighting advances in and examples of space technology in support of disaster management.

61. The representative of Deep Blue Globe, a start-up company based in Darmstadt, Germany, informed participants of the company's efforts to detect tsunamis using space technologies. He noted the potential of satellite data, in particular, altimetry data, to track tsunami waves in the deep ocean. He also noted that his company's technique could confirm the presence of tsunamis triggered by any source (such as shallow earthquakes in coastal areas, lateral volcanic eruptions on volcanic islands, underwater eruptions, underwater landslides and asteroids). With significantly reduced time requirements for data arrival, download, processing and analysis, it was expected that the technique would soon be operational.

62. The second presentation, by the representative of Telespazio VEGA Deutschland, introduced participants to the potential of the Sweet Water Earth Education Technologies CubeSat constellation. The mission's objective is to monitor the water levels and water quality of medium-to-large freshwater reservoirs in Africa with a spatial resolution of 136 meters. Monitoring of freshwater bodies is key for water management, for addressing major challenges and for ensuring water security for growing populations, in particular, in Africa. The CubeSats are expected to be launched from the International Space Station and will be equipped with hyperspectral imagers built by the VTT Technical Research Centre of Finland.

63. The third presentation, on open geospatial information and services, was given by the representative of the Open Geospatial Consortium. The Consortium is an open location standards organization consisting of a global consortium of members from industry, government and academia. The goal of the Consortium is to connect people, communities, technology and decision-making. That goal is achieved by improving the discoverability, accessibility, interoperability and reusability of geodata through a proven, consensus-based process that combines standards, innovation and partnerships. In the recently completed Disasters Interoperability Concept Development Study, the Consortium investigated specific requirements relating to data access, spatial data infrastructure, data exchange and open standards and noted that it was key to provide the right information to the right person at the right time. That is especially true in relation to early warning and disaster management, where time is the critical factor.

64. The fourth presentation addressed the use of multitemporal radar interferometry to map the geographical extent of landslides and other mass movements. The presentation was given by a senior researcher from the Autonomous University of the State of Mexico who is currently working as a visiting scientist at the UN-SPIDER Office in Bonn. She presented two case studies: the volcanic eruption of Anak Krakatau on 23 December 2018 as a pre-event example, and the volcanic eruption of

Fuego on 4 June 2018 as a post-event example. The approaches taken were based on Sentinel-1 data in combination with digital elevation data. A multitemporal analysis of the Sentinel-1 data was conducted to identify ongoing displacements. The resulting maps can be used to identify lateral deformation of volcanic domes and are useful in early warning systems. The senior researcher presented an additional example relating to the mapping of the debris flow that was triggered by the collapse of a dam in Brazil on 25 January 2019.

65. The final presentation was given by the representative of the UE Geoinformation Systems company of Belarus. She provided information on the Belarusian Earth observation system and its capabilities for supporting disaster management. She noted that UE Geoinformation Systems worked closely with different partners and functioned as an accredited project manager for the International Charter on Space and Major Disasters. She presented an example of maps of flooded areas in Iraq in March 2019 produced using Sentinel-2 data. UE Geoinformation Systems supports several education programmes jointly with universities and uses and operates a system of remote sensing platforms ranging from satellites to unmanned aerial vehicles. One example of its own satellite system is the BKA satellite, which was launched in 2012. It has a spatial resolution of 2.1 metres and provides multispectral data. Plans are under way for a joint mission between Belarus and the Russian Federation to launch an ultra-high-resolution satellite in 2023. The RBKA satellite will provide a spatial resolution of 1.4 meters in the multispectral range.

F. Hands-on segment

66. The conference featured a hands-on segment that provided an opportunity for participants to learn about cloud- or web-based applications, including some developed by the private sector, and several recommended practices developed by UN-SPIDER and its regional support offices. Ten solutions were presented and information was provided on how to access and use them and the type of information that could be acquired with each one.

