SUMMARY NOTES

GEOGLOWS and the Harmonization of GEO Water Activities
October 23-24, 2017

Regan Building, Room Meridian C
Washington, DC

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Meeting Summary

(Please note that these sessions can be viewed at:
Day 1: https://www.youtube.com/watch?v=jNwORtsQvF0
Day 2: https://www.youtube.com/watch?v=kK31RFOB-kM&feature=youtu.be)

Introduction

Barbara Ryan: "Introduction to GEOGLOWS and the Harmonization of GEO Water Activities"

The session on GEOGLOWS and the Harmonization of GEO Water Activities opened with a presentation by Barbara Ryan, the Director of the GEO Secretariat. She opened by noting the successes of GEO in areas such as broad open data policy, which have been advocated by GEO, and the ability to monitor landscapes change, particularly in the Water and Biodiversity domains. However, more work is needed on issues such as coordinated, comprehensive, and sustained Earth Observations on the provider side. In the last few years GEO has been transitioning to the user side and making sure our extensive data finds its way into users' hands. Building that bridge to users is important.

In the water domain, there are a lot of challenges. From a GEO perspective, water management—including water quality, water use, groundwater, and surface water components—is a SBA. Within GEO, we can bring these areas closer together, not necessarily by merging them into a single initiative but by becoming more coordinated and integrated. This event is really going to provide a good briefing for the whole community and provide a place for discussion to look at the inner spaces between and among the different GEO Water-related activities so that the whole system can operate more effectively. For example, space agencies want to see a consolidated suite of requirements from the GEO Water community. This need is going to be a forcing function for future water management requirements.

We all live in institution but it is the interpersonal relationships that we form with each other that help build trust so that our institutions function better. There is a tremendous responsibility on us as individuals to break down some of these barriers so that we can have a positive effect on our institutions. There is no better place than this meeting to show this coordination.

GEOGLOWS (GEO Global Water Sustainability)

The GEOGLOWS session was chaired by Adrian Strauch of the University of Bonn.

Angélica Gutiérrez: "Overview of GEOGLOWS"

Angélica Gutiérrez, Co-Chair of the GEOGLOWS Steering Committee and NOAA hydrological expert, introduced GEOGLOWS' unique ability to contribute to modernized water resources management to improve productivity and better manage climate risks. GEOGLOWS promotes the effective use of

satellite data to contribute to water management. Its mission is to connect the demand for sound and timely environmental information to the supply of data and information about the Earth's water system; to explore the science needed to achieve the initiative's goals by advocating for broad, open data policies and access information; and helping to ensure that the data collected through national, regional, and global observing systems are made available in the public domain to support applied decision-making. GEOGLOWS seeks to strengthen the understanding of water data and analyses needs; develop user-driven applications products using Earth observations and applications; engage end users and boundary organizations to understand needs and decision-making process by region; prioritize activities based on vulnerability analyses; promote synergy among initiatives for open water data and analytical services to support improved understanding and decision support; support awareness, strengthen capacity-building, and facilitate professional networking activities related to Earth observation data and analytical tools; contribute to the assessments of population and economic growth impacts on water resources availability and climate change; inform planning and adaptation activities; improve public-domain access to water sustainability-related data, tools, and knowledge products and services; and enable innovations and support documentation of activities related to the effective use of Earth observation for sustainable water management. GEOGLOWS supports regional initiatives, thereby bringing diverse regional water projects into a global framework for improving water sustainability. In terms of the GEOSS Water Strategy, GEOGLOWS, CEOS, and other groups will implement its recommendations.

Rose Alabaster: "Socio-economic issues of the water crises and policy linkages (WG#1)"

Rose Alabaster, Co-Chair of the GEOGLOWS Steering Committee, discussed GEOGLOWS' engagement with the private sector. Since November 2012, GEO has been developing a framework for public sector engagement, primarily through papers presented at GEO plenaries, Ministerial Council meetings, and, most recently, at the GEOGLOWS meeting held in Tuscaloosa, AL in May 2017. Private sector engagement is needed to enhance and expand GEOGLOWS, but private companies need to engage within an agreed-upon framework for more effective, sustainable, and relevant practices and partnerships. The framework must be broad because the goal of these interactions is to leverage private capital, expertise, and innovation in the Earth observation sector. Building vibrant and systematic partnerships with the private sector is a vital prerequisite for the successful implementation of a transformative agenda. Potential contributions may include finances, technologies, skills, outreach, and innovations. GEOGLOWS also aims to address the public-commercial debates about open data. The SDGs provide unique opportunities for the private sector to engage as a development agent. Business models used in such ventures must align business agendas with societal aims and the results must clearly benefit the public use of Earth observations. With this goal in mind, GEOGLOWS will carry out a pilot project to apply Earth observations in support of a legal framework for water sustainability. This project's objective is to develop a methodology for characterizing water resources using Earth observations that can be used to reveal environmental and (social) indigenous vulnerabilities. Earth observations will serve as a baseline for advancing interlinkages between the SDGs (namely: SDGs 3, 6, 10, 16, and 17). GEOGLOWS also established several partnerships as well as cross-SBA linkages with GEO Wetlands and GEO BON and pilot studies with two Colombian reservations' Indigenous Authorities.

Jim Nelson: "Data Dissemination, Community Portal, Capacity Building and Communication (WG #4)"

Jim Nelson of Brigham Young University reported on Working Group 4's progress in its goals of harmonizing relevant data portals and engaging in better marketing and storytelling of existing data and information. The activity's goals are to enhance the AmeriGEOSS portal, develop a global streamflow

information and forecasting service, and collect stories. The activity encourages GEO to transition from "users discovering data" to "data discovering users." The problem isn't finding new data, data portals, or means of dissemination; rather, it is leveraging existing data and, more importantly, getting critical feedback that will help us understand what is working and what is not—and then using that feedback to design better systems and services. Deliverables for 2018-19 include data survey and inventory; mapping which data and portals already exist; a global streamflow forecast service; capacity building and dissemination; and sharing success stories (CORMagdelena, CIRMAG, SERVIR, the Asian Water Cycle Initiative, and so on). Plans for cross-SBA linkages and SDG support include linking to all SBAs with water as a major theme and contributing to SDGs 2, 3, 6, 7, 11, 13, 14, and 15. Jim noted that although there is a lot of interest in harmonizing activities, it is difficult to find room for this mandate within day-to-day activities. It is also challenging to facilitate the integration of related activities.

