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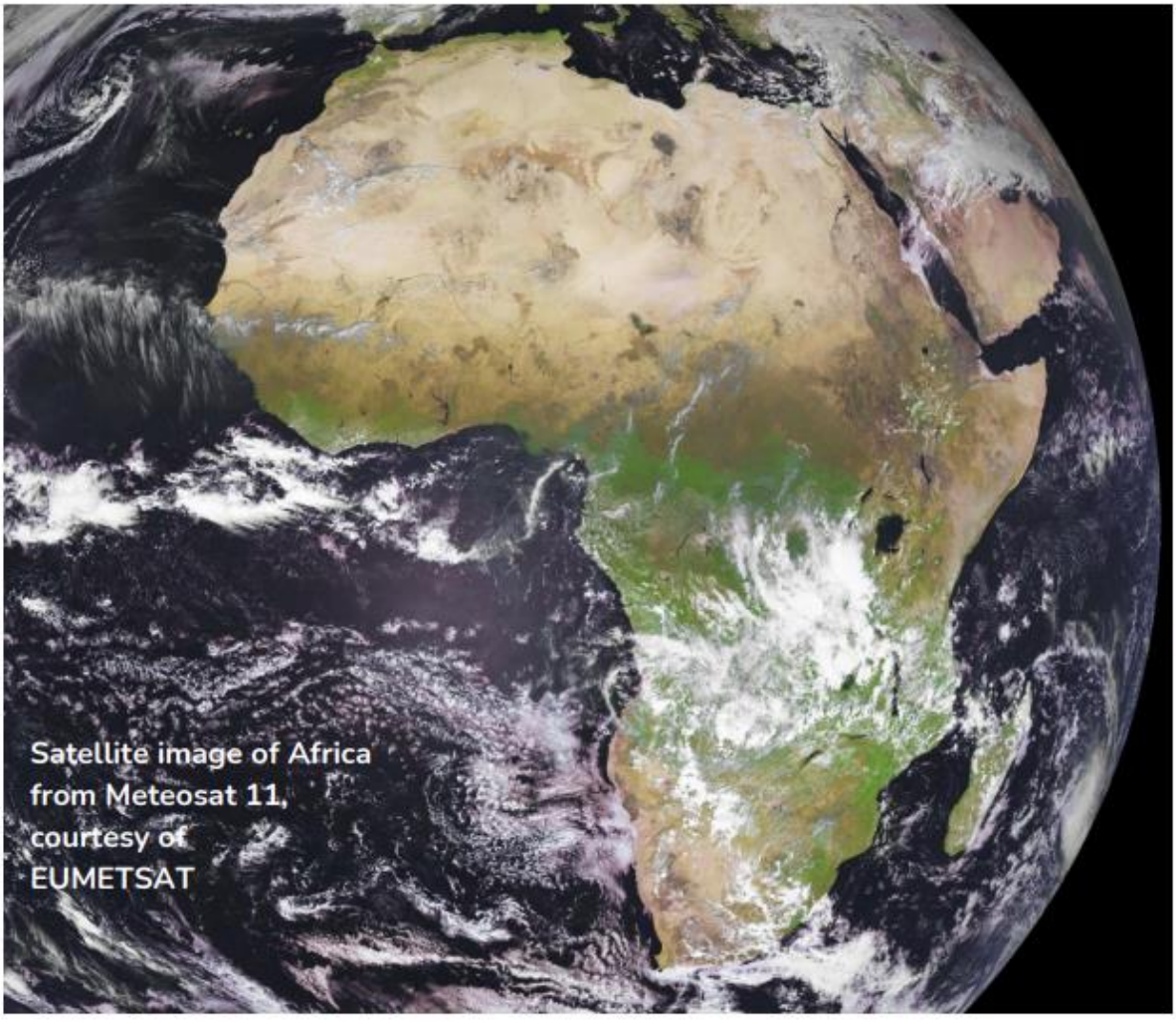
UNIVERSITÄT BONN ZFL

REPORT

UN-SPIDER Bonn International Conference (virtual)

"Space-based Solutions for Disaster Management in Africa: Networks and Information Technologies in times of crisis."

16 November – 18 November 2021



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Introduction

In recent years, communities around the world began to experience foreseen and unforeseen impacts of the combination of climate change, improperly planned development processes, uncontrolled urban expansion, population growth, political crises, rising inequalities within and among countries, and improper management of the environment.

Several delegations and stakeholders attending the 26th Climate Change Conference of Parties in Glasgow are highlighting the need to address the challenges posed by climate change with a particular focus on developing countries and vulnerable communities that contribute to a lesser degree to the problem but suffer the consequences. Recognizing the need to increase their ambition, parties to the United Nations Climate Change Convention (UNFCCC) concluded the recent 26th Conference of Parties adopting the Glasgow Climate Pact. This pact recognizes the fact that climate change is a common concern for humankind, it reiterates the need to increase efforts related to mitigation and emphasizes the need to scale up action to enhance adaptive capacity, strengthen resilience and reduce vulnerability to climate change using the best available science and technology.