67. The company Sinergise presented the Sentinel Hub, a cloud-based geographic information system platform for the distribution, management and analysis of satellite data. Sinergise also presented the Earth Observation Browser, a web application for browsing, visualizing and analysing Sentinel, Landsat and other Earth observation imagery directly in the Browser. During the hands-on segment, participants had the opportunity to conduct various types of analysis, including flood extent mapping, forest fire mapping and change detection.

68. The Copernicus Global Drought Observatory was presented by the European Commission Joint Research Centre. It is a freely accessible Internet-based portal that provides dynamic assessments of the risk of drought for different regions of a country based on hazard, exposure and vulnerability. The assessment is updated every 10 days. Besides explaining the risk modelling framework, including the various exposure and vulnerability indicators used, the presentation also highlighted the analytical reports and daily maps developed by the Joint Research Centre Drought Team in case of severe droughts.

69. The United Nations Environment Programme-Danish Hydraulic Institute Flood and Drought Portal was presented by the Danish Hydraulic Institute. The Portal is part of the Drought Toolbox of the Convention to Combat Desertification and is used for drought assessments. The Portal is an online tool with more than 100 data layers available for overlay and analysis. The Portal allows large data downloads and analysis is carried out completely in the cloud. It includes a set of tools to generate graphs, charts and summaries.

70. The European Space Agency Hydrology Thematic Exploitation Platform for flood forecasting was presented by isardSAT. It is an operational flood forecasting application developed using the Hydrology Thematic Exploitation Platform. The cloud-based Platform is a project funded by the European Space Agency and is aimed

at facilitating access by the hydrology community to Earth observation data. Several thematic applications are provided, covering water quality, flood monitoring and forecasting free of charge. The presenters from isardSAT showcased the FANFAR project, which is aimed at developing a flood forecasting and alert system for West Africa. Following an introduction to the project and the technical principles of monitoring and forecasting floods, participants were guided through several steps of processing Earth observation data and in situ measurements for a chosen study area in Africa using the Hydrology Thematic Exploitation Platform.

71. The free radar software suite SARbian was presented by the Earth Observation College of the Friedrich-Schiller University of Jena. The Linux-based application uses synthetic aperture radar analysis to map the geographical extent of floods. The main benefit of the software suite is that users do not have to install each piece of software individually but can access all the software in the SARbian toolbox, which can be shared through a virtual machine, ISO file or USB stick. For the purpose of the presentation, SARbian was made available in virtual machines provided by the European Space Agency Research and Service Support CloudToolbox service. Participants used SARbian to analyse the flooding caused by Cyclone Idai in the Beira region of Mozambique in March 2019.

72. The automated application for monitoring burned areas was presented by Remote Sensing Solutions GmbH. The cloud-based application makes use of new data analytics methods based on machine learning, deep learning and other artificial intelligence approaches. The presentation outlined workflows for automated mapping and the strengths and weaknesses of the approach, and provided a step-by-step explanation of how to use the Obsidian platform of the Research and Service Support for burned area mapping. While mapping is currently carried out using optical Sentinel-2 data, the presentation provided information on the integration of Sentinel-1 synthetic aperture radar data into the automated mapping process.

73. UN-SPIDER used the opportunity to present several of its recommended practices. The recommended practice on storm surge coastal flood modelling was presented by Airbus Defence and Space. The procedure can be used to model coastal floods resulting from storm surges using the Airbus World Digital Elevation Model. During the session, participants were able to visualize the geographical extent of coastal flooding or sea level rise on local, regional and global scales. The modelling can serve as a preliminary approximation to identify areas that are prone to flooding and as a preliminary assessment for further, more in-depth analysis of coastal flooding and sea level rises.

74. The UN-SPIDER recommended practice on drought monitoring was presented by the Centre for Remote Sensing of Land Surfaces. Participants were introduced to the spectral characteristics of healthy and unhealthy vegetation and soil as well as different vegetation indices used for drought assessments with remotely sensed data. They noted that the recommended practice had been developed using the RStudio open software. After obtaining data for the area of interest, participants adjusted and ran an “R” script to obtain maps of the vegetation condition index for different moments in time, which could be compared to assess the severity of droughts in specific geographical areas.