Jean-Noël Thépaut: "ECMWF, GEOGLOWS, and Support for Developing Countries"

Jean-Noël Thépaut of ECMWF gave an overview of the Copernicus Emergency Management Service. Copernicus employs Earth observations to deliver value-added products based on satellite observation and in-situ measurements. The Service provides flood monitoring and forecasting, on-demand mapping of geospatial information, risk and recovery mapping, and forest fire information. The European Flood Awareness System will eventually be expanded into the Global Flood Awareness System (GloFAS). It will deliver probabilistic early flood warnings on a global scale using the best weather prediction tools available. GloFAS, which will serve stakeholders with useful and timely information on upcoming floods, originates through collaborations between ECMWF and JRC. Its significant achievements in 2016-17 include its extension of forecasts to 30 days lead time using ECMWF's extended-range forecast. Regional hydrologists and meteorologists were trained through RIMES and UN-ESCAP in Thailand in 2016 to utilize this product. Plans and deliverables for 2018-19 include new products and web improvements for better dissemination; a real-time data and archival service; and calibrating models with local observations. Plans for SDG support include working with SDG 3, 6, and 7; cross-SBA linkages will focus on collaboration to ensure that GloFAS development is in line with user needs.

Ashutosh Limaye: "Science, Applications, Product Development, and Testing WG#2"

Ashutosh Limaye of NASA presented on the objectives of Working Group 2, which are to identify the needs of end users; develop a global hydrologic framework; identify and provide tools to extract global datasets; and provide tools to end users to address needs at the local scale. The Group's goal is to make global water datasets available and accessible to decision-makers. The Group plans to connect with users in government departments, NGOs, agricultural extensions, and other sectors. Given the breadth of the topic, the Group gives freedom to the contributors to explore wide-ranging solutions. Progress and achievements include an assessment of needs and extracting actionable activities from relevant activities (the Group has already started exploring this in Africa and Asia); cataloguing existing activities and frameworks; and bringing datasets and portals together to connect global- to local-scale applications. Deliverables for 2018-19 include a white paper illustrating the development and transferability of relationships between global and local datasets for local-scale applications; a study quantifying global water availability and how it may be altered in response to climate and/or land cover-land use change; assessing water management approaches to mitigate impacts; inventorying water-related products from all GEO initiatives, relevant non-GEO activities/products, and available/future satellite missions; and developing tools for local, regional, and global multi-variate (cross-catalog) analyses. The Working Group links to SDGs 2, 6, and 11. Cross-SBA links include Food Security and Sustainable Agriculture, Disaster Resilience, and Public Health Surveillance. Challenges include the lack

of coordination among several ongoing aligned activities; an overarching goal for such activities will enable these groups to coalesce.

George J. Huffman: "Essential Water Variables (EWVs) and Observations WG#3"

George Huffman reported that WG#3 is tasked with establishing a minimum set of EWVs and assessing the status for each EWV; assessing opportunities in using citizen science and private data to provide EWV data; and promoting continuity in observational systems and open access to data. The Group's goal is to make high-quality key water datasets freely available and easily useable for water research, management, and policy application. The EWV status will be established through user and expert group surveys. Non-traditional data sources will be explored by engagement with citizen science and data groups. Observational system continuity and open data access will be pursued via white papers and advocacy to agencies. In terms of governance and structure, Group members will take lead responsibility in specific areas. Progress and achievements include establishing a list of EWVs, clarifying the need for a more formal definition of EWVs, their sources, and their targets; making contact with citizen science organizations; and advocating for continued observational networks and continuity in satellite observations. Deliverables for 2018-19 include carrying out a study to sharpen the definition of Water Cycle and Water Quality EWVs; developing a sub-group focused on citizen science; drafting a list of at-risk EWV observing systems; and writing one or more white papers on the following current or future short-comings in specific EWV observing systems: satellite passive microwave sensors for precipitation, observing the water cycle in cold regions, the future of groundwater measurements, or opportunities for active remote sensing [radar, laser] in terrestrial hydrology). Working Group 3 supports SDG 6 and links with the Biodiversity, Agricultural and Forestry monitoring, Disaster Risk Management, Climate Resilience, and Renewable Energy SBAs. Challenges include determining the proper organizational structure of the water cycle and water quality EWVs and engaging a wide range of experts to address the very different technical and application issues that each EWV poses.

Toshio Koike: "GEOGLOWS & AOGEOSS & DIAS – Asia Links"

Toshio Koike, Director of ICHARM, provided an overview of flood risk reduction and sustainable development. Current issues include increasing losses from floods, human influences on climate change, globalization and 21st-century interconnectedness, the gap between science and society, and the lack of effective inter-agency coordination. Key directions include the Sendai Framework for Disaster Risk Reduction, the SDGs, and the Paris Agreement; budgetary limitations and capabilities; a spiral-up approach to addressing needs; interdisciplinary and transdisciplinary perspectives; and quantifying and minimizing the uncertainty of data, assessments, change identification, awareness, preventive investment, and response-recovery. Actions taken to remediate these problems include establishing national platforms on water and disasters, inviting IFI partners to support the platforms, and seeking incremental support from donors. Activities in the Asia-Pacific Region include water and disaster platforms in Pakistan, Myanmar, and Sri Lanka and a platform on water-related disasters in the Philippines.

Sarva Pulla: "SERVIR Applications to Address Water Challenges in Africa = African Links"

Sarva Pulla of SERVIR's Science Coordination Office and NASA's Marshall Space Flight Center presented on SERVIR's current applications addressing water challenges in Africa. SERVIR's mission is to help developing countries use information provided by Earth-observing satellites and geospatial technologies for managing climate-sensitive issues such as disasters, agriculture, water, ecosystems, and land use. It

aims to leverage the capabilities of free and open source software to bridge the gap between decision-makers and scientists. Datasets sources include Sentinel (modified Copernicus data for 2015-17), Landsat, IMERG, SMAP, MODIS, GRACE, Tellus, GLDAS, NCEP, and NMME model outputs.

Selma Cherchali: "Contribution of CNES Programs to Water Activities"

Selma Cherchali, Land and Hydrology Program Manager at the CNES Directorate for Innovation Applications and Science, provided an overview of the state of space missions for hydrology. Missions now have increased accuracy (more adapted spectral bands), spatial resolution, temporal resolution, and data accessibility. The hydrological sciences community is moving to global multi-model and multi-sensor integrated modeling and assimilation systems. This creates challenges arising from the complexity of the observed systems and the impact of anthropogenic activities (WG#6). CNES contributes to innovative missions, including the SWOT, SMOS, Megha-Tropiques, and Sentinels missions; supporting research activities; increasing the relationships among research laboratories and water sector actors; and maintaining the Copernicus Water and Snow Service and the THEIA Land Data Center. The SMOS program monitors soil moisture at the global scale and these data enhance the predictability of extreme events and transfer the knowledge to operational services like ECMWF, WMO, and GEO. The SMOS program fuses multi-source Earth observations data in operational data processing centers and support SDGs 2, 6, and 13. Future goals and challenges include integrating observations to establish a more complete system description; integrating model components to build a comprehensive Earth modeling system; integrating research results in order to establish end-user solutions; integrating data to allow for spatial and temporal rectification and to allow for the intercomparison and quality evaluation of different models and observation data; data-model integration in order to constrain data and its errors by physical processes using four dimensional data assimilation techniques.