This year, countries in Southern Africa including Madagascar and South Africa continued to suffer the impacts of droughts. In contrast, Morocco, Mozambique, Somalia, Sudan, and Togo experienced floods. Large forest fires occurred in Algeria and Tunisia, and the Democratic Republic of Congo experienced the impacts of the eruption of the Nyiragongo volcano.

At the more global level, regions in Western Canada and the United States experienced a severe heatwave in the spring, and massive forest fires impacted areas in Greece, Turkey, the United States, and the Russian Federation. In addition, the Cumbre Vieja volcano continues to impact the island of La Palma in Spain, and earthquakes impacted several countries around the world including China, Haiti, and Indonesia. Furthermore, several countries continue to suffer the impacts of floods triggered by tropical cyclones and monsoons. Germany, the Netherlands, and Belgium experienced unprecedented floods and debris flows that triggered damages and losses of many kinds.

The UN-SPIDER Bonn International Conference “Space-based Solutions for Disaster Management in Africa: Networks and Information Technologies in times of crisis.”, was carried out virtually from 16 to 18 November and allowed nearly 150 participants to take note of recent advances developed by the space community, UN-SPIDER, and other relevant institutions. In addition, the conference allowed several national disaster management agencies, and regional and international organizations to present their work. The conference included an opening segment and was structured in five technical sessions, including presentations and a panel discussion.

The conference was jointly organized by UN-SPIDER and the Center of Remote Sensing of Land Surfaces (ZFL) of the University of Bonn. In June 2019, ZFL and UN-SPIDER began to implement the project entitled “Spaceborne Earth Observation Applications for Emergency Response and Disaster Risk Reduction” (SPEAR). SPEAR activities include the organization of awareness and outreach efforts, such as conferences and expert meetings, the provision of technical advisory support to African countries, the implementation of knowledge management efforts, applied scientific research to enhance the use of space technologies in disaster management and contribution to UN-SPIDER networking activities.

Background

Satellite technologies have been used in recent decades to track the status of natural resources, the climate, oceans and polar caps, land use patterns, the spatial expansion of cities, agricultural and mining activities, the expansion of the agricultural frontier, and other features of the planet. When incorporated in routine monitoring activities, Earth observation supports informed decision making at the local, national, regional, and global level; helping us to find ways to reduce

disaster risks; identify different alternatives to plan our adaptation to climate change, prepare better for inevitable losses and damages triggered by disasters, and contribute to monitoring how well our efforts are leading to sustainable development; providing relevant information to align targets and indicators included in these global agreements; and can be used to develop harmonized national reporting systems.

The integrated use of satellite telecommunications, Earth observation, and global navigation satellite systems is allowing researchers engaged in climate change to track changes in the extent of sea ice and glaciers, the physical properties of the ocean including temperature and salinity, and sea-level rise.

During the last decade, the space community has made extremely relevant advances that are contributing to achieving the Sustainable Development Goals (SDG) and targets, as well as those stipulated in the Sendai Framework for Disaster Risk Reduction and those included in the Paris Climate Agreement. Furthermore, new satellites have been launched that provide continuity to existing satellite observations, and the open data policies implemented by several space agencies are facilitating access to such satellite imagery. In a complementary fashion, the space community is developing open services and products that facilitate access to ready-to-use geospatial information with a focus on floods, droughts, forest fires, atmospheric contamination, and weather.

At the international level, in October 2021 the United Nations General Assembly adopted the **Space2030 Agenda: space as a driver of sustainable development**. This agenda includes four overarching objectives wrapped around four pillars: space economy, space society, space accessibility, and space diplomacy. This agenda emphasizes that space tools are highly relevant for the attainment of the goals and targets included in the 2030 Agenda for Sustainable Development, the Sendai Framework for Disaster Risk Reduction 2015–2030, and the Paris Agreement.

More recently, faster processing capacities and cloud-based computing platforms are becoming available. These are allowing the space community, international and regional organizations, national institutions, and private companies to launch services or platforms that enable users to access pre-processed satellite imagery in combination with other sources of data in the format of “analysis-ready-data”. For example, the Copernicus programme has set up dedicated services like the Global Flood Awareness Systems (GloFAS), the Global Drought Observatory (GDO), and the Global Wildfire Information System (GWIS). In addition, efforts are underway to facilitate access to a variety of data through “Data Cubes”. Furthermore, the use of artificial intelligence and machine learning is enhancing the capacity to process satellite imagery faster and with improved object recognition procedures to contribute to disaster response efforts, specifically damage assessment.

Several companies and organizations are facilitating access to cloud-processing tools and cloud-based platforms. Among them are the Data and Information Access Services (DIAS) launched by Copernicus, the Google Earth Engine of Google, and the Planetary Computer of Microsoft. All these developments are contributing to an improved understanding of risks, to enhanced visualization of geospatial trends regarding the exposure of vulnerable elements, to track the spatial and temporal evolution of hazards, to improve early warning systems, and towards a more efficient response in case of disasters.

