

Draft Report of GEO XVI

This document is submitted by the Secretariat to the Programme Board for discussion.

Wednesday, 6 November 2019

Meeting convened at 09:00 am

OPENING SESSION

Chair: Mr. Pengde Li, Deputy Director General, China Geological Survey, Ministry of Natural Resources, People's Republic of China.

1.1 Welcome from Australia

Mr Stuart Minchin, Chief, Environmental Geoscience Division, Geoscience Australia, warmly welcomed all delegates to Canberra, and prefaced his remarks by paying respect to traditional peoples of the Canberra Region. He noted that communities had met in region for thousands of years, exchanging insights, and thus it was appropriate for GEO to be hosting its Plenary and Ministerial in Canberra. He extended a welcome to the local chief and descendants of the indigenous Namur people in their native language. He then went on to express that Australia was proud to host this major event with over 1,400 registered delegates taking part in various activities of GEO Week 2019. He emphasized that the focus this year was on Earth observations (EO) investments in Digital economy, which was intended to show that investments are just that: they provide return to governments, businesses and individuals through forming an important part of economic activity. Additionally, discussions were set to highlight tangible actions towards achieving sustainable development with EO, and several new events would be introduced throughout the week, such as the Pacific Island Programme designed to enable GEO to engage with this group of nations for the first time. Other events held in parallel with GEO Week 2019 included co-hosting with the UN Environment Programme (UNEP) the Working Group on Big Data and Digital Ecosystems for the Planet, as well as the Regional Committee of UN Global Geospatial Information Management for Asia and the Pacific (UN-GGIM-AP). The Industry Track running in parallel with the GEO Plenary was another innovation, providing an opportunity for the private sector to network with GEO Members and Participating Organizations. He noted that the Exhibition area would be open to public with school children be especially encouraged to come and visit, stimulating the next generation to think of careers in the fields of EO applications and geospatial information. He concluded by explaining that the GEO Plenary Week 2019 “Earth Dreaming” logo was designed by local artist Dion Devow and that the meaning of the various components were as follows: the white dots within the central blue region were islands in the sea surrounding Australia; the multi-coloured dots surround the blue region represented the different peoples of Australia; the dots aligned between the open hands illustrates that the Earth and its inhabitants are all connected, with the hands symbolizing that we are guardians of the planet and its resources.

1.2 Opening Remarks

Plenary Chair Pengde Li representing Dr. Wei Huang, the Lead Executive Committee Co-Chair, China, thanked Mr Minchin and expressed his sincere appreciation to Australia for the thoughtful arrangements made in preparation for GEO Week 2019. He also wished to thank to Co-Chair Mr. Mmboneni Muofhe, South Africa, for his hard work as Lead Co-Chair over the past year, and also welcomed to Mr Jim Reilly as new Co-chair for the United States. Mr Li also expressed his heartfelt thanks to GEO Members and Participating Organizations for their long-term efforts and contributions to the development of GEO and the progress of Earth observations. He welcomed in particular the businesses and sub-national organizations that had joined GEO as Associates this year, making GEO a more inclusive and more energetic community.

Mr Li remarked that GEO had achieved much in implementing its Strategic Plan since the last Ministerial Summit in Mexico City, and would make even greater efforts to deliver on the Work Programme for 2020-2022. He added that the development of national Earth observation systems had made steady progress and the role of regional Earth observations systems had become more prominent. These efforts have laid a solid foundation for the implementation of GEOSS. With the concerted efforts of all stakeholders, GEO was firmly committed to the three engagement priorities, becoming more focused on global agendas and challenges and producing more practical results in response to local needs. Further, he noted that Earth observations are undergoing a significant evolution through constant integration with new digital technologies. With the support of such technologies, Earth observations are making continuous advances, Earth observations instruments becomes more practical and easy to use, and related industries are thriving with greater social and economic benefits.

Mr Li commented that the GEO Week 2019 included a series of wonderful activities, focusing on key topics of GEO and main concerns from all stakeholders. In particular, he noted that fruitful results had been achieved at the 12th AOGEO Symposium held just prior to GEO Week 2019 with over 200 participants from 35 countries, including Mongolia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand and Vietnam convening in Canberra. Collaboration across the region was set to accelerate this year as AOGEO launched three Integrated Priority Studies in Mekong River Basin, Pacific Island States and Himalayan Mountains, to co-design and co-produce solutions with end users. For the studies, new data, both in-situ and satellite, were being made openly available by China, Japan and the Republic of Korea.

Mr Li also highlighted that the Industry Track activities and events being held during GEO Week 2019 represented a unique opportunity for GEO delegates to interact with the private sector. The Ministerial Summit at the end of the week would highlight achievements of GEO in recent years and be presented to Ministers from the perspectives of policy, science, business and other stakeholders. Ministers would be then welcomed to provide guidance and make commitments for the future development of GEO.

Mr Li concluded his remarks by emphasizing that GEO is a community in which Members and Participating Organizations gather together to provide public services of Earth observations for the shared aim of promoting sustainable economic and social development and building a community with a shared future for mankind. China will, as

always, devote its efforts to building a better and more capable Global Earth Observation System of Systems (GEOSS). It was his hope that that all stakeholders would work closely together to grasp the opportunities and address challenges brought by the digital economy to create an even brighter future for GEO.

Co-Chair Patrick Child, Deputy Director-General, Research and Innovation, European Commission (EC), welcomed all delegates to GEO-XVI Plenary and thanked Australia for hosting GEO Week 2019 along with the marvellous organization preceding the event. He commented that the week represented a milestone in the life of GEO, and thanked the Secretariat Director, Gilberto Camara and the GEO Secretariat for their support. He also thanked the members of the Executive Committee and the Co-Chairs for fostering a spirit of collegiality that was inspirational. In particular, he thanked the lead Co-Chair from South Africa, Mr Mmboneni Muofhe, for his calm but progress-oriented leadership through the year. Mr Child was pleased to see that feedback from the GEO-XV Plenary the previous year in Kyoto had been taken on board, evidenced by the current Plenary agenda which made space for substantive discussion around the three GEO priority engagement areas. In particular, he was glad that a session on climate issue had been included to help GEO make progress on with key actors in area of climate change, such as the UN Framework Convention on Climate Change (UNFCCC) and the Intergovernmental Panel on Climate Change (IPCC). He emphasized the importance of devoting time to discussing how to make GEO more results oriented, having a focus on what GEO can actually do to produce outputs that will make GEO more relevant to the broader community. Other innovations for GEO Week 2019, such as Australia’s vision to host the industry track were seen as positive, presenting an opportunity to make progress in dealing with Earth observation challenges across region.

Mr Child next presented three key messages, which were:

- 1) New setting in the European Commission as of 1st December.

The new president of the Commission, Ursula von der Leyen, has presented her priorities, three of which were relevant for the Plenary meeting, including: a European Green Deal, a Europe fit for the digital age, and a stronger Europe in the world.

- Under the “European green deal” a strong emphasis will be put on preserving Europe’s natural environment which is very relevant to many societal benefit areas of GEO;
- The priority “a Europe fit for the digital age” is very compatible with the objectives of the theme of the GEO week on the way Earth Observation can contribute to the digital economy;
- Regarding the “Role of Europe in the world”, GEO is definitively an ideal platform to network and connect with international partners. So, the overarching priorities of the new Commission provide opportunities for GEO in Europe.

He explained that the way the Commission will be organised is also quite promising in view of future actions of the Earth Observation community. The portfolio of the Commissioner in charge of Internal market will include two important topics: the digital economy & space with the Copernicus programme. The portfolio of the Commissioner in charge of innovation and youth will include Horizon Europe the future EU Research &

Innovation Framework Programme which will support the European GEO contribution. He also informed Plenary that, as the new Commission had only recently been put into place, it was unfortunately not possible to secure the participation of the Commissioner in this Ministerial Week. However, the GEO community should be reassured that the EC will continue supporting GEO under its new arrangement

2) Welcome content of the Plenary agenda concentrating on GEO priorities

Mr Child remarked that, after the successful organization of the Kyoto Plenary which included discussion with key stakeholders in the three GEO priority areas, it was very encouraging to see this effort continued on the occasion of this Plenary. It was the hope of the EC that the discussion in the climate session would enable progress towards linking GEO better with key actors in the climate domain. Indeed, there is a need to make the role of GEO more official as a unique international actor in the domain of Earth Observation, that can provide information and data for the Climate community. He noted that the EC was looking forward to see the proof of concept of the GEO Knowledge Hub (GKH) that would be presented under point 6 of the agenda by the GEO Secretariat Director. The EC believed that GEO needed build on this demonstration to evolve GEOSS towards a result-oriented initiative. The Commission is prepared to support such an evolution through a concrete and financeable implementation plan

3) Highlights on 2019 progress by Commission together with European Partners in implementing GEO and future steps included:

- The Copernicus programme is a major contributor in Europe to the GEOSS. Its popularity among users worldwide is increasing significantly. Important improvements on easy and fast data access were implemented in 2019. Five Copernicus data information and access system platforms (DIAS) are now fully operational and accessible for users;
- One example of 2019 Copernicus achievement is through the exploitation of the Sentinel-5P satellite mission that comes now to maturity and is the first Copernicus satellite dedicated to monitoring our atmosphere. Very accurate maps are now produced on a regular basis from this mission showing a range of trace gases that affect air quality such as carbon monoxide, nitrogen dioxide and ozone;
- The EuroGEO regional initiative is also progressing well and entering now in its operational phase with the launching of the Horizon 2020 project e-shape, an investment of 15 M€ in support to EuroGEO. e-shape currently includes 27 cloud-based pilot applications under 7 thematic areas (agriculture, health, renewable energy, ecosystem, water, disasters, and climate) to address societal challenges, foster entrepreneurship and support sustainable development;
- Meanwhile, the preparation of the Programmes - to be implemented under the next Multiannual Financial Framework of the European Union (2021-2027) - has progressed well. An agreement of principle was found between the European Commission, the European Council and Parliament on the future Framework Programme on Research and Innovation in which both the support to Copernicus and to GEO are included. At the same time a similar agreement of principle was found regarding the future EU space programme, which includes the operations of the Copernicus Programme during the time frame 2021-2027.

Mr Child concluded his remarks by reconfirming the strong commitment of EU to the work of GEO, and wishing everyone a successful Plenary and encouraging the entire community to work towards taking GEO to a new level.

Co-Chair Mmboneni Muofhe, Republic of South Africa, SA, welcomed all delegates to the Plenary meeting, and thanked Australia for its excellent preparation and venue. Reflecting on work over past year, Mr Muofhe wished to acknowledge and congratulate the community for the active role everyone has played in advancing GEO. Having set its engagement priorities through the Mexico City Declaration, GEO was able to now come and report on progress made towards their achievement. He thanked Australia for the fact that the Plenary agenda spoke to those priorities, and wanted to acknowledge in particular role that Australia had been playing in establishing Digital Earth Africa (DE-Africa). South Africa was proud to be a key partner in driving forward DE-Africa, noting that development of its own open data cube (ODC) would allow South Africa to provide added value services and products for the nation, thereby demonstrating that GEO can downscale its work to the appropriate level for impact. He noted that the AfriGEO secretariat had been established in Kenya which should enable the Regional initiative to move forward.

Mr Muofhe went on to explain that, in his view, the engagement priorities identified in the Mexico City Declaration are even more relevant today, and it is therefore essential that we push GEO to achieve these goals. The digital economy can be an important part of that process, given the value and power of data, availability and access, and analytics which can allow us to meet objectives for mitigation and adaption to climate change, food security, and environmental protection. Indeed, a focus on role of the commercial sector – evidenced by the interest generated around the Industry Track – could be leveraged by power of GEO and the way in which the community collaborates and cooperates. In other words, a joint effort is needed if GEO is to achieve its goals. He commented that the strength of a chain was a function of its weakest link. Care must be taken not to leave anyone behind, thus need to build capacity in developing countries was ever present and it was good that awareness of this issue was being raised with the Ministers on Friday. He was also looking forward to learning about progress towards a results-oriented GEOSS, reminded Plenary that there was a need to see that GEOSS delivered actual impacts, not just activities. In his view, the demonstration of the GKH proof-of concept was a step towards building on the possibilities that we can exploit as GEO moves towards delivering impacts. Building on what has happened last year in Kyoto, the Plenary presentations should also point to how GEO moves forward on making its impacts felt globally.

This is the reason we are here. He concluded by stating that GEO must not wake up too late to respond to the urgent needs of society for Earth observations to assist with evidence-based decision-making.

Co-Chair Jim Reilly, Director US Geological Survey (USGS), United States of America, welcomed all delegates to GEO Week 2019. Mr Reilly noted that he was representing Mr Neil Jacobs, Acting Administrator of the National Oceanic and Atmospheric Administration (NOAA) who is the designated GEO Principal for the US and had been detained by urgent business in Washington, DC. Mr Reilly noted that it was gratifying to see the GEO community expanding to include more of the global community as GEO

examined the ever-expanding roles of Earth Observation in supporting the critical functions and services necessary to manage everything from natural resources to hazards assessments and mitigations. In his view, it was evident that good science is necessary to develop good policy, and the challenge lay in defining the requirements for the Earth observation systems that would deliver the foundational knowledge required to advise policy makers as they consider the challenges in our communities. Given the advances in Earth Observations, analytical tools and characterization, the underlying concept of the Global Earth Observation System of Systems (GEOSS) is more important today than ever. GEO must work towards strengthening its cooperation in delivering analysis-ready data, and this means not only including more of the international community but also the private sector participants. There is still a lot of work to do on establishing a globally integrated network of comprehensive environmental systems but collectively, GEO will continue the journey to an integrated science approach to answering society's pressing challenges.

Mr Reilly recalled that the USGS is one of the participants and consumers in the GEOSS architecture, and, together with NASA, was committed to continued operation of the Landsat series of satellites, just as it had over the past 47 years, delivering the longest time-series of land imaging data in existence, all freely available. He noted that Landsat had from its inception been conducted in partnership with the international community, and that he would be visiting a ground station in Alice Springs operated in partnership with Australia to celebrate this long-standing, important relationship. He continued by observing that the US government uses Earth Observations for everything from hazards detection and mitigation to resource characterization. As just one example, USGS, NOAA, and NASA work together to provide hazard assessments, disaster characterization, humanitarian assistance to wildfire-prone regions of the United States. Last year the state of California alone saw more than 7500 fires that burned more than 1.6 million acres of land. The losses associated with these fires included lives lost and net economic impacts of approximately \$72 billion. But beyond this, the US also works with its international partners to further our understanding of Earth system dynamics at local to global scales.

Mr Reilly remarked that we are at an inflection point where the publicly-funded observations are being supplemented by a rapidly expanding array of services from the commercial sector. Combining commercial observations with the major advances taking place in data systems will revolutionize information capabilities and allow stronger support to society in developing a truly digital economy. He therefore encouraged GEO to partner with these sectors to accelerate the delivery of new and comprehensive Earth observation-driven decision-support services. He expressed his pleasure to note that the focus of this GEO Week is on the Pacific Islands region, and looked forward to an expanding role in GEO for the Pacific Island countries and territories, not only in terms of science capabilities but also global participation.