The session ended with a panel that included short introductions and comments about commitments to GEOGLOWS from representatives of a number of agencies. Panel members included Vanessa Aellen (GEO), Bradley Doorn (NASA), Selma Cherchali (CNES), Tom Graziano (NOAA), Nagaraja Rao Harshadeep (World Bank), Osvaldo Moraes (CEMADEN), and Paul DiGiacomo (CEOS).

GEO Secretariat: Vanessa Aellen, who represented the Secretariat, noted that GEOGLOWS had made substantial progress since its inception. She noted the importance of having other GEO water programs coordinating their activities with GEOGLOWS to ensure each initiative focuses on their contribution.

CNES: Comments by Selma Cherchali are included in the talk listed above.

World Bank: Nagaraja Rao Harshadeep (Harsh) noted that the community has access to a large amount of data but we need to actively place more of these data into users' hands in formats that they can use. He noted that the World Bank has been developing apps for data use and e-books to educate people on why and how to use different data types. The Bank is focusing on communicating more knowledge and using its extensive networks to have data flowing out to countries for application and back from countries to providers for validation and calibration.

NOAA: Tom Graziano noted that the NOAA structure represents a large user community for GEOGLOWS. The National Water Center, with its capability for high-resolution prediction, has a requirement for high-resolution data and looks to GEOGLOWS to assist in meeting this need. He also noted that NOAA support for GEOGLOWS includes support for Angélica Gutiérrez to serve in GEOGLOWS specifically and in the other areas of GEO Water (including AmeriGEOSS) more generally.

CEMADEN: Osvaldo Moraes reported that there were many opportunities for collaboration between CEMADEN and GEOGLOWS. CEMADEN's mandate includes hazard warning, including flood warnings. Their approach includes understanding, forecasting, and alerting. For each of these functions there are needs for data and they are ready to look to GEOGLOWS as a source of these data.

NASA: Bradley Doorn mentioned their very active Water Applications Program, which has generated many solutions, but notes that these solutions are not taken up. A clear role for GEOGLOWS is to develop sustainable platforms for users around the world that would take these solutions and ensure they are used for the benefit of society. He also noted that the CEOS Water Quality study is complete and that CEOS is now looking to the water community to be more specific in spelling out its needs.

During the discussion period there were two organization-related interventions worth noting. Marie Colton of the Great Lakes Water Board mentioned that the Board faces a number of problems related to training and a lack of private sector involvement. Training programs are needed for their own personnel and data are needed to correct biases in their observational network. They would also like to produce a standard set of outputs for their user community. The Board would like to engage GEOGLOWS in addressing these problems.

ICHARM: Toshio Koike indicated that although IFI began helping Asian countries develop a flood prediction capability, they are now spreading their efforts around the world. They would like to work with GEOGLOWS to demonstrate their capability more broadly and link it to socio-economic needs.

One concern that came out of the discussion involved the lack of coordination between in-situ and satellite date.

Freshwater Biodiversity, Wetlands, and Related Emerging Opportunities

Derek Vollmer of Conservation International chaired a session on freshwater biodiversity, wetlands, and related emerging opportunities.

Adrian Strauch: GEO Wetlands

Adrian Strauch of the University of Bonn presented the GEO Wetlands initiative, which acts at the intersection of water, ecosystems, and biodiversity. The objectives of this initiative are to develop a global wetlands observation system (scaled from global to local) , establish a community of participants, and build on existing efforts and products. GEO Wetlands has links to the freshwater and marine groups of GEO BON, GEOGLOWS, and several other potential GEO links.

The Initiative seeks to create a user portal and work with end-users. Due to funding, the current focus is on Europe and Africa, but the goal is to expand this coverage to the globe. The GEO Wetlands team has developed a community portal and mapping tools and created a large user community. There is a strong focus on SDG 6 and Indicator 6.6.1. Planned deliverables for the current period include global products on mangroves and best practice guidelines.

Alan Belward: Global Surface Water Explorer

The objective of the Global Surface Water Explorer (GSWE) is to document every land pixel globally and document the transition from land to water, month by month, year by year, using the entire Landsat archive going back to 1984. The resultant products and the analysis system will be free and open. GSWE uses Google's Earth Engine and all data are therefore downloadable. GSWE maps the Earth's areas with permanent water cover. GSWE displays down to the pixel-level the permanence of surface water, assessments, and trends in the duration and frequency of water coverage, maximum water extent, and transitions from inundation to lack thereof (or vice versa). Recent trends show that 184,000 km^2 of new lakes have appeared in last 30 years and 90,000 km^2 of lakes have disappeared during the same period. GSWE just finished packaging the records by country (for reporting on SDG Indicator 6.6.1) and is interested in reporting on coastal water changes. They also want to bring GSWE up-to-date: they currently show data to 2015 but want to include Sentinel 2 data to bring this up to the current time. GSWE shows where the world's truly permanent water is located. GSWE is working with CBD and the Convention to Combat Desertification.

Erin Hestir: Freshwater Group of GEO BON

Erin Hestir provided an overview of this thematic BON, which was recognized in June 2017. The theme promotes best practices for tracking change in biodiversity of freshwater systems. By 2020, the aim is to establish a global network of practitioners who can make global assessments of the status and trends of freshwater biodiversity in order to make recommendations for action to meet the 2020 targets. There is real urgency for this. FW BON is a growing global network with 135 members at present. Its objectives are to improve the harmonization of data; to develop data standardization methods; to facilitate data-sharing and integrate biodiversity data with other datasets; and to make information available to decision-makers. To achieve, this FW BON aims to:

1) Develop globally consistent assessments of freshwater biodiversity with standardized protocols.
2) Support the Red List of Ecosystems.
3) Work with other GEO groups and supply ecosystem/biodiversity data to GEOGLOWS, GEO-Wetlands, and AquaWatch.
4) Develop macroinvertebrate and fish sampling protocols to have available within a year.
5) Promote local and indigenous knowledge for assessing freshwater ecosystems.
6) Develop sampling protocols for eDNA, zooplankton, phytoplankton, algae, and fungi.
7) Support harmonized observations for reptiles, birds, mammals, and amphibians.
8) Develop harmonized protocols for eco-acoustic monitoring.

