# GEO Work Programme 2020-2022

# GEO Global Water Sustainability (GEOGLOWS)

**February 2019**

**GEO Global Water Sustainability (GEOGLOWS)**
**GEO Initiative**

## Executive Summary

### Overview

The following document outlines the plans and activities of the GEO Global Water Sustainability (GEOGLOWS) Initiative for the period 2020-2022. Many of these activities were initiated in 2018 and will go beyond 2022.

GEOGLOWS is a user-driven Initiative and brings together water and Earth observation activities around the world to guide the decision-making process. GEOGLOWS provides coordination knowledge, data, and products among diverse freshwater activities within and outside GEO, to assist in the decision making process. By bringing together global partners to improve and test much-needed tools and resources, GEOGLOWS is contributing to global water management, disaster risk reduction, and water sustainability.
GEOGLOWS activities include a comprehensive perspective on observations and services for water sustainability. Within GEOGLOWS, the term 'sustainability' encompasses humanity's goal of balancing social, economic, and environmental well-being, and as such, water sustainability, including water quality is an essential part of these broader sustainability goals. GEOGLOWS uses these three dimensions of sustainability to determine the direction of the Initiative and as a requirement in all GEOGLOWS activities. GEOGLOWS is working to provide relevant, actionable information about water that promotes the use of earth observations while strengthening observational networks in local operational frameworks. GEOGLOWS provides a space for self-organizing International Water Cycle observations, and its applications to forecasting (including water cycle extremes), Water Accounting, drought (and water stress), climate change detection, adaptation and impact mitigation, and many other freshwater activities. GEOGLOWS also provides a forum for government to government collaboration and engagement with the academic and private sectors. In addition to the mentioned collaborations, this forum leverages and coordinates its activities among historical intergovernmental mechanisms of the UN. GEOGLOWS is a voluntary mechanism and informal agreement among multiple partners within and outside the UN system. With an operational focus, GEOGLOWS allows for engagement and greater integration with transboundary organizations (e.g., ECMWF) and others that are not hydromet services (e.g., CEMADEN-Brazil).
The most significant technical elements of GEOGLOWS since its inception are:

- The implementation of the GEOGLOWS technical development for the Global streamflow forecasting service at ECMWF.
- The development of a framework for the selection of audiences for the Essential Water Variables (EWVs) and a process for the selection and processing of EWVs addressing inland and coastal waters.
- A number of ideas that have emerged from GEOGLOWS meetings and from commitments of NASA and CNES investigators to support GEOGLOWS activities.

The initiative is relevant to the GEO strategic objectives and follows the model of GEO projects. It achieve its objectives by facilitating collaborations, enabling projects, and encouraging conversations that will strengthen these programmes, increasing awareness of related activities and leverage existing or planned activities.

### Planned Activities

GEOGLOWS requires for all its activities to provide vital information in places where little or none exists and to strengthen national, regional, and local water information to guide management efforts. Through renewed and new alliances and partnerships we will continue fostering collaboration to provide valuable resources to the broader community in need of water knowledge and services and to inform and enhance decision making. GEOGLOWS will deliver a series of advancements over the next 10 years, including:

- 2020-2022: While significant progress will be achieved in 2019 with the Implementation of GEOGLOWS technical development for the Global streamflow forecasting service at ECMWF, we will continue, through strategic partnerships, to close gaps, assisting organizations with hydrological forecast responsibility to implement this unique service to complement their national and local efforts. We expect to expand the service to include other forecast services such as NOAA/NWS-GEFS.
- 2019-2022: A plan will be submitted by 2019, for coordinating the definition of EWV in support of the SDGs, Sendai, and other priority policies. By 2020, the plan will expand to leverage existing programs and organizations for the implementation of data acquisition, analysis, exchange, and distribution systems for the accepted EWVs. By 2021 the plan will expand to include a system development and governance that will provide all nations with consistent access to EWV estimates and related processing tools at preferred resolutions.
- 2020-2022: GEOGLOWS will work to increase regional capacity to acquire, share, store, maintain and utilize water data and information by leveraging data-exchange efforts of the Regional GEOs and will establish a web presence through these Regional efforts.
- 2019-2020: Capacity building and training are central values for the GEOGLOWS initiative to ensure that the knowledge, capabilities, and services developed in advanced countries are made available to nations with the greatest need; GEOGLOWS will work closely with regional GEOs to deliver these capabilities.
- 2020-2022: Starting in 2019 and through a partnership with the AmeriGEOSS Platform, GEOGLOWS will pursue the development of the “Water Accounting Framework” to support sustainability in the Americas.
- 2019-2022: Increase the contributions of hydrometeorological products by GEO members in the regional GEOSS projects through GEONETCast, SERVIR, TAHMO (primarily through the H2020 TWIGA project) and other GEO systems.
- 2019-2022: Develop new sensors, improve and extend in situ networks and provide actionable information for water management and flood risk reduction in sub-Saharan Africa through the H2020 TWIGA project.
- 2019-2022: Encourage all GEO members to contribute to the overall GEOGLOWS framework on an on-going basis, and strengthen the network of investigators and organizations working to achieve GEOGLOWS objectives.
- 2018-2020: With the most recent partnership with the Asian Water Cycle Initiative (AWCI), GEOGLOWS will explore collaboration in the area of "agriculture drought monitoring and prediction" contributing to the food-water nexus.
- 2020-2022: Develop tests to ensure that GEOGLOWS data submitted to the GCI and GEO Data Core are easily discoverable in these archives. Develop a set of principles for countries and agencies to ensure the development of a coherent interoperable data system for water.
- 2018-2020: Develop a collaborative platform (Tethys) where solutions to transform data into knowledge can be shared and reused.
- 2019-2022: Improving the integrated water resources management and climate change adaptation schemes within the Space Climate Observatory over the main African basins and in close cooperation with national agencies and basin organizations. The work has started over the Congo basin and will be pursued over the Niger, Chad and Senegal basins. It aims to provide useful information about water quantity and quality derived from space observations. It will support also in-situ measurements to validate and calibrate satellite products and also to

optimize the complementarity between space and ground measurements. The ultimate goal intends to define adaptation scenario and risk mitigation.

- 2019-2022: Increase awareness of the hydrological community to the GEOGLOWS initiatives to help the creation of a federated community around common objectives through workshops, conferences and training

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## Purpose

**Rationale**

In 2015, the World Economic Forum cited the lack of freshwater resources to meet the water demand as the most significant global risk regarding potential impact over the next decade. It is indisputable that there are severe deficiencies in water availability, supply, and distribution in many parts of the world exacerbated by multi-sectoral stresses, unsustainable demand/consumption, transboundary issues, climate variability, and climate change. Perhaps, the origin of the present water crisis could be seen as a consequence of environmental, economic, and social activities, augmented by uninformed decision due to the lack of a coordinated, comprehensive, and sustained Earth observation framework. However, at a deeper level, the water crisis today is not one of absolute scarcity, but instead of the distribution of resources, in which services and information in many developing countries are inadequate in recognition of the inadequacy of the operational use of EO water data in the decision-making. Except for meteorological data, the operational use of EO water data in the decision-making process is still in its early development. The World Bank, with a current hydro-meteorological investment portfolio of around US$ 500 million, estimates that globally improved weather, climate, and water observation and forecasting could lead to up to US$ 30 billion per year in increases in global productivity and up to US$ 2 billion per year in reduced asset losses. The World Meteorological Organization (WMO) is pursuing a reform process that intends to boost the importance of water in the WMO framework. As expressed in 2018 by the WMO Secretary-General Petteri Taalas, "We need to build better operational services to handle water resources. We have to adapt to climate change, and one way of doing this is to invest in weather, climate and water services".

