

Report on the Implementation of the GEO Knowledge Hub

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

1 PURPOSE

This document presents the status of the implementation of the GEO Knowledge Hub (GKH). Additionally, the document focuses on lessons learned and the issues considered most relevant to continued implementation of the GKH.

Based on the proposed Roadmap (Section 5), Resource Requirements (Section 6), and Recommendations (Section 7) contained in this report, the Programme Board is invited to:

- endorse the continuation of the development of the GKH; and
- provide an appropriate statement of endorsement for inclusion in GKH implementation plan that will be presented for approval to the 54th meeting of the GEO Executive Committee.

The technical details supporting this document are contained in “GEO Knowledge Hub Implementation Plan”, abbreviated as GKH-IP-2020, approved by the 52nd Session of the GEO Executive Committee (ref ExCom 52.5).

2 THE GEO KNOWLEDGE HUB

The development of the GKH is part of the GEOSS Infrastructure Development Foundational Task outlined in the 2020-2022 GEO Work Programme (GWP):

"The Knowledge Hub is envisioned as a set of curated and linked documents that contain relevant information for Earth observation applications and which is integrated with the GEO website. It is intended to provide authoritative, validated and reproducible content for evidence-based reporting on policy commitments and decision-making."

The GKH is a central digital repository that provides access to codified knowledge, featuring replicable, open science workflows for applications using big EO data to support sustainable development. The GKH contains documentation linking: (a) research papers describing methods; (b) algorithms/cloud computing resources for processing; (c) EO datasets used (in situ, satellite, airborne, citizen science); and (d) results for verification.

The primary goal of the GKH is to advance the transformation of EO data into knowledge-based services for evidence-based decision-making. Several Flagships and Initiatives of the GEO Work Programme (GWP) have called for the establishment of a centralized, efficient means for transferring knowledge and scaling-up applications developed as a result of their efforts. In this way, the GKH will respond to the need for greater efficiency in reproduction and dissemination of applications from the GWP, while lowering the barriers for developing countries to access to

free cloud services and help with the hosting, processing and analysis of big Earth observation data in support of sustainable development.

3 IMPLEMENTATION STATUS

Initial GKH implementation has focused primarily on development of two modules: (a) data search; and (b) document submission. Based on keywords provided by users, the **data search** module retrieves the relevant documents. Related documents pertaining to a given application of EO are presented together as knowledge packages. The **document submission** module allows users to submit documents to the GKH, either individually or as part of a knowledge package. Before insertion into the GKH database, these submissions should be endorsed by members of the GEO community or by designated persons in the GEO Secretariat.

As of May 2021, the **data search** module will be completed, with the capabilities described in GKH-IP-2020. The data search module will be demonstrated at the Programme Board meeting.

The development of the **document submission** module is behind schedule, due to delays in the implementation of the InvenioRDM spatial data infrastructure, which forms the foundation of the GKH. This development is led by CERN and suffered delays due to the Covid-19 pandemic. InvenioRDM version 3.0, a pre-operational version, was originally planned for mid-2020. It was not released until April 2021.

Based on the availability of InvenioRDM version 3.0, the GKH team expects to achieve the full implementation of the GKH by the end of 2021, in time for presentation at the GEO Plenary.

Simultaneously, the GKH team has been working closely with the leadership of Flagships and Initiatives of the GWP to produce knowledge packages from EO applications developed as part of their activities. Engagement thus far has included:

1. GEO Global Agricultural Monitoring (GEOGLAM)- Sen2Agri
2. Global Observation System for Mercury (GOS4M)
3. GEO Human Planet
4. Global Wildfire Information System (GWIS)
5. Global Network for Observations and Information in Mountain Environments (GEO Mountains)
6. GEO Global Water Sustainability (GEOGLOWS)
7. GEO Land Degradation Neutrality (GEO-LDN)
8. Brazilian Data Cube – Land Use/Land Cover (LULC)

Five knowledge packages have been completed as a result of this engagement, and others are in advanced stages of preparation.

Finally, the GKH Webinar Series has introduced the GKH to the broader GEO community, showcased the initial deployment of knowledge packages, and provided the opportunity for interactive questions & answers with both package providers and the GKH team.

4 COMMUNITY ENDORSEMENT

Initial reaction to the GKH received from the leadership of a select number of GWP Flagships and Initiatives, as well as the broader GEO Community, has been positive, including the following endorsements:

Ian Jarvis, GEOGLAM:

“Over the last decade GEOGLAM has been focused on turning research into operational monitoring systems to enhance global food security. In the process, the community has produced a tremendous amount of knowledge, usually driven by project funding. GEOGLAM has been concerned with retaining and organizing these knowledge resources once project funding ends, but until recently sustained support for knowledge management has been beyond our means. The GEO Knowledge Hub (GKH) was seen as a possible solution to this challenge, and as a result GEOGLAM has been a major early supporter, helping develop the GKH proof of concept.

