

Proposal for GEO Initiative for the 2020- 2022 GEO Work Programme

Earth Observations and Citizen Science

Proposed category: GEO Initiative

Point of Contact (primary contact person(s) for the Initiative and their email address)

Dr. Uta Wehn, Associate Professor, IHE Delft Institute for Water Education, Delft, The Netherlands (u.wehn@un-ihe.org)

Dr. Lea Shanley, Research Fellow, University of Wisconsin, Madison, USA
(lshanley@wisc.edu)

1. Executive Summary (2 pages)

During the last decade, Citizen Science initiatives, which are based on knowledge generated from citizens both individually and collectively, have dramatically increased. The European Commission (EC) has been supporting the development and integration of new sources of in-situ Earth observation (EO) data collection with the support of Citizen Observatories in Europe, while the United States has supported citizen science in its National Strategic and Implementation Plans for Civil Earth Observations, and provided the legal framework for Citizen Science to flourish in national government institutions.

This GEO Citizen Science Initiative seeks to fill the gap to elevate the value of citizen science communities and data from local to global scales. Building on other initiatives and programmes in the field of crowdsourcing and Citizen Science around the globe, efforts within this GEO CS Initiative will focus on demonstrating, facilitating and increasing Citizen Science for GEOSS. We will demonstrate the value of citizen science data for advancing the GEOSS priorities in terms of research and informing policy by showcasing what is existing and finding gaps in Earth Observation that Citizen Science can cover. We will facilitate the creation of a linked ecosystem of open citizen science data and supporting resources under GEOSS and the GEOSS Data Management Principles by testing approaches in interoperability experiments and by providing recommendations and tools for overcoming the current barriers. Finally we will increase the use of Citizen Science in GEO by supporting global coordination and collaboration within and beyond GEO, by communicating with other ongoing activities and initiatives in GEOSS and sharing the potential and best practices of Citizen Science for augmenting and enhancing their work.

Overcoming institutional barriers, perceptions and technical issues will be addressed and resolved by the Initiative in terms of heterogeneity in data models, flavours and data formats formed by the long tail of Citizen Science projects. Furthermore we will address data

accessibility, metadata harvesting, data quality documentation, annotation and connectivity with the GEOSS platform.

Overview (summary of section 2 below).

The widespread adoption of mobile devices and social media platforms, coupled with the development of low cost sensors, has made it easier for the public to contribute to and engage in scientific and engineering research and monitoring. **This collaborative exchange with the scientific community, in which members of the public actively join the co-creation of new scientific knowledge, is known as *Citizen Science*.** Citizens science observations, data and information can complement official, traditional in-situ and remote sensing EO data sources in many application areas relevant to GEOSS. Governmental entities around the globe, from Australia and Asia to Europe and North America, are supporting the development and integration of new sources of in-situ EO data collection at the local, regional, and global scales through citizen science observatories and projects. Building on these initiatives, this *GEO Earth Observation and Citizen Science Initiative* will focus on the following goals: **(1) Demonstrate the value of citizen science data for advancing the GEOSS priorities in terms of research and informing policy; (2) Facilitate the creation of a linked ecosystem of open citizen science data and supporting resources under GEOSS and the GEOSS Data Management Principles; and, (3) Increase the use of Citizen Science in GEO by supporting global coordination and collaboration within and beyond GEO.**

2. Purpose (3 pages)

Rationale

During the last decade, Citizen Science initiatives, which are based on knowledge generated from citizens both individually and collectively, have dramatically increased. In particular, numerous initiatives have emerged that actively involve citizens in environmental monitoring and stewardship, supported by Earth Observation (EO) enabled applications. Citizens science observations, data and information can complement official, traditional in-situ and remote sensing EO data sources in several areas, such as climate change, sustainable development, air quality monitoring, vector-borne disease monitoring, food security, flood, drought and natural perils' monitoring, and land cover or land-use change, among other topics. There is an enormous potential to use citizen-driven observations in combination with EO data from the Sentinel family of satellites, NASA Earth Observing Systems, and commercial imagery. For example, the public can assist with satellite, aerial or ground-based image interpretation and classification, potentially in combination with machine learning. They can provide in-situ data for calibration and validation activities, and for the integration of satellite and citizen observations to fill existing gaps.