In conclusion, Mr Reilly thanked the government of Australia for hosting GEO Week 2019, noting that the US and Australia have long had a robust and vibrant relationship based on shared values of democracy, commercial interests, and cultural affinities. He anticipated, over the course of our Plenary and Ministerial sessions, a reaffirmation of GEO's commitments to bridge the Earth Observation divide, begin the journey into the

digital economy, and cement joint commitments to growth and security of the broader international community we all serve.

Secretariat Director, Mr Gilberto Camara, thanked the government of Australia for both its excellent organization and hosting of GEO Week 2019, and welcomed the GEO Co-Chairs and all Plenary delegates. He noted that a series of important events was happening during the week, some of which were occurring for the first time such as the Industry Track, providing the GEO community with the opportunity to engage face-to-face with the commercial sector. He thanked the leadership of UNEP, and UN-GGIM-AP for co-organizing their strategic meetings in cooperation with GEO, bringing a greater diversity of participants to GEO Week 2019 than in previous years.

He then reminded participants of the fact that, just 20 years ago, it was not at all the case that Earth observations were freely available and accessible. Brazil began a policy of providing open access to its archives of Earth observation data, a trend that was then formalized at the GEO-IV Plenary in Cape Town, South Africa when the USGS announced that its entire archive of Landsat data would be made openly and fully accessible for all. He cited a study commissioned by the United States Geological Survey (USGS) in 2017 which showed that the estimated value of Landsat archives to the world's economies was US\$ 3.45 billion. A similar story had taken place with the Copernicus programme, in which the European Commission worked hard to adopt a policy of open and free access to Sentinel data. These events paved the way for huge amounts of Earth observations for Africa to soon be made available via a public cloud as part of the Digital Earth Africa project. Just 10 years ago, this type of arrangement was not foreseeable, and it is amazing that these amounts of data are now available, along with software to handle it. Mr Camara emphasized that this turn of events demonstrated the power of GEO, and that it was essential that GEO continue to move with times and changing technologies. He concluded his remarks by stating that GEO was going forward quickly, due to concerted work of all, and by expressing his appreciation that the GEO community had embraced idea of moving towards a results-oriented GEOSS.

1.3 Welcoming of new Members, Participating Organizations and Associates

The Secretariat Director, Mr Gilberto Camara welcomed the new GEO Member governments:

- Guatemala;
- El Salvador;
- Sierra Leone;
- Tonga.

Total GEO Membership: 109

He then welcomed the Participating Organizations joining GEO:

- African Smart Cities Foundation;
- Caribbean Institute for Meteorology and Hydrology (CIMH);
- Conflict and Environment Observatory (CEOBS);
- Cooperación Latino Americana de Redes Avanzadas (RedCLARA);
- Economic Community of West African States (ECOWAS);
- Mercator Ocean International;

- Open GeoHub Foundation (OpenGEOHub);
- Sustainable Development Solutions Network (SDSN);
- World Food Programme (WFP).

Total GEO Participating Organizations: 136

Finally, Mr Camara welcomed newly accepted private sector entities in the GEO Associate category:

- Acclimatise Group Ltd;
- Beijing Piesat Information Technology Co (Piesat);
- Environment Systems Research Institutes Inc (ESRI);
- ICES: International Centre for Earth Simulation Foundation;
- PCI Geomatics;
- Space Enabled Research Group MIT Media Lab;
- Space Will Info Co Ltd (SpaceWill);
- SuperMap Software;
- Terradue;
- The Centre for Ecological Research and Forestry Applications (CREAF);
- Trimble.

Total GEO Associates: 11

1.4 Approval of Agenda

Outcome: The agenda was approved, with no modifications.

1.5 Approval of Draft Report of GEO-XV Plenary

Outcome: The draft report was approved, with no modifications.

1.6 Opening Keynote Presentation

Mr Sameh Wahba, The World Bank, gave a presentation on Geospatial Technologies for Resilient & Sustainable Cities & Economies. He outlined the major trends shaping our world today include urbanization & demographics, climate change, conflict and technology. With 60% of the world's population predicted to live in major city metropolitan areas by 2030, the future is urban where 80% of the planet's activities will be taking place. In this context, he noted that, according to the Economist (2017), data is to this century what oil was to the previous one. New technologies are making it possible for Earth observation data (drones, satellites, cell phones, crowd sourcing) to be processed and analyzed "good, fast and cheap", a 3-way nexus that has never before been feasible. Especially in the urban context, geospatial technologies are enabling better planning, better service delivery, strengthened resilience and revenue enhancement. He then went on to illustrate how these new technologies were being put to use via several case studies, such as crowdsourcing being used to create flood maps for Dar Es Salaam, Tanzania; drone mapping used to study urban and territorial dynamics in Zanzibar; data from multiple observation platforms being combined to analyse retrofitting possibilities for resilient housing in Saint Lucia, Guatemala; and rapid city scan techniques using publically available data used to mainstream resilience in urban planning for Ulaanbaatar, Mongolia.

Mr Wahba concluded by noting that the World Bank was working collaboratively with several cities to operationalized a mix of diagnostics and products under a four pillar framework:

- Institutional Arrangements: the ability to develop/sustain public policies, regulations and governmental structures that support activities related to geospatial concepts. Similarly, it refers to the role that local government has to promote the growth of the geospatial environment;
- People: creating awareness about the capacity needed for human resources and identifying gaps in those resources with respect to geo-spatial abilities (production, maintenance and use of spatial data);
- Data: assessments of current situation of data availability, quality and policies related to formats, analysis and geospatial information exchange;
- Systems: the infrastructure (software and hardware) required to support a Municipal Spatial Data Infrastructure (MSDI). Its key components are the adequacy, the functionalities and the user interface of city-level Geoportals that combine GIS and tabular data with spatial references.

1.7 Introduction of the Canberra Ministerial Declaration

Mr Stuart Minchin outlined the process followed by the Ministerial Working Group to develop the Canberra Declaration, which included interaction with GEO Principals at several stages. The principle themes of the Declaration included:

1. Acknowledge the progress made. Appreciation of the extensive efforts;
2. Investments in the Digital Economy and critical role of Earth Observations;
3. Importance of the inclusion of Developing Island Nations;
4. Note and realise the benefits for Regional, National, Sub-National, individual communities and businesses;
5. Ensure benefits also available for all countries;
6. Continue to realize and contribute to the success of the GEO Strategic Plan 2016-2025. Build on efforts to support international policy agendas.

The next steps include a resolution for Minister to meet again in four years to:

- assess GEO's progress towards the goals, objectives and priorities; and
- consider new challenges and themes to guide consideration of GEO's future beyond the term of the current Strategic Plan.

Before closing the session, the Chair made the announcement that, thanks to a visit from the Secretariat Director in April this year, the China National Space Administration (CNSA) had taken the decision to provide free and open access to 16m resolution satellite data from its Gaofen satellites. Specifically, access to three types of data with coverage outside China will be provided: historical records; daily updated Wide-Field-of-View (WFOV) images; and global coverage data. Additionally, China will provide PIE online software for the better use of WFOV data with a swath of 800 km. The data platform CNSA-GEO, hosted by the Huawei Cloud, allows registered users around the world to freely discover and download the WFOV data. Users can use the data without restrictions as long as they cite the source of the data. The Plenary expressed its appreciation for this announcement with a round of applause.

2 ACTION ON CLIMATE CHANGE

2.1 Session Objectives: The main objective of the session was for GEO Principals to provide guidance on actions for GEO to accelerate its efforts to address climate change including supporting countries in their implementation of the Paris Agreement.

The session consisted of an introductory keynote talk by an invited speaker, followed by a moderated open discussion with GEO Members. The session was closed with a summary of the discussions.

The Speakers included:

- Mr Patrick Child, Deputy Director-General, Directorate-General for Research and Innovation, European Commission;
- Mr Nga Puna, Director, Tu’anga Taporoporo - National Environment Service, Cook Islands;
- Mr David Oehmen, Associate Programme Officer for Digital Strategy and Innovation, United Nations Framework Convention on Climate Change (UNFCCC) secretariat;
- Mr Steven Ramage, Head of External Relations, GEO Secretariat (providing support to the facilitator and speakers).

Based on the discussion paper prepared by the GEO Secretariat, Mr Child invited delegates to focus their interventions on:

- The role of GEO to improve the use of EO for monitoring and understanding of climate change;
- Engaging with key partner institutions, such as IPCC and UNFCCC;
- Best approaches on the use and application of EO in support of Member actions on climate change;
- Enhancing the GWP for the use of EO to inform and monitor mitigation and adaptation;
- Prioritising action for the GEO Secretariat on climate change.

Mr Puna delivered his opening keynote by presenting the perspectives and issues of the Cook Islands, 15 islands spread out in 240 square kilometres of ocean that have faced climate change for a long time. Mr Puna acknowledged the importance of data collection and monitoring for Small Island Developing States (SIDS) in the Pacific and the ambition to be part of GEO in order to be able to monitor changes and future-proof or climate-proof the environment policies that his government is expected to deliver.

Mr Puna said he was impressed with the display of technologies and solutions presented at the GEO Week. Mr Puna highlighted the fact that SIDS, such as the Cook Islands have little margin of error in the face of climate change. The increased occurrence and severity of king tides and beach erosion is already a reality in these countries, against the overall lack of early warning systems.

Mr Puna then asked the audience a challenging question: “what would you do if you knew you could not fail?”, and in concluding his intervention he made a plea to the GEO community “not to leave anyone behind” and support the efforts of the Cook Islands and all SIDS as Earth observations can provide small nations the right perspective and

instruments to fight the climate change battle and take care of the environment for future generations.

Following the keynote talk, the session facilitator Mr. Child then opened the floor to discussions and interventions from GEO Members.

Australia noted the existing experience in using Earth observation data in support of climate change action, and in particular the building of a robust monitoring system for Australia's greenhouse gas (GHG) inventory system. One of the main innovations was the use of Landsat data for carbon stock monitoring. Australia used free and open Landsat data to monitor changes in forest cover and then linked that observation data with an advanced ecosystem model. The idea of linking the Earth observation radar with important datasets and modelling to help draw out the implications of the Earth observations data was really important in the case of Australia, where data on forests were lacking. This is a common situation in many developing countries. The Australian experience is a living proof of the value of Earth observation data.

Furthermore, another valuable example is the Global Forest Observation Initiative (GFOI) that has produced detailed methods guidance standards to assist countries in developing their measuring and reporting capabilities in the context of reducing emissions from deforestation and forest degradation, and foster conservation, sustainable management of forests, and enhancement of forest carbon stocks (REDD+) in conjunction with the guidance provided by the IPCC.

Regionally, other relevant initiatives include forest monitoring through the Asia Pacific Rainforest Summit that Australia helped establish these last few years, and the ongoing establishment of the International Partnership for Blue Carbon where Earth observation data can be important.

The Netherlands informed the GEO community about the Global Commission on Adaptation, an initiative by several international organisations and supported by the Dutch government, aimed to share knowledge on climate change adaptation. The Netherlands suggested GEO to explore collaboration with the Global Commission on Adaptation also with a view to engage in the Climate Adaptation Summit in October 2020.

China noted the ongoing efforts to achieve global CO₂ emission reductions and the goals set in Nationally Determined Contribution (NDC), including through developing GHG satellites techniques. China has launched TanSat, GAOFEN series TF 5, and meteorological satellite series, which makes China the country with the largest GHG satellite constellation. In addition, China is soon launching high-resolution TanSat CO₂ data which will make a contribution to global CO₂ observations. A new GHG satellites called Atmospheric Environmental Monitoring Satellite(AEMS) will be also launched in 2021, which will be followed by another high-precision GHG satellite in 2023.

China welcomes cooperation with other space agencies to reduce the uncertainty of the national GHG emission inventory reporting. Cooperation with Japanese and American space agencies is already ongoing, and this represents a good example of how to use the space techniques for GHG monitoring.

International cooperation especially under GEO will provide guidance to promote emission reduction strategies and track changes in the natural carbon cycle caused by anthropogenic activities and climate variability.

The European Commission noted that the European Union (EU) is deeply engaged in supporting the global effort in the domain of climate change for the benefit of Europe and also for the benefit of the world. The European Commission's overall expectations from GEO include, firstly, continuing the efforts to collect, make available and upscale Earth observation climate knowledge already existing in GEO members. With that it will be possible to support the EU engagement regarding environmental sustainability, as well as combating and adapting to climate change. These engagements are reflected in the priorities of the new EU governance with the new European Commission's President-elect Ursula von der Leyen.

In practical terms, GEO should allow the EU member states and other countries to track progress with regard to the Paris Agreement goals. To achieve this, GEO should accelerate its effort to ensure an increased recognition of the value of Earth observations in the IPCC and the UNFCCC, in particular producing a GEO information document that would address specific needs of the IPCC, beyond the effort that is already taking place, and in particular taking advantage of the recent IPCC special reports. GEO should be prepared to support countries in meeting their NDCs, not by doing the work that the countries should do but supporting them with technologies and information.

The European Commission encouraged GEO members to participate in side events and exhibitions at the UNFCCC, the Conference of the Parties (COP) and the Subsidiary Body for Scientific and Technological Advice (SBSTA) meetings. The European Commission informed the audience that they will be present at COP25 taking place in Madrid, Spain.

The European Commission supports an in-depth assessment of the relevant GEO Work Programme (GWP) activities so that those resources can be made more visible. Furthermore, the GWP should be drafted with the participation of key stakeholders, going beyond the existing closed circle and involving parties like the Cook Islands. In particular, GEO should focus its action around the use of Earth observations for impact assessment and adaptation.

Finally, support should be given to GEO members so that they can approach their national delegates and experts in the UNFCCC and the IPCC to promote the GEO added-value role; in this context it would be very useful to prepare a standard briefing that could be used by GEO members to contact their national counterparts in IPCC and UNFCCC.

Greece noted that it is our duty as the GEO community to do all that is possible to ensure that we pass a better and safer planet and environment to the next generation who are increasingly mobilized and have asked for immediate climate action, at the same time warning us that they will be watching us.

One great way as a community to build upon this momentum is to demonstrate that we have great respect for our world's cultural heritage. To this end, Greece has proposed to the UN Climate Action Summit, an additional action needed to protect natural and cultural monuments that are threatened by anthropogenic climate change. The proposal

has been supported by WMO and UNESCO. It was presented in New York by the Prime Minister of Greece who will organize a Summit to invite world leaders to endorse the Greek initiative to the UN. The Secretary General of the UN, Antonio Guterres, has already included the Greek proposal together with the group of emblematic proposals of interest to the UN.

The Greek proposal provides a strong opportunity to the Global Earth Observation System of Systems (GEOSS) and GEO, especially now that the regional GEOs have agreed to be pioneers of this important issue, allowing us to work together on common activities, co-design, traversing all three GEO engagement priorities and targeting the use of Earth observations for the monitoring, the preservation of our planet's cultural heritage both natural and man-made. It is anticipated that such a proposal would strengthen cohesion within GEO and create unique opportunities for collaboration between the regional GEOs with a focus on protecting our past in order to create a better future for everybody.

France recalled that the science message is very clear: countries are not on track to achieve the temperature targets set by the Paris Agreement. As climate marches around the world led by active youth remind us of our responsibilities towards future generations, we need to define concrete and integrated responses from global to local to fight climate change based on the best available scientific knowledge.