FW BON seeks to expand its network of participants. It has strong links to SWFP's Freshwater Biodiversity Working Group, contributes to assessing SDG Targets 15.1 and 15.5, and will work with Ramsar. An important future objective is to work on the definitions of Essential Biodiversity Variables (for freshwater) and coordinate work with the definition of Essential Water Variables and Essential Climate Variables.

Michele Thieme: Free Flowing Rivers Programme

Michele Thieme began by noting that society should care about free-flowing rivers (beyond the protection of biodiversity) because they are important for the provision of sediments to downstream deltas, they provide sediments to flood plains, and they are the freshwater equivalent of terrestrial wilderness areas. Today, river connectivity is changing because we are in the midst of a global hydropower boom, which is causing problems for rivers and their biodiversity. Agreement on what constitutes a free-flowing river does not exist and there is no global registry of where free-flowing rivers

occur. Hence, we are limiting global awareness and motivation to keep existing free-flowing rivers in place, or to restore free-flowing rivers where this is possible. Dam removal presents an opportunity to reconnect rivers that were free-flowing, especially for dams that are no longer serving their original function. Hence there is a need for a global assessment of free-flowing rivers and to develop a standard methodology that can be applied in the longer term. The global inventory will identify where free-flowing rivers will remain. The methods for this include:

1) Identifying global datasets for variables that place stress on free-flowing rivers.
2) Weight the importance of each of these variables for free-flowing rivers.
3) Benchmark these weighting methods against known free-flowing rivers and select the best.
4) Develop an Index of Connectivity/Connectivity Status Index.
5) Apply this weighting method and Index of Connectivity to every known river reach in HydroSHEDS (12 million river reaches).
6) Assess whether each river reach is above the threshold for definition as a free-flowing river.

The global view of the connectivity index shows that rivers in the northern part of the continents are heavily impacted, but the tropics and the Arctic are less so. The analysis shows that society is losing the world's largest free-flowing rivers and that only a handful of free-flowing rivers actually reach the sea. The tropics and the Arctic are the final frontiers of free-flowing rivers. The free-flowing rivers project can raise awareness of critical natural infrastructure, integrate connectivity metrics into planning for hydropower at system scales, can be downscaled, and can be used for protection at the basin scale.

Paul DiGiacomo: Future Earth Lagoon Workshop

Paul DiGiacomo reported that a proposal for a Future Earth Lagoon project tentatively called Lagoons for Life was developed at a recent workshop of Future Earth Coasts (previously Land Ocean Interactions in the Coastal Zone) and the European Space Agency. He noted that there is a lot of attention focused on lagoons because they are hotspots of human settlement, they are affected by high sediment runs, and are very vulnerable to climate change. There already exists a global lagoon monitoring service but it needs to be strengthened. The workshop, held in Cork, Ireland in September 2016, looked at the effects of climate change on lagoon management and the potential for Earth observation applications. Specific goals for the workshop/project included addressing lagoon monitoring and management, Earth observations for lagoon management, and identifying potential opportunities for future research applicable to monitoring lagoons. The workshop recommended the following:

1) Development of a transdisciplinary network of experts for monitoring lagoons.
2) Creation of an inventory of what is known about lagoons for publication.
3) Collaboration on identifying funding sources.
4) Joint activities with other projects, such as the Global Lakes initiatives, where extensive datasets have been developed and could be harvested/utilized for studying lagoons.

Lagoons are understudied and under-observed but are important ecologically and for people. A lagoons project would have many potential links to many other GEO activities, namely GEO Blue Planet.

Ian Harrison: SWFP Freshwater Biodiversity Working Group

Ian Harrison of Conservation International described the Freshwater Biodiversity Working Group within the Sustainable Water Future Programme (SWFP). The group, which was formed a year ago, has two main project themes:

1) Integrating in-situ observations with Earth observation data: linking satellite data of societal and biodiversity relevance to map trajectories of change for species and ecological assemblages; Hydro ATLAS, which provides a data backbone; species information data from other sources such as the BioFresh Freshwater Information Portal; species information data from the IUCN Red List; data from the Freshwater BON; and other remotely sensed variables that can be integrated with the biodiversity data.
2) Flow alterations that affect richness will be tested with regional case studies. There are links to WWF's Free-flowing Rivers project. There is the assumption that species show adaptability to different conditions of flow, but these adaptations can be quite complex. The increasing number and sophistication of hydrological models and data allows us to map these connections.

This work is currently conceptual. The Working Group will link across several of the SWFP Working Groups and other projects. The outputs will be informative to the Aichi targets; to SDG Targets 15.1 and 15.5, which focus on freshwater biodiversity and its loss; and to SDG Target 6.6, which focuses on restoring freshwater ecosystems for services. There will also be recommendations to guide the Ramsar Convention. The program is highly dependent on funding. Proposals for mapping species distributions and freshwater services have been developed. The Group hopes for support to advance programmatic developments in 2018.

Ian Jarvis: GEO Global Agricultural Monitoring

Ian Harris of the Canadian Agriculture and Food Agency and now GEO Secretariat member described the GEO Global Agricultural Monitoring (GEOGLAM system). It was an initiative developed in response to the G-20 nations ad adopted as a GEO Flagship. Its early achievements include an early warning crop monitor and market information system monitoring, joint experiments for crop assessment and monitoring, and an Asian rice crop production monitoring program. Planned developments include establishing more quantitative metrics, looking at changes in agriculture between seasons over time to assess the effects of climate change, and linking research to operations. GEOGLAM has many links to other GEO initiatives. Developing relationships to the statistical community is a challenge and the GEOGLAM community will work to improve this. Other challenges include moving from qualitative to quantitative measurements of growing conditions.

Nagaraja Rao Harshadeep: "World Bank and the High Level Panel of Water and Water Data"

Harsh postulated that integrated spatial approaches need to be promoted as support for better planning and management. In this context, Harsh provided a framework for looking at the relationships between data providers (wholesalers) and knowledge communicators (retailers). For this to be effective, we need to look beyond hydro cycles by looking at different users and the types of data they use. Better strategies to generate meaningful information and better analytical tools are needed to make this process function more effectively. We also need to develop systems that bring local in-situ data collected from people on the ground and in the field (referred to as bottom-up data) together with top-down satellite and other Earth observations. He also noted that the World Bank uses two platforms to address data and knowledge distribution:

1) Spatial agents: generally software apps that compile multiple different data sources. These provide quick access to country-level and subnational datasets and include platforms for data analysis.
2) E-books: for presenting data.