Hydrological Stress, particularly in the Tropics, has become a significant source of inflationary pressures through the increasing volatility of food prices. In the economic literature, this phenomenon is known as 'the food dominance of inflation.' Behind this reality is climate variability with an increase in extreme events and particularly in hydrological stress, which is the actual origin of this shock supply. Water supply is by far the most important varying element in agriculture, energy, and commerce, and in this framework it is understood that water must meet not only the needs of the present population but also those of future generations. The proportion of people living under high water stress is increasing due to climate change, population growth, and economic growth; and inequities exist in nations' access to data for decision-making. Water supply defines the real boundary of the agro-ecological frontier for primary food production. The 'food dominance of inflation' represents a far-reaching challenge for monetary policymakers, as the tools at their disposal – interest rates, reserve liquidity requirements, credit, and capital controls, etc. -, are designed to affect only the demand in the economy but are innocuous when facing supply factors. As a result, different orbits of public policies become fundamental to face the problem of the hydrological stress.

In regard to priorities of sustainability, water data plays an essential role in eleven of the seventeen SDGs in achieving the targets and the calculation of indicators with critical interdependencies with the water sector. Ignoring these interdependencies will lead to contradictions in management practices, and inefficient allocation of water resources around the globe. In this sense, the identification of EWVs is vital to address the 2020 deadline for SDG indicators for targets such as 6.6 and 15.1 because the suggested indicators do not precisely match the objectives of the target – as noted in the review of indicator 6.6.1 relative to target 6.6 by UN Environment. It is, therefore, crucial to identify EWVs that are useful as possible indicators to assist with the assessment of SDG targets. Moreover, the Convention on Biological Diversity (CBD) community will be reviewing its Aichi targets and defining a new set of post-2020 targets to ensure that freshwater is adequately represented in those targets. These post-2020 targets will also need reliable and consistent indicators for the assessment of the status of freshwater ecosystems, and thus collaboration is needed to design indicators that can work across both the SDGs and the CBD targets.

GEOGLOWS provides a “safe space” for self-organizing international hydrologic sciences, observations, and their application to forecasting, and provides a forum for government-to-government collaboration, engagement with the academic and private sectors. This forum also leverages and coordinates among historical intergovernmental mechanisms of the United Nations, including Commissions of the WMO Commission and the programs of UN Environment. GEOGLOWS is a voluntary mechanism, created by informal agreement among multiple partners from inside and outside the UN system. GEO allows for engagement and greater integration with European and other transnational organizations not represented in the UN (e.g., ECMWF) and other water agencies that are not hydromet services (e.g., CEMADEN-Brazil), and therefore not represented in the WMO.

**Mission**

To connect the demand for sound and timely environmental information to the supply of data and information about the Earth’s water system and to explore the science needed to achieve the goals outlined in the initiative. Advocacy for broad, open data policies and for the realization of the right to access information (to seek, to receive, and to impart information) helps ensure that the data collected through national, regional, and global observing systems is both made available in the public domain and applied to decision-making.

**Policy Mandate**

GEOGLOWS policy drivers include the Sustainable Development Goals (SDG), the Addis Ababa Action Agenda, the Paris Agreement on climate change, the Sendai Framework for Disaster Risk Reduction, the Aichi Targets of the Convention on Biodiversity, and Convention No. 169 of the International Labor Organization (ILO) as it is the only international treaty open for ratification that deals exclusively with the rights of indigenous and tribal peoples within the nation-States where they live and the responsibilities of governments to protect these rights. These priority policies call for urgent transformative steps to shift the world onto a sustainable and resilient path, and possess significant challenges regarding data issues.

Activities related to the selection of freshwater EWVs for water quantity and quality mainly respond to the need to characterize the water cycle and water availability from local-to global scales while the EWVs for water quality respond to the need to characterize and manage information that varies across the inland and coastal water quality communities and address local and regional problems.

**Outputs of the Initiative**
GEOGLOWS is working to fill gaps and provide relevant, actionable information about water that promotes the use of Earth Observations while strengthening observational networks in local operational frameworks and to succeed in the implementation of global water observation where EO data and in-situ networks complement one another. GEOGLOWS promotes GEO's open data and open architecture policies, and plays a key role in delivering the systems and system inputs central to GEO and its user community: it brings data, forecasts, information, and knowledge to the world's water resources management community.

**End Users**
GEOGLOWS build on user communities such as the IGWCO and other GEO Initiatives, and take advantage of its links with Regional GEOs and international science programmes such as the WCRP's GEWEX programme and Future Earth's Sustainable Water Future Programme.

Within the partnership of the Global Streamflow forecasting, experts from around the world have collaborated on an open global streamflow forecasting system. This system provides vital information in places where little or none exists, and fills gaps to strengthen national, regional, and local water management efforts. GEOGLOWS Global Streamflow forecasting pilots - led by researchers at Brigham Young University - have been undertaken in the Dominican Republic, Colombia, Bangladesh and Nepal, in order to assist with the analysis of past floods, forecasting of future floods and damage, as well as other water resource uses based on local needs. In the Dominican Republic, GEOGLOWS worked closely with the National Institute of Hydraulic Resources (INDRHI) to create customized applications for nationally-defined needs in the areas of flood protection, agricultural demand and reservoir management. In Colombia, the customized GEOGLOWS application enables the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM) to visualize water levels and historical data from their 200+ monitoring stations, in order to both assess the simulations and more accurately identify areas at risk of flooding. In Nepal, GEOGLOWS partnered with the national Department of Hydrology and Meteorology (DHM) on a pilot application that increased capacity to identify and forecast flood events and their impact. In Bangladesh, the pilot application was developed in collaboration with the national Flood Forecasting and Warning Centre and the International Centre for Integrated Mountain Development (ICIMOD), and was customized to help decision makers forecast transboundary flows that were used to drive their national flood warning system. Since 2018, we have been actively engaging with the WMO community, sharing information and participating in their discussions; we hope to achieve progress and establish a formal collaboration in the area of hydrological forecasting.

The needs for water cycle observations have been prioritized by a review of various user needs surveys (Unninayar et al., 2010). Two primary client groups are evident in defining user needs, particularly: 1) water managers and operational decision-makers, and 2) climate and macroscale hydrological researchers. In both cases, water data are essential to allow them to carry out their responsibilities. To meet their needs, a list of EWVs was developed. The requirements for EWVs are defined in terms of resolution, refresh rates, data accuracy, and data latency based on this review. The requirements varied on the end user's classification. Adopting these EWVs will influence priorities for product reanalysis and provide stronger support for the terrestrial variables included in the climate variables. Users need access to the best EWV products possible. By combining geospatially consistent remote sensing data and high-frequency in situ point measurements, it is possible to produce more reliable and integrated data products.

GEOGLOWS will conduct a gap analysis to clarify the adequacy of existing products and services and the need for new services. It is expected that emerging applications related to water quality and extreme event monitoring should lead to new services.
Activities of the Regional GEO's are leveraged to identify data, products, and services needs in each region. AmeriGEOSS functions as a user engagement element through the surveys it undertakes during meetings and training sessions to address this need. Other user engagement is achieved through continuous active participation in the IGWCO CoP, where emphasis is placed on engagements with users around the world. In addition, GEOGLOWS organizes side events at the GEO Work Planning Symposium and Plenary meetings to inform experts in other SBAs of their activities and to stimulate cross-SBA activities. GEOGLOWS members will be encouraged to organize scientific sessions and town halls at international science meetings to expand their activities. More effective approaches are needed in a multilingual world with a wide diversity of capabilities. To facilitate the co-design of new products, a process should be developed to continuously identify, articulate, and refine user needs for water products at multiple scales. Users should have access to data on the uncertainties in data and prediction products to assist them in using the information in risk management frameworks.