To enhance the use of all these opportunities, UN-SPIDER, and its network of Regional Support Offices, as well as several universities and centres of excellence, are carrying out training activities. Other institutions carrying out training activities include the Applied Remote Sensing Training (ARSET) programme of the National Aeronautics and Space Administration of the United States (NASA), the EO College of the University of Jena, the Working Group on Capacity Building and Data Democracy of the Committee on Earth Observing Satellites (CEOS). In the case of Africa, the Global Monitoring for Environment and Security and Africa (GMES & Africa) programme has a dedicated segment for capacity building.

Objectives

The International Conference aimed to contribute to an increased use of space-based solutions in African countries to respond to challenges posed by natural hazards in times of crisis such as the ones exacerbated by climate change and the COVID-19 pandemic. The outcomes, results, and key recommendations of this International Conference are presented in this technical report and will be incorporated into the UN-SPIDER plan of work for the coming years.

Attendance

The conference received 192 registrations from 31 countries. 122 registrations came from countries on the continent of Africa, the main target group of the conference. The countries with the highest number of registrations were Nigeria (42), Germany (41), Mozambique (35), Niger (11), and Rwanda (9). Considering the types of institutions, more than half of the total number of registered participants work in governmental or national institutes, mainly representing disaster, space, or meteorological agencies. This is followed by the group of registrations from people working in the university or research sectors, including students (55). Fourteen staff members from UN agencies joined the conference including UN-Habitat, UNU-EHS, UNICEF, UNAMA, UNISC, UNOOSA, and UN-SPIDER. The rest of the registrations included colleagues from regional organizations, companies from the private sector, and NGOs. Evaluations of the final numbers revealed that 132 persons participated in at least one of the sessions. 33% of the participants were women.

Programme

The international conference included an opening segment with welcoming remarks by the Director of the Office for Outer Space Affairs (UNOOSA), followed by a series of introductory presentations. The rest of the conference was divided into five thematic sessions: floods and storm surges, forest fires, capacity building and emergency response mechanisms, drought, and innovative tools. Each session included various presentations by experts from various institutions. During the thematic session on capacity building, a panel was conducted. For more details, please refer to the agenda in Annex 1.

Opening segment and keynote presentations

The Director of the United Nations Office for Outer Space Affairs (UNOOSA) welcomed all participants on November 16th putting into context the topics of the conference, stating that disaster impacts, together with inequalities and the consequences of climate change, put vulnerable communities more and more at risk. The Director noted that space technologies and applications offer solutions for disaster risk response and the entire disaster risk cycle. Revealing the potential of these technologies and applications often leads to long-term strategies. The Director concluded her remarks indicating that it must be the goal of the international community to share experiences, solutions, challenges, and try to solve them together.

Subsequently, the Space Agency at the German Aerospace Center (DLR) reported on its activities and the Space2030 Agenda. The expert from DLR noted that Space is considered as a driver of sustainable development and that in this context the Space2030 Agenda also underlined the importance of global space governance and the sustainable use of outer space. She remarked that one task for DLR and several UN agencies is to bring together the space community with decision-makers from other areas such as climate change, sustainable development, and disaster management. She presented a summary of the Space2030 agenda, which was adopted by the United Nations General

Assembly earlier in 2021, noting that implementation efforts have already started and will be reported on under the pertinent agenda item at UNCOPUOS.

The Coordinator of the Africa & GMES programme of the African Union Commission reminded participants that this programme aims to develop space solutions for public services in Africa and presented several initiatives launched by the programme. He pointed out that addressing the African development challenges is a task that needs to be tackled by multiple countries in collaboration, as no country can solve the problems alone. He reiterated that decision-makers rely on policy-relevant evidence, which can be delivered by Earth observation on multiscale-level approaches. He also presented some examples of the Africa & GMES programme such as seasonal agriculture monitoring, forecasting of ocean conditions, and the MiFMASS Multiscale flood monitoring and assessment service.

The National Disaster Management Centre of South Africa (NDMC) made participants aware of how it uses space technologies in disaster management applications. The NDMC mentioned its use of online early warnings platforms and introduced the NDMC portal. The expert remarked that in South Africa different types of hazards may manifest themselves in a near-simultaneous manner in several provinces at any given time. Both slow and quick onset hazards are experienced annually due to different climate conditions throughout the country. The centre is working together with many government agencies to develop and operate early warning systems, especially institutions like the South African Weather Service. The tropical storm ELOISE in January 2021 was given as an example. The centre commented on the benefits when activating the International Charter for Space and Major Disasters. The expert also revealed the challenge of a multi-hazard situation, as the country was facing heavy rainfalls and floods in one part of the country while experiencing a drought in another part at the same time. Following up on these experiences, the NDMC signed a memorandum of understanding with the South African National Space Agency (SANSA) to enhance its capacity to use space-based information developed by SANSA.