That is why, the EU launched the Copernicus Climate Change Service as an operational service in June 2018, and why the Space Climate Observatory was launched by President Macron in June 2019 by 26 space agencies and organizations that signed a Joint Declaration of Interest. The Space Climate Observatory is aiming at studying and monitoring the impacts of climate change, especially at local scales, using satellite-based Earth observation tools in combination with field data and models. In this way it will complement and extend existing initiatives, boosting them at national and local scales. So in the framework of best approaches of the use of Earth observations in support of member actions on climate change the Space Climate Observatory could therefore be included in the list of opportunities to be supported.

Japan considers that the 2019 refinement of the IPCC Guidelines for National GHG Inventories was a great step forward for the GEO community, in which the role of satellite observation data, including that of GOSAT2 of Japan, is now recognised as one of the ways to measure global GHG emissions. Japan is grateful for the efforts by the GEO community in terms of integrating Earth observations according to the IPCC Guidelines. At the same time, it is up to our future efforts to try to integrate the satellites as observation data into the methodology to measure and assess global GHG. Japan pointed out that the GEO community needs to keep on working in this area including the response to the first global stocktake of the Paris Agreement in 2023.

The United Kingdom informed the meeting that the UK planned to host a side event alongside COP25 on the role of Earth observations to support efforts in tackling climate change. The event will cover four main themes: measuring ice from space; oceans, and using Earth observations to measure marine climate variables including ocean acidification; natural hazards and climate change, and the relationship between those and what Earth observations can do to help.

The UK also noted that an important theme for GEO is nature-based solutions and how Earth observation can support work not only in measuring climate change, but also looking to mitigate the impacts of climate change using natural solutions.

Following the interventions from the floor, the session facilitator Mr. Child then introduced the second speaker, Mr Oehmen from the UNFCCC secretariat.

Mr Oehmen opened his talk by reminding the audience that high quality Earth observations are the foundation for solid decision making on future action on climate change. The Paris Agreement was mandated based on the best available scientific information. Observation is pivotal to providing the alerts on global temperatures related to the 1.5 and 2 degree C temperature limits under the Paris Agreement, as well as other climate indicators to assess progress on the Paris Agreement goals.

Under the UNFCCC, the SBSTA is the place where scientific information is brought into the process and discussed, particularly under the research and systematic observation agenda item, including the research dialogue and the Earth Information Day. The UNFCCC secretariat works closely with a number of international and regional organizations to enable information exchange at the science-policy interface.

Mr Oehmen added that GEO has a unique role to play in serving the Paris Agreement. The Global Climate Observing System (GCOS) Essential Climate Variables provide a basis for decision making at all levels on action for both mitigation and adaptation as well as assessing progress. First of all, GEO is well positioned to support the provision of ECVs, particularly for the terrestrial domain. Also, GEO could support Parties and the broader community in the provision of socioeconomic variables. One recommendation is for GEO to develop a set of essential socioeconomic variables, with the same concept as ECVs and with appropriate quality control and in the context of FAIR (Findable, Accessible, Interoperable, Reusable) data sharing principles.

Secondly, Mr Oehmen noted that, to reach its goals, the Paris Agreement outlines a “cycle”:

- Countries provide a national climate target every 5 years (current NDCs will be altered or updated in 2020); these communicated targets are “nationally determined”, but must be stronger than the previous targets;
- With their NDC, Parties will also provide a long-term low GHG-emission development plan;
- Countries then undertake action to meet the targets identified in their NDCs (with developing countries receiving appropriate support);
- Starting in 2024 and every subsequent 2 years, countries report on action taken through a transparent reporting process;
- Starting in 2023, there will be a global stocktake to look at collective progress towards the goals; the stocktaking recommends ways to be more ambitious in the next cycle;
- Following each global stocktake, countries will take the recommendations and their experiences home, and then, provide more ambitious targets in the next round.

In their NDCs, Parties are responsible for identifying indicators to track progress. Against this background, Mr Oehmen pointed out that GEO could explore how to support Parties identify and track indicators, particularly for adaptation.

Thirdly, Mr Oehmen informed the Plenary that, in a recent paper the Least Developed Countries Expert Group (LEG) and the Adaptation Committee, two constituted bodies under the UNFCCC, identified gaps and needs for countries to integrate science in adaptation planning and implementation. Four gaps/needs relevant for this discussion are:

The capacity of national, subnational and sector experts to work effectively with climate data and climate change scenarios in adaptation planning and decision making;

Availability and accessibility of climate data and climate change scenarios to underpin effective adaptation planning and implementation, taking into account the specific needs at the national, subnational and sectoral level;

Capacity to develop, analyze and define baselines;

Capacity to undertake comprehensive risk and vulnerability assessments covering all key sectors and systems at the national, subnational and sectoral level.

Therefore, to track progress in the reduction of vulnerability from National Adaptation Policies (NAP) implementation – any indicator must have a baseline for adaptation to monitor change; be framed in a manner that policy makers understand; be responsive to the physical science, e.g. temperature, support planning; be ample and consistent, such that trend lines can be established to assess progress; be aggregated to assess collective progress.

Mr Oehmen raised a number of questions for the GEO community. In particular, he asked to consider how GEO can support Parties use Earth observation information better to provide a baseline for NAPs and NDCs as well as support implementation and tracking long-term progress.

Finally, Mr Oehmen stated that we are moving into a new age of satellite imagery. Space 4.0 represents a new era for the space sector, characterised by a new playing field. This era is unfolding through interaction between governments, private sector, civil society and politics. Information from satellites will be fully integrated with other observations and data. It will be processed using big data analytics and artificial intelligence (AI) to produce real-time, high-resolution, relevant information for society to provide collaborative data-driven and transformational risk-informed decision-making tools for policy and investment, while also monitoring ambition progress. Mr Oehmen asked how GEO can mobilize this information to support the Paris Agreement and at the same time enable global wellbeing, sustainability and equity.

In closing his intervention, Mr Oehmen encouraged the GEO community to reach out to support this important work, find opportunities to bring the open data, knowledge and services needed to promote the implementation of the Paris Agreement at global, regional and national level. He also informed the audience that all efforts are being taken to ensure the full execution of side events at COP25 despite the recent change of venue.

Mr Child then took into account some of the comments that were submitted through sli.do, including the need to: use GEO monitoring systems to track impacts of climate

change in the Arctic; use Earth observations to help with the necessary transition in particular of energy-intensive industries; focus Earth observation work on adaptation; and make better use of data knowledge and systems.

Mr Child opened the floor again for interventions.

The representative of the Sustainable Development Solutions Network (SDSN) TReNDS group addressed the issue of coordination between GEO and the IPCC. The IPCC has recently reconstituted the Task Group on data. The representative of SDSN is an ex officio member and noted that the Task Group is meeting in Montreal Canada at the same time as this GEO Plenary and will be addressing key issues related to data from the IPCC assessments. The recommendation is that the GEO Secretariat initiates a discussion about coordination with the Task Group on data.

Australia spoke to the importance of Earth observations in helping agriculture and food security in a changing climate. Three propositions were presented alongside concrete examples. First, Earth observations are crucial to understanding and properly managing natural resources, including agricultural production. Research by the Australian Government - Agricultural Research Bureau, looking at the impacts of variability and change, linked decades of admin survey data to Bureau of Meteorology's weather data and applied advanced machine learning to find out that the shifting climate conditions entirely explained a complete pause in agricultural productivity growth for a decade from 1995, and that adaptation so far has not managed to fully re-establish previous productivity levels.

The second proposition is that Earth observation remote sensing capabilities are improving rapidly, and this offers all sorts of improved decision support. These include on-farm decision support, as well as off-farm or wider decision support such as understanding the pattern of biosecurity spread through understanding plantation density in vineyards and bananas for example, which also helps with compliance and trust in the system.

Thirdly, while agriculture researchers appreciate the benefits of improved real-time information and decision support, the step changes, the major gains are going to occur when Earth observations are combined with information and data from other sources to deepen our understanding of the system, the complex natural systems we live in and the social and economic systems that are intertwined with them. For instance, it would be a game changer in Australia to have reliable regional long-term weather forecasts. For farmers struggling with that, improved parametric insurance would be fabulous and enable them to manage risks that they can't currently manage. Proper quantification assessment of a wide range of ecosystem services would be a great value to public and private decision makers including through the design and implementation of improved policy programs; this would include the management of environmental water. And lastly, improved evidence-based understanding of the impacts of climate variability and change, and how these might be managed to mitigate, is central to the future of agriculture around the world and associated food systems. Taking that evidence base and then putting it into public models and forecasts and scenarios of climate change and impacts under different GHG emissions trajectories is crucial to understanding the relative merits of different pathways and motivating sensible global action.

2.2 Panel session outcomes and recommendations

At the end of the session the facilitator Mr Child noted that there is a strong interest and mobilisation in the GEO community to become more directly involved and more directly relevant in the debate on climate change. The following outcomes highlight some of the ways to take action, that were distilled from the talks and the interventions:

- International cooperation and new sensors are increasingly important for national GHG inventory;
- There should be a focus on supporting developing countries through guidance on the use of Earth observations for climate action, upscaling and/or sharing existing knowledge;
- There should be a focus on increasing the recognition of GEO within the UNFCCC, and engagement with other partners such as the IPCC, the Global Commission on Adaptation and the Space Climate Observatory;
- Additional stakeholders should be included in the GWP development;
- There should be a focus on Earth observations in support of the Arctic, Clean Energy, Cultural Heritage, and Adaptation, particularly for the Agriculture sector;
- The GEO community present at COP25 will include: the UK, Germany, Japan, EC, Kenya, Chile, Spain, and other Members.

3 ACTION ON DISASTER RISK REDUCTION

3.1 Session Objectives: Principals provide guidance on the actions that GEO needs to take to accelerate its efforts to support implementation of the Sendai Framework for Disaster Risk Reduction.

This session was organized with an introductory keynote talk by an invited speaker, followed by a moderated open discussion with GEO Members. The session was closed with a presentation by a representative from a GEO Participating Organization followed by a summary of the discussions.

The speakers included:

- Mr Yoshiyuko Chihara, Deputy Director-General, Research and Development Bureau, Ministry of Education, Culture, Sports, Science and Technology (MEXT), and GEO Principal of Japan;
- Ms Lisa Robinson, Head of Advisory at British Broadcasting Corporation (BBC) Media Action;
- Ms Tiziana Bonapace, Director Information and Communications Technology and Disaster Risk Reduction Division, UN Economic and Social Commission for Asia and the Pacific (UNESCAP);
- Mr Steven Ramage, Head of External Relations, GEO Secretariat (providing support to facilitator and speakers).

Ms Robinson was representing BBC Media Action, which is an NGO and the BBC's international development charity. Ms. Robinson gave the opening keynote to the session which focused on "Five mistakes of communicating risk". The talk focused on how GEO can accelerate its impacts in disaster risk reduction, and make effective use of

the data that the GEO community generates and uses. More specifically, there was a focus on the role of communication in reducing disaster risk. Ms. Robinson's talk mainly focused on communication to the public, as this is the focus of BBC Media Action, but can equally be applied to governments and decision makers.

The talk focused on five mistakes that are typically made when communicating risk. The mistakes are:

- Assume that information leads to action;
- Skimp on audience research;
- Create a snazzy product with no solid plan for change;
- Avoid conversation; and
- Be dull.

The first mistake 'Assume that information leads to action' is related to the Sendai Framework for Disaster Risk Reductions Priority for Action 1: Understanding Disaster Risk. It touched on the need to be realistic about what actions we expect the information we create and provide to result in and why it is difficult for these actions to take place. Mistake one also focused on cognitive bias in responding to a disaster event, and the challenges of the social constructs that we inhabit. Disaster risk reduction requires a systematic approach and although difficult should be considered as part of the communication processes.

Mistake 2 'Skimp on audience research': people and the environments in which they live are extremely complicated. Investing in understanding people and the environment, and how the two interact is crucial to understanding them. Demographic information is helpful but it is only part of the picture. Understanding what motivates people and their priorities allows you to identify ways to help motivate them and make plans which may be outside normal messaging campaigns.

Mistake 3 'Create a snazzy product with no solid plan for change': There is a place for apps, maps, and other products and they are key to how we communicate risk, however they need to be linked to a solid plan for change. Ms Robinson reminded the audience that communication about risk is not a product, rather it is a process.

Mistake 4 'Avoiding conversations': Discussions around risk reduction happen at multiple levels, the personal/individual level and the community/governance level. We need to be having these often difficult conversations before a crisis happens. Sharing information also brings with it the risk of sharing misinformation, this is not a new concept, but one that is more prevalent nowadays. The proactive provision of information avoids the creation of knowledge voids, which are at risk of being filled with misinformation.

Mistake 5 'Be dull': Talking about disaster risk reduction doesn't have to be dull, especially if we are trying to communicate potentially abstract or complex issues to busy people. Communication should be engaging and relatable to peoples' daily lives.

Ms Robinson finished off her talk by summarizing that we are all in the same boat it often takes a joint effort by media professionals and technical experts, and that we should work together to communicate disaster risk reduction for action.

Following the keynote talk, the session facilitator Mr Chihara then opened the floor to discussions and interventions from GEO Members.

The European Commission opened the discussion by stating that Open Science is a priority for the European Commission and has been since 2014 and is expected to continue under a future new Commission. One of the many areas partnership and collaboration is around disaster resilience. An example of this is the Horizon 2020 eShape project which has just started with a number of pilots several on disaster resilience. As well as research, the European Commission has a number of operational services including the Copernicus Emergency Management Service (CEMS) which can provide rapid on demand mapping and an early warning and monitoring component. There are opportunities to integrate these services, and those from other GEO Members, to make them available and usable to other GEO Members and the wider disaster risk management community.

Mexico highlighted that the Sendai Framework for Disaster Risk Reduction must make use of Earth observations, and valued GEO's participation in the recent Global Assessment Report (GAR) 2019, and other mechanisms. Mexico also highlighted and supported the growing focus on disaster risk management within the 2020-2022 GWP.

The USA actively participated in GEO activities across the whole cycle of disaster risk management by providing risk information to communities when it is needed. The USA is actively involved in leadership in AmeriGEO and hosts two Supersites as part of the Geohazard Supersites and Natural Laboratories (GSNL) Initiative. The USA supports fostering enhanced cooperation across the Regional GEOs, and are looking to expand multilateral partnerships with other international agencies. The recent Open Geospatial Consortium (OGC) Pilots on using Earth observations for disasters was led by the USA and they invite other members of the GEO community to take part in the next phase of the Disaster Risk Reduction Pilots in 2020.

China shared some of their activities in the area of Earth observations for disaster risk reduction. China and they recognizes and regards space-based technologies as an important part of national disaster risk governance. China actively supports capacity building to support disaster risk governance, and international cooperation in space-based disaster prevention and reduction, this includes the hosting of several UN conferences on space-based technologies. China has recently provided data for emergency response, included for the cyclone in Mozambique and flooding in Laos. Satellite images have also been provided as part of the Chinese commitment to the International Charter Space and Major Disasters. Earth observations have a huge potential for disaster risk reduction, and China is looking to contribute to these efforts under GEO.