**2. Expected outcomes, impacts and beneficiaries from adoption of the outputs from the Initiative.**

A requirement to qualify as a GEOGLOWS activity is for the project to provide vital information in places where little or none exists and to strengthen national, regional, and local water services and management efforts. Some examples of this objective are provided by the GEOGLOWS work funded by NASA which aims to reach communities by collaborating with international and local partners. One project is working with Brazilian partners to develop apps that would deliver groundwater data harvested from GRACE. Another project is working with the National Center for Water Resources Planning and Investigation (NAWAPI) of Vietnam and the National Hydro-Meteorological Service (NHMS) of Vietnam to use satellite information for monitoring and forecasting of river discharges, inundation extents and water level changes in the Lower Mekong countries.The third project is working with the Pakistan Meteorological Department, Indus River System Authority, Pakistan Water Power Development Authority, and the Pakistan Ministry of Climate Change on optimizing the Indus Basin Irrigation System and reservoir operations using remotely sensed snow surface properties. Finally, a project with the Karnataka Department of Water Resources is focusing on the evaluation of risk and capacity development for two Indian river basins. More information on each project is provided below.

**3. Background and Previous Achievements**

Significant progress has been achieved in the following areas:

**Global Streamflow Forecasting**

The Group on Earth Observations is a unique global network that promotes collaboration to create innovative solutions. As an example, the GEOGLOWS Partnership has brought together experts from around the world to create a global streamflow forecast that is freely available, providing actionable information, as a service, to places where little or none exist, and filling gaps that can complement and strengthen national, regional, and local efforts. GEOGLOWS partners are leveraging advances in cloud computing, physics-based modeling, data sharing standards, and data visualization that have enabled a more holistic Earth system approach to modeling the hydrologic cycle - addressing a gap that no single organization has been able to address. As a result, GEOGLOWS has developed a practical and technical approach that translates raster information from ECMWF's forecasting system to forecast streamflow discharge for river networks around the world. This system is capable of transforming the way we understand, analyze, and solve critical problems that requires streamflow information.

World-leading experts in meteorological predictions at the European Centre for Medium-range Weather Forecasts (ECMWF), have developed a land surface model that produces hydrological runoff made freely available to the Copernicus activities that are part of GEO. From this a system focused on forecasting extreme events was developed as part of the Copernicus Emergency Management Service (CEMS). This system, available through the CEMS GloFAS interface, provides awareness for flood events. However, as with most global systems, the resolution makes it difficult to use it directly without any further post-processing to support local decision-making.

Through an effort led by BYU and Esri, which grew out of NOAA's effort to build a National Water Model National in 2015, a derivative application of the ECWMF global runoff forecasts was developed to map and route the global runoff through a vector stream network to produce localized 15-day forecasts and a 35- year simulated historical streamflow on every river. This national system demonstrated that globally generated forecasts could be useful at a local level, especially when it is coupled by web applications that provide new ways to visualize and download data on individual streams. The successful US pilot, motivated the NASA/USAID SERVIR Program to develop the streamflow forecast applications for Nepal, Bangladesh and other countries in South Asia where the ability to create, operate, maintain and disseminate good hydrologic information is resource-limited. The streamflow forecast was also implemented by CEMADEN in Brazil to provide guidance to the federal government in the monitoring and management of actions for the Madeira River basin.

The SERVIR Project further demonstrated that a global streamflow forecast service, developed from the collective GEOGLOWS Partnership expertise, could fill gaps and provide actionable information to national and local agencies charged with the responsibilities of water supply and extreme weather/water management, as illustrated by the testimonial of end-users in Nepal, Bangladesh, Dominican Republic, and Colombia in which pilot projects were implemented.

In May, during the CEMS GloFAS workshop: *Hydrological services for business and the* GEOGLOWS Business meetings at ECMWF we agreed to migrate the service-oriented approach developed through science projects in the NASA/USAID SERVIR Program, to the CEMS GloFAS workflow, and set it up as reliable service from where others can derive personalized applications. In June, project managers from the World Bank agreed to support the migration effort in 2019 to ECMWF and in January, 2019 funding was provided for the implementation of a quasi-operational system.

In October the project was highlighted at the GEO Plenary in Japan, creating hope and expectation to organizations with hydrological forecast responsibility from around the world, as this unique service seeks to complement national and local efforts.

The global streamflow services completely disrupts the paradigm for how streamflow information is created and disseminated. Rather than each water organization accessing large global datasets and develop models to forecast their own streamflow that is useful for decision-makers, the streamflow forecasting, with all its accompanying modeling resources, are created and run on proven global systems, and then made accessible locally through web services. This freely provided streamflow information, which leverages the hydrometeorological computational expertise of the GEOGLOWS Partnership, delivers forecasts that support national and local decision-makers and allows them to focus resources on developing solutions and applications specific to their local water resources management needs.

Kyoto Plenary Presentation Overview: https://www.youtube.com/watch?v=hAX5AHLtC0o
GEO Plenary Overview from 2017: https://www.youtube.com/watch?v=FFx92ztEezA
Story Map with more detailed information, but just a little dated:
http://www.arcgis.com/apps/Cascade/index.html?appid=bf1ecca8ff374691871ba82be570dcdb

**Essential Water Variables (EWVs)**

The concept of Essential Water Variables was introduced in the "GEOSS Water Strategy: From observations to decisions"[1], resulting in a draft list of EWVs and their characteristics, most specifically for quantitative variables. Subsequently, work by CEOS and others has focused on EWVs for water quality. These efforts have exposed the need for water managers to have access to reliable and timely data to plan and monitor the availability, quality, and use of water resources, as well as the need for a forum to make their concerns known and have the opportunity to influence the planning of observational networks and services. A range of issues poses limitations in data useability: lack of regular reporting, inadequate data resolution and frequency, and delays in getting the data to the user. While accuracy and long continuous records are considered important, they are not as critical as they are for those who measure climate trends. In this regard, some of the EWVs have been included with the list of Essential Climate Variables (ECVs), but they are not provided frequently enough and at the proper resolutions necessary to support many of the water management decisions.

In 2018 various meetings and discussions took place among GEO and non-GEO members on possible paths and activities needed to achieve the goal of identifying EWVs. These conversations led to the development of an initial white paper presented at the GEO Plenary in Kyoto, 2018. The paper introduces a framework for the selection of audiences for the EWVs and a process for the selection and processing of EWVs addressing inland and coastal waters. The selection of a set of EWVs will be based on a multi-step user-driven approach with the guidance and collaboration of many organizations, including communities that are already in the process of developing Essential Variables (EVs) and for which water is an essential element (e.g., GEO BON [EBVs], GCOS [ECVs], GOOS [EOVs]). Synergies with other user and provider organizations are being identified, and collaborations will be pursued for developing criteria, identifying data gaps, and developing implementation strategies.

After consultations with members of the ECV and EBV communities, and the outcomes of Working Group discussions among participants from the global community, adopted initial general guidelines were adopted:

(1) Standards and best practices: The study should identify such process guidelines for defining EWVs; (2) Source: EWVs can be measured, modeled, or a proxy. The most acceptable ways of providing an EWV will be identified in this analysis; (3) Redundancy: Select the variable that is easier to acquire even if it is not perfect; (4) Hierarchy: The more direct and less prescriptive an EWV is, the more likely it will be to accept a variety of different measurement sources and methods; (5) Attributes: A single variable can have a variety of sub-variables (aka attributes), which will be explicated in the definition process; (6) Stages of approval: An EWV will be "conditional" until it is demonstrated in the field to actually work, with the target status of "sufficient consensus, and to know its accuracy and sources or error"; (7) Updates: The EWV list will be updated periodically; (8) Distribution: Open data distribution is key, starting with existing data portals, and considering more broad-based solutions, such as GEOSS links to other systems (e.g., WIGOS).

This work on EWV will be coordinated and in close cooperation with the CEOS who is willing to create a group on Freshwater that will address most of the same concerns on that topic.

**EO applications to monitoring indicators of Sustainable Development Goals, especially SDG-6 (Freshwater and sanitation):**

In 2018 (continuing through 2019 and beyond), NASA-ESD and GSFC initiated activities for the application of EO (e.g., Landsat and Sentinel satellite data) to the monitoring of SDG-6

[1] The GEOSS Water Strategy: From Observations to Decisions, 2014. GEO Secretariat, Switzerland, 255 pp. Publisher: Japan Aerospace Exploration Agency.