Based on the excellent progress by the GEO Secretariat so far, the GEOGLAM community believes the GKH concept has been proven. It is now time to move boldly beyond concept and ensure the GKH system is developed to a point where we can openly access, enter, organize, discover, and maintain our community knowledge resources. We believe this will be a transformative initiative for GEO, a great step forward for the global EO community, and a significant contribution to open science. Beyond GEOGLAM, we believe the GKH will provide a multi-sectoral knowledge integration platform to address the wicked challenges embedded in our shared GEO priorities. The time to move beyond proof of concept is now, and GEOGLAM looks forward to helping the GEO community move forward.

We are looking forward to the GEO KH collected knowledge packages for establishing cooperation and exchanging datasets with GEO projects in order to address societal challenges, and science and policy data demands. Most of societal challenges need to be addressed by pooling together different expertise and datasets, and the knowledge packages that you are collecting provide a valuable insight in what resources are available. We feel the GEO-KH should be able to maintain the knowledge packages and hopefully receive updates from the knowledge providers.”

Carolina Adler, GEO Mountains Initiative:

“We foresee a benefit in that it would allow us to combine, package, and present relevant data and information in formats that are accessible and that respond to explicit knowledge needs expressed by users, especially those in policy and management. It also provides us a means to connect and collaborate with other partners (data providers) whose data resources show potential and relevance for our thematic area of focus around mountains”.

Daniele Ehrlich, GEO Human Planet:

“The GEO KH could facilitate the dissemination of the knowledge – beyond what the knowledge providers do directly. In fact, the consistent knowledge structured within GEO KH will facilitate the access of users. The GEO Hub could also keep track of the downloads from the user community and feed that information back to the knowledge providers. I would also encourage GEO projects to come together to identify thematic areas that remain uncovered, and to rise the visibility of those knowledge packages and datasets used by other GEO projects within the GEO community. I strongly believe that the value of the combined knowledge packages you are collecting under the GEO KH will be more than the sum value of all knowledge packages”.

Tomas Artes Vivancos, Global Wildfire Information System (GWIS):

“In the case of wildfires, the European Forest Fire Information System (EFFIS and GWIS at global scale with GEO) produces and shares data, works in multidisciplinary fields and tries to fill the gap between research and civil protection mechanisms.

A common nexus or a hub is an essential piece to break the silos between research fields and organizations. A common place to work and share data could lead to improve data accuracy, multidisciplinary analysis, exchange of data and knowledge between actors. This last fact would speed up the production and disseminate the knowledge...sharing the data and knowledge at global scale would allow us to analyze and produce potential knowledge that would be impossible only focusing on a single country and using only one knowledge field.”

Stefan Nilsson, Manager International Relations (Swedish Meteorological and Hydrological Institute, Swedish GEO Alternate):

“The first GEO Knowledge Hub webinar was a real success, and it clearly showed the potential of the GKH. The presented examples from GEOGLAM, the Human Planet Initiative and the Land use via the Brazilian Data Cube were all excellent showcases.”

5 LESSONS LEARNED

The most relevant lessons learned during the first year of GKH implementation concerned the dependency on *InvenioRDM*, and to the adequacy of the allocation of the development team. The team combined expertise in *InvenioRDM* API programming with an effort to identify and engage partners from the GEO Work Programme.

Regarding *InvenioRDM*, while full development of the GKH has been impacted by delays in the deployment by CERN of version 3.0 of the product, the overall experience has been positive. The initial releases of *InvenioRDM* have met the basic requirements with respect to support software for the GKH. It provides a powerful application programming interface (API) that has reduced the workload of the GKH implementation team.

Regarding the adequacy of the current development team, although recent experience shows that the resource allocation in terms of Secretariat support met the minimum requirements, the importance of this phase needs to be underscored: collaboration with the leadership of GWP activities is crucial for ensuring the successful production of each knowledge package, given the effort required to collect and format the requisite corresponding knowledge resource components. Additionally, given the sometimes complex nature of the EO application shared via the knowledge package, the need for appropriate, adequate dissemination and capacity development cannot be underestimated. To benefit from the knowledge available in the GKH, capacity development activities across GEO must emphasize skills that include programming in scripting languages (such as Python and R), understanding the principles of machine learning, and advanced remote sensing techniques (such as synthetic aperture radar [SAR] polarimetry).

More generally, experience in developing the GKH has shown that the Secretariat needs to have the technical capacity to adequately engage with members of the GEO community on topics such as data and knowledge infrastructures, cloud computing, analysis-ready data, data standards, etc. While the Secretariat is not expected to play a leading role in these areas, it is important that the Secretariat is able to bring together relevant stakeholders to pursue

opportunities, track developments and advise GEO governance bodies on their implications, and play an informed challenge role as part of the governance of the GWP.

6 PROPOSED ROADMAP

The proposed roadmap sets the following milestones for the second half of 2021:

1. Completion of the development of the GKH *document submission* module in time for presentation at the GEO 2021 Plenary.
2. Inclusion of knowledge packages in the GKH, even before the document submission module has been completed.
3. Availability of the GKH data search module to the community by August 2021.
4. Development of a strategy for GKH operations, including defining the roles and responsibilities of the various stakeholders, and the associated workflows and processes.
5. Presentation of the strategy for GKH operations at the GEO Plenary 2021.