The introductory session concluded with a presentation by the Rwandan Space Agency on their efforts to support the Department of Disaster Management Affairs (DODMA). The national geospatial datahub was presented and examples of applications and the potential of using space technologies were given. During an eruption of the Nyiragongo volcano at the border with the Democratic Republic of the Congo, for example, satellite information revealed that high damages could have been expected in Rwanda. While the first concerns were rather related to a potential migration and the connected challenges concerning COVID-19, only by using space technologies Rwanda was prepared for direct impacts of the eruption. Space technologies were used for gas emission monitoring in this context. Furthermore, the agency reported on their development of disaster indices, such as a flood susceptibility index, a lightning susceptibility index, and a landslide susceptibility index.

Session 1: Floods and Storm Surges

The thematic session on Floods and Storm Surges started with a presentation by the Center for Remote Sensing of Land Surfaces (ZFL) and the German Aerospace Center (DLR) on the Sentinels-4-African-DRR project that aims to strengthen the use of Copernicus data and services for flood prediction and monitoring in African countries. The project aims to enhance the use of Copernicus and its services in Africa. It is planned to conduct two to three trainings per year in 2022 and 2023, ideally connected to UN-SPIDER activities and events. The experts from DLR and ZFL provided examples of the use of Copernicus in flood prediction and monitoring in African countries. Also, exemplary workflows were presented in the context of radar-based flood detection, Sentinel-2-based flood detection, and flood mapping on a cloud environment (Google Earth Engine).

In the next presentation, the Joint Research Centre of the European Commission (JRC) reported on the global flood forecasting and monitoring activities that run under the Copernicus Emergency Management Service (CEMS). GloFAS, CEMS's flood forecast system, provides daily updated global flood hazard and impact forecasts for the next 30 days, alongside with updated forecast and model skill information and a seasonal outlook for the next 16 weeks. The underlying hydrological model is called LISFLOOD and is open source. The CEMS flood forecast service has recently been expanded by a Global Flood Monitoring (GFM) component, being a SAR-based, global, automated all-day and all-weather flood monitoring service.

The Nigeria Hydrological Services Agency (NIHSA) presented information on its flood monitoring and assessment services in Nigeria and its contribution to flood management. NIHSA elaborates annual flood outlooks that provide a first early warning on areas that can experience floods. NIHSA also elaborates risk analysis maps and performs extensive baseline studies that are used to assess flood vulnerability and to develop hydrogeological maps. Furthermore, monthly flood and drought bulletins are prepared and published. An example was given about the monitoring of transboundary flood flows into Nigeria and the challenges that arise in this context.

Subsequently, the Gambia National Disaster Management Agency (NDMA) presented an overview of disaster management efforts in the Gambia. The expert from NDMA made participants aware of the country's profile and its exposure to hazards. He noted that floods, droughts, windstorms, and fire incidents trigger the highest damage in the Gambia. He also pointed out that communities in flooded areas often struggle with following infectious diseases. However, there is a high political will to build capacities. He commented that recently NDMA was incorporated as an Authorised Used with the International Charter Space and Major Disasters.

The sessions continued with a presentation by the National Meteorological Institute of Mozambique (INAM). The Deputy Director of INAM remarked that Mozambique is confronting severe weather situations and is especially prone to disasters triggered by cyclones, droughts, and floods. Participants took note that the main responsibility of INAM is to provide meteorological products elaborated using different sources, including those from the Regional Specialized Meteorological Center (RSMC) in La Reunion. Bringing these different sources together, INAM creates bulletins about potential disasters, including recommendations for decision-makers, which then can be used by the disaster management authority in Mozambique. In the future, it is planned to improve the meteorological services and create an expanded observation network.

The German Aerospace Center (DLR) concluded this session by presenting results regarding the use of artificial intelligence to delineate the flood extent of the recent floods in Western Germany and to pinpoint damaged and destroyed infrastructure. The expert from DLR showed participants how the Center for Satellite based Crisis Information (ZKI), which is an institution of the German Remote Sensing Data Center (DFD) in the German Aerospace Center (DLR), pre-processed imagery of the flooded area. Different methods for classifications were performed and tested. She commented that she used Google Earth Engine for a machine learning approach and tested a convolutional neural network for a deep learning approach. Using these methods, maps for the flooded area were created.

Session 2: Forest Fires

The second thematic session focused on the topic of forest fires. It started with a presentation by the Beyond Centre of Excellence of the National Observatory of Athens (NOA), Greece, reporting on the use of space technologies for forest fire prediction and monitoring in Greece and the Mediterranean. The expert presented the centre's Firehub platform, which Is used as a 24/7 real-time fire monitoring service. She also presented approaches to monitor active fires and to create burned scar maps. The participants were able to take note of advances related to this forest fire information system.

The session continued with a presentation by the Algerian Space Agency (ASAL) on the use of space technologies to map the geographical extent of forest fires. ASAL uses medium- and high-resolution images from its own as well as other satellites covering the north of Algeria to locate and estimate the forest areas affected by fires. The expert also presented information on the recent forest fires that impacted Algeria during this summer.