(Freshwater and Sanitation) in collaboration with and as a contribution to the UN Environment (custodian agency for SDG 6) and countries, focusing on SDG indicators: 6.6.1, 6.3.2., in particular: Water quality of open water bodies, and Spatial extent of coastal mangroves. Specific efforts will include 1) exchanging data with additional countries to validate the methods developed so far and produce uncertainty metrics for satellite EO products; 2) facilitating SDG reporting by creating relevant tools to enable end-users to view and use EO products in indicator production, and for effective and timely decision making; 3) building capacity in the use of these data and methods by participating in UN regional and country workshops and via one-on-one virtual and/or in-country consultations; and, 4) contributing to the development of technical guidelines, with national good practices, on the integration of EO data streams into the production of SDG indicators (one technical guideline / toolkit for each of the aforementioned indicators). These efforts will be done in collaboration with the respective UN agencies, and in support of the UN Inter-Agency Expert Group on SDGs (IAEG-SDGs) Working Group on Geospatial Information (WGGI)) and the GEO EO4SDG initiative. Examples of Initial countries with pilot projects either already initiated or under discussion include: Peru, Uruguay, Brazil, Columbia, Panama, Zambia, Uganda, Senegal.

**Research Projects from NASA**

The NASA Applied Sciences Program through its Water Resources Projects participates in GEOGLOWS by coordinating the provision of data from current and planned satellite missions and develops and shares tools and applications from its research activities. Current missions meet the needs of GEOGLOWS related to the measurement and understanding of precipitation, snow cover and snow dynamics, soil moisture, evapotranspiration, groundwater change, sea level rise, surface water extent and elevation, and indicators of water quality, among other hydrologic variables. The ongoing GEOGLOWS contributions build on projects that have received funding in 2018 and are now producing outputs for use in water management. One project, focused on Southeast Asia, involves collaboration among the University of Houston Viet Nam and other government authorities in the Lower Mekong Basin. This project on monitoring surface water changes over the Lower Mekong with Multiple Satellite Techniques toward Sustainable Water Management seeks to build resilient capacity within co-riparian countries to manage water resources under the current socio-economic development pressures and more frequent extreme flood and drought events. This project provides GEOGLOWS with 1) Satellite altimetry-based monitoring of water levels over the floodplains and wetlands; 2) Satellite image-based monitoring of inundated extents; 3) InSAR-based monitoring of two-dimensional water level changes over floodplains and deltas; and 4) InSAR- and altimetry-based monitoring of absolute water volumes over the floodplains and delta to other areas. Through this project GEOGLOWS is building capacity in Vietnam and Cambodia to support decision making with satellite data. A second project focuses in the Ganga basin, India, one of the largest river basins in the world with total area nearly about 1 million $km^2$. The purpose of this research is to compare performance of different precipitation inputs in representing the hydrology of the basin using the SWAT model. A third project extends an open source environmental web app development system, Tethys Platform, creating an App Warehouse for rapid deployment of water resources decision support system web apps and creating new specific decision support web apps for collaborators in Latin America. A number of other NASA Principal Investigators have indicated their interest in contributing as GEOGLOWS collaborators. In 2020-2022 more effort will be devoted to integrating their activities into the GEOGLOWS program.

**Research and operational projects from CNES**

CNES funds and supports actively several projects that concerns directly the GEOGLOWS initiative. They are mainly developed within the framework of the SWOT downstream program

which aims to leverage the use of Earth Observation data in hydrology. The ultimate objectives of the SWOT downstream are to ease the use of space data and derived products give access to qualify and freely available data.
To do so, CNES has created a working group in hydrology from space to leverage new services gathering scientists, experts, private companies, public institutions and local organizations. The Congo basin, the world's second largest river basin, has been selected as the first pilot project to foster the research in altimetry and runoff estimation and, inter alia, to study the hydropower potential. This project meets the needs of the CICOS, the International Commission of the Congo-Oubangui-Sangha basin. It is supported by AFD, the France inclusive public development bank and moderated by IOWATER, the International Office for Water. The scientific lead is Stéphane Calmant from the French Institute of Development and more than 25 people are involved from different institute and companies : Hydroscience Montpellier (HSM), the geophysics and oceanography research centre (LEGOS), the National Research Institute of Science and Technology for Environment and Agriculture (IRSTEA) and private companies that have export activities (BRL Ingénierie - a consulting firm in water and environment, CNR - the holder of the Rhone River concession and CLS – provider of applications and services using satellite data).
The first part of the implementation plan over the Congo basin was focused on altimetry and quantitative water resources management. As a matter of fact, the current operating gauge stations (~30) over the Congo basin are not sufficient for a good water resource management and the hydropower potential of the basin is underexploited. Within the working group we worked on enhancing the water elevation network with space altimetry: more than 500 virtual stations (measurement point at the crossings between the river and the ground track of the orbits) provides now water levels all over the Congo basin and complement the in-situ measurements. They are freely available on the Hydroweb website supervised by LEGOS http://hydroweb.theia-land.fr. An hydrological information system has also been built. It gathers in-situ + altimetry measurements so that the CICOS has now an operational tool to better understand the hydrodynamic of its basin. The ongoing work focuses on estimating discharge with both a hydraulic model assimilating the observed water levels and a hydrological model. Meanwhile we investigate the potential of the SWOT mission for hydrological forecasts for navigation and hydropower potential estimation.

The first results are very encouraging and have been acknowledged by national and regional agencies. This motivates to spread this initiative to other watersheds in Africa (Niger, Senegal, Chad), in South Asia (Mekong) and in South America (Amazona) and also to emphasize other variables derived from Earth Observation satellite: land cover maps, water quality products, monitoring of water bodies, groundwater storage, soil moisture products. A working plan for each watershed with their own distinctiveness is being drafted in close cooperation with all the current partners. The question of funding is however a matter of concern.

Besides these SWOT downstream program CNES supports heavily research in all subject relatives to water cycle and climate change. It fosters the development of algorithm, modelling and appropriate products and the promotion of Earth Observation data. Without being exhaustive, we can quote:

- Support to the study of cold regions and snow like the observation and monitoring of cryosphere with radar altimeter or the Siberian permafrost monitoring and frozen lakes with remote sensing data or the use of stereoscopy to survey the polar ice. Frédérique Rémy, Alexei KOURAEV, Etienne Berthier from LEGOS, Simon GASCOIN (Cesbio)
- Water quality : operationalization of the OBS2CO algorithm to give access in near real time to qualified water quality products (see https://theia.cnes.fr/ ) with perspective to health risks

in West Africa for instance and the estimation of the sedimentary flow. Jean-Michel Martinez (GET – IRD), Thierry Tormos (AFB), Laurent Kergoat (GET), Charles Verpoorter (LOG)

- Strong support in altimetry and discharge estimation to prepare the arrival of the future SWOT data that will open up a new avenue for scientific research in hydrology. There is a specific focus on Africa, South America and south-east Asia like in Bangladesh for floods dynamic understanding. Jean-François Crétaux (LEGOS), Pierre-Olivier Malaterre, Stéphane Calmant (LEGOS – IRD), Sylvain Biancamaria, Fabien Durand (LEGOS), Fabrice Papa (IRD).
- Global modelling of the water cycle and all its component (including soil moisture, groundwater storage, etc.) to better understand the hydrologic cycle and its evolution with climate change. Catherine Ottlé (LSCE), Aaron Boone (CNRM), Ahmad Al Bitar (Cesbio), Yann kerr (Cesbio- CNES), Benoît Meyssignac (LEGOS-CNES)°.
- Water energy-food-environment nexus with the study of spatial and temporal high resolution images (optical and radar) to map irrigated crops and the land's seasonal dynamic in South India. Samuel Corgne (LETG), Gilles Boulet (CESBIO), Albert Olosio (INRA)
- Study of the impact of climate change and its societal aspects on local territories especially in Africa (agriculture and crop yield evolution, drinking water, transportation, coastline retreat). Marielle Gosset (GET), Sylvain Ferrant (CESBIO), Rafael ALMAR (LEGOS).