Japan focused on the need to convey Earth observations to people in a way that means they can take actions. There was also a focus on the integration of knowledge and how it should be passed to the community in an appropriate way. Japan also commented that the GEO community can act as a facilitator in this process to develop trusted relationships and help identify potential actions and solutions. Japan urged the GEO community to strengthen its role as a trusted facilitator for Earth observations.

Australia spoke on the wealth of knowledge that the GEO community can contribute to disaster risk reduction. This included highlighting the strong local and regional approach that is being undertaken by initiatives such as GEO-DARMA. Australia also commented that we should be focused on creating EO products that are of immediate use to the disaster risk reduction community. Engagement with communities at the right level is important for driving change, and we should consider how we approach developing in-country expertise to ensure that products we create are ready to be used. Australia noted that there could also be stronger links developed between the Earth observation community and the risk modelling community given the wide range of approaches to risk modelling. The availability and access to authoritative data is still an area where more consideration should be given.

Chile recalled that November 5th 2019 was World Tsunami Awareness Day, and spoke on their experiences, as a country that is exposed to a high level of vulnerability to hazards with a natural origin such as earthquakes, tsunamis, volcanic eruptions, and more recently with events such as drought or fire. Chile stated that disaster risk reduction is a national priority, and they are committed to working together under the Sendai Framework and through regional forums. Chile also highlighted lessons learned from dealing with recent disasters including the priority role of government states in responding to disasters through appropriate legislative mechanisms. This also included well developed and well understood disaster management plans at the local and regional levels. Different scenarios may cause disasters and there should be continuous research, data gathering, and modelling to enable quicker recovery from events. This includes strengthening the early warning systems and better links for simulation exercises, and regional early warning centres and processes that are continuously operating. Chile also welcomed the creation of the GEO Disaster Risk Reduction Working Group as a mechanism to coordinate efforts with the UN Office for Disaster Risk Reduction (UNDRR) and support the different GEO activities in this area. With regards to regional cooperation, Chile is planning on hosting an AmeriGEO DRR meeting in March/April 2020.

After the open discussion Ms Bonapace gave a presentation from the viewpoint of a GEO Participating Organization. UNESCAP is one of the UN's five regional commissions whose mandate is to promote regional cooperation, Ms Bonapace focused the talk on the perspective of the Asia and Pacific Region.

As part of a regional initiative UNESCAP mapped the risk landscape in the region and found action points that can build pathways for action, empowerment, and resilience. This was drawn together into a regional report called: The Disaster Riskscape Across Asia-Pacific - Pathways for Resilience, Inclusion, and Empowerment.

Ms Bonapace focused her talk on three key challenges for the GEO Community and the Asia Pacific region. These are:

- Data that is freely open and available;
- Data that is universally accessible;
- Data that is usable.

Ms Bonapace reaffirmed that as a community we all agree with the principle of freely open and available data, however we sometimes have difficulty with the details. Using the example of air pollution, which is a transboundary issue, satellite imagery can be used to see and track the levels of air pollution. The challenge comes when trying to use country-specific in situ data to ground truth and verify the data. This is often where data sharing stops.

The second challenge is around the accessibility of data, particularly as more data is being made available. This is especially important when you consider that many communities don't have access to high-speed internet connections. Ms Bonapace also discussed that one of the key steps to making data available, is to identify everyone and to know their profiles and data needs, this also helps with creating policies that leave no one behind.

The final challenge was to make sure that the data is useable. This can range from ensuring that data is provided in a user-friendly context through to popularizing the use of data and providing continuous training and support. This ongoing training and support is really important to some of the poorest countries in the region who are growing their in-house local expertise. Another aspect of data being usable is to make sure that the geospatial data needs of a broad range of policy makers is met. This often requires an understanding of different communities and disciplines. Good progress in the integration of geospatial information with other disciplines has been made with official statistics, however there are other disciplines, such as foreign affairs and finance organizations which could benefit from a better understanding of geospatial data.

Given these challenges Ms Bonapace suggested actions which could lead to the development of solutions to these challenges.

The main consideration is the development of partnerships. As an organization UNESCAP is focused on regional cooperation and partnerships. Some of the relevant key partnerships include the Asia-Pacific Plan of Action on Space Applications for Sustainable Development (2018-2030), the Regional Space Applications Programme, and the fact that UNESCAP is the Secretariat to the UN-GGIM: Asia Pacific Group.

Some of these partnerships are relatively new, however others, such as the Regional Space Applications Programme has been active for over 25 years. Each of the partnerships focuses on different aspects from local capacity development and the development of a toolbox approach to regional cooperation mechanisms, such as the integration of support between UN-GGIM: Asia Pacific and AOGEO.

The final consideration focuses on the challenges of digital connectivity and the need for universal internet access within the region. This is being delivered through initiatives such as the Asia-Pacific Information Super Highway which is focused on bringing affordable, reliable, secure broadband to all.

3.2 Panel session outcomes and recommendations

At the end of the session the facilitator Mr Chihara supported by Mr Ramage provided the following summary points for the talks and the interventions:

- Relevant communication of risk information is crucial to action including behavioural change (process not a product);

- Significant progress has been made in the use of open science for disaster risk reduction (such as eShape and the Copernicus Emergency Management Service [CEMS]);
- Growing future engagement of the GWP disaster risk reduction activities, and building on existing activities (such as UN-GGIM, UNOOSA, UNDRR, and the International Charter);
- Coordinated efforts within and among Regional GEOs is beneficial to the sharing of knowledge and experiences;
- For a number of countries DRR is a national priority, linked to the work of GEO and Sendai Framework. We should learn from past experiences and undertake future planning.

4 ACTION ON SUSTAINABLE DEVELOPMENT

4.1 **Session Objectives: Principals provide guidance on the actions that GEO needs to take to accelerate its efforts to support implementation of the 2030 Agenda for Sustainable Development.**

The Session took the form of an introductory keynote talk by an invited speaker, followed by a moderated open discussion with GEO Members. The session was closed with a presentation from a GEO Participating Organization representative followed by a summary of the discussions and key points.

The speakers included:

- Mr Sasha Alexander, Policy Officer, United Nations Convention to Combat Desertification (UNCCD), who served as Session facilitator;
- Ms Claire Melamed, Chief Executive Officer, Global Partnership for Sustainable Development Data (GPSDD);
- Mr Fang Chen, Deputy Director, Institute of Remote Sensing and Digital Earth, (RADI), Chinese Academy of Sciences;
- Mr Steven Ramage, Head of External Relations, GEO Secretariat (providing support to the facilitator and speakers).

Mr Alexander set the scene by explaining that as UNCCD he represents one of the three Rio conventions and that they are the custodian agency of the land degradation indicator SDG 15.3.1. At the last UNCCD Conference of the Parties (COP14) in Delhi in September 2019, they recognised the work of the GEO community.

Based on the discussion paper prepared by the GEO Secretariat, Mr Alexander invited delegates to focus their interventions on:

- Promoting coordination between national and regional GEOs, and national statistical offices to integrate EO into SDG monitoring and reporting processes;
- Identifying strategies for testing internationally accepted, EO indicator methodologies at country and regional settings;
- Establishing criteria for ensuring data quality standards and fitness for purpose for EO derived information for the statistical community;
- Applying new methods and tools, processes, and training approaches.

Ms Claire Melamed delivered her opening keynote by highlighting how GPSDD brings other networks together with the GEO community and that they work closely with the GEO Secretariat and the broader Earth observations network. She went on to explain that she thinks the SDGs are unique as a politically developed utopia, which was negotiated and agreed by the United Nations.

The question is no longer what we want, but how we get there. This is where Earth observations and other sources of data and information can provide insights and show how we live our lives. Claire then explained how Lake Chad has reduced in size by 90% over the last 40 years and the staggering impact this has on the lives of people. It's data that tells the story of this change over time.

Governments that we rely on to take informed decisions around the SDGs are very often not taking advantage of new technologies that can help provide insights and evidence. Some organizations are using data that was collected before the SDGs were even agreed. Claire highlighted that some of the official figures relating to deforestation lag behind reality. This really matters to support effective decision makers, such as farmers planting crops in areas that are not fertile. GPSDD, under the guidance of the UN Deputy Secretary General, Amina Mohamed, launched Data for Now, in conjunction with partners UN SDSN, the World Bank and UN Statistics Division. The goal is to increase the capacity of governments to use timely data and for timely data to become the norm, for example from mobile phones and satellites. The GEO community are key contributors including from programmes, such as Digital Earth Africa in the GWP. Success is all about partnerships, no single organization has the answer or can orchestrate all the steps required and the key to partnering is shared common vision or objectives.

The European Commission strongly supports work with statistical agencies, particularly through Copernicus services and EuroStat. Also trying to increase work on methods and this is where the Digital Europe programme is relevant. The European Green Deal is also important to shift behaviours – public administrations, businesses and citizens.

Japan reiterated the importance of Earth observations to support the SDGs and their support for the GEO initiative EO4SDG and work with major UN custodian agencies. Japan also supports broader SDG activities across the GWP, noting the importance of GEOGLAM and GEO Blue Planet to support monitoring and reporting of SDG targets and indicators.

Providing education to girls and women can change the landscape dramatically according to Australia and they point out that there should be a deliberate effort to include them in science technology engineering and mathematics known as STEM. The number of girls and women in STEM is extremely low and this underrepresentation is a crisis. Opportunities exist in the GWP to proactively engage girls and women at the community level and by introducing proven approaches to changing cultural norms and expectations with champions and mentors.

The Netherlands is contributing towards SDGs 1 and 2, zero poverty and no hunger, they currently have 25 projects running in 50 countries supporting 1m smallholder farmers. They propose following the ambition of the Global Commission on Adaptation (GCA)

and going for 10m or 100m smallholder farmers through collaboration including the private sector and financial institutions.

Norway supports an approach to finding concrete solutions to problems, underpinned by a knowledge-based management system. We need support from researchers to make use of technologies for decisions at different levels and continue to innovate. Consider public procurement and other financing of monitoring are technology-neutral, as well as increase cooperation across ministries and sectors. Norway also contributes to Space2030 and COPUOUS, and satellites for sustainable ocean economy.

Testing internationally accepted EO methods and standards is recognised by Mexico, as well as noting the gap between the geospatial and statistical community and encourage collaboration with regional GEOs and other communities to demonstrate the usefulness and value of Earth observations.

China has kicked off numerous programmes at multiple scales. For the implementation of GEOSS, China launched the Global Ecosystems and Environment Observation Analysis Report Cooperation (GEOARC) to provide knowledge for decision making with data openly available in the China data portal. For example for SDG15 supporting land degradation data sets are presented for central Africa and south America primary net productivity has decreased due to forest fires. For SDG 2 (Zero Hunger) GEOGLAM has been supporting food security. China calls for more cooperation and a knowledge hub to support the SDGs.

For the Agenda 2030 Ecuador has declared this as a national planning instrument, this includes the government working with others, such as civil society, academia and research institutes. There is also a statistical development plan for the reporting of SDG indicators to attain the closing of information gaps. In 2020 Ecuador will provide Voluntary National Review (VNR) as an update on progress against implementation SDGs, the next 10 years are important and the joint work of National Statistical Offices (NSOs) with Regional GEOs is essential.

Work done to preserve Costa Rica's rich and diverse biodiversity has global application to the climate crisis – the climate emergency. More action is required to reach the goals of the Paris Agreement, ice is melting, sea levels are rising, flood and drought are the new normal. Decarbonisation is one of the great challenges of our generation and Costa Rica uses renewable energy, wind power and hydro power. They have reduced deforestation. Costa Rica would like to be an exemplar to other GEO Members relating to the achievement of the SDGs.

The USA has contributed to the development of workflows that support freshwater ecosystems, marine pollution, land use change and other areas. The development of new indicator methodologies and tools for Earth observations are still needed. Discussions with national statistical offices are moving to topics of trust, for example relating to timeliness and data quality. The USA supports national responsibilities for the SDGs, collaboration with the private sector and relevant international organizations, such as GEO. The USA encourages the GEO community to inform the GEO Secretariat what they would like to see in an SDG Toolkit.

India has also been working on the SDGs for many years, supporting efforts by GEO and CEOS (ISRO is serving as CEOS chair for 2020). India has developed an institutional

framework to work across ministries. Capacity building is essential to GEO's work in the area of the UN 2030 Agenda.

Fang Chen then spoke to his organization's experience in supporting the SDGs. Firstly, the Chinese Academy of Sciences (CAS) developed some methodologies for monitoring progress against the SDG indicators, but there are still large gaps in this area. Secondly, it is not easy to find high quality data relating to the SDGs for developed or developing countries. Finally, the data and the methodologies are created and held by numerous parties, there is a lack of a single place or body to hold all of this information.

Mr Chen then described the Technology Facilitation Mechanism (TFM) developed by the United Nations to support the achievement of the SDGs. This was developed to strengthen coherence and synergies among science and technology initiatives within the UN system. He then introduced work done to support Earth science data and the SDGs via CASEarth, a big data engineering programme, which is a research strategic priority of CAS. They worked on 6 goals to develop good practice: SDGs 2, 6, 11, 13, 14 and 15, and to transfer information to knowledge. One outcome was a report for the SDG Summit in September 2019 called "Big Earth Data in Support of the Sustainable Development Goals". The closing statement referenced the need for collaboration and international efforts in the Digital Belt and Road (DBAR) programme.

The Lead Co-Chair asked about the different levels to be considered, global, regional, national and local. Cambodia then made a point about the difference in resolution between national and regional levels, as well as the need for funding mechanisms to support poorer countries, for example with the open data cube.

4.2 Panel session outcomes and recommendations

At the end of the session the facilitator Mr Alexander supported by Mr Ramage provided the following summary points for the talks and the interventions:

- Relevant actions on SDGs underway by many GEO Members, e.g. China, Costa Rica, Ecuador, Japan, Mexico, the Netherlands, Norway and USA;
- Ongoing activities in the GWP and by partner organizations, e.g. GEOGLAM, GFOI, GPSDD, SERVIR, UN COPUOS, UNDRR, UNSD, UN-GGIM;
- Focus on increased coordination with Regional GEOs and also with National Statistical Offices (NSOs), and other initiatives such as Data For Now;
- Focus on establishing criteria for ensuring practical guidance for EO-derived information for the international statistical community;
- Support indicator development for the Sustainable Development Goals (SDGs) and increased transparency in follow up and review process;
- Develop new methods to highlight value and practical guidance, through input to GEO SDG Toolkit, and linked to knowledge-based management systems;
- Provide inclusive and quality education for girls and women – support inclusion of STEM in GEO SDG work.

Meeting adjourned at 5:30 pm.

Thursday, 8 November 2019

Meeting convened at 09:00 am.

5 BROADENING THE IMPACT OF EARTH OBSERVATION AND GEO**5.1 Introduction to Session: The main objective of this session was for the GEO community to determine how GEO will accelerate its impact through enhancement of key relationships and implementation of targeted strategies.**

This session comprised several speakers addressing specific topics. Each speaker remained on stage for a question and answer session after their talk.

The speakers included:

- Facilitator: Li Pengde, Representative of Lead Co-Chair China;
- Economic Impact: Nicholas Davis, Director, SWIFT Partners, World Economic Forum (WEF);
- Regional Impact:
 - Phoebe Odour, RCMRD AfriGEO;
 - Angelica Gutierrez, NOAA – AmeriGEO;
 - Xingfa Gu, RADI – AOGEO;
 - Gilles Ollier, European Commission – EuroGEO;
- Local Impact: Valrie Grant, GeoTechVision, Jamaica;
- Engaging and Enabling Communities: Rolando Ocampo, UN Economic Commission for Latin America and the Caribbean (ECLAC).