Within this emerging field, the European Commission (EC) has been supporting the development and integration of new sources of in-situ EO data collection with the support of

Citizen Observatories in Europe. As defined by the EC, Citizen Observatories are community-centric initiatives that build on the social change that is taking place where citizens become more active in collecting and sharing environmental information, typically harnessing the latest technological advances (e.g. ubiquitous Internet connectivity, Internet of Things (IoT), machine learning, social media, portable and inexpensive sensors). Citizen Observatories can empower citizens to get informed about and actively participate in environmental decision making, raise awareness about environmental issues, and help build more resilient societies. Five Citizens' Observatories (CITI-SENSE, WeSenseIt, COBWEB, Citclops and OMNISCIENTIS) were funded under the EC's FP7 programme, covering different environmental issues such as air quality, flood and water management, coastal ecosystems, biodiversity and odour annoyance. Following on the success of the pioneering Observatories, more Citizen Observatories—MICS, LandSense, Ground Truth 2.0, SCENT, and the GROW Observatory—have been funded under the Horizon 2020 programme through calls associated with Science for and with Society (SwafS) 14 and 15. Each of these projects demonstrates approaches to create actionable knowledge for participatory governance and policy making with a particular focus in the field of Land Use and Land Cover (SwafS14) and “across science and the humanities” (SwafS15). From the perspective of the EC, harnessing the power of the public through such observatories and other citizen science initiatives can enhance and augment the influence of existing Earth Observation monitoring systems, including GEOSS and Copernicus.

In recognition of the importance of citizen science and citizen observatories, the EC also funded the WeObserve H2020 Coordination and Support Action to tackle three key challenges that Citizen Observatories face: awareness, acceptability and sustainability. The project aims to improve the coordination between existing COs and related regional, European and International activities. Its four Communities of Practice (on the co-design of COs & citizen engagement; impact and value of COs; interoperability and standardisation; and COs and the SDGs) are consolidating practice-based knowledge of Citizen Observatories, sharing information and resources, and working to further develop best practice guidelines and toolkits for COs.

The European Space Agency has recently funded a Citizen Science Earth Observation Lab to explore the potential of using Citizen Science approaches and new digital technologies for experimenting and generating new EO products and services. This lab will engage a wide community of users of EO data and providers of information to support the validation and exploitation of EO with citizen science. CSEOL serves to catalyse the potential of CS for EO into concrete, funded and achievable pilot projects.

In North America, the US National Strategic and Implementation Plans for Civil Earth Observations highlight the important role of Citizen Science in augmenting and enhancing EO, and “encourage[s] innovations for collection, exploitation, and wider use of Earth observations based on improved availability of open data, including new applications, new services, Citizen

Science, and crowdsourcing.” The United States government is supporting over 400 Citizen Science projects across more than 60 federal agencies and organizations as documented by the Federal Community of Practice on Crowdsourcing and Citizen Science. This support includes the development and integration of in-situ citizen observations with EO data through a variety of federally sponsored-projects, such as the collaborative partnership between the Soil Moisture Active Passive Mission (SMAP), the GLOBE Program and SciStarter, which engages citizens in gravimetric soil moisture measurements for calibration validation, and also NASA’s DEVELOP program, which conducted a proof-of-concept combining citizen science observations with earth observations to better understand the spread of vector-borne disease.