All these actions help also to promote the complementarity between all available data (Earth Observation, in-situ, drone, models, etc.). For instance, the climate change impact scenario over the Niger basin uses a new technique to estimate the amount of precipitation through the attenuation of mobile phone signal during heavy rainfall in addition to in situ measurements, modelling and earth observation data (see work of Marielle Gosset, Geosciences and environment Toulouse (GET)). This kind of study should help to mitigate risk of flood. More information can be found here : https://www.spaceclimateobservatory.org/scenarios/tropical-floods-revisited/?lang=en

Finally, CNES strives for the creation of a living community of users in hydrology gathering experts, scientists and end-users. One instance is the organization of SWOT Early Adopters from South America conferences in 2015 in Brazil and 2018 in Chile to gather researchers from South America who could be interested in hydrology from space and the future SWOT mission. This leads to the implementation of 6 French- South American projects in the frame of SWOT that has been underway since 2016 for 4 years with common studies in hydrology, the support for field work, the exchanges of scientists and students. A meeting is now planned every year in South America to inform the South American academic world about the latest news on the use of modern remote sensing techniques and models to monitor water resources and to strengthen the cooperation. It will be organized by CNES, the French Development Institute- IRD and the geological survey of Brazil –CPRM. The next conference will be held in Manaus at the end of this year.

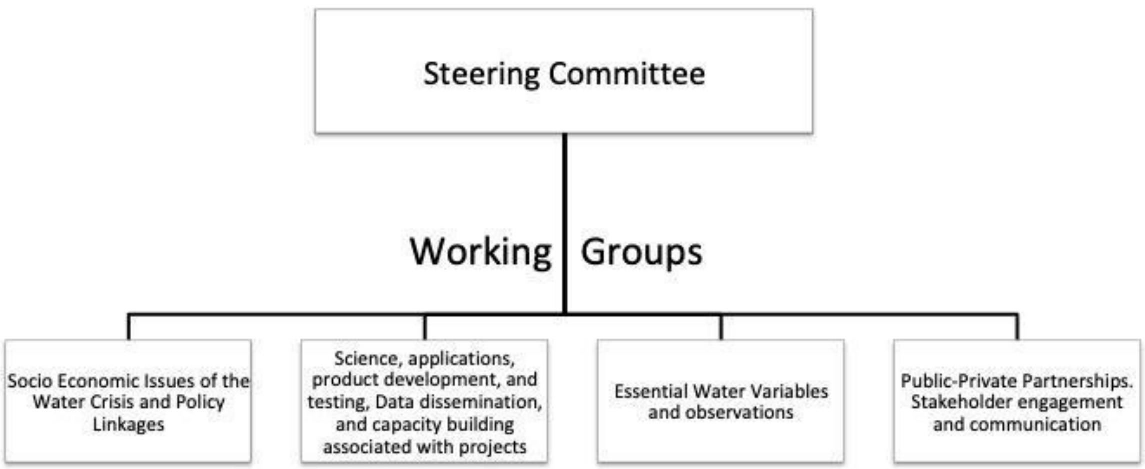
4. **Relationship to GEO Engagement Priorities and to other Work Programme Activities**

GEOGLOWS is critical to GEO's strategic objectives, as it provides a way to coordinate diverse water activities and bring them to bear on important policy and management questions confronting the world: water scarcity, the SDGs, the Water-Energy-Food Nexus, climate change, and biodiversity, among many others.

GEOGLOWS supports the GEO Strategic Objectives throughout its activities. It advocates, through influence and example, the use of Earth observations in decision-making and evidence-based policymaking. This advocacy is directed at national governments, United Nations agencies, science organizations, NGOs, and the general public.

5. **Stakeholder Engagement and Capacity Building**
Capacity building and training are central values for the GEOGLOWS initiative to ensure that the knowledge, capabilities, and services developed in advanced countries are made available to nations with the greatest need; GEOGLOWS works closely with regional GEOs to deliver these capabilities. Capacity building activities within GEOGLOWS are attached to activities lead by the Working Group members and to projects.
In 2019 GEOGLOWS will be participating at the AmeriGEOSS week, providing a course on hydroinformatics and the implementation of the streamflow forecast in operational environments.

**6. Management and Governance**
GEOGLOWS is governed by a Steering Committee, which provides the vision, strategy, policy, and guidance for GEOGLOWS.
The management structure of GEOGLOWS relies on two primary management components: an Executive Board/Steering Committee, and a Leadership Team. Communications will take place primarily through WebEx, emails, and an annual in-person meeting.  The work are carried out by members of Working Groups, who have representation on the Leadership Team. Figure 2 outlines this structure.




The GEOGLOWS Steering Committee provides strategy, policy, and technical guidance and recommendations to the GEOGLOWS Working Groups and the GEO Secretariat and assesses progress on GEOGLOWS activities. The steering committed reviews GEOGLOWS Working Group activities to ensure they meet the objectives as they relate to relevant policy mandates; through the co-chairs, advises the GEOGLOWS Working Groups on how to strengthen and broaden the engagement and expand institutional support for its activities; reviews and approves, as needed, documents prepared by the co-chairs for the GEO Work Program; provides guidelines for projects and activities that seek GEOGLOWS support; identifies and mobilizes potential funding opportunities for GEOGLOWS activities; and responds to requests for advice from the GEOGLOWS Working Groups and co-chairs.

Coordination of the activities relies on the Co-chairs who are members of the Steering Committee. The current Co-chairs of the Steering Committee are Dr. Angelica Gutierrez-Magness (NOAA, U.S.A.) and Dr. Alice Andral (CNES, France) work to strengthen partnerships with regional GEO activities, and share responsibilities of the GEOGLOWS Secretariat. The Co-chairs have the responsibility to prepare information to be reviewed by the Steering Committee, including the development of Implementation Plans;  They assist in the communication between the Steering Committee and the GEO Secretariat, and maintain close communication with the Working Group's leads to ensure that the activities objectives are met; ensures that the initiative's goals, achievements, implementation plans, progress, follow GEOGLOWS objectives; synthesizes information and ensures that it is distributed to the community. It maintains infrastructure (e.g., website), organize meetings, represent the programme as needed, and are responsible for communications and identification of opportunities. The co-chairs organize the GEOGLOWS Annual Business meeting and assist in the coordination and organization of events related to Capacity Building.

The working groupsl:

- meet at least once every year during or outside the GEOGLOWS business meeting;
- Make effective use of electronic forms for coordination and collaboration;
- Organize communication and outreach to inform the global hydrological community of ongoing work, achievements, and opportunities;
- Ensure that all activities comply and include a comprehensive perspective on observations and services for water sustainability.

**Working Group #1: Socio-economic issues of the water crisis and policy linkages** (Co-Chairs: Harsh Nagaraja, Rose Alabaster, Felipe Gutierrez).
This group evaluates aspects of the water crisis seen as a consequence of environmental, economic, and social activities. This Working Group looks for opportunities to link the technical capabilities from GEOGLOWS members in the use of EO, to reveal vulnerabilities in the implementation of policies and other policy needs in the area of water sustainability. This WG advocates for the use of EO in the decision-making process.

**Working Group #2: Science, applications, product development, and testing, data dissemination, and capacity building associated with projects** (Co-Chairs: Jim Nelson, Edward Beighley and Ashutosh Limaye).
This group seeks to identify and provide tools to extract and analyze global datasets; and provide tools to end users to address needs at the local scale. This Working Group contributes to the development of a global framework for use in water assessments and works in coordination with WG#4.  Data processing tools will be developed for end users.  The Working Group reaches out to local networks to identify end users and explore the potential use of cloud-based services.