5.2 Economic Impact

Mr Davis spoke first on broad economic impact, linking it with emerging technology and partnerships. He posited that GEO is making the Fourth Industrial Revolution both real and inclusive. This refers to the activities of the GWP being linked to outcomes for the collective good. He mentioned that this was apparent if you had read the 2020-2022 work programme and saw the alignment with international policy instruments, such as the UN 2030 Agenda. He gave an example of one community activity, Digital Earth Africa, where the World Economic Forum carried out some analyses of potential economic benefits. It is estimated that a potential \$900m worth of annual cost savings in illegal mining can be made using the Landsat and Sentinel open data resources. They also estimate that by creating public good, i.e. through the work of GEO and developing such public infrastructure can increase opportunities in Africa and offer an additional \$500m in market growth.

The topic of partnerships was then addressed, namely partnerships to deliver, amplify and sustain Earth observations by bringing diverse communities together. He concluded by stating how important it is to partner with the non-traditional actors and how GEO and WEF have come together to work on Earth observations as a global, public, digital good.

Australia highlighted that they have just launched a study on the Impact of Earth Observations on the APEC Economies with a value figure for the application of EO at \$375b for the APEC region. The growth estimates in the next 20 years, i.e. by 2040 go beyond \$1trillion. At today's value, it is \$20b in Australia and estimated to grow to \$66b by 2030. It is important that we continue to integrate all sectors of the economy with Earth observations, for example agriculture technologies, insurance and financial technologies. It's also important that we highlight the central role that Earth observations play in multilateral economic cooperation priorities and driving inclusive and sustained economic growth, which is of interest to all countries in GEO.

Finland asked about the speaker's experience with value trees and understanding the complexity of value. Mr Davis responded that in some of their work (WEF), the gains have been in tax or fiscal revenue. There is also value around private versus public sector and the availability of open data, which supports local capacity development and entrepreneurial activities.

The United States of America highlighted the role of Earth observations to bring about many different, positive societal outcomes. Understanding and quantifying these outcomes is critical to EO planning, prioritisation and product development. The value or worth of the information depends on many things, for example the ability to use the information for better decisions regardless of the precise accuracy or timeliness of the data, also perceptions of the users of the data are important. We have seen the economic dividends provided by EO data, the USGS study in 2019 found that Landsat open data annual benefits resulted in \$2bn for the United States and \$3.5bn globally; Digital Earth Africa is one example of using Landsat overseas. The EO data collected from NOAA and weather satellite agencies around the world are also essential for daily decisions by people, businesses, academia and governments.

Netherlands asked about how to develop a market based on the value of EO. Mr Davis suggested working closely with application providers or developers, for example Geoscience Australia. The second set is with community capacity building, working as close as possible to the people that need to benefit, such as a farming cooperative.

Switzerland talked about the social economic impact of Earth observations and whether or not GEO should support socioeconomic data in the future. Mr Davis suggested that it makes sense and invited the Gilberto Camara, the GEO Secretariat Director to comment. Mr Camara agreed that socioeconomic data requires a higher profile, but also added that GEO should be able to do impact assessments. He suggested that this is a higher priority for him, but noted that this cannot be done without socioeconomic and in situ data. Mr Camara closed by inviting all GEO members and participating organisations to bring their approaches to impact assessment into the GWP.

5.3 Regional Impact

In line with the 2016-2019 Report on Impact developed by the GEO Secretariat, Mr Li introduced the next session comprising leaders from each of the regional GEOs. They were invited to present a short success story from their region and speak about regional impact. This was to agree on actions GEO should take to better exploit the role of Regional GEOs, and their ability to connect GEO to additional countries and communities.

The first speaker on was Phoebe Odour from AfriGEO who spoke about the use of crop monitors in Africa via GEOGLAM. This started as a continental product then regional and has been downscaled to national level for Kenya, Rwanda, Tanzania and Uganda. Although initially for crop monitoring it is now used for early warning. She talked about the impact that planning for disasters had on market price, including informing insurance companies, helping warehouses plan and controlling crop pests. A powerful case study was provided where GEOGLAM enabled Uganda to trigger World Bank Disaster Risk Financing to help more than 150,000 people in Karamoja.

Next up was Angelica Gutierrez from AmeriGEO who talked about building and strengthening partnerships at the international and local level, including new GEO members El Salvador and Guatemala, new participating organisation Red Clara and existing partners, such as SERVIR. She then talked about open data policies and how the number of portals has grown from 7 to 19 over the course of the development of the AmeriGEO Platform in the last two years. Infrastructure is also supporting capacity building, for example through GEONetCast. When AmeriGEO was created in 2014 there were 20 ground stations today there are 89 stations. AmeriGEO week has enabled knowledge transfer and technical skills development for government staff in the region.

The third presenter was Mr Xingfa Gu from AOGEO. He spoke on behalf of the four co-chairs from China, Australia, Japan and Korea. The annual AOGEO workshop and symposium continue to be effective and now they have more than 90 young scholars from 14 countries in the region that are financially supported to participate. They also developed a new fellowship programme and Toshio Koike from Japan was the first recipient of the Fellow award for his contributions to Earth observations. He then highlighted another innovation in AOGEO, which is the Integrated Priority Studies in three areas. This is monitoring environmental changes in the Lower Mekong River Basin, Himalaya Mountains and the Pacific Islands. This exercise is done using EO data from the region, including Kompsat, ALOS and Gaofen, as well as international open data from Landsat and Sentinels. He closed by sharing some of the activities AOGEO is doing with other regional GEOs, including the climate change side event with EuroGEO in the preceding days at GEO Week 2019.

The fourth and final speaker was Gilles Ollier from EuroGEO. Since its launch in 2017 EuroGEO has provided a platform for the exchange of products, services and knowledge across many different players in Europe. This collaboration has been supported by a policy of data sharing, most notably around open data, such as Copernicus and the European Open Science Cloud (EOSC). A short video was then shown on wildfires and how Earth observation helps to monitor the extent of fires and burnt areas. It explained the EODESM: Earth Observation Data Ecosystem Monitoring System model in the Virtual Laboratory (VLAB) working across many different European organisations using the Copernicus DIAS and the EOSC. The Trends.Earth tool was also used to look at the Sustainable Development Goal (SDG) indicator for land degradation neutrality.

Japan provided the first intervention outlining how regional collaboration can support global goals, particularly using their experience with Sentinel Asia and addressing disaster management activities in the Asia Pacific (APAC) region. JAXA has provided ALOS data to more than 75 requests from countries in APAC.

At their first GEO Plenary meeting, Tonga provided some ideas about outreach for GEO by highlighting their involvement at the World Geospatial Information Congress in China, also recognising the work of USGS, Geoscience Australia and the GEO Secretariat. The outcomes from GEO Week 2019 and notably the Pacific Islands Programme will feed into the regional activities going forward, including the annual conference on remote sensing. Both SPC and SPREP were recognised for their efforts in the Pacific region.

Based on experience from the SERVIR programme, the United States of America suggested a network of regional GEOs. The SERVIR network links with AfriGEO, AmeriGEO and AOGEO. Examples of collaboration were provided for the Mekong region working with the Himalayas on a drought information service, as well as the West Africa water mapping service working now in East Africa and with AfriGEO. Regional GEOs are encouraged to organise meetings to work across regions.

Also at their first GEO Plenary CEDARE intervened with an offer to work with AfriGEO and more countries, they are involved in GMES and Africa marine activities. They are also the North Africa focal point for the Global Environment Outlook.

South Africa made a statement to continue to support the AfriGEO Secretariat currently hosted by RCMRD (Nairobi, Kenya) through their Department of Science and Innovation. SANSA has also established an EO research, development and innovation fund. The Intra-Africa Space Programme will support industry nationally and regionally, as well as research collaborations across AfriGEO. They would also like to strengthen partnerships with other regional GEOs.

Switzerland is a strong supporter of EuroGEO and highlighted strong support from participating organisations, including ESA and EUMETSAT.

There then followed a question from Costa Rica about the main priorities for the regional GEOs for 2020. EuroGEO will strengthen efforts on data and knowledge sharing, as well as continue to work with other regional GEOs. AmeriGEO will strengthen National GEOs, also work with thematic initiatives and partners (participating organisations). AfriGEO wants to increase GEO membership in Africa, strengthen coordination, increase resource mobilisation and capacity for African countries, champion more youth and women engaged in GEO and deliver against sustainable urban development, forestry, food security and water. AOGEO will continue with the Integrated Priority Studies, work with other regional GEOs and bring in more countries in the region to AOGEO and contribute to global GEO.

Finland introduced Arctic GEOSS where there is already involvement from Canada, China and the USA, stressing that this is an area where regional cooperation is essential and that Europe has already committed \$50m for a project.

5.4 Local Impact

The next session was on local impact and Valrie Grant from GeoTechVision, Jamaica was the presenter for this session. Valrie started by describing that knowledge does not mean understanding and that knowledge without action is useless. She outlined that data access, education and innovation are all important, and that to deliver in these areas it requires strategic partnerships, professional expertise and institutional support. Some examples of local action were provided around the use of EO for mangrove restoration in

Guyana and a shore zone management system; also in Trinidad on land availability. Other examples included coral reef monitoring in Florida, an environmental health project in Barbados and a road safety project in Guyana. Youth engagement has been carried out through the UAV Summer Camp in conjunction with Jamaica Flying Labs and GeoTechVision where they are tackling local challenges; Fly Like A Girl was also a special drone camp for girls.

Disaster management is a major issue in the Caribbean due to hurricanes and other natural hazards, Valrie provided additional examples of the important use of Earth observations in this arena. Following Hurricane Matthew, there was a request from the World Bank to fly some drones to look at the extent of the damage in St Maarten, as well as what had already been rebuilt. Another building activity is underway through the GIRI – Geospatial Information Research and Innovation group at the University of the West Indies (UWI), they are developing a community of professional mappers based on Esri software. Three pillars of growth were also highlighted as strategic partnerships, training and education, and new users. Through these pillars it is hoped to find sustainable solutions to local and regional challenges, reach new users and communities, make an impact via contributions to the UN 2030 Agenda and help facilitate engagement with small and medium-sized enterprises (SMEs); this last activity is supported through work in the UN-GGIM Private Sector Network and UN-GGIM Americas. GEO is requested to help with the empowerment of government institutions and financing projects that can be piloted and scaled at different levels.

The United States of America acknowledged the work of GEO in the area of local impact, notably ongoing work with indigenous communities and first observers. Mr James Rattling Leaf was introduced to provide his perspective as a member of South Dakota's Rosebud Sioux tribe. He spoke about combining traditional knowledge with geospatial science, data and technology, as well the continental scale restoration programme for buffalo in North America and the positive ecosystem effects.

Greece mentioned the role of national GEO nodes and offices in this area, particularly downwards towards users or upwards to work with regional GEOs. For example, EuroGEO can facilitate improved working of national nodes, including increased collaboration with the private sector.

First Earth observers were the indigenous community in Australia and this was recognised. We can learn from their perspective, their expert local knowledge. This is particularly recognised in the Pacific Islands Programme and the Talanoa Dialogue is an exemplary approach where active listening is required. The Indigenous Hackathon also brought together teams from different continents that were mentored by indigenous elders; the winners of the hackathon were from Team Triton from Australia National University (ANU) who developed an app to support intergenerational cultural exchanges.

5.5 Engaging and Enabling Communities

The final session was engaging and enabling communities with the plenary talk delivered by Rolando Ocampo from the UN Economic Commission for Latin America and the Caribbean (ECLAC). He spoke about enabling engagement around the GEO engagement priorities and other key actions areas, notably with the statistics community and relating to ecosystem accounting. He started by explaining the activities of the Working Group

on Geospatial Information (WGGI), which supported the Inter Agency Expert Group (IAEG) on SDG Indicators. There was work done to review the use of Earth observations with SDGs 6, 11 and 15 involving the UN custodian agencies, UN Environment, UN-Habitat and UNCCD. This also involved working with the Joint Research Centre (JRC) of the European Commission, Google and EO4SDG, as well as with countries including Benin, Brazil, Colombia, Egypt, Fiji, Mexico, Mongolia, Peru, Philippines, Senegal, Uganda, Uruguay and Zambia.

Over the last three years there has been progress in this area, for example the statistical community in Latin America has been working on geospatial data information integration with national statistics including collaboration with UN-GGIM Americas and the Statistical Commission of the Americas, where AmeriGEO is also invited to participate. There is also work ongoing for MEGA – a statistical geospatial framework for the Americas. There was also support provided for a Caribbean project on land use, capacity building and technology transfer. Country specific examples were also provided, specifically for the work on the Open Data Cube by Mexico.

For ecosystem accounting Mr Ocampo introduced the recently launched NCAVES project: Natural Capital Accounting and Valuation of Ecosystem Services, which aims to improve measurement of ecosystems and their services while incorporating biodiversity and ecosystems in planning and implementation policies. This work is aligned with the GWP activity EO4EA: Earth Observations for Ecosystem Accounting. Country examples were also provided in this area, namely Colombia and Costa Rica both working on forestry and water resources/accounts. He then closed his talk by summarising the key aspects required at national and regional level. This included strengthening national governance to link the Earth observations and statistical communities with the agencies responsible for the UN 2030 Agenda in countries, promoting alliances with academia and research institutes, dissemination and development of capacity around methods and tools for processing and using Earth observations. At the regional level it was suggested that there is closer links between roadmap developments, sharing of good practice around the use of statistical information and Earth observations, as well as continuous improvement of tools relating to the SDGs.

The Australian Bureau of Statistics (ABS) highlighted the milestone of having a presentation relating to the statistical commission from Latin America. It's imperative that alternative data sources are available to complement statistics and Earth observations offer value in this area. Statistical agencies can also provide historical information as field observations; ABS is already working with Geoscience Australia in this way. The Global Statistical Geospatial Framework from the UN system is important to provide guidance on how to integrate statistics with Earth observations.

China highlighted that GEO has always wanted to support institutional strengthening. A point was also made about the global Internet community and bringing more of this community into GEO was proposed. It is also important for GEO to integrate with the digital economy.

In terms of global communications infrastructure and services, GEANT is part of GEO to help support this activity. An example was shared of NREN working with Copernicus to support the global Earth observations community. GEANT connects over 100 countries through 43 national research networks; they are behind Eduroam and Edugain.

Community services represent one of their ongoing activities and they are also working as part of the European Commission NextGEOSS.

CEOS raised the issue of floods and droughts, per the message of UESCAP from the previous day at Plenary. It was highlighted that space-borne data, analysis ready data, geospatial tools and capacity development can all help tackle these issues. CEOS is also supporting GEOGLAM and GFOI, and is also supporting disaster and climate; coastal regions are another area being assessed in the scope of climate change. These activities would undoubtedly benefit from the involvement of the wider GEO community.