The European Commission's Joint Research Centre (JRC) made a presentation on the Global Wildfire Information System (GWIS). The expert described how the system developed from a European system (EFFIS) to the open worldwide system GWIS, which is accessible by everyone. The system includes a fire danger forecast, active fire, and burned area mapping. Also, near real-time monitoring is available and updated twice daily. GWIS additionally offers country profiles with data on wildfires at the country level.

In the following presentation, the European Centre for Medium-Range Weather Forecasts (ECMWF) introduced its work on monitoring fire emissions and air quality using the Copernicus Atmosphere Monitoring Service (CAMS). Participants took note that the Sentinel-5P satellite can be used for the estimation of the NO_2 tropospheric column. The expert also presented the results of a global reanalysis of CAMS data covering the period from 2003 to 2020.

Subsequently, the Fraunhofer Institute for Technological Trend Analysis (INT) presented the FIRELOGUE project, which aims to enhance the capacity to manage wildfire risk through supporting and coordinating innovation actions funded under the European Green Deal. The project has 15 partners spread in Europe while it supports more than 180 organisations in collaborating on the topics. A central part of the activities of this project is related to knowledge exchange and networking. It wants to explore the potential of the presented information systems and platforms in monitoring progress in managing wildfire risk.

UN-SPIDER concluded this session presenting a new procedure to use country data available on GWIS to extract data for one of the specific sub-indicators included in the Sendai Framework Monitor to report on the annual impacts of forest fires. The procedure uses the GWIS country profile to develop a benchmark and to assess the burned forest area per year in a country, which is a measurement to be reported within the Sendai Framework. The workflow was published in the UN-SPIDER Knowledge Portal.

Session 3: Capacity Building and Emergency Response Mechanisms

The third thematic session started with a panel on capacity building efforts. The panel included experts from the United Nations University Institute for Environment and Human Security (UNU-EHS), the Ruhr-University Bochum (RUB), the EO College of the University of Jena, the Africa Regional Center for Space Science and Technology Education in English Language (ARCSSTE-E), and the Disaster Management Training and Education Centre (DiMTEC) of the University of the Free State in South Africa.

The expert from ARCSSTE-E pointed out its function as a regional training centre on space-based technologies. He noted that there is a lack of collaboration among agencies and recommended enhanced communications with disaster management agencies to identify needs. The centre is implementing a regional flood management project in five West African countries under the umbrella of the GMES & Africa programme. Taking advantage of virtual communications, it has trained over 500 people. A challenge identified is making sure that people that are being trained subsequently work in the position that they have been trained for after the training is concluded. The expert noted that the COVID-19 situation allowed to reach more people, as online resources were developed and are now established. Furthermore, he recommended that organizations dealing with capacity building in

space technology should focus on training members of regional centres, which can train other potential users.

The experts from UNU-EHS and from DiMTEC gave an overview of the collaboration which started in 2010 through intensive training courses targeting a mixture of academic scholars and practitioners involved in disaster management. The two experts commented that students from many universities from all over the African continent participated in these trainings. They noted that there is a need to find ways to reach out more to potential participants and to find more trainers, specifically from the African continent.

Furthermore, the expert from UNU-EHS commented that UN-OCHA has recognized the benefit of the use of Geographic Information Systems (GIS) and Earth observation technologies during emergency response deployments. He commented that OCHA is therefore working together with EO service providers such as EU COPERNICUS or UNOSAT and OCHA response mechanisms, such as the UN Disaster Assessment and Coordination (UNDAC) are closely working in the field with onsite service providers like MapAction or Impact Initiatives.

Subsequently, the expert from the RUB introduced efforts in capacity building and training efforts in Africa. More specifically, a massive open online course (MOOC) on the topic of zero hunger as a contribution to the Sustainable Development Goals was presented which also targets disasters such as drought and flood, and their impact on food security. The MOOC is currently in preparation and will be free and open for everyone. The first modules will be opened in 2022 and will address user types from different backgrounds and with different levels of EO knowledge. As the MOOC will include recommended practices, cooperation with UN-SPIDER will be explored and the recommended practices that are currently included in the UN-SPIDER Knowledge Portal will be considered for inclusion in the MOOC.

The expert from the EO College of the University of Jena discussed the role and experience of the EO College regarding training activities and summer schools in Africa. A new summer school on the topic of radar remote sensing is planned. In the future, a focus shall be laid on training the trainers, to enable people to teach others, which would result in a more sustainable capacity building approach. This would need to include not only thematic content in Earth observation technology but also teaching and media competency. Such activities could be carried out in collaboration and in synergy with regional partners, such as ARCSSTE-E and DiMTEC.