**Working Group #3: Essential Water Variables and observations** (Co-Chairs: Jose Romero, George Huffman, and Richard Lawford).
The group priorities include 1) following up on the recommendations of the GEOSS Water Strategy Report, 2) defining GEOGLOWS's role in developing the concept of EWVs, and 3) coordinating the development of the EWVs with other initiatives and organizations with expertise, interest, and space-based and in situ observations for water quality variables. The Working Group contributes to assessments of the impacts and opportunities of new observational systems (cube satellites, citizen data, private sector data collection, etc.) on the flow of usable data and the long-term continuity of datasets. The group is assessing the continuity of precipitation and other water cycle measurements.  The Group explores data quality concerns and will seek partnerships with other organizations such as the WMO, CEOS, UN agencies, etc., to assist in the development of a strategy for maintaining high data quality standards for both conventional and nonconventional data.

**Working Group #4: Public-Private Partnerships. Stakeholder engagement and communication.** (Chair: Venkat Lakshmi).
This WG serves as an advisory group to WG#1, 2, and 3 in addition to developing new linkages to GEOGLOWS and other GEOGLOWS activities.GEOGLOWS builds and nurtures innovative partnerships to support water sustainability.

1. This Working Group enables GEOGLOWS to engage local and regional populations and to understand which decisions it can support.
2. It guides GEOGLOWS with strategies for supporting users across government, academia, and industry. It facilitates the migration of models, tools, and techniques developed in WG#2 from the research labs to operations through the GEO and other community portals, webinars, and support for small innovative research projects involving users applying GEOGLOWS data and capabilities.
3. It advises on standards, OGC Standards, and open data APIs; on making data intelligible by integrating them into software; on cloud services so that data can be processed where it resides; and on metadata templates.
4. It provides advice on ways to communicate GEOGLOWS capacity and services to countries and organizations that need them and demonstrates the value of EO to decision-making.
5. It explores opportunities for private sector innovations to be incorporated into GEOGLOWS activities.

7. **Resources** (1 page)
GEOGloWS has garnered over $2.5 million in investment in its technical projects. Contributions come from France (CNES) €1 million (CNES TOSCA, SWOT downstream program, Research and Technology studies), the U.S. (NASA-ROSES) $1.5 million, World Bank ($500,000), Microsoft ($15,000), and Brigham Young University (BYU) ($15,000). The cost of coordination activities is approximately $150K per year. At the moment, this coordination is sponsored by NASA ($40K outside contractor), NOAA ($ 60,000), and the Swiss government ($50K for global coordination at the GEO Secretariat). In-kind contributions for projects and meetings come from ECMWF, JRC, BYU, SENAMHI-Peru, INDHRI-Dominican Republic, CEMADEN-Brazil, IDEAM-Colombia, UNAL-Colombia, NASA-SERVIR, and ESRI.
GEOGLOWS focuses on activities that are user-driven.

**Summary of existing commercial sector engagement in the Initiative**
**World Bank** - In addition to the ongoing partnership with the Bank's Global Hydro informatics Platform on the implementation and use of the streamflow forecasting system, the WB supports GEOGLOWS with continued advocacy with bank's counterparts. In the Americas, leveraging activities of GEOGLOWS, the regional GEO (AmeriGEO), as well as the bank's activities in the region, activities planned ahead of the 2019 AmeriGEOSS week will serve to open the dialogue to continue building on potential synergies with the GEOGLOWS initiative in LAC.
Similarly, with other ongoing activities such as the development of a drought forecasting system in Brazil, the WB supports advocacy with country counterparts and tool developers to showcase the system as a country example of hydro-met products and services deploying EO. This Pilot will be featured through the different platforms supported and facilitated by the GEOGLOWS initiative.

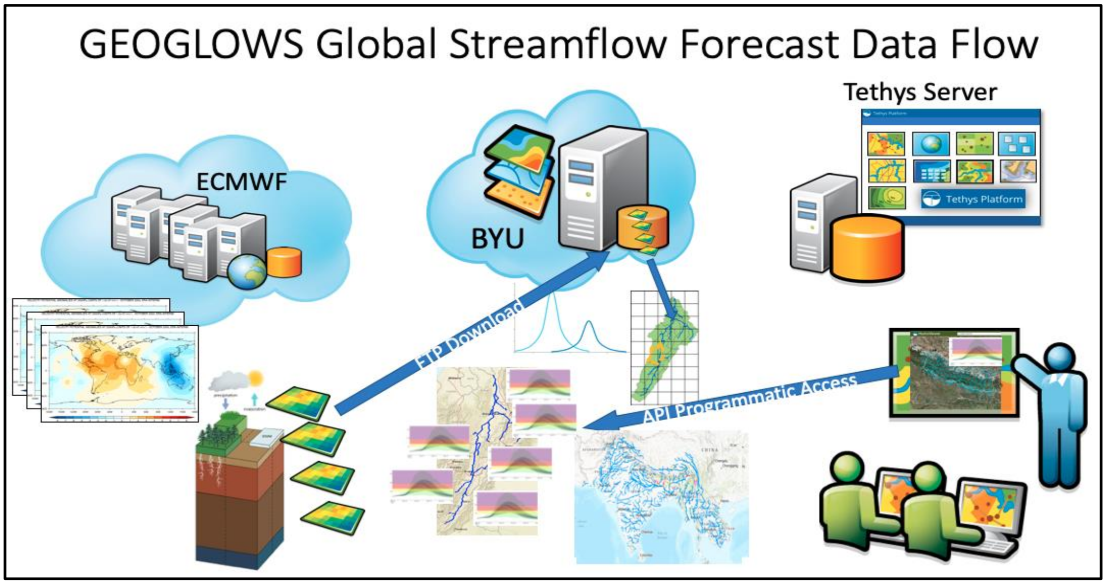
**Esri** has been a key partner of GEOGLOWS since its creation. (1) In the Global Stream Flow Forecasting project, Esri has worked in close collaboration with Brigham Young University since the beginning of the initiative, providing data processing and technical guidance. As the initiative transitions from research to operations, Esri will provide daily web map services and web application to make these forecasts easily accessible to the widest possible community. Esri will continue its research collaboration with BYU and others working toward flood inundation forecasting; (2) Through the regional AmeriGEO, ESRI is providing in kind technology and site support for the GEOGLOWS Americas website; (3) ESRI hosted analytic web services for global watershed delineation and downstream tracing. These services can be consume by any application to create custom defined watersheds from nearly anywhere in the world in seconds. These are key foundational tools for evaluating many aspects of water resources. Global services are built upon the 90m resolution HydroSHEDS, and US services are built upon the 30m resolution NHDPlus.

For the Implementation plan 2020-2022 the following contributions are provided by ESRI:

- Africa GeoPortal – a geospatial hub providing free open access to water data, imagery, and many other types of open data and applications, as well as hosted web GIS analytics, training, custom web app development and hosting, etc. http://www.africageoportal.com/ Data from the Africa GeoPortal can be automatically registered into the GEOSS Portal.
- Digital Earth Africa – Esri will provide open web services and web applications to access to imagery as well as analytic web services, and capabilities for simple creation and hosting of analytic imagery web applications. Water related capabilities will include Landsat and Sentinel 2 water indices, Water Observations from Space (WOfS), and others.
- EWVs – Esri's ArcGIS Online and Africa GeoPortal data archives are registered with the GEOSS Portal and provide access to nearly 20,000 open water data layers provided by Esri and its customers. Esri will continue to collaborate with the GEOSS Portal team to improve this integration and federation of data items.
- SDGs – Esri will continue its ongoing work with UN and supporting numerous national governments in developing their SDG portals, building and sharing open data, and providing free training materials and capacity building.
- Ecological Freshwater Units – following on the work Esri has done for GEO in collaboration with USGS and others on global Ecological Land Units and Ecological Marine Units, we will be working on Ecological Freshwater Units, which will provide a global dataset of all freshwater resources with new ecosystem classifications.
- Capacity Building – we will continue to support GEOGLOWS, AmeriGEOSS, GSFF, UN SDGs, and others with in kind capacity building and free online training.