Ecosystem accounting translates natural capital into the language of statistics according to Conservation International. A systems level shift is required to meet the requirements of the SDGs. How can we fast track work on ecosystem accounting? Earth observation provides the means to systematically and repeatedly track these activities. EO4EA is a key activity to further the development of EO for natural capital accounting, connecting the EO community with ecosystem accounting community. The US government was thanked for their support of the EO4EA Secretariat. The Global Environment Facility (GEF) is already very active in this area helping governments to mainstream nature into decision making through natural capital accounting programmes. Liberia, CI and NASA are working together on a GEF-funded programme for ecosystem services. EO4EA plans to better link platforms, plans, programmes and tools for ecosystem accounting.

Mexico thanked ECLAC for their presentation and support in the region, notably their involvement in development and promotion of the Global Statistical Geospatial Framework and the Integrated Geospatial Information Framework. A meeting is planned in Santiago, Chile to bring together mapping and statistical agencies.

The Chair then invited Steven Ramage from the GEO Secretariat to provide a short summary of the talks:

Economic impact:

- Technology, partnerships & economic impact, Landsat example of \$2bn USA \$3.5bn overseas, plus higher APEC analysis figures: need to understand figures & societal impact;
- GEO is making 4IR real and inclusive (Fourth Industrial Revolution).

Regional Impact - Advances noted in:

- GEOGLAM crop monitoring and early warning;
- Partnership, policy, use & knowledge transfer;
- Regional GEO collaboration/AOGEO growth;
- Copernicus and European Open Science Cloud;
- JRC, ESA, EOSC working together and with Regional GEOs;
- Building on work with National GEOs;
- Bringing in new members, increasing capacity and funding, as well youth/women engagement;
- Integrated Priority Study focus and work across Regional GEOs.

Local Impact - Key issues:

- Provide meaningful access to knowledge;

- Work on mangroves and coral reefs very important to local ecosystems and economy;
- Supporting youth via UAV Summer Camps;
- Focus on disaster management, e.g. communicating hurricanes to local population.

Engaging and enabling communities – Progress made with respect to:

- Engagement with official statistics community through IAEG SDG;
- 2016 to 2019 development of ECLAC on integration of geospatial and statistical info;
- Partnership through ECLAC, UN-GGIM Americas and the UN-GGIM Committee of Experts (Sec);
- MEGA platform is open geographic portal, also Open Data Cube;
- Capacity development has been across all ECLAC region;
- UNSD, UNEP, CBD and EU ecosystem accounting : EO4EA aligned.

6 IMPLEMENTING A RESULTS-ORIENTED GEOSS

6.1 Introduction of proposed strategy to implement Results-Oriented GEOSS

The Secretariat Director provided an update to the work that had been achieved by the Expert Advisory Group (EAG) on the proposal for a GEO Knowledge Hub (GKH) as part of the framework for a results-oriented GEOSS. He noted that the Executive Committee, at its July meeting, had provided feedback and guidance on the framework, and in particular called for a proof of concept for the GKH to be delivered to the GEO-XVI Plenary. Following from discussions at the 49th Executive Committee held the day previously, he emphasized that the decision currently before Plenary was whether, after taking note of the proof of concept demonstration, to delegate authority to the Executive Committee to take a decision on moving forward with development of the GKH at their 51st meeting in March 2020, based on a GKH implementation plan that the Secretariat has been tasked to draft over the next few months.

He then gave a presentation to set the scene, in which he noted that Earth observations were beginning to receive attention at the highest political levels, including the G7. The question before decision-makers when faced with societal challenges is: how do you know? On what basis to you take decisions? Given the power of Earth observations – there are no secrets anymore, thanks to global satellite imagery - politicians are increasingly aware of the need for continuity of observations and continuous innovation in sensor technology. And yet, given the ease with which false information can circulate, trust is the key: how can decision makers place confidence in the information, products and services that are increasingly available? This is the niche that the GKH is trying to fill, that of a trusted, authoritative information for decision making. The GKH will function as a digital library containing “recipe books” for reproducing and scaling up the Earth observation applications for societal benefit globally. These open source solutions will be vendor independent and take advantage of the zero download model of the new digital economy, where big Earth observation data is queried and analysed on the cloud, eliminating the need for costly and quickly-outdated computing infrastructures at the national level. Advances in technology, coupled with the convenience of cloud

computing, thus will lower the barrier to for governments, particularly those of developing countries, to access and apply Earth observations.

Ms Paola De Salvo, GEO Secretariat Information Technology Officer, then proceeded with the GKH proof of concept demonstration. She started her presentation by asking the question: where is knowledge? Looking at the GWP, there is a wealth of useful Earth observations applications being produced by the community through Flagships, Initiatives and Community Activities. The GEO Community has a great opportunity to broaden and secure access to its knowledge.

The knowledge behind the Earth observation applications is composed of numerous elements which can be referred to as knowledge resources. Key knowledge resources of a given Earth observation application include: the research publications, algorithms, models, codes and software to execute them; remote sensing and in situ data; cloud working environments; and training materials. All of these knowledge resources reside in different platforms and in different formats. Thus the challenge to the GEO community has often been these knowledge resources are scattered, hidden and/ or difficult to access, which makes it hard for a user to replicate or re-use an EO application. Through the development of the GKH, the GEO community has the opportunity to provide the entire set of Knowledge resources mediated and organized into an integrated end to end solution which would be enhanced by leveraging cloud computing environment. By including the Cloud based working environment in the research working practices of the GEO Community, the entire community would benefit of the long term discoverability, accessibility and re-usability of all the knowledge elements developed by activities of the GWP. The organization of the knowledge resources in the GKH will provide the user with a single entry point and a smoother access to a full suite of those components necessary to understand, reproduce and scale up the Earth observation application, leading to impacts. The mediation process, performed by the knowledge provider together with the GEO Secretariat, is crucial in order to transform a disparate set of knowledge resources into a complete knowledge package of trusted information.

In the process of designing the proof of concept of the GKH, special attention had been given to 3 essential parameters:

- Leveraging existing components and already made efforts of the GEOSS Infrastructure such as the GEOSS Platform and its multitude of Data made openly available by the Data Providers;
- The possibility for the user to run the available services directly in the cloud environment leveraging multiple Clouds computing infrastructures;
- The possibility for the user to run services without having to download EO Data (the zero download model).

The Sen2Agri Earth observation application developed in the framework of the GEOGLAM Flagship, was selected as the case study for the proof of concept. Sen2-Agri is an open source system designed to provide access to Sentinel 2 data, complemented as needed by Landsat 8 for local to national operational agriculture monitoring. Within the Sen2Agri, there are four outputs products of which the Cropland Mask product has been selected. A cropland mask is a map showing the presence and absence of crops over a given area. In close collaboration with the Knowledge Provider (Université catholique de

Louvain, Belgium, and GEOGLAM), the knowledge resources required to reproduce the Cropland mask, have been identified:

1. The research publication which contains the methodology and the description of the product;
2. Input EO Data:
 - a) Remote sensing Sentinel 2 time series complemented with Landsat 8 data;
 - b) In Situ with samples of existing crops to train the algorithm.
3. Training Material and full documentation;
4. Access to the free open software and open code to be run locally or in the cloud computing environment in the zero download model;
5. The output product: cropland mask.

Ms De Salvo then provided a live demonstration of how a technical expert in a developing country looking to reproduce the EO application of a cropland mask for his own country would discover and access the cropland mask knowledge package, starting with a search in the GEOSS Portal. The Sen2Agri software included in the package was available to be run, in this specific case study, on an Amazon Virtual Machine cloud computing environment by any user who has Amazon Web Services credentials.

Ms De Salvo concluded the demonstration by noting that the establishment of the GKH will require the full commitment of all players along the information chain, as well as a change in focus across the GEO community regarding the open science aspects of the research process. She recommended the establishment of GKH Focal Points for each of the GEO Flagships, Initiatives and Community Activities, to work in close collaboration with the Secretariat, the GEO Infrastructure Development Task Team and the GEO Programme Board.

6.2 Interventions from Delegations

The Chair then opened the floor for comments.

China noted that it has been endorsing idea of results-oriented GEOSS for some time, and realizes its importance for promoting Earth observations for decision-making. The issue has been how to best realize this objective. China sees GEOSS becoming the integrator of data and production of information, and could providing funding support to its scientists along these lines. Also, Earth observations systems raise issues related to standards as reliable information requires that each pixel be geo-spatially aligned. The scalability of cloud computing is a very welcome prospect, and China wishes to work with all interested colleagues to help build the GKH.

The European Commission thanked the Secretariat for its work in developing the GKH concept, and wished to underline that development of practical tools for the research community will add value to what GEO does. The Commission reminded Plenary that the decision before them was not whether the GKH will happen, but rather how to take further development forward. The Executive Committee directed the Secretariat to submit an implementation plan for the GKH to the 51st Committee meeting in March 2020 for decision. The implementation plan will need to be as concrete and comprehensive as possible, including resources, the role of the Secretariat, and whether

there may be competition with other priorities. The Commission was glad to see that the GKH would be built on what currently exists, noting that there are many initiatives of this type, some of which stumble because of lack of resources. Thus, the GKH needs to be a collective project engaging the full GEO community.

South Africa extended its congratulations to the Expert Advisory Group (EAG) and to the Secretariat for laying the GKH groundwork. South Africa sees the GKH as helping the GEO community to build trust, and a true realization of the GEO strategy for capacity development. The concept of data democracy had been introduced by South Africa and the GKH will ensure that critical strides are taken towards uptake of Earth observations. South Africa has taken note of the proof of concept demonstration, and endorsed the proposal of the delegation of authority to the Executive Committee to decide on further development.

The United States of America remarked that GEO continues to add value, appreciated the proof of concept presentation, and supported the GKH framework as it is firmly based on the GEO Strategic Plan. The US was happy to see work devoted to transferring of research to applications, noting that the water community in the US has considerable expertise in converting research to public operations based on Earth observations and credible models. The US concurs that publically funded research should be broadly disseminated for reproduction to ensure longevity of results, and thus encourages the open science approach. The US fully supported the proposal to further explore development of GKH.

France commented that, although the GKH is a good idea in principle, the proposal raises many questions and needs further discussion pertaining to how the GKH will be implemented, governed, financed on ongoing basis, handle transparency, and ensure access will remain open for the benefit of all. France recommended that experts on the topic of open science should be mobilized so that links between science and public utility remain open.

Costa Rica expressed the hope that environmental system accounting information would be included in the GKH since this is a powerful tool that can provide valuable information to decision-makers. Ecosystem accounting applications need to be shared, along with development of capacity to use them.

Germany thanked the Secretariat, expressed appreciation for the progress made, and has taken note of the proof of concept. Germany agreed that it is important for GEO to share knowledge created within its activities, and communications and partnerships are crucial for this. In Germany's view, more time was needed to reflect on the appropriate architecture and operational realities for GKH development, and that further enhancements to the GEOSS platform for data access must not be forgotten. Germany also stressed the importance for having the GEO Programme Board provide inputs on GKH development.

ESIP remarked that the power of GEO is way in which the entire community cooperates and collaborates. ESIP would be happy to apply its data training clearing house to support and promote the GKH.

The United Kingdom thanked the Secretariat for taking forward the concept of a results-oriented GEOSS, a notion anchored in the GEO Strategic Plan. The UK supported the

proposal to further develop GKH implementation plan for submission to the March 2020 Executive Committee. The UK considered that transparency of relationships between the GKH and commercial providers was essential, along with estimates of costs and resources required to implement GKH, including ongoing maintenance and curation.

Italy observed that, although the GKH could bridge the gap between data and knowledge across different domains, there was still a need to have a more comprehensive implementation plan for decision by the Executive Committee in March 2020. In particular, Italy would like to see the plan address governance clearly, sustainability in terms of financial and human resources, and linkages to the GEOSS Platform.

The Secretariat Director took of the points raised by Plenary, including: long-term sustainability; implications of Intellectual Property Rights (IPR); integration with the GEOSS Platform; provision of concrete steps towards development; and engagement with governance entities of GEO such as the Programme Board. The Director noted that he will work with the Programme Board to attain their full support for the GKH implementation plan that is submitted to the Executive Committee for decision in March 2020. He concluded by extending his personal thanks to Plenary for their inputs and acceptance to move forward with plans for GKH development.

6.3 Next Steps

The Chair summarized by noting that, based on interventions, Plenary accepted the proposal for the GEO Secretariat to develop an implementation plan for development of the GKH, in consultation with the GEOSS Infrastructure Development Task Team and the GEO Programme Board. The GKH implementation plan will then be submitted to the 51st meeting of the Executive Committee for decision.

7 DELIVERING ON THE STRATEGIC PLAN – THE GEO WORK PROGRAMME

7.1 The role of the commercial sector in the delivery of GEO’s vision

GEO Programme Board co-chair Ms Yana Gevorgyan, NOAA, USA opened the session by recalling that the GEO 2015-2016 Strategic Plan: Implementing GEOSS made specific reference to engaging with the private sector which, in the GEO context, included the commercial sector.

Ms Eva Rodriguez (FrontierSI) and Mr Yuxiang Wang (Beijing, Piesat) were then invited to provide summary highlights of the Industry Track sessions being held during GEO Week 2019. They recalled that the aims of the Track were to:

- Recognize the important role the commercial sector already plays in contributing to GEO’s work and objectives;
- Bring together world’s leading tech, space and geospatial companies to GEO Week 2019;
- Provide unique opportunity for private sector to promote their capabilities;
- Enable building stronger relationships between commercial companies, public sector, Earth Observation users and the overall GEO community.

With a focus on fostering partnerships, the Industry Track established that:

- governments cannot do it all alone, but rather serve as an enabler and beneficiary of working with the private sector;
- there are multiple opportunities to tap into the huge reservoir of data collected by the private sector and end users;
- collaboration is key for building capability, education, awareness and knowledge sharing;
- it is critical to move from the current R&D project base scenario to having operational services and solutions that are sustainable;
- there is a need to focus on the human aspect: building trust through partnerships particularly at regional and country level.

In conclusion, Ms Rodriguez noted that:

- GEO Week 2019 Industry Track had been a success exceeding expectations;
- It had been important in creating opportunities for GEO Delegations – including Plenary attendees – to talk and truly engage with industry;
- GEO should further consider the voice of industry during the creation of its program of work to ensure a sustainable program, that is well informed and considers all aspects of EO activity and innovations in the public and private sector.

Ms Gevorgyan then informed Plenary that, in keeping with goal of the GEO Strategic Plan to engage the private sector, the GEO Secretariat issued an Announcement of Opportunity on 24 September 2019 in which companies that provide cloud-based geospatial processing platforms were invited to offer data access and processing credits to the GEO community in order to develop Earth observation applications for sustainable development. The response had been very positive with enquiries from several companies including: Amazon Web Services (AWS), Google Earth Engine (GEE), Sinergise, Meteorological Environmental Earth Observation (MEEO), Mundi – DIAS, Earth Observation Data Centre for Water Resources Monitoring (EODC), Sobloo/Airbus and Microsoft Corporation. This effort is ongoing and it is hoped engagement will continue through these open opportunities.

Next, Ms Ana Pinheiro Privette, Lead for the Amazon Sustainability Data Initiative, spoke about the successes of the GEO-AWS Earth observation cloud credits programme, in which proposals from 21 developing countries were getting underway and starting to make use of their allotments of USD\$ 1.5 million in AWS cloud credits. She also announced support for democratizing access to sustainability data through the Amazon Sustainability Data Initiative which was offering to provide 4 Terabytes of data storage free of cost to handle the Earth observation data needs of Digital Earth Africa.