The World Bank is working with the United Nations to develop a system for collecting and disseminating the data required for monitoring SDG 6.

Sushel Unninayar: "Overview of Contributions of EO to SDG-6 (Clean Water and Sanitation for All)"

Sushel Unninayar of NASA and Morgan State University presented on GEO's contributions to Earth observations and SDG 6. Briefly, the goal aims to provide safe access to water, sanitation, and hygiene; improve water quality; increase water use efficiency; implement integrated water resource management; protect and restore water-related ecosystems; expand international cooperation; and support the participation of local communities. Dr. Unninayar demonstrated that Earth observations are relevant to many components of SDG 6. Population distribution and densities, for instance, can be assessed using remotely-sensed surface features like Landsat. Similarly, Earth observations can help determine several water availability-related parameters when used in conjunction with models and data assimilation schemes. Earth observations and related models can measure and compute, to name but a few, precipitation, surface temperature, surface soil moisture, groundwater, river flows, and reservoir and lake levels. In summation, Earth observations contribute to Water SDG-related indicator monitoring by providing data and model outputs for a broad range of SDG monitoring and water-related end user applications.

Plenary Discussion of the Ecosystems Presentations

Following the presentations, key issues were discussed. The main points raised were that the GEO Water Community needs to:

- Share data, collaborate, and avoid duplication of work.
- Translate the large quantities of available Earth observation data into useful information for stakeholders and make this information easily accessible.
- Look for opportunities to engage Earth observation information in monitoring the SDGs.
- Find out what the public sector's information needs are.

World Café Session

Vanessa Aellen and Ian Harrison co-chaired the World Café Session, during which participants in the side event split into three discussion groups. The following questions were provided to help steer their discussions:

1) Based on the presentations we have heard, what appear to be the strengths of the various GEO groups (GEOGLOWS, GEO Wetlands, Freshwater BON)? Where can our work can have most effect? How can our work effectively fill niches that are not being addressed by other global initiatives?
2) Are there critical issues associated with sustainable development of water resources, research into freshwater ecosystems, and conservation of those ecosystems that have not been highlighted today, and where can GEO's water groups make a contribution?
3) What are the best opportunities for collaboration between different GEO groups (for example, in sharing data, developing projects, and joint fundraising) and what are the specific products that we can produce collaboratively?
4) Are there specific policy items that GEO's water groups should be addressing? For example, what SDG Targets should our work and products focus on? How can we ensure that the GEO water groups approach policy-makers and other stakeholders with a united, well-coordinated set of messages?

5) What are the other global initiatives, outside of GEO, to which the GEO water groups should be linked, and what are the best opportunities for collaborative projects?

Report from Discussion Group #1: Ian Harrison

The group discussed items related to Discussion Question 4 and the SDGs. If a country is not achieving its goals for protection of water resources and freshwater ecosystems as defined in the SDGs, then what is its liability? Should GEO be monitoring countries' liabilities for meeting SDGs related to water?

Achieving the SDGs requires an understanding of the baseline condition of aquatic ecosystems and the way in which conditions are changing (hence whether SDG targets are being attained). Earth observations can provide the reference information for those baselines and GEO plays an important role in assimilating and synthesizing that information and providing accounts and recommendations that are useful to policy-makers. Thus, GEOGLOWS, Freshwater Diversity, and other GEO Water activities need to identify which Earth observation applications are available for assessing the baselines of water-related SDG targets. We also need to provide advice on a harmonized process for monitoring SDGs. We need to identify the SDG Targets that require freshwater ecosystems in an intact state to supply ecosystem services. We need to identify the SDG Targets that may otherwise impact freshwater ecosystems (i.e., When do freshwater ecosystems become compromised as a consequence of attaining certain SDG targets?) and the relationships between these different SDG targets (i.e., Do we compromise some to attain others, as recently discussed by Nilsson et al. (2016) in their broadly applicable framework for assessing Target interactions?). Are there cases where economy is advanced at the expense of society and/or the environment? Conservation International, a GEO Participating Organization, is investigating this and is leading a proposal to apply this specifically to freshwater systems in sub-Saharan Africa, in collaboration with other partners from GEOGLOWS and from SWFP.

Recommendations:

1) GEO should identify indicators that can be consistently mapped across different countries (i.e., indicators that are informative for assessing SDGs but that can be usefully and easily applied in different regions with different data constraints).
2) GEO should assess what water-related indicators for SDGs will also be informative for targets not related to water. Also, we can look at what non-water-related indicators are applicable to water studies. For example, how can human settlement maps be used to assess water systems (the needs placed upon them) and SDGs?

Can GEO provide advice on new or overlooked indicators for assessing SDG Targets that are not yet part of the SDG process (e.g., in the Tier 3 SDG targets)? GEO Water initiatives need to work closely with EO4SDG. GEO water interactions have several recommendations for water sustainability and ecosystem conservation but we need to identify the enabling environment that allows us to develop these recommendations in the first place. Thus, we need to integrate our recommendations into one functional socio-economic framework. One possible approach is to identify links between green infrastructure (natural capital), gray infrastructure, and the SDGs. GEO needs to find a way to integrate remotely-sensed data with in-situ data for local applications. GEO should be looking at the role of Earth observations in SDG 17, which aims to "Strengthen the means of implementation and revitalize the global partnership for sustainable development" (e.g., How can we mobilize Earth observation data so that developing nations can use these data for planning and policy?).

Questions were also raised about how GEO addresses policy and how to ensure that GEO groups present a united and well-coordinated set of messages. We need to engage with representatives from IUCN (e.g., in the IUCN Water program) who can provide advice on best policy approaches. We also need to work closely with the Ramras Convention.

Discussion Group #2: Mark Reichardt

The group addressed questions related to the strengths and impacts of GEO. GEO has an established network of nations and members with access to many more key organizations and constituents. This gives GEO unprecedented access to user requirements and needs for which it can provide current products and services or tune and develop new methods. Given GEO's broad mandate, we need the ability to harmonize across related disciplines. On the topic of EWVs, we need input from other communities beyond the water quantity community. What can we collectively do to apply proxy for things we cannot observe or observe clearly? The issue of EWVs is therefore critical. We need to focus on what needs to be addressed and what is actually essential as opposed to what is easy or simply nice to have. We must strive for a GEO approach that addresses each of the SDG indicators to help align the methodology and interests of contributing organizations.