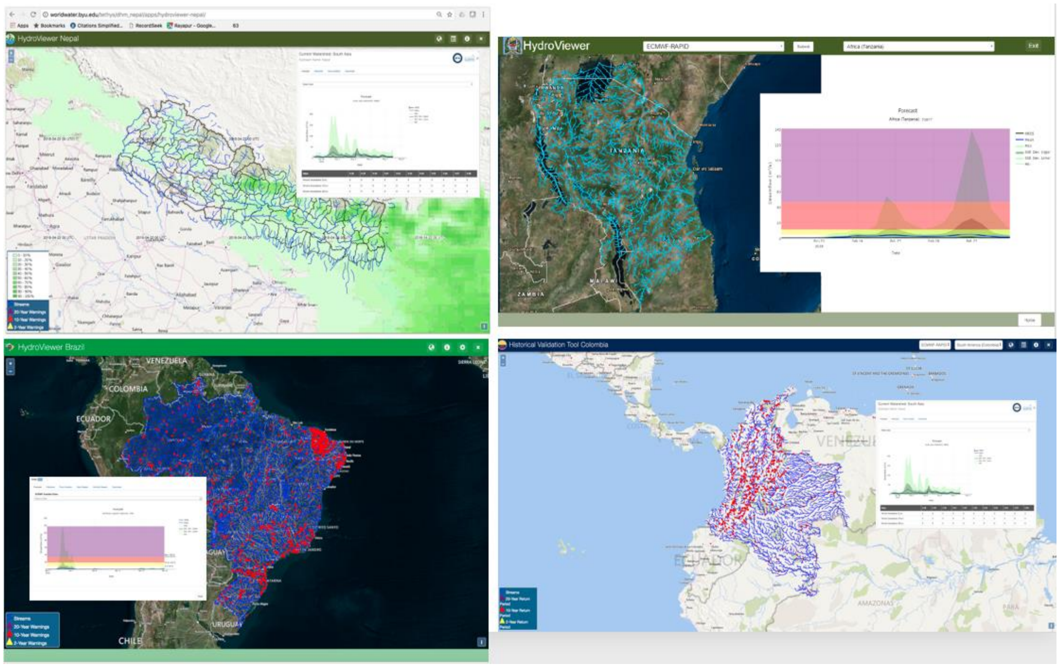
## 8. Technical Synopsis

The GEOGLOWS Global Streamflow Forecast uses a data flow described by the following diagram

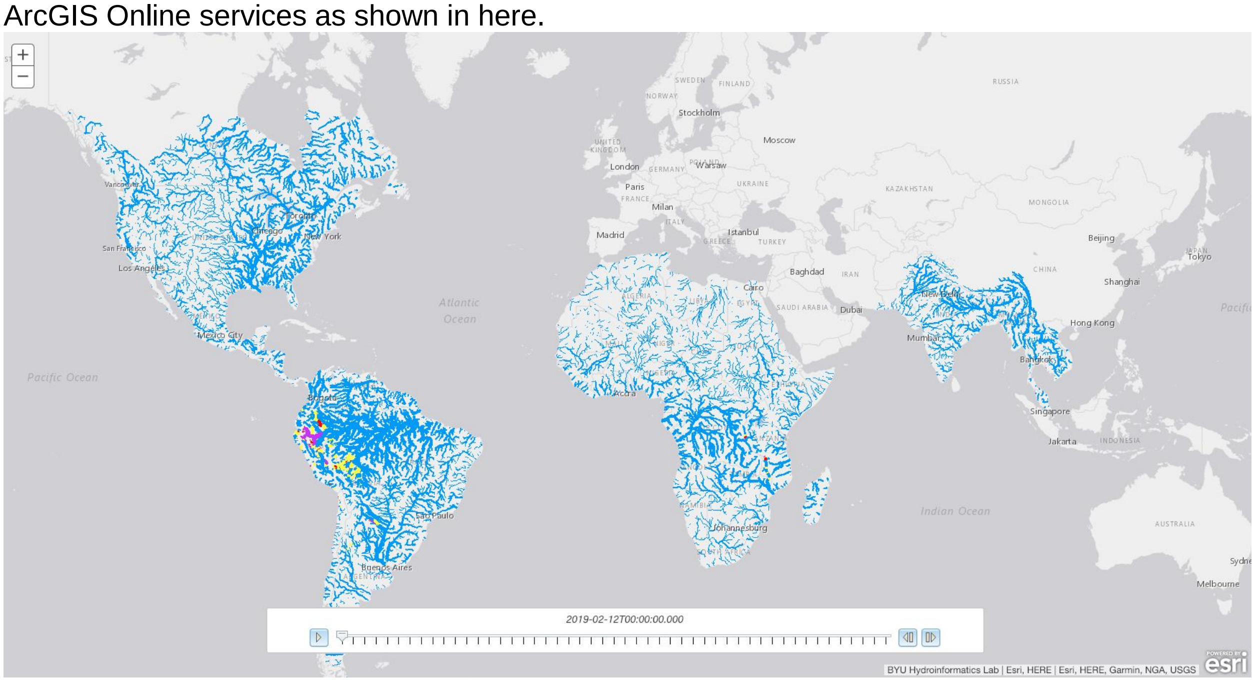



The European Centre for Medium-Range Weather Forecasts (ECMWF) produces daily an ensemble 15-day global forecast using numerical weather predictions derived from a variety of space and land observations system. These numerical weather predictions are in turn used with a land surface model, all computed on the ECMWF cyberinfrastructure with the result being a global gridded surface runoff dataset. These ensemble forecasts are then downloaded via ftp to the BYU data center where they are mapped to a predefined set of global watersheds that average about 350 sq. kilometers and routed using the **R**outing **A**pplication for **P**arallel computat**I**onof **D**ischarge (RAPID) to generate a runoff hydrograph for each of the rivers defined in the precomputed basins. These results are stored in a series of netCDF files and made accessible through REST web services to thin client applications. An important part of the streamflow forecasting service is the simulated 35-year (1980-2014) historical discharges stored for every one of the global rivers from the ERA-Interim reanalysis weather data run through the same land surface model. This provides a context for the forecasted streamflow along with a supplement to in situ observations, something that is extremely valuable where little or no observed data exists

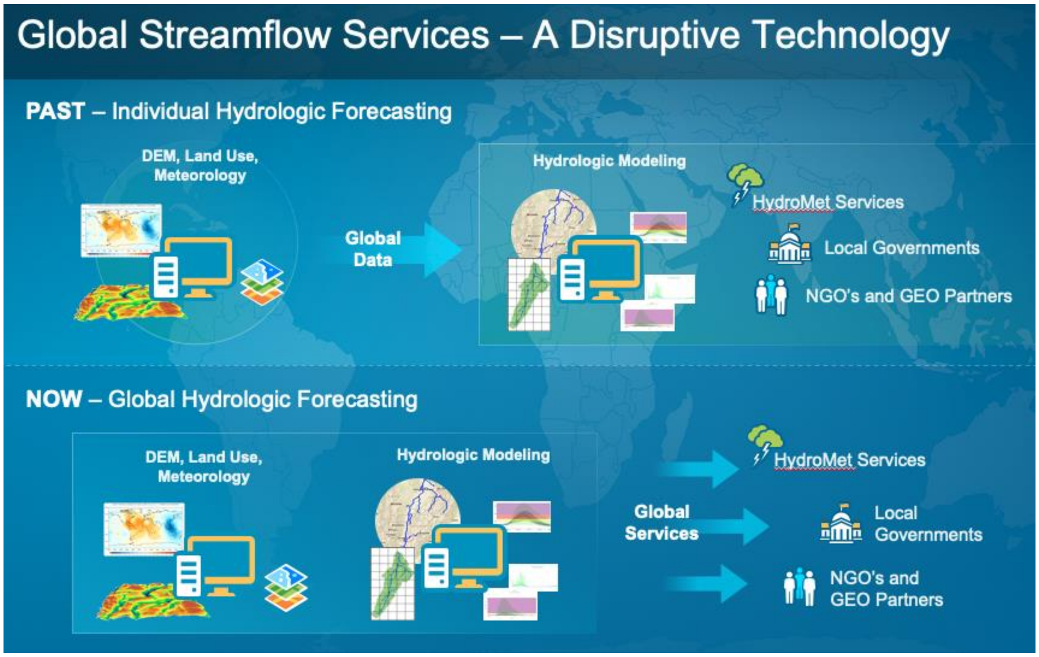
To date we have principally used the open source Tethys Platform to create custom abstractions of the global dataset that have been customized for different countries and applications as shown in the following figure.