Last, Ms Rebecca Moore, Director of Earth Outreach, Google Earth, outlined the GEO-Google Earth Engine Programme, which aimed to close the gap from Earth observation data and science to solutions at scale. The outlines of the programme, to be formally unveiled in the coming weeks, included:

- Global programme available to GEO Members and Participating Organizations;
- Impact focus: operationalize environmental & developmental applications aligned with GEO priorities;

- Up to 25 applicants chosen;
- Selected applicants receive, at no cost:
 - Full Google Earth Engine license (no restrictions on usage) for a 2-year period;
 - Technical support, capacity development provided by EO Data Science.

7.2 The Impact of the first GEO Work Programme

Programme Board co-chair Mr Ivan Petiteville, ESA, summarized the impacts of the 2017-2019 GEO Work Programme (GWP) by first commenting that a coordinated, collective response was needed from the entire GEO community to help countries respond to societal/environmental challenges that transcended borders. He noted that the GEO community had worked hard to foster partnerships, and that the trend towards the provision of open Earth observation data had increased, globally. Around the world, GEO was delivering information and knowledge to help find sustainable solutions to global challenges. As a result, Earth observations were increasingly being taken up into strategies and approaches to disaster risk reduction, climate mitigation and adaptation, sustainable development, and other uses. GEO has been achieving its goal of supporting global policy with Earth observation information and knowledge, as well as major stakeholders such as the United Nations and regional development banks.

A video then was shown, featuring examples of how GEO is making advances in providing science-based evidence for policy-making, and how it integrates the state of the art in technology to turn Earth observation data and information into knowledgeable actions. The video featured the GEO-AWS Earth observation cloud credits programme; open data cube technology; Digital Earth Africa; GEOGLAM for food security; GEO BON / regional BONs for biodiversity monitoring and protection; GOS4M in support of the Minamata Convention; and GFOI for forest monitoring as a few examples of how GEO is working to find solutions to societal challenges by turning Earth observation data into knowledge for action.

Mr Petiteville concluded by noting that the GEO Report on Impact 2016-2019 was also available at the GEO website (earthobservations.org) for more examples of the ways in which Earth observations have been having a positive impact through the work of GEO.

7.3 Presentation of the 2020-2022 Work Programme

Programme Board co-chair Mr Osamu Ochiai, Japan Aerospace Exploration Agency (JAXA), provided an overview of the development of the 2020-2022 GEO Work Programme (GWP). The Programme Board worked iteratively over the past year with leadership of candidate activities for the GWP to refine their implementation plans, resulting in a new GWP that contained 4 Flagships, 19 Initiatives, 4 Regional GEOs and 31 Community Activities. Key differences with the 2017-2019 GWP included:

New GEO Initiatives

- Data Integration and Analysis System;
- Earth Observations for Health.

New GEO Community Activities

- Construction and Services of Chinese High-Resolution Satellite Data Resources;
- Earth Observation and Copernicus in Support of Sendai Monitoring;
- Earth Observation Industrial Innovation Platform;
- Earth Observations for the Atlantic Region;
- Enhancing Food Security in African Agricultural Systems with the Support of Remote Sensing;
- GEO Essential Variables;
- Geodesy for the Sendai Framework;
- Global Land Cover;
- Global Observation of Deltas and Estuaries;
- In Situ Observations and Applications for Typical Ecosystem Status of China and Central Asia;
- Night-Time Light Remote Sensing for the Sustainable Development Goals;
- Space Climate Observatory.

The Programme Board also worked with the Secretariat to revise the Foundational Tasks into a reduced (5) more streamlined format:

- Engagement Priorities Coordination;
- GEOSS Data, Information & Knowledge Resources;
- GEOSS Infrastructure Development;
- GWP Support;
- Secretariat Operations.

Also new was the proposed establishment of working groups for climate, disaster risk reduction, data sharing and data management, and capacity development. These working groups were to be tasked with developing objectives for the relevant components of the Foundational Task to which they are associated. The GEOSS Infrastructure Development Task Team was also proposed for guiding the work of that Foundational Task as a whole.

7.4 Interventions from Delegations

The Chair then opened the floor for comments.

The European Commission expressed gratefulness to the Programme Board for the excellent work achieved, bringing together diverse set of activities, and fully endorsed the GWP. The EC noted that GEO should try to reach out to other stakeholders, those not normally at GEO table, such as indigenous groups. The EC welcomed increased visibility given to the private sector and the provision of sustained solutions it could bring. The EC also viewed positively the advent of cloud credits programmes within GEO, noting that it was important to ensure that these relationships with the private sector were done transparently, with clear rights and obligations, so that whole of GEOSS – as and endeavour for public good – remained greater than the sum of its individual parts.

The Secretariat of the Pacific Community (SPC) announced it would be preparing a Community Activity for inclusion in the GWP.

Australia endorsed the GWP, and welcomed the intervention of the SPC and other Pacific partners. Also, Australia was looking forward to supporting the UN Decade for

Ocean Science, and was happy to see uptake of Open Data Cubes (ODC) globally, with Digital Earth Africa set to produce first products in the very near future.

The United States of America endorsed the GWP, and was very pleased to support SPC, in particular looking for ways in which traditional knowledge could be woven together with Earth observations. The US wished to support island leaders in their management of islands. The US also welcomed the decision taken by the Executive Committee on refining the terms of reference for the various GWP working groups.

The Secretariat of the Pacific Regional Environment Programme (SPREP) commented that good data governance was indeed needed, while respecting national sovereignty. SPREP welcome support from GEO to support the UN Decade for Ocean Science.

China expressed its pleasure at seeing a wide variety of activities continuing in the new GWP, and renewed its commitment to open sharing of data, technology and comprehensive applications of Earth observation data. China also declared launching an International S&T Cooperation Project of 80 million CNY (more than 11 million USD), naming China GEO Cooperation Initiative (CGCI) in 2019, to support 2020-2022 GWP and welcomed GEO community's participation.

Japan expressed its appreciation for the work of the Programme Board and supported the new GWP.

SA stated it was in favour of the new GWP, and also highlighted its support for the Blue Planet Initiative and the innovative goals of Digital Earth Africa.

Germany stated that it clearly endorsed the new GWP and appreciated the work that had been done to produce it. Germany remarked, however, that it had been a mistake to eliminate climate as a Societal Benefit Area (SBA), and that consequently the GWP must clearly show what the contributions to climate are. Climate observations are important across all of the GWP, not only in support of the Paris Agreement on climate.

Peru requested that all regional activities be register with the relevant Regional GEO, and also made a plea for a platform for data availability at national and subnational levels.

Kenya announced it was pleased to be hosting the secretariat for Digital Earth Africa, and expressed its desire to see up upgraded in status from Community Activity to an Initiative in the GWP.

Italy, as lead for one of the four Flagships (GOS4M), expressed its thanks to the Programme Board and was pleased to endorse the new GWP. Italy was also pleased to note that the commercial sector was starting to provide a qualified and important contribution to realizing GEO's objectives.

Switzerland noted its support for the GWP while echoing the call of Germany to make contributions to climate change more visible.

7.5 Formal Endorsement of the 2020-2022 GEO Work Programme

Noting no objections, the Chair pronounced that the 2020-2022 GEO Work Programme had been formally endorsed by Plenary.

8 GEO BUSINESS

8.1 Report of the Secretariat Director

The Secretariat Director informed Plenary of Secretariat operations during 2019. An important development was the mandate given by the Executive Committee to prepare a Concept of Operations (CONOPS) document, which contains a description of Secretariat staffing and operational procedures. The CONOPS describes the current posts within the Secretariat, along with the associated responsibilities, providing an essential overview of how the Secretariat operates. Also listed are posts which are vacant at the current time.

The Director explained that there are four main areas which include:

- Management: fully staffed;
- Engagement: pertains to the GEO engagement priorities, for which the position of resource mobilization is vacant due to lack of sufficient funding; the climate and disaster resilience expert positions are currently filled, although the former only until 1st quarter 2020; the SDG position remains unfilled due to lack of sufficient funds;
- Work Programme: fully staffed; capacity development coordination is filled at only 20%, and a full time position would be welcomed to support projects such as Digital Earth Africa, but funds are a limiting factor;
- Data and Science: fully staffed with the exception of a space-data expert due to limited funds.

This slate of posts, along with a description of duties, has been approved by the Executive Committee.

Regarding engagement with UN agencies and conventions, strong progress has been made in many areas. As an example, coordinating with the GEO Secretariat, the UN Environment (UNEP) held a segment of its science, policy and business forum in conjunction with GEO Week 2019 as they share GEO's interest in supporting a digital ecosystem for the environment. Stemming from a co-hosted meeting with the GEO Programme Board in September, engagement has begun with UN-Habitat which is expected to result in a mandate for EO to support the New Urban Agenda. The Secretariat has been working closely with UN Convention to Combat Desertification (UNCCD) and the GEO Land Degradation Neutrality (LDN) Initiative, and will be welcoming a contractor to work on data quality standards in support of the upcoming revision of the Best Practice Guidance document for countries reporting on LDN. The Secretariat has also been very active with UN Office for Disaster Risk Reduction (UNDRR), having drafted segments of the Global Assessment Report, highlighting the value of Earth observations. With respect to the Intergovernmental Panel on Climate Change (IPCC), GEO has been formally recognized as an observer and the new Secretariat expert on climate, Sara Venturini, having worked closely with the IPCC in the past, is looking for new ways to engage in IPCC processes. The Convention on Biological Diversity (CBD) has mandated the Secretariat to support development of the essential biodiversity variables (EBVs), which will be supported by Google Earth Engine (GEE). Dialogue with UN-GGIM is ongoing with the Secretariat having been present at key meetings throughout the year. Finally as the World Meteorological Organization (WMO) is undergoing reform, it is becoming apparent that the WMO is positioning itself as the

provider of climate information to UNFCCC processes, which will require careful consideration of the complementary role that GEO can play in this area, in order to avoid duplication. The Secretariat has worked closely with the Programme Board to produce the new 2020-2022 GEO Work Programme (GWP), which features a streamlined set of Flagships, Initiatives, Community Activities and Foundational Tasks. The Secretariat has worked to increase support for developing nations through initiatives such as Digital Earth Africa (with a budget of US\$ 18 million), the GEO-Amazon Web Services cloud credits programme supporting projects from 21 developing countries (valued at US\$ 1.5 million), and the new GEO-Google Earth Engine programme which will provide unlimited licenses over two years for development of Earth observation applications in support of sustainable development (valued at US\$ 3 million). Last, the GKH, a digital library for Earth observation applications, is an ongoing effort of the Secretariat and GEOSS Platform team to scale up work done by activities of the GWP. Development of the GKH will be a focus of Secretariat work in the new year, subject to approval of the GKH implementation plan by the Executive Committee at its 51st meeting in March 2020.

8.2 Review of the Ministerial Summit Agenda

Mr Stuart Minchin reviewed the key session of the Ministerial Summit Agenda. The first session featured keynote addresses on themes including GEO progress over past four years since the previous Ministerial Summit and investing in the digital economy. The second session highlighted strategies for using Earth observations for sustainable economic development, and developing an inclusive and diverse GEO. The third session focussed on actions for implementing these strategies and investing in the success of GEO, including industry contributions. The fourth and final session provided opportunities for closing remarks and the formal adoption of the Canberra Declaration.

8.3 2018 Financial Statements and Audit Report

Ms Virginia Burkett, speaking on behalf of the Budget Working Group (BWG), reminded Plenary that the GEO Trust Fund supported the operations of the GEO Secretariat, the only body within the GEO governance structure that has daily oversight across the full spectrum of GEO activities. Being under the WMO, the Secretariat follows all rules and regulations of the WMO, one of which is the requirement for an external annual financial audit. The Swiss Federal Audit Office produced the 2018 Audit Report, offering a clean, unqualified, “perfect” audit report for GEO.

The Trust Fund currently has healthy reserves of approximately CHF 3.1 million and sufficient funds to cover all WMO expectations for staff salary reserves and long-term benefits.

Regarding the 2019 interim report on income and expenditures, Ms Burkett noted that the Secretariat envisages current rates of expenditures will match projected income through the end of the year. Any shortfalls will be compensated from the working capital fund which is at CHF 1 million. She also mentioned that the budget for supporting developing country participant travel to GEO meetings had been increased.

8.4 Proposed 2020 GEO Trust Fund Budget, including Pledges and Approval

Ms Virginia Burkett noted that the 2020 Proposed Trust Fund Budget, approved by the BWG, was designed around the Concept of Operations document introduced earlier by the Secretariat Director, and included an increase in the travel budget based on the need for increased Secretariat representation at GEO-related events as well as increased support for developing country participation. The BWG wished to thank Mr Stuart Minchin in particular for his leadership on the BWG since 2014, and wished him every success in his new position as Director General of the Pacific Community. She concluded by reminding Plenary that the voluntary contributions to the GEO Trust Fund were what kept the Secretariat operational, and an indicative scale of contribution, based on UNGDP was available from the BWG or Secretariat for any government to consult.

The Chair then opened the floor for pledges.

Pledges were noted from the European Commission, Australia, Japan, South Africa, the United States of America, China and Sweden.

Australia also noted it was intending to second an individual to the Secretariat for Digital Earth Africa support. China also expressed its intent to second an individual to the Secretariat.

Hearing no objections, the Chair concluded by stating that both the 2018 Financial Statements and Audit Report and Proposed 2020 GEO Trust Fund Budget were approved by Plenary.

8.5 Update of the GEO Rules of Procedure

The update to the GEO Rules of Procedure was approved.

8.6 Announcement of 2020 Lead Co-Chair and Slate of 2020 Executive Committee Members

The 2020 Executive Committee will include the following Members:

- Africa: Republic of South Africa (Co-Chair), Ghana, Senegal;
- Americas: USA (Co-Chair), Chile, Peru;
- Asia-Oceania: People's Republic of China (Co-Chair and Lead Co-Chair for 2020), Australia, Japan, Republic of Korea;
- Europe: European Commission (Co-Chair), France, Italy, Switzerland.

8.7 Slate of the 2020 Programme Board

The Slate as recommended by the Executive Committee, containing representatives from 18 Members and 14 Participating Organizations for a total membership of 32 was approved.

8.8 GEO-XVII Announcements

The Chair announced that South Africa had offered to host the GEO Week 2020, featuring the GEO-XVII Plenary in Port Elizabeth the week of 2-6 November 2020. A video welcoming the GEO community was then showed by the delegation from South Africa.

The Chair expressed appreciation for the offer and was pleased to accept on behalf of Plenary.

8.9 Any Other Business

None.

8.10 Session Outcomes

Mr Douglas Cripe, Secretariat Senior Scientist, summarized the main points and outcomes of each of the Sessions of the Plenary agenda in his presentation.

8.11 Closing Remarks

The Secretariat Director expressed his sincere thanks to Australia for their tireless efforts, and being a force for good. He also thanked the GEO Secretariat for their work and reaffirmed that the Secretariat's was fully committed to supporting Digital Earth Africa.