Collaboration

Short Term Challenges and Actions

We need to develop data inventories that will inform users of the following information: Who has the data? Where is it housed? Is it locally-to-globally accessible? There should be dialogue between communities and GEOGLOWS to close the loop on data discovery and accessibility.

In the short term, we should aim for the following goals:

- Provide exemplars of data-sharing agreements that can accelerate data exchange agreements.
- Link national registers, portals, and initiatives like the Open Data Initiative more formally with GEO for discovery and access (i.e., AmeriGEOSS is working with organizations to register their data to national registries).
- Continue training and capacity-building activities through GEO Partners with regional organizations. Exercise in-country and virtual training deployment with government institutions. How can we better connect with Participating Organizations to tap these training and capacity building resources (e.g., WMO)?
- Stimulate data exchange locally to globally. Global Earth observation providers should consider a model that encourages data in return for providing its products and services.
- Facilitate access to rain gauge data.

Longer-term Challenges and Actions

There is a lack of understanding at the regional level regarding GEO and its mission. In a number of cases, GEO does not have sufficient political support at the national level to achieve its goals. Formal political support and the engagement of GEO in public policy (as has been done in Colombia) would tend to formalize collaboration more fluidly.

Discussion Group #3: Alan Belward

This discussion group also dealt with questions of whether there are specific policy items that GEO's water groups should be addressing. For example, what SDG targets should our work and products focus on? How can we ensure that GEO water groups approach policy-makers and other stakeholders with a united and well-coordinated set of messages?

It was noted that GEOGLOWS and other GEO Water activities could benefit by engaging corporate stakeholders, NGOs and the development community, UN agencies like UNHCR, WHO, UNECE, and other agencies that ask for alternative uses of existing data, as well as representatives of the general public. In order to help GEOGLOWS interact more effectively with policy, we need translators who can make the policy-makers, corporate entities, NGOs, and other agencies aware of what data and information is available to them. Tools are needed to help develop the interface. Crowd sourcing should be used as a means of raising funds for some GEO activities. Indicators are needed to monitor how well freshwater ecosystems and biodiversity are progressing. The indicators would be lined to specific SDG indicators but should also extend beyond them. In terms of advertising, is there a clickbait quality to the data/services on offer? Actors involved could be space agencies for sure, but also universities and enterprise (business-to-business does not involve government money). Specific targeted products linked to specific thematic perspectives can help target NGOs and similar organizations. The products should be designed and presented with a goal of communicating key messages to the public.

Issues

Time frames may not be the same. For example, corporate world time-frames are often short (the return has to be shown quickly). Additional users are flagging clear needs for predictive capabilities. In terms of scale, the global scale is of course interesting, but the local scale gains a different traction. GEO may not be best adapted to serve this scale. Regional groups become important (i.e., Africa, China, differences by continent?). Two-way communication between producers' and users' needs to be maintained across all communities, including consumer-pull, business, research, and policy users. In terms of accountability, water is both a commodity and a public good.

The discussion group also identified other global initiatives beyond GEO to which the GEO water initiatives should be linked and opportunities for collaborative projects. The links included World Water Week, initiatives addressing global legal frameworks for water, UNFCCC, carbon assessments, carbon reporting, national reporting, ECVs, CBD, CCD, the Sendai Framework, and the Ramsar Convention's opportunities for crowd sourcing.

GEO Plenary XIV Side Event: GEOGLOWS and the harmonization of GEO Water Activities
Side event: IGWCO and Water

October 24, 2017
Ronald Regan Building and International Trade Center
Washington, DC

Meeting Summary

The IGWCO CoP discussions were chaired by Vanessa Aellen of the GEO Secretariat.

1. Richard Lawford: "IGWCO CoP Overview"

Richard Lawford of Morgan State University and Future Earth gave an overview of the IGWCO CoP's objectives. Its mission is to undertake or contribute to GEO studies involving innovative approaches to data collection and the application of Earth observations to decision-making in the water sector. Its goals include expanding the range of data, data products, and services available through GEO to water managers; advising on synergies among GEO water activities and with other SBAs to advance GEO; undertaking exploratory studies and reviews to assess the adequacy of current activities and the feasibility of exploring new opportunities, technologies, and program relationships; and tracking the implementation of the GEOSS Water Strategy. The CoP is a horizontal organization of approximately 150 members with a Chair. It receives administrative support from the GEO Secretariat in arranging its periodic teleconference calls. It has a global scope and focuses on the Americas, Europe, Africa, and Southeast Asia. Significant achievements in 2016-17 include supporting the implementation of GEOGLOWS and the incorporation of other GEO Water Activities into GEOGLOWS; contributing to the completion of the CEOS study of synergies in water cycle observations; and revising an accepted *BAMS* article on the follow-up to the GEOSS Water Strategy.

The IGWCO CoP has contributed to and overseen the implementation of the GEOSS Water Strategy. First, CEOS developed two major studies in response to the GEOSS Water Strategy and is now exploring mechanisms for coordinating some aspects of the Strategy's implementation. Second, GTN-H made some adjustments to improve quality control in its data centers and added the FAO AQUASTAT archive to its list of participating centers. Third, GEOGLOWS has committed to implementing the Strategy and is progressing in the following areas: user needs assessments, water use, Essential Water Variables, capacity building, and promoting open and free access to data, among other topics under development. Plans and deliverables for 2018-19 include holding an annual meeting in 2018 to bring together all of GEO Water's elements. In addition, based on its recent annual meeting, GEOGLOWS will consider the potential for developing applications related to smart cities and water, comprehensive water assessments (such as COMPASS), climate extremes and resilience, and the role of indices and accountability in engaging stakeholders. The IGWCO CoP links will continue to identify and, where appropriate, develop linkages between space agencies' capabilities, in-situ programs, and the SDGs. Challenges include fostering the development of a new focus for its analytical capabilities and integrating new observational capabilities and practices into data streams and data products for users. With the emergence of GEOGLOWS, the future role of the IGWCO COP is subject to discussion and assessment.

2. Will Pozzi: "The GEO Hydrological Extremes Information Service and Global Drought Early Warning Framework"

Will Pozzi, an affiliate of NOAA's National Climate Data Center, presented on the Global Drought Information System (GDIS). GDIS must be global in scope because droughts can cover significant parts of the world, including parts of North America, East and West Africa, East and South Asia South America, and Australia. The largest droughts tend to be produced by atmospheric-ocean circulations and are affected by global climate patterns. Drought identification, however, cannot be completely automated. It requires collaboration between drought managers, meteorologists, hydrologists, groundwater specialists, agricultural operators, and ecologists. Vulnerability to drought varies spatially and is determined by social factors that lead to exposure, coping mechanisms, and resilience. The social factors include the number of people exposed, per capita water availability, and water use trends that change over time. This GEO activity can help support SDG target 6.4 monitoring and its connections with agriculture and energy. In terms of agriculture, GEO can develop a satellite constellation to monitor agricultural crop types and crop areas. It can also monitor water consumption over these agricultural areas and can identify water consumption per plant type age.