However, because the end result is a data service they can be used in any web application and enhanced services, including an animation that shows the 15-day forecast in space and time have been developed in conjunction with Esri and Microsoft Azure and a web app using the ArcGIS Online services as shown in here.




This pilot GEOGLOWS project for global streamflow forecast which produces open access web service data will be operationalized at the ECMWF during 2019 so that a more reliable service can be provided so that many more countries and organizations can leverage both the simulated historical data and the global forecasts. This work is being funded by the World Bank because they see a future where investments in hydrologic services can be focused on proper use of adequate hydrologic information in decision-making rather than having to invest in the cyber-infrastructure and capacity to develop adequate hydrologic information. During the GEOPlenary this shift in how the World Bank looks at supporting hydrologic information has been termed by them a "disruptive technology."




Another important benefit and activity within this GEOGLOWS data flow is that the mechanism for converting the global gridded runoff data to routed discharge on a stream network is replicable with similar land surface models such as are used by NOAA in the GEFS, NASA with the Land Information System (that produces the Global Land Data Assimilation System or GLDAS), and others. We have already developed a generic workflow and experimented with developing data from these models and hope to bring these services forward in a similar fashion as part of this work plan.

The coordination of the EWVs seeks to achieve consensus on the selection criteria of the EWV and to address gaps in water quality requirements by producing an assessment of water quality variables, including those not measurable from space, such as those which are essential in small streams. This assessment will include model outputs and the range of variables needed as input for water quality models. By their collective definition, the EWVs encompass a large market basket of Earth science parameters, for which there are diverse observational systems, algorithms, and data distribution strategies. The Water Strategy Report (GEOSS, 2014) captures a snapshot of these attributes (for the EWVs envisioned in the report), and should be consulted for a more complete description. In summary, the different EWVs are at very different levels of maturity. Precipitation has a relatively long history, with several major observational approaches (surface gauges, surface radar, and various satellite sensors), decades of algorithm development, modelling-based approaches, multiple products available in open archives (although surface data sources have only spotty open access), and active research programs. [The last is critical because there continue to be generally recognized deficiencies in precipitation dataset accuracy, detail, and error characterization.] In contrast, analyses of soil moisture have a sparser set of surface observations, and a much less rich history of satellite observations, with modelling approaches substituted in many uses. Stream flow observations are almost entirely surface-gauge-based, with sparse-to-deficient sampling, and some notable limitations to open data access.

A multi-faceted approach is required to achieve the GEOGLOWS goal of improving the state of EWVs as a whole. At one level, the basic, practical work of disciplinary work for each parameter needs to be nurtured to continue advancing their utility and to innovate cost-effective improvements to sensors and observing systems, both surface- satellite-based. At the same time, by considering the EWVs as a set, GEOGLOWS will identify best practices in building and maintaining the various datasets, as well as identifying fundamental differences that will remain, such as the intrinsic spatial basis in point, connected network, and area-average values, depending on the variable. The exercise of discussing the datasets as a set will help identify the innovations that are most needed for each variable to bring it into greater harmony with the rest of the set. One key issue will be the degree of open access that is available. Another will be developing alternative strategies for obtaining observations or observation-informed analyses in regions that are currently data-sparse, -void, and/or -denied. As well, previous experience in the NASA NEWS program has shown that attempts to create an integrated set of water and energy variables can give important insight into the utility of the error estimates attached to each variable. Finally, bringing the EWVs into a consistent set will help address the long-term problem of data discovery, which continues to be a hit-and-miss odyssey for both data providers and data users. That is, bringing the entire set of EWVs into the same forum will enable a one-stop shop for finding links to the relevant data sets.

9**. Data Policy** GEOGLOWS advocates for broad and open data policies and for the realization of the right to access information to ensure that data collected through national, regional, and global observing systems are made widely available. In term of operational-services data, GEOGLOWS has adopted the standardization of the World Meteorological Organization (WMO), and promotes WMO's recommendations among GEO members. GEOGLOWS has adopted WMO's International Meteorological vocabulary and the international Glossary of Hydrology for data curation purposes.

GEOGLOWS assist in the coordination and production of a range of datasets and products to support water management decisions. These products come from the combination of existing datasets through analysis and synthesis, model outputs, and integrated data products where in-situ and satellite data, and, in some cases, model outputs are combined.

**GEOGLOWS Data Plan**

A data plan will be developed for the programme to assess data requirements in each of the policy and application areas. This plan will address the following challenges as they relate to GEOGLOWS themes:

a) Manage the large volumes and diverse data types available. Data are produced by comprehensive observing and monitoring systems, citizen observing groups, and models.

b) Reduce the volume of data for archiving at multiple locations by porting analysis systems to the data archive and by ensuring that only the most important variables and products are archived at multiple centres.

c) Identify and address lags in data collection, basic processing, and dissemination.

d) Meet user needs for better access to detailed metadata regarding datasets and products.

e) Advocate standardized data formats for the exchange of hydrological data.

f) Balance continuity in remote sensing products with the conflicting jumps in capability implicit in the development of new technology.

g) Inventory the location of historical data containing older hydrological records that are frequently listed in the peer-reviewed and "grey" published literature.

h) Improve the efficiency and traceability of quality assurance for archived data.
i) Strengthen declining surface networks or find better ways to compensate for them with satellite data.
j) Develop tests to ensure that GEOGLOWS data submitted to the GCI and GEO Data Core are easily discoverable in these archives. Volunteer data providers will be encouraged to work with GEO GCI to ensure that this system meets the highest level of quality service possible.

This activity will be supplemented by U.S. (USGS) efforts to develop a set of principles through the OWDI to ensure the development of a coherent interoperable data system for the U.S. government and other countries. The private sector, U.S. states, and NGOs would be encouraged to follow these principles through a U.S. federal information source and portal on water. The GEOSS Data Core and the GCI will be primary vehicles for making these data available to the broadest user base possible. The user consultation framework provided by AmeriGEO will be used to obtain baseline information on standards (monitoring, formats, and other related elements) as GEOGLOWS works toward a curation process for in-situ water data in the Americas. This pilot is expected to be later on expanded at the Global level through cooperation with other Regional Geo's.

In the Americas, GEOGLOWS will Support the development and implementation of a *Water Accounting Framework* through the AmeriGEOSS Platform. The AmeriGEOSS community platform brings together social, economic and environmental data from a global community of contributors to support communal access, discovery and usability.  The platform was established to increase regional capacity to acquire, share, store, maintain and utilize EO data and information. GEOGLOWS will take advantage of the AmeriGEOSS Platform to develop and implement the Water Accounting Framework through the following activities:

- **Develop Partnerships:** Will utilize the AmeriGEOSS platform collaboration and communication resources to bring the hydrological community and statistical communities together, to encourage and cultivate public-private partnerships, to strengthen national and regional systems to develop and implement the Water Accounting framework.
- **Communities of Practice and Research:** Leverage the platform to interact with communities of practice and research to improve systems, knowledge and technology transfer, and engage the community in coordinated projects that focus on water accounting societal benefits.
- **Providing Access to Data, Tools, and Services.** The key to using hydrological data for decision-making is making the data open, accessible, discoverable and usable. GEOGLOWS will utilize the AmeriGEOSS platforms technical resources, to connect and scale up existing capabilities throughout the region to help stakeholders access, discover, use and apply hydrological data so they can solve problems and improve decision-making capabilities. GEOGLOWS will use the platform to build awareness of EO and support the development of skills to use EO through a variety of venues that include webinars, technical seminars, workshops, and conferences.