Given the current resources available for implementation and the stability of the base software, it is *highly likely* that the GKH will become operational at the end of 2021. Once full implementation is complete, the focus of the GKH will shift from *implementation* to *operations*. A synoptic view of the Roadmap with additional details is provided in Annex A.

The most important part of the operation of the GKH is engaging the GEO community. As noted above, the concept of the GKH and its added value in terms of scaling up GWP activities is gaining traction with the GEO community. The Secretariat needs to ensure that this momentum continues such that the ultimate goal of the GKH – that of sharing applications of EO to address environmental issues – is fully realized and aligned with community expectations.

7 RESOURCE REQUIREMENTS

The current resource allocation for the initial phase of implementation of the GKH has relied on staff from the GEO Secretariat and on voluntary contributions from Brazilian experts. As the implementation phase nears completion and the GKH enters an operational phase, it is relevant to analyze long-term resource needs.

Based on experience, from the Secretariat management perspective, the operational phase of the GKH will - at a minimum – require a combination of skills, including:

- a) **Programming skills**, to keep the software up to date with the evolving development of InvenioRDM and to make improvements requested by users. These needs could be met by a combination of Secretariat staff and external experts, as is the case today, or entirely by external experts on an as-needed basis.
- b) **Engagement skills**, along with familiarity with EO and knowledge resources, to maintain close contact with the GEO community and specifically with the GWP to increase and improve the documents available in the GKH. Additional skills would include broad geospatial experience and knowledge of EO solutions proposed by the GWP activities to identify essential knowledge resources that a particular user may need. This position would likely be best filled with resources from the Secretariat, as only the Secretariat has the contacts and long-term mission objectives necessary to perform this task well.
- c) **Project Management skills**, to lead further improvements of the GKH by the programming and communications individuals while ensuring that user needs are addressed, and to interact with the GEOSS Platform team and the GIDTT for

coordination of efforts to integrate the GKH and the GEOSS Platform. Effective project management is arguably the most important incremental requirement for a successful GKH implementation. This requirement could be met through Secretariat resources (perhaps in combination with the above engagement tasks), or by a (virtual) secondment to the Secretariat from the GEO community. However, the GKH is a very complex initiative, with many interdependencies that will impact the critical path, some of which may be outside the control of the Secretariat.

In addition to resources managed directly by the GEO Secretariat, each activity of the Work Programme will need to allocate resources to organize its knowledge and make it available in the GKH. Over time, resources from the GWP are expected to surpass the GEO Secretariat operational contribution, if the GKH is to succeed.

8 CONCLUSION: ENSURING THE SUCCESS OF THE GKH

Based on the results and lessons learned on the first year of implementation, the document now outlines several indications of the actions required to ensure that the GKH becomes a useful and relevant resource for the community. The recommended actions are:

- Ensure that the planned implementation of the GKH is completed by the end of 2021.
- Allocate adequate GEO Secretariat staff to enable effective interaction with the GEO community and thus ensure GKH relevancy.
- Identify a mix of internal and external resources that will be responsible for supporting the operational mode of the GKH.
- Engage strongly with the GWP to enhance and improve the documents available in the GKH, as well as reinforce and scale-up activities of the GWP through the sharing of tools and knowledge resources.

The success of the GKH will depend on the continued close collaboration between the GEO community and the Secretariat. The GKH is not an end in itself, but a means of promoting sharing and reuse of EO applications and results by the GEO community. Ideally, it will become a key tool for capacity development and empowerment of GEO Members, especially institutions from developing countries.

Based on these considerations, the Programme Board is invited to:

- Endorse the continuation of GKH development; and
- Provide an appropriate statement of endorsement for inclusion in the GKH implementation plan to be presented for approval at the 54th meeting of the GEO Executive Committee.

Annex A

Planned Roadmap

July 2020- July 2021	July 2021-December 2021	2022-2023
Infrastructure		
Deployment in the Cloud (temporary hosting in AWS) GEO Knowledge Hub (development V1)	Development of the Document Submission Knowledge Interface GEO Knowledge Hub (Operational v1)	Fully functional GKH (Operational v2) on a stable/fully supported hosting environment
Content and Engagement with GEO WP Activities		
Initial Engagement with GEO Work Programme Activities to create Knowledge Packages. Establish the GKH focal points through all GEO WP activities.	Continue to engage the GEO community by registering additional Knowledge Packages provided by GWP activities. Build communities around Knowledge Providers and its EO solutions; "streamline the communication strategy around this".	Enable Knowledge Providers to register and update their Knowledge Packages on their own. Conduct a data and knowledge workshop to bring together the GEO community around the GKH.
Promotion/Marketing/ Users' uptake of the GEO Knowledge Hub		
	Inform and promote the GKH through webinars with hands-on courses as well as examples of the Knowledge Packages.	Create effective communication tools, such as flyers, websites, webinars, to explain and promote the GKH. Inform and promote the GKH through webinars with hands-on courses as well as examples of the Knowledge Packages.