3. Yubao Qiu: "GEOCRI – GEO Cold Regions Initiative"

Yubao Qiu of the Chinese Academy of Sciences provided an overview on the GEO Cold Regions Initiative (GEOCRI). More than 100 countries around the world have cryospheric elements and in many cases these elements are a major source of fresh water for downstream societies. Cold regions are very ecologically and environmentally sensitive areas and changes to these areas comprehensively affect the dynamic Earth system. GEOCRI addresses global environmental change and its resulting impacts and challenges on all aspects of society. An information service for cold regions has been established to broaden and share Earth observations for societal benefits and inform decision-makers by strengthening coordination and engagement with stakeholders. GEOCRI's geographical scope includes the Arctic, the Antarctic, the Himalayas (the Third Pole), high-latitude oceans, and high-mountain cold region areas. Its mission is to develop a user-driven approach for cold region information services to complement the mainly current science-driven effort and foster collaboration for improved Earth observations and

information on a global scale. Its objectives include integrating, brokering, and promoting Earth observations over the planet's cold regions; advocating for and sharing data; building community portals and services; and strengthening capacity building and partnerships. Recent progress includes reinforcing the development and implementation of the GEO Cold Regions Initiative, identifying priorities, and holding a meeting on remote sensing models.

Ian Harrison and Adrian Strauch (GEO Wetlands) noted the possibility for collaboration in studying climate change effects on boreal swamps.

4. Richard Lawford: "EO4WEF Community Activity"

Richard Lawford of Morgan State University presented the GEO EO4WEF Community Activity, which promotes the use of Earth observations within the Water-Energy-Food (W-E-F) Nexus and its sectors and the use of data as the basis for advancing the joint co-management of the W-E-F Nexus. Its goals are to articulate the requirements of the W-E-F Nexus community for Earth observations and information systems and to document them in a report, and to relate the monitoring needs of the W-E-F Nexus to the appropriate elements of the SDGs, GEOGLOWS, and GEO agenda. Four regional workshops were held and the results of the workshop are being synthesized and analyzed. The workshops were financially supported by the Belmont Forum along with the U.S., Germany, Japan, and South Africa. In terms of governance structure, final report preparation is being done by the project co-leads and volunteers. A U.S. W-E-F Nexus Community has been launched; the completion of a matrix assessing the relationship between the targets in SDG 2 (Food), 6 (Water), and 7 (Energy), along with a draft discussion paper on the connections between the W-E-F Nexus and the SDG has begun; and for a special collection of papers on the W-E-F has been accepted by Frontiers Environmental Sciences. To date, 22 authors have indicated a willingness to submit manuscripts. The following observation opportunities and issues were identified in the W-E-F Nexus Study: 1) A rigorous definition of the W-E-F Nexus is needed as the basis of the design of monitoring programmes; 2) Simple indicators need to be developed as a means of monitoring the W-E-F Nexus at the country level and to track changes over time; 3) To address regional W-E-F Nexus issues, regional information platforms are needed; 4) Watersheds, basins, and areas are needed for case studies on how Earth observations can contribute to joint planning of W-E-F Nexus actions; 5) W-E-F Nexus implementation could benefit from citizen science, especially if it is linked to Earth observations; and 6) Research is needed to link Earth observations and analysis systems for the W-E-F Nexus understanding to economic and governance issues (e.g. trade). Plans and deliverables for 2018-19 include holding a special W-E-F session at the Fall 2017 AGU meeting in New Orleans, LA; submitting the final W-E-F synthesis report to GEO, the Belmont Forum, and Future Earth; writing a peer-reviewed paper on the connections between the W-E-F Nexus and SDG monitoring; and launching a pilot project on information systems and the W-E-F Nexus. EO4WEF will help initiate more integration between the Water, Agriculture, Energy, Ecosystems/Biodiversity, and Health SBAs. It may also provide a basis for enhancing GEOGLOWS W-E-F activities. Challenges include obtaining funding and other support for a pilot project to demonstrate the benefits of Integrated Information Platforms for management of the W-E-F Nexus.

5. Richard Lawford: "The SWFP COMPASS Project"

On behalf of the COMPASS Team, Richard Lawford of Morgan State University provided an overview of SWFP's COMPASS project. The COMPASS mission is to provide comprehensive assessments for global water to help plan and manage water resources on multiple scales. Its goals include developing a prototype assessment system, using it to produce a suite of potential products, operationalizing the

system, and producing routine assessments of water status. COMPASS is a state-of-the-art digital toolbox that detects, evaluates, and reports on existing, imminent, and emerging water resources challenges. It produces indicators and indices that merge satellite data with model outputs, in-situ observations, socio-economic information, and citizen data to produce continuously updated monthly assessments. Planned COMPASS products include a water future index, six-month water outlooks, annual "state of the resource" report cards, SDG report cards, medium-term water trends, and business intelligence reports. Its interpretation services will be provided by 11 different SWFP working groups. COMPASS will be driven by a cloud-based system that accepts multiple data streams to produce a suite of products for use by different agencies and programs. Although global in scope, COMPASS will also be validated through regional studies (the first one will likely be carried out in Australia). Achievements for 2016-17 include the development of a complete conceptual plan and marketing document and regular meetings with potential funders and contributors. Deliverables for 2018-19 include presenting a system design and implementation plan at the 2018 WWF, developing and testing a prototype assessment system, continuing to seek partners and funders, and defining a pilot project in which global products would be prepared and validated against regional ones. COMPASS assessments will link to the Water Resources, Food, Energy, Ecosystems/Biodiversity, and Health SBAs, among others. The system directly contributes SDG 6.4 and more broadly to other targets such as 6.6. Challenges include the lack of human and financial resources to undertake all of the necessary development work.