After the panel session was completed, a presentation about the International Charter ‘Space and Major Disasters’ was given by an expert from the National Institute for Space Research (INPE) in Brazil. It was highlighted that any national disaster management agency can register with the Charter in order to receive Authorized User status after training. As Authorized Users, they will then be able to directly trigger the Charter’s support in case of a major disaster. The session concluded with a presentation by the Joint Research Centre of the European Commission (JRC) on the Copernicus Emergency Management Services (CEMS). The CEMS supports all actors involved in the management of natural or manmade disasters by providing geospatial data and images for informed decision-making. CEMS constantly monitors Europe and the globe for signals of an impending disaster or evidence of one happening in real-time. It immediately notifies national authorities of their findings or can be activated on-demand and offers to provide them with maps, time series, or other relevant information to better manage disaster risk. CEMS products show information about a disaster event on a scale, timeline, and perspective that only geospatial information can provide. They can examine changes to an area of Earth over a series of days, weeks, months, or years. The CEMS Early Warning and Monitoring component supports the preparedness and emergency response at the European and global level, through the provision of early warning, risk and impact assessment, and monitoring of specific natural hazards – namely floods, forest fires, and droughts – through publicly accessible online services.

Session 4: Drought

The thematic session on droughts began with a presentation by the United Nations Framework Convention to Combat Desertification (UNCCD), which shared information on challenges that need to be considered when confronting droughts. The expert put the efforts of UNCCD into the context of the Sustainable Development Goals (SDG), specifically connecting to goal 15 (Life on Land), which aims to reverse land degradation. Examples of drought management were given, and the expert recommended further development of an African network, strengthening collaboration among agencies and specifically addressing women as "drought knows gender". He furthermore introduced the UNCCD drought initiative and the drought toolbox as well as a UNCCD platform that will enable the exchange of information and technologies for drought monitoring.

The session continued with a presentation by the Food and Agriculture Organization of the United Nations (FAO) on its Agricultural Stress System Index (ASIS). An applied example of the ASIS in Ethiopia was outlined and the general system-based approach on remote sensing was described. ASIS allows countries to monitor vegetation and crops using satellite data. ASIS has been developed based on the vegetation health index (VHI) across scales showing examples on the global as well as on the country-level while considering the phenological cycle in their analysis.

Subsequently, experts from Airbus Defence & Space made a presentation on the use of Synthetic Aperture Radar (SAR) imagery & Digital Elevation Model (DEM) solutions for disaster management in Africa. The high potential for the application of radar data was pointed out, for example, due to its ability to observe the Earth's surface through cloud cover. The experts also presented an example of the use of global Digital Terrain Model (DTM) data for river inundation modelling, which together with 3D models of buildings can be used for potential damage calculations.

The International Water Management Institute (IWMI) then presented its efforts regarding space-based technologies and droughts. The expert outlined that early warning systems are the core of all systems in drought management. He noted that information needs to be integrated, also into long-term planning which includes citizen science through participatory approaches. A specific example was given on drought surveillance for South Asia. Additionally, a drought early warning decision support tool for Afghanistan was presented, followed by information on drought resilience initiatives in Africa, including a national drought risk index and countrywide risk profiles.

The European Commission's Joint Research Centre (JRC) followed with a presentation on the Copernicus Global Drought Observatory (GDO) highlighting drought as the most important disaster economic-wise and its complex nature. According to the expert of JRC, knowing where and when droughts would and could strike is crucial. The GDO offers a rich selection of maps and explanatory reports to help answer these questions and combines multiple information and datasets, including the lack of precipitation and soil moisture.

The final presentation of the drought session was given by the Center for Remote Sensing of Land Surfaces (ZFL) and dealt with remote sensing for agricultural drought monitoring and assessment. In this context, results from the GlobeDrought project were presented. The expert from ZFL remarked that there is a need to monitor and understand droughts better, as there is still no universal definition of drought, and many international frameworks and initiatives exist. She pointed out that the GlobeDrought project tried to assess drought risk and drought impact at a global scale and in different selected regions. This is combined in a web-based drought information system.

Session 5: Innovative Tools

The final session on innovative tools included presentations by ARCSSTE-E, UN-SPIDER and two private companies: Microsoft Corporation and Mayday.ai. An expert from ARCSSTE-E presented on the Multi-scale Flood Monitoring and Assessment Services for West Africa (MiFMASS), a programme sponsored by the African Union and the European Union. MiFMASS uses open-access software and freely available and accessible data to monitor floods in flood-prone areas in participating countries. The overall objective of the project is "to enhance the efficiency of flood monitoring, assessment and management in West Africa by providing Earth Observation (EO) based services on a real-time basis to disaster management organisations and boosting their human capacity to adapt to their services".

Mayday.ai presented its solution for real-time risk and disaster intelligence, covering multiple disasters and all geographical regions. The company, whose activities are supported by the ESA, NOAA, and DLR, processes various EO sources and ancillary data through its proprietary AI fusion engine. As events are being detected, a real-time common operating picture is provided for all phases of a disaster lifecycle, thereby meeting the Sendai goal of multi-hazard early warning. With its democratization of pertinent fused data, Mayday principally aims at shifting the focus of disaster management cultures to being inherently proactive and it provides dynamic guidelines on early risks prevention and mitigation. Different visualisations and self-serving reporting are provided through its Esri-based platform. The capabilities of the platform were demonstrated by showing examples and use cases for wildfire disasters and how these can be monitored in real-time with Mayday's systems.