The U.S. government is also beginning to support activities that facilitate coordination and support. For example, the U.S. State Department, along with Earth Day Network, and the Wilson Center, co-founded Earth Challenge 2020 as a global activation experience around the 50th anniversary of Earth Day on April 22, 2020. By working with existing citizen science projects and building capacity for new ones, Earth Challenge 2020 seeks to engage millions of people in collecting and integrating 1 billion interoperable data points to advance research and support better decision-making through individual and policy action. On one hand, Earth Challenge 2020 is a global call to action for anyone who wishes to contribute to the ideal of increasing the amount of open and interoperable citizen science data. On the other, the team is targeting a set of 6 critical environmental problems (identified through a global crowdsourcing campaign) to help prioritize data collection and data integration activities. The initial list of problems includes many topics relevant to GEO, including: *What is the extent of plastics pollution? What’s in my drinking water? What are the local impacts of climate change? How are insect populations changing? How does air quality vary locally? And, How secure and sustainable is my food?* Earth Challenge 2020 will recruit 6 research teams to come together to collaborate on solutions. The first task of each research team will be to narrow the problem down into more concise research questions that can be tackled through a citizen science approach. For example, “*How are insect populations changing?*” may evolve into two research questions, such as “*What is the distribution of disease-vector mosquitoes?*” and “*How are pollinator populations changing over time?*” Research teams will also help identify existing data sets and citizen science projects that can help answer a specific research questions, and (if necessary) leverage data and metadata standards to help develop additional protocols to shape future data collection campaigns.

While the EU and US are leaders in policy and implementation, citizen science is increasingly a global phenomenon. Citizen science associations (CSAs) have been formalized in the EU (European Citizen Science Association, or ECSA) and the US (Citizen Science Association, or CA), and also in Australia (Australian Citizen Science Association, or ACSA). New networks are forming or formalizing in Asia (CitizenScience.Asia), Africa (Citizen Science Africa Association), and South America (Iberoamerican Network of Participatory Science, or RICAP). The newly established Citizen Science Global Partnership, launched in collaboration with a

range of CSAs, United Nations Environment Programme (UNEP), and other partners, seeks to help support and seed these and additional geographically-based associations (among other goals).

The EU's citizen observatories and similar projects, along with the 400 projects supported by US federal agencies, demonstrate the value of citizen science to advance research and inform evidence-based decision making while creating more informed and interconnected communities of citizen science volunteers. Some of the most recent initiatives, including WeObserve and Earth Challenge 2020, are already demonstrating the need for collaboration and coordination across citizen science projects in the EU and globally. The CSAs offer some coordination, but are not always informed of each other's work, are not yet globally representative. Further, these organizations typically leverage their convening power to help practitioners connect virtually and through in-person events; they do not, as a general rule, seek to develop and share concrete resources such as technologies and data sets that the citizen science and larger scientific research community can use.

This GEO Initiative seeks to fill this gap to elevate the value of citizen science communities and data from local to global scales.

Building on the aforementioned and other initiatives and programmes in the field of crowdsourcing and Citizen Science around the globe, efforts within this GEO Initiative will focus on the following **goals and activities**:

Goal 1: Demonstrate the value of citizen science data for advancing the GEOSS priorities in terms of research and informing policy.

Activities:

- Support the existing GEOSS priorities.
- Support and elevate demonstration projects that showcase the use and value of scalable citizen science projects (e.g., citizen observatories, Earth Challenge 2020, CSEOL pilot projects), particularly in the provision of in-situ data.
- Showcase the use of citizen science data sets (from the GEOSS-Data Core) in combination with other Earth Observation products and for validation and exploitation of EO via the Earth Challenge 2020, the citizen observatories and other projects.
- Demonstrate new technologies such as machine learning trained by Citizen Science data (i.e, "human in the loop"), to improve calibration/validation of sensors, increase the speed and accuracy of image processing, provide in situ ground truth data, and/or augment and enhance validation and knowledge extraction.

- Identify and prioritize gaps in *in situ* observations for GEOSS, and then identify existing Citizen Science projects that could cover these gaps, for example through the Sustainable Development Goal (SDG) framework.