6. Paul DiGiacomo: "GEO Blue Planet efforts to support the SDGs"

Paul DiGiacomo, Co-Chair of the GEO Blue Planet Steering Committee, gave an overview of the GEO Blue Planet initiative. Its mission is to advance and exploit synergies among ocean and coastal observational programs; increase integration of and access to in-situ and remote sensing ocean observation data; improve engagement with a variety of users for enhancing the timeliness, quality, and range of services; and raise awareness of the societal benefits of ocean observations at the public and policy levels. Blue Planet's overall goal is to ensure the sustained development and use of ocean and coastal observations. It provides a worldwide network of experts with members from government, academia, NGOs, and other organizations. The program is currently prioritizing the development of the user engagement working group; considering building high-level products and services that can be tailored to specific regional and local needs; and producing and compiling case studies and examples of how ocean observations benefit society. Current projects include a special issue of the *Journal of Operational Oceanography* on different sectors' use of end-to-end case studies of ocean observations and a workshop on SDG implementation and monitoring in the Caribbean (January 17-19, 2018) in St. Vincent and the Grenadines. In keeping with SDG implementation, Blue Planet supports the Multipurpose Marine Monitoring Mechanism (4M) project for implementation in Barbados and Grenada currently being developed by UNDP Barbados, the OECS, IOCARIBE-GOOS, and GEO Blue Planet. The 4M project will provide data and information necessary for successful implementation of the SDGs in the Caribbean.

7. Paul DiGiacomo: "The GEO *AquaWatch* Initiative: Global Water Quality Monitoring and Forecasting Service for Inland and Coastal Waters"

Paul DiGiacomo, Co-Chair of the AquaWatch Steering Committee, summarized the initiative's mission to improve the coordination, delivery, and utilization of water quality information. Its goal is to develop, build, and disseminate the global capacity and utility of Earth observation-derived water quality data, products, and information to support integrated water quality management and decision-making. AquaWatch emerged from a working group under the Water Cycle SBA and IGWCO CoP to a service that would use satellite data to identify areas with deteriorating water quality. Additionally, in-situ data

considerations have been added as another possible data source. In 2017 AquaWatch was formally approved as a GEO Initiative. AquaWatch integrates with and coordinates across other water activities, especially GEOGLOWS and Oceans and Society: Blue Planet. As a GEO Initiative, AquaWatch will work to improve access to data and information, provide a venue to share best practices, and advocate for the importance of sustained and routine water quality monitoring at the global scale for coastal and inland waters. A recently completed informational booklet on water quality monitoring is available at www.geoaquawatch.org. Current activities include developing an integrated and coordinated product suite for NTU turbidity, Secchi disk depth product, diffuse attenuation coefficients, and surface reflectance. This product suite is a first step in developing a global water quality monitoring and forecasting service. Plans for 2017-19 include continuing to build on the water quality information service; supporting and collaborating with other GEO groups on water quality project needs (GEOGLOWS, EO4SDGS, GEO Blue Planet, GEO Wetlands, GEO BON, and regional GEO groups); further populating the AquaWatch Steering Committee; building Working Group activities; increasing engagement and collaboration with other GEO groups; and accelerating capacity building activities. A conference call is being planned to discuss collaboration between AquaWatch, GEO Wetland, Blue Planet, and Freshwater BON.

Discussion (Chaired by Rick Lawford):

A discussion following the individual presentations dealt with three primary questions:

1) Going forward, do we need the IGWCO CoP and, if so, what role should it play?

This discussion began with the observation that with the changes in the role of the GEO Secretariat and its water expert for the new Work Plan, GEO has less need for an external CoP to coordinate and consolidate inputs. This has decreased the role of the IGWCO and also diminished its funding support over the past two years. In addition, GEOGLOWS has now become a GEO initiative and has a broad mandate that could grow to include coordinating all of GEO Water activities.

Participants argued in favour of maintaining the IGWCO CoP. It was argued that the independence of the coordination is important to maintain rather than having one initiative oversee the other initiatives. GEOGLOWS itself seemed to also see value in continuing the IGWCO. The second argument revolved around changes arising in the GEO Secretariat in 2017 and uncertainty about whether the Secretariat would have a full-time water expert in 2018. It was also argued that the IGWCO plays an important role in informing groups outside of GEO about its water activities and allows GEO to engage in more non-GEO (e.g., UN) activities related to water. (A participant not included in the side event also raised the question of the status of the implementation plan promised by IGWCO for the GEOSS Water Strategy, which was developed in an admittedly piece-meal fashion by IGWCO but never fully consolidated.)

On the other hand, GEOGLOWS plans to staff a full-time Secretariat position that promises to support broader outreach from GEOGLOWS, which could in turn also help promote other GEO Water initiatives. Given this uncertainty, it was decided that the IGWCO CoP should continue for another year and should then be reassessed. It may be appropriate to have co-chairs for the IGWCO to provide better geographical representation and to help share the workload.

2) What priorities does GEOGLOWS need to pursue in order to ensure it engages the capabilities of the other GEO water initiatives? The topic is particularly relevant in designing a strategy for dealing with EWVs.

Jose Romero of the Swiss Department of the Environment reiterated the importance of Essential Water Variables and noted the Swiss government's interest in being involved with GEOGLOWS and other GEO initiatives on this issue. It is clear that Essential Water Variables involve both water quantity and water quality variables and more work may be involved for the water quality variables since water cycle (quantity) variables have been addressed by CEOS and others. However, there was also a strong sentiment that water quantity and water quality variables should be addressed by the same analysis group in order to ensure consistency in the analysis. Moreover, only one list of Essential Water variables should be produced in order to avoid confusing users with having multiple points of contact. Finally, GEOGLOWS should provide a uniform voice to CEOS and other interested groups and simplify the updating process by ensuring it is done through one group. It was noted that the water quality discussions would need to involve the expertise of AquaWatch. It was also noted that the assessment of EWVs needs to bring in in-situ measurements and water quality modeling, areas where AquaWatch has not been particularly active. It was noted that ISGS and some NASA water quality projects do not have strong engagement in AquaWatch. Participants shared the feeling that a GEOGLOWS point of contact or a neutral broker should play the coordination role.

The issue was also discussed in the larger context of essential variables. It was felt that the experience of biodiversity experts in establishing essential variables should be considered to ensure that coherent approach to requirements exists. (This discussion was accelerated by the Swiss government's announcement during the GEO Plenary that it supports the EWV study and that it plans to provide support to GEOGLOWS to address this problem.)

3) What steps can GEOGLOWS take to more effectively engage with AO GEOSS and AfriGEOSS to promote engagement?

It was agreed that the SERVIR network and programs like DEVELOP provide opportunities for engaging these other programs. In terms of capacity development networks in developing countries, the infrastructure available through the World Bank provides a way forward. The links with AO GEOSS can build on the interactions of DIAS and AWCI with IGWCO and these can be broadened to GEOGLOWS. Due to recent personnel changes at the GEO Secretariat, AfriGEOSS is in a state of flux. However, it is recognized that there are opportunities, but we need to engage water experts from these groups more regularly and actively in the GEOGLOWS and IGWCO CoP discussions.