Afterwards, UN-SPIDER presented a prototype of a geospatial decision support system for forest fires. The system has been developed to facilitate the visualization of conditions before, during and after forest fires using data sources developed by the space and the geospatial community, as well as by UN-SPIDER Regional Support Offices. In the stage before forest fires, the system presents information on the climate and the susceptibility of vegetation to fires in geographic areas of interest. During forest fires, the system presents information on hotspots, smoke emissions, and satellite imagery of the area of interest. In the stage after the fires, the system gives information on the geographical extent of forest fires and on the burn severity of forest fires. The system benefits from the use of Google Earth Engine to analyse and combine multiple sources of data to facilitate the visualization of many products.

The United Nations University Institute for Environment and Human Security (UNU-EHS) made participants aware of the results of the CLIMADA research project, which focuses on the estimation of economic losses due to climate change and the potential of adaption efforts. The idea is to move from climate risk data to climate finance. An example of the application in Ethiopia was given. As a result, decision-makers should have the opportunity of having access to a mixed portfolio of adaption measures, based on the economics of climate adaption.

In the last presentation, Microsoft's AI for Good introduced its efforts on disaster preparedness, disaster response, and humanitarian actions with artificial intelligence technology. As examples, damage assessment using AI and machine learning after an event, as well as flood preparedness based on detection of roofs and an estimation of the quality and therefore vulnerability of houses before an event were presented.

Recommendations and Conclusion

The Conference allowed UN-SPIDER, ZFL, and those institutions making presentations:

- To showcase recent advances and identify challenges regarding the use of space-based information, big data approaches, and information technologies in disaster management in Africa.
- To present and provide a hands-on experience of space-based applications through tutorials on technical solutions ranging from standalone desktop packages to cloud computing environments that facilitate the access to and the use of space-based data and information products for disaster management.
- To contribute to the efforts of UN-SPIDER to strengthen its network of stakeholders in Africa and to identify synergies between stakeholders as well as opportunities for future collaboration.

Many participants from the African continent expressed a further need for capacity building, networking, and institutional strengthening. They noted that capacity building needs to be carried out on different levels, and not only about how to use certain applications but also with regards to what data and application solutions exist and in which circumstances they can be used.

Interesting ideas about the concepts of virtual trainings, MOOCs and roundtables for networking were expressed and their feasibility needs to be assessed further. Experts from academic institutions noted the usefulness of the approach of training the trainers to ensure long-term sustainability of training efforts in Africa. In addition, the recommendation was made to rely on African academic institutions for training activities, to carry out capacity building efforts aligned with the GMES & Africa programme, and to collect needs related to training from end-users such as disaster management agencies so that training courses can be tailored to address such needs.

New tools and approaches on the use of space-based technologies for disaster management and emergency response were presented to encourage their use. Representatives from national disaster management agencies agreed that one way to assess how to use such novel tools was to carry out tabletop exercises or simulations that would allow them to determine how to use such tools in their routine activities. In addition, they noted that smart mapping tools could be very useful for their efforts and elevated the request for such tools to be developed.

The conference allowed participants to take note of novel computational technologies such as artificial intelligence, big data, and cloud computing to map the extent of floods and to identify infrastructure that has been damaged or destroyed by floods. In a similar fashion, the conference allowed participants to take note of solutions developed by the Copernicus Emergency Management Service (CEMS) including GWIS (Global Wildfire Information System), GDO (Global Drought Observatory), and GloFAS (Global Flood Awareness System), the use of products such as digital elevation models, and solutions developed by the private sector.

Participants agreed on the usefulness of quarterly webinars to continue raising awareness regarding solutions developed by the space community and to exchange information on lessons learned on the use of space technologies and geospatial information.

The conference also allowed UN-SPIDER to present two tools that it developed recently: the procedure to use GWIS to generate data on the impact of forest fires to be used in the Sendai Framework Monitor and the prototype of the forest fire decision support system.

More generally, the conference contributed to raise awareness on the contributions of space technology to the Sendai Framework for Disaster Risk Reduction, and the recently launched Space2030 Agenda.