75. The UN-SPIDER recommended practice on flood mapping was presented by UN-SPIDER. This recommended practice focuses on radar-based flood mapping using the open-source software SNAP and QGIS. The participants used virtual machines provided by the European Space Agency Research and Service Support CloudToolbox service to perform their analysis in the cloud. Participants took note of the step-by-step tutorial on synthetic aperture radar pre-processing and flood extent delineation, including a basic damage assessment. The session concluded with a discussion on the use of the solution for disaster management in Africa.

76. The UN-SPIDER recommended practice on burn severity mapping was presented by the Centre for Remote Sensing of Land Surfaces. Participants took note of the spectral characteristics that are relevant when assessing fire severity (as

opposed to fire intensity) and were provided with an overview of the related terminology. Besides providing an overview of relevant satellite sensors, the presentation also highlighted existing web-based applications that provided information products indicating active fires well as outlining burn severity for a given area. Using the case of the fires in the Cape Peninsula in early 2019, participants were then guided through the UN-SPIDER recommended practice using Google Earth Engine, which allows users to carry out burn severity assessments in the cloud. Participants also tested the workflow in different geographic areas of interest and time periods.

G. Panel on challenges in the use of space-based information for disaster management in Africa

77. The second panel, on challenges in the use of space-based information for disaster management in Africa, was chaired by UN-SPIDER and the Centre for Remote Sensing of Land Surfaces. Panellists included the Coordinator of the Disaster Risk Reduction Unit of the African Union Commission, the Executive Director of the National Disaster Management Organization of Ghana and high-ranking officers of the Department of Civil Protection of Cameroon, the National Disaster Management Centre of South Africa, the Ministry of Agriculture and Forestry of Sudan and the National Civil Protection Office of Tunisia.

78. The panellists noted that some disaster management agencies had made greater progress than others regarding the routine use of space technologies in their activities. They agreed that the use of such technologies required investment in information technology infrastructure, extensive bandwidth, staff with the appropriate skills and data sharing practices.

79. The panellists highlighted several challenges, including limited access to the Internet in rural regions, the limited skills of staff in the use of space-based products and information, inadequate information technology infrastructure and a disconnect between the space and disaster management communities in some African countries. In addition, language might be a barrier to such technologies in some countries. In other countries, the use of space technologies was somewhat blurred owing to institutional mandates and a lack of cooperation.

80. In the light of those challenges, panellists indicated the need to showcase to decision makers the benefits of the use of space-based technologies in a language they could understand, to enable those decision makers to develop and enact policies to institutionalize the use of such technologies. They also suggested the continuation of capacity-building and institutional strengthening efforts, the implementation of strategies that enhanced cooperation and data sharing among institutions and the implementation of partnerships that brought together disaster management agencies, the space community and academia.

81. Panellists noted the usefulness of the cloud-based applications presented during the hands-on segment and suggested additional training on their use in African countries, ways in which such cloud-based solutions could be used in the field, as well as efforts to combine the information gathered with those cloud-based applications with in situ data. They also noted that the routine use of such cloud-based tools required a change in the way in which information was generated by disaster management agencies.

VI. Observations and recommendations

82. The following observations were compiled from the comments made by panellists and the information provided in the presentations and discussions during the conference.

Use of space technologies for disaster management in Africa

83. The African Space Policy and the African Space Strategy have been put in place by the African Union Commission to enhance the use of space technologies with a view to contributing to the achievement of the Agenda 2063 of the African Union. It is important for the international space community to align its efforts with those instruments. Equally important is the need to be aware of the efforts being made at the national and local levels concerning the use of space technologies in disaster management applications.

84. The space community has implemented several services that are supporting disaster response efforts, such as the International Charter on Space and Major Disasters and the Copernicus Emergency Mapping Service. A growing number of disaster management agencies in Africa are benefiting from the support provided by those mechanisms and the technical advisory support provided by UN-SPIDER and its regional support offices.