The European Commission Co-Chair thanked China for the effective Plenary leadership, and added his congratulations and thanks to the Australian team for the magnificent organization and warm atmosphere that set the tone for a successful Plenary. He noted that the past days had shown that substantive progress had been made on GEO. At the same time, more work lay ahead as evidenced by, for example, the suggested contributions that GEO could make to supporting commitments under the Paris Agreement. He welcomed the success of the industry track, noting that care was needed to navigate the sensitive middle ground with private sector organizations whilst preserving the intergovernmental flavour of GEO. The concept of results-oriented GEOSS had been satisfactorily demonstrated, and illustrated what GEO can do concretely to contribute to societal challenges with Earth observations in a practical way. He believed that there was now a clear path to follow on development of the GKH, and he thanked the Secretariat Director and team for their hard work, concluding that GEO is in a good place going forward in 2020.

The Co-Chair from South Africa thanked China for having steered the Plenary ship very well over the past two days. He very much appreciated the contributions of Australia to GEO and thanks the GEO Secretariat for strong support during the past year as Lead Co-Chair. He thanked the various task teams that had been involved in the GEO Week 2019 preparation, noting that their important contributions were all the more remarkable given the voluntary nature of GEO. He was looking forward to continued work around the GKH, as well as continued dialogue with the private. He concluded by expressing his satisfaction that a GEO had laid a good foundation in terms of content and context for the next day's Ministerial meeting.

The Co-Chair from the United States of America observed that this had been a remarkable week with the continued relevance of GEO being highlighted at many junctures. Going forward, the focus must be on actions to be taken as GEO works to better communicate the importance of what it does in support of its engagement priorities. He emphasized that many in the GEO community are working hard to try to make the world a better place, which included efforts on such wide-ranging topics as capacity and access to understanding how to use digital clouds, and generally standing up to be a force for good. Throughout the week, we have recognized and celebrated

examples of accomplishments of the organization from individuals, communities and regions; these are good, but not enough. GEO needs to work towards being more productive through, for example, better merging of data for seamless integration while providing increased access to all communities. The sense of working together as an international community is clear, as was shown in the convening approach for island nation engagement where GEO needs to support them in their quest to simply survive. GEO has a responsibility to them, to their children, and to the world. He concluded by stating that the GEO Plenary had left him reinvigorated for the work ahead.

The Chair concluded by observing that the Plenary had achieved a full measure of success, with a bright, shared perspective for Earth observations and GEO. He wished to extend his thanks once again to Australia for hosting a wonderful GEO Week 2019, and to the GEO Secretariat for their support. He was looking forward to building on the work and achievements gained thus far, noting that China would faithfully perform its duties as Lead Co-Chair for the coming year. He thanked South Africa for the offer to host the GEO-XVII Plenary, and invited everyone to participate in the GEO Data and Knowledge Week, 18-21 February 2020 in Beijing.

Meeting adjourned at 5:30 pm.

Draft List of Participants

Argentina

Raul Kulichevsky
Hugo Gobbi
Dario Polski

Australia

Stuart Minchin
Alex Held
Joe Andrews
Rebecca Andric
Lawford Benning
Vivienne Bordas
Tony Boston
Martin Brady
Ann Bray
Jasmine Chambers
James Day
Andrea De Leon Ewers
Trevor Dhu
Chantelle Doan
Nikki Fitzgerald
Kriton Glenn
Lisa Hall
Steve Hatfield-Dodds
Steve Hill
Indi Hodgson-Johnston
David Hudson
James Johnson
Ewan Johnston
Jadranka Keillor
Carina Kemp
Flora Kerblat
Trent Kershaw
Agnes Lane
Aliesha Lavers
Adam Lewis
Chris Lewis
Emma Luke
Elizabeth McDonald
Emmi Mikedakis
Zaffar Mohamed-Ghouse
Anthony Murfett
Chris Penning

Stuart Phinn
James Pitman
Celeste Powell
John Pring
Shanti Reddy
Jonathon Ross
John Shepherd
Neil Sims
Andy Steven
Jane Stewart
Rob Sturgiss
Alicia Thomson
Camille Thomson
John Timermanis
Matthew Van Horen
Kate Vinot
Kylie Walker
Rob Walter
Thomas Walter
Martine Woolf
Jennifer Zhu

Austria

Chris Schubert
Peter Zeil

Bangladesh

Khaleda Pervin
Shamsuddin Ahmed
Tareq Ahmed
A. Z. Md. Zahedul Islam
Mohammad Muniruzzaman
A B M Salah Uddin
Farida Yasmeen

Brazil

Romero Maia Filho

Cambodia

Bunlay Heng
Ix Hour
Chhan Lay
Phaly Leng
Kimhor Meng
Bunnak Poch
Vang Seng

Da Srey	Yuxiang Wang
Canada	Zhigang Wang
David Harper	Di Wu
Marie-Josée Bourassa	Jianjun Wu
Jason Duffe	Junjun Wu
Angelina Ermakov	Yanhua Wu
Arnold Hougham	Yingduo Xia
Shannon Kaya	Fei Xiao
Eric Laliberté	Jing Xiao
Nathaniel Newlands	Liping Xu
François Souldard	Wenjian Xu
Chile	Fanghong Ye
Patricio Powell	Guanghui Yin
Luciano Parodi	Shucheng You
Arturo Giadala	Yanhua Yu
Macarena Quezada	Wenping Yuan
Juan Paulo Vega	Zeng Yuan
China	Jing Zhang
Pengde Li	Peihong Zhang
Fang Chen	Songmei Zhang
Hao Chen	Xingying Zhang
Yong Gan	Jian Zhao
Yuhang Gan	Qi Zhao
Zhihai Gao	Wenbo Zhao
Xingfa Gu	Dachuang Zhou
Changchui He	Xiang Zhou
Xianqiang He	Colombia
Zhihong Jia	Jose Luis Ortiz
Guifei Jing	Costa Rica
Wenhui Kuang	Marta Juarez Ruiz
Guoqing Li	Rafael Monge Vargas
Suju Li	Croatia
Wei Li	Betty Bernardica Pavelich Sirois
Zengyuan Li	Ecuador
Dong Liang	María Alexandra Reyes Cedeño
Jiuliang Liu	Estonia
Qinhuo Liu	Kersti Eesmaa
Yan Liu	Ethiopia
Yi Liu	Aidan Lloyd
Yuhua Liu	European Commission
Ziping Lyu	Patrick Child
Chen Miao	Michael Pulch
Yubao Qiu	Mika Camps
Dingding Shao	Massimo Craglia
Chengzhi Sun	Carmela Cutugno
Xinming Tang	Jean Dusart
Xiaodong Wan	Daniele Ehrlich
Guanghui Wang	Kamil Kiljanski
Li Wang	Astrid Koch

Stefano Nativi
Gilles Ollier
Nick Pedley
Jan Ramboer
Jonas Rupp
Chrysovalantis Tsiakos
Marjan Van Meerloo

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Mikko Strahlendorff
Jyri Heilimo
Lars Backström
Petteri Vihervaara

France

Isabelle Benezeth
Vincent Pircher
Rémi Andreoli
Franck Arnaudon
Raphaëlle Barbier
Adrien Boissenin
Laure Capar
Nicolas Duhaut
Julie Duhaut-Bedos
Laurent Durieux
Nicolas Fichaux
Damien Gratadour
Yves Lafoy
Pascal Le Masson
Didier Lille
Jean Massenet
Lionel Menard
Guan Oon
Thierry Ranchin
Nathalie Simenel-Amar
Paul Soyez
Giovanna Varra
Gaetan Vilette

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George Dolidze
Nino Janelidze
Lali Lomsadze

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Carsten Dettmann
Thorsten Büßelberg
Thomas Fitschen
Michael Hovenbitzer
Marie Kronberg
Thomas Lege

Martin Lenk
Kathrin Mandic
Julian Meyer-Arnek
Laetitia Navarro
Bernhard Polten
Martin Schodlok
Helmut Staudenrausch

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Edwin Adjei
Farouk Alhassan
Vivian Asempapa
Kwame Boamah
Peter Kofi Awuah

Greece

Haris Kontoes
Jennifer Bailey
Eleni Christia
Eleftherios Mamais
Alexia Tsouni
Tsiakos Valantis

Guatemala

Heinz Hiemann
Mario Rodriguez

Indonesia

Orbita Roswintiarti
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Enrico Brugnoli
Anna Maria Fioretti
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Takashi Ishikawa
Kentaro Ando
Masao Fukasawa
Mariko Harada
Chu Ishida
Rintaro Ito
Satoko Kanazawa
Kanae Koike
Kumi Koike

Toshio Koike	Jan Pierce
Noriko Kojiro-Brown	Graeme Blick
Mamoru Miyamoto	Rob Deakin
Izumi Mizuno	Karl Majorhazi
Akira Mukaida	Niger
Hiroyuki Muraoka	Mamane Bako
Tsugito Nagano	Norway
Nobutaka Nakagawa	Morten Aulund
Atsuko Nakasone	Bente Lilja Bye
Osamu Ochiai	Valerie Bichard
Taiyo Okamoto	Camilla Hatling
Shutarō Omura	Paul Gulleik Larsen
Maiko Sano	Pakistan
Hideaki Shibata	Muhammad Khalid Ejaz
Shinichi Sobue	Adnan Badar
Ichiro Takahashi	Hafiz Faisal Mukhtar
Yuki Takano	Peru
Hironori Yabuki	Gino Arciniega
Akiko Yamada	Ezio Piana
Takehisa Yamakita	Philippines
Kenya	Ma. Corina Reyes
Isaiya Kabira	Romania
Mathew Kaikai	Ion Nedelcu
Korea, Republic of	Cosmin Nistor
Yongseung Kim	Viorel Vulturescu
Sun Gu Lee	Russian Federation
Malaysia	Sergey Tasenko
Mohd Hisham Bin Mohd Anip	Sergey Uspenskiy
Malta	Vitaly Bormashov
Christopher Cutajar	Dmitry Kozeev
Ian Meli	Vitaly Mironichev
Mexico	Maxim Volkov
Paloma Merodio	Senegal
Alejandro Alcade Mendez	Amadou Gaye
Abel Coronado	Amadou Dieye
Nashieli Garcia Alaniz	South Africa
Jimena Juarez	Mmboneni Muofhe
Eduardo Patricio Peña Haller	Humbulani Mudau
Michael Schmidt	Motshedisi Lydia Letuka
Mongolia	Martin Lynwill
Davdai Bulgan	Andiswa Mlisa
Nepal	Nyameko Royi
Khim Lal Gautam	Imraan Saloojee
Netherlands	Mandla Tshabalala
Ruud Grim	Robert Van Zyl
Mark Noort	Spain
Uta Wehn	Julio González Breña
New Zealand	Carlos Domene
Gaye Searancke	

Sweden

Rolf Brennerfelt
Stefan Nilsson

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Karine Siegwart
José Romero
Carolina Adler
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Elena Faverio
Sebastien-Joel Monnet
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Pedro Zwahlen

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Anond Snidvongs

Tonga

Rosamond Bing

Uganda

Joyce Kikafunda
Patrick Muganda
Catherine Nakalembe

Ukraine

Oleh Fedorov
Nataliia Kussul
Mykola Kulinich
Volodymyr Shalkivskyi
Andrii Shelestov

United Arab Emirates

Asma Alyammahi

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Bertie Archer
Iain Williams
Terri Freemantle
Caroline Harper
Stuart Marsh
James Norris
John Remedios
Sarah Vande Velde
Daniel Wicks

United States

Jim Reilly
Virginia Burkett
Chris Cannizzaro
Albert Degarmo
Ivan Deloatch
Jamie Favors
Eldrich Frazier
Lawrence Friedl
Yana Gevorgyan
David Green

Angelica Gutierrez

Richard Heim

Dave Helweg

Betzy Hernandez Sandoval

Daniel Irwin

Argie Kavvada

Aries Keck

John Kerekes

McRae Lenahan

Shanna McClain

Merrie-Beth Neely

Justyna Nicinska

Wade Price

James Rattling Leaf

Scott Rayder

Roger Sayre

Cindy Schmidt

Lea Shanley

Timothy Styker

Dan Takaki

Stephen Volz

Zdenka Willis

Vietnam

Lam Dao Nguyen

CEDARE

Omar Elbadawy

CEOS

Raj Kumar

Adam Lewis

David Green

Alex Held

Brian Killough

CI

Daniel Juhn

Timothy Max Wright

Candido Pastor

Anurag Ramachandran

Nick Souter

Karyn Tabor

Alex Zvoleff

CODATA

Alena Rybkina

John Broome

Lesley Wyborn

COSPAR

Stuart Phinn

EARSC

Geoffrey Sawyer

Simon Campbell

Nuno Catarino	GRSS
Tom Farrow	Anthony Milne
Sven Gilliams	i-BEC
Peter Hausknecht	Nikolaos Tsakiridis
Mónica Miguel-Lago	Nikolaos Tziolas
Seyed Miri	IAF
Koushik Panda	Christian Feichtinger
Franck Ranera	Mino Rathnasabapathy
Fabio Volpe	Danielle Wood
Andrew Zolli	IAG
ECLAC	Richard Gross
Rolando Ocampo	Allison Craddock
Álvaro Monett	ICIMOD
ECMWF	Basanta Shrestha
Fabio Venuti	Birendra Bajracharya
ESA	ICOS
Ivan Petiteville	Emmanuel Salmon
Guido Colangeli	Magdalena Brus
Joost Van Bemmelen	Jacco Konijn
ESIP	IEEE
Erin Robinson	René Garello
Karl Benedict	Jay Pearlman
Shane Crossman	Malcolm Heron
Kathleen Fontaine	Françoise Pearlman
EUMETSAT	Hans-Peter Plag
Vincent Gabaglio	Alan Smart
FAO	IIASA
Thomas Harvey	Steffen Fritz
FrontierSI	Dilek Fraisl
Graeme Kernich	ISDE
Geraldine Li	Changlin Wang
Caitlin Adams	ITC
Andrew Hicks	Tom Veldkamp
Brendan McAtee	Andrew Skidmore
Chris Morgan	IUGG
Eva Rodriguez	Chris Rizos
Future Earth	Mercator Ocean
Tayanah O'Donnell	Cecile Thomas-Courcoux
Sarah Crowe	Alain Arnaud
Taryn Laubenstein	MTS
GBIF	Zdenka Willis
Donald Hobern	OGC
GEANT	Bart De Lathouwer
Chris Atherton	Marie-Françoise Voidrot
Mark Urban	Chris Body
GODAN	Nuno Catarino
Foteini Zampati	Chia-Hui (Rosie) Chen
GPSDD	Ming-Chih Cheng
Claire Melamed	Tien-Yin Chou

Patricia Cummins	APSCO
Chen-Yu How Hao	Yan Song Xu
Ken Harkin	Yu Bai
Steve Kopp	UN-GGIM
Chen-Yang Lee	Gregory Scott
David Medyckyj-Scott	Amazon
Koushik Panda	Ana Privette
Alistair Ritchie	Joe Flasher
Andrew Skidmore	AUC
Yin Yang	Meshack Kinyua
Mei-Ling (Milly) Yeh	BBC Media Action
Hsiao-Yuan Yin	Lisa Robinson
RCMRD	CI Kenya
Phoebe Odour	Titus Letaapo
Eric Nganga	COICA
Anastasia Wahome	Mario Vargas
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