Annex I: Agenda

OPENING SEGMENT 16 November 2021	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
10:00 am – 10:15 am	**Opening** Welcome remarks, *UN-SPIDER and ZFL*
1O:25 am – 12:00 pm	**Introductory presentations** • Welcome remarks by the Director of the United Nations Office for Outer Space Affairs (UNOOSA) • Presentation by the Space Agency at the German Aerospace Center (DLR) on its activities and the Space 2030 Agenda: space as a driver of sustainable development. • Presentation by the Africa & GMES programme of the African Union Commission. • Presentation by the National Disaster Management Centre of South Africa. • Presentation by the Rwandan Space Agency.
12:00 pm – 12:30 pm	Discussion on the benefits of networks and information technologies in times of crisis
12:30 pm	End of Opening segment

THEMATIC SESSION 1: FLOODS AND STORM SURGES 16 November 2021	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
14:00 pm – 14:20 pm	Presentation by ZFL and DLR on Strengthening the use of Copernicus data and services for flood prediction and monitoring in African countries.
14:20 pm – 14:40 pm	Presentation by the Joint Research Centre (JRC) on the Global Flood Awareness System (GloFAS).
14:40 pm – 15:00 pm	Presentation by the Nigeria Hydrological Services Agency (NIHSA).
15:00 pm – 15:20 pm	Presentation by the Gambia National Disaster Management Agency (NDMA)
15:20 pm – 15:40 pm	Presentation by the National Meteorological Institute of Mozambique (INAM).
15:40 pm – 16:00 pm	Presentation by DLR on the Use of Artificial Intelligence to map floods.
16:00 pm – 16:30 pm	Discussion on the benefits of networks and information technologies in case of floods
16:30 pm	End of session 1

THEMATIC SESSION 2: FOREST FIRES 17 November	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
10:00 am – 10:20 am	Presentation by Beyond Centre of Excellence, NOA, Greece on the use of space technologies for forest fires risk prediction and monitoring in Greece.
10:20 am – 10:40 am	Presentation by the Algerian Space Agency (ASAL) on the use of space technologies in Algerian forest fires.
10:40 am – 11:00 am	Presentation by the Joint Research Centre (JRC) on the Global Wildfire Information System (GWIS).
11:00 am – 11:20 am	Presentation by the European Centre for Medium-Range Weather Forecasts (ECMWF) on Monitoring fire emissions and air quality using CAMS.
11:20 am – 11:40 am	Presentation by the Fraunhofer Institute for Technological Trend Analysis on the FIRELOGUE project: addressing forest fires through supporting and coordinating Innovation Actions.
11:40 am – 12:00 pm	Presentation by UN-SPIDER on using GWIS for the Sendai Indicator on impacts of forest fires.
12:00 pm – 12:30 pm	Discussion on the benefits of networks and information technologies in case of forest fires
12:30 pm	End of session 2

THEMATIC SESSION 3: CAPACITY BUILDING AND EMERGENCY RESPONSE MECHANISMS 17 November	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
14:00 pm – 14:10 pm	Introduction to the panel
14:10 m – 15:10 pm	**Panel on Capacity Building** • UNU-ViE, UNU-EHS • Ruhr Bochum University, Germany • EO College, University of Jena, Germany • Africa Regional Center for Space Science and Technology Education in English Language (ARCSSTE-E) • DiMTEC South Africa
	SEGMENT ON EMERGENCY MECHANISMS SET UP BY THE SPACE COMMUNITY
15:20 pm – 15:40 pm	Presentation by the International Charter Space and Major Disasters.
15:40 pm – 16:00 pm	Presentation by Copernicus on its Emergency Management Service.
16:00 pm – 16:30 pm	Discussion session
16:30 pm	End of session 3

THEMATIC SESSION 4: DROUGHT 18 November 2021	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
10:00 am – 10:20 am	Presentation by the United Nations Convention to Combat Desertification (UNCCD): Confronting droughts.
10:20 am – 10:40 am	Presentation by the Food and Agriculture Organization of the United Nations (FAO) on its Agricultural Stress System Index (ASIS).
10:40 am – 11:00 am	Presentation by Airbus Defence & Space.
11:00 am – 11:20 am	Presentation by International Water Management Institute (IWMI).
11:20 am – 11:40 am	Presentation by the Joint Research Centre (JRC) on Global Drought Observatory (GDO).
11:40 am – 12:00 pm	Presentation by ZFL and UNU-EHS: Remote Sensing for agricultural drought monitoring and assessment: Results from the GlobeDrought project.
12:00 pm – 12:30 pm	Discussion on the benefits of networks and information technologies in case of droughts
12:30	End of session 4

THEMATIC SESSION 5: INNOVATIVE TOOLS 18 November 2021	
TIME **All times are CENTRAL EUROPEAN TIME**	**ACTIVITY**
14:00 pm – 14:10 pm	Introduction to the session
14:10 pm – 16:00 pm	**6 Technical presentations: 20 minutes** • ARCSSTE-E: Multi-scale Flood Monitoring and Assessment Services for West Africa (MiFMASS). • Mayday.ai: Real-Time & Near-real-time information services for disaster management. • UN-SPIDER: Decision Support System for Forest Fires. • UNU-EHS: CLIMADA for estimation of economic losses. • Microsoft AI for Good.
16:00 pm – 16:30 pm	**Summary, Outlook and Closing Remarks** • Recap of the different sessions and discussions • Short Q&A and discussion block Outlook and way forward • Closing remarks: UN-SPIDER and ZFL
16:30 pm	End of virtual conference