85. When promoting the use of space technologies, it also necessary to consider the challenges faced by the disaster management community in Africa regarding their routine use.

A variety of solutions are available, but it is a challenge to discover them

86. The space community and the international community have introduced a variety of web-based and cloud-based applications that provide relevant and timely information on natural hazards and their impact, as well as solutions to address those challenges; however, it is difficult to discover them. Therefore, a catalogue of such resources in a single location, such as the UN-SPIDER Knowledge Portal (www.un-spider.org), would be ideal to facilitate their discovery and subsequent use. In addition, awareness-raising efforts should be made at the national level in African countries to encourage professionals in various institutions to use the resources more systematically.

Actionable information

87. African decision makers require information in a format that is readily usable. Taking into consideration the open policies implemented by space agencies that are allowing institutions around the world to access satellite imagery and the trend to make use of alternate data sources, such as crowdsourcing (big data), it is important to promote the establishment of information services that combine various sources of data stored in different types of platforms to generate actionable information.

88. Equally important is the need to develop applications that facilitate the visualization of space-based and geospatial information in rural areas where access to the Internet is limited or non-existent.

A need for the harmonization of efforts at the national level

89. African countries could benefit from the involvement of UN-SPIDER as an external, credible and honest mediator to facilitate the harmonization of efforts among relevant institutions, the sharing of data and information among institutions and the creation of synergies between institutions and the international space community.

An international partnership among institutions in Africa to facilitate the use of space technologies

90. Disaster management agencies could benefit from an international partnership or network that also engages stakeholders from the space community. That partnership or network would foster dialogue among stakeholders of both the disaster management and space communities and enable the space community to develop solutions and the disaster management community to test and use them. Such a partnership or network could be used for:

(a) Knowledge-building and technological transfer;

(b) Identification of novel applications developed by the space community and subsequent testing in simulated conditions to identify their applicability in Africa;

(c) Coordination of efforts in case of transboundary hazards.

VII. Conclusions

91. Earth observation plays a vital role in disaster response efforts. Space-based information contributes to an improved situational awareness of the geographical extent of events such as floods or tsunamis, the number of kilometres of roads damaged or destroyed by landslides, the severity of forest fires, the impact of droughts on crops and other types of impact. Endeavours such as the International Charter on Space and Major Disasters, the Copernicus Emergency Mapping Service and Sentinel Asia are leading the way in facilitating access to such space-based information.

92. The incorporation of open data policies by several space agencies in recent years is allowing professionals and specialists in many countries, including developing countries, to acknowledge the strength of Earth observation in a variety of applications of use in the management of natural resources and ecosystems, in order to assess the impact of humanity on the environment and the impact of natural hazards on vulnerable societies exposed to such hazards.

93. Furthermore, advances in geospatial, information and communication technologies are paving the way for novel cloud-based solutions, the acquisition of massive amounts of data through crowdsourcing efforts and the visualization of a variety of products useful in disaster risk reduction, preparedness and emergency response and recovery efforts.

94. Since 2007, the UN-SPIDER programme of the Office for Outer Space Affairs has been conducting international conferences and expert meetings in Bonn to raise awareness of those advances in the use of space technologies and to bring together representatives of disaster management and the space communities to identify areas of cooperation. The 2019 Bonn international conference provided continuity to those outreach activities and offered the opportunity:

(a) For participants to take note of the potential use of novel cloud-based applications to manage disasters in Africa;

(b) For participants to take note of the challenges faced by disaster management agencies in Africa in relation to the routine use of space solutions;

(c) For the international space community to take note of the policies and strategies implemented by the African Union Commission and certain African countries;

(d) For participants to formulate recommendations on ways to promote the combined and complementary use of space-based systems and ground/in situ systems to contribute to disaster management efforts in Africa.

95. Participants emphasized the need to tailor methodologies in such a way that information derived from the combination of space-based and in situ data could be acted upon by decision makers and other end users. In that regard, such information will contribute to the implementation of the Sendai Framework for Disaster Risk Reduction and the Sustainable Development Goals and will help to enhance the resilience of nations.