Goal 2: Facilitate the creation of a linked ecosystem of open citizen science data and supporting resources under GEOSS and the GEOSS Data Management Principles.

Activities:

- Enable the discovery and access of free and open citizen science data through GEOSS data core.
- Mobilize existing and newly emerging citizen science initiatives to make the data that they collect available through the GEOSS platform (e.g., Earth Challenge 2020 and the citizen observatories).
- Increase discovery and access of open science resources including citizen science data and complementary data sets; data collection tools (hardware and software); platforms for data analysis and visualization; educational resources such as lesson plans or other toolkits; and, publications.
- Showcase best practices for discovery and access of citizen-observed data through GEOSS, and the implementation of the GEOSS Data Management Principles (also known as FAIR in general).
- Provide guidelines for using and managing Citizen Science in GEOSS incorporating use of existing standards for data collection and management:
 - Working with the Open Geospatial Consortium (OGC), conduct interoperability experiments and recommend how to offer access to Citizen Science through GEOSS
 - Conduct interoperability experiments about data access, single sign on mechanism and data quality, data annotation and user feedback.
 - Generate “data profiles” and data collection protocols that can serve for scaling up citizen science. Use the Earth Challenge 2020 research questions (2020) as inspiration..
- Based on the work described above, develop recommendations for the increased use of citizen science data for GEO, and for using products available through GEOSS in citizen science communities.
- Collaborate with the Earth Challenge 2020, including by linking Earth Challenge 2020 data to GEOSS data core and by registering a wide range of citizen science metadata in GEOSS data core (2020).

Goal 3: Increase the use of Citizen Science in GEO by supporting global coordination and collaboration within and beyond GEO.

Activities:

- Leverage the GEO work program to support coordination and collaboration within the global citizen science community, and between the citizen science community and related activities providing in-situ data (e.g. GEOBON on biodiversity) and improving the knowledge base to provide evidence-based action (e.g., Earth Observations; Disaster Response).
- Addressing potential synergies between Citizen Science and GEO activities, foundational tasks, initiatives and flagships including GEO BON, GFOI and GEOGLAM and regional activities (AmeriGEOSS, EuroGEOSS, etc.), e.g. via the specification and showcasing of complementary contributions from these activities to support CS in GEOSS as a whole.
- Identify the need for and contribute to relevant policy frameworks (UN, GEO, domestic) and data sharing agreements to support the collection and use of citizen science data and information.
- Leverage the GEO network, including partners such as the UN, to help promote the growth of global citizen science in the areas where GEO has identified a gap or an opportunity (e.g. GBIF) through targeted outreach and capacity strengthening and mobilization.
- Promote GEOSS Data Management Principles and easy to use EO based products and services for citizen science at a wide range of project-related workshops, outreach events among the GEO community at large (Africa, Australia, Europe, US).
- Working closely with the Citizen Science Global Partnership, leverage GEO's role as a global convener to help keep track of and coordinate a range of complementary activities led by different communities

Actual and/or planned outputs of the Initiative will include::

Goal	Actual and/or planned outputs	Geographic scope
Goal 1: Demonstrate the value of citizen science for advancing the GEOSS priorities in terms of research and informing policy.	Documentation (e.g., whitepaper) of exemplary citizen science projects that can support GEOSS, particularly if citizen science data are combined with EOs (2019).	Global
	Documentation (whitepaper/ academic publication) of exemplary Citizen Science projects that can provide inputs for monitoring and supporting the SDGs (2019).	Global
	One or more interactive platform harmonizing citizen science data with other sources of information, including Earth Observations, for Earth Challenge 2020 (2020).	Global

<p>Goal 2: Facilitate the creation of a linked ecosystem of open citizen science data and supporting resources under GEOSS and the GEOSS Data Management Principles.</p>	<p>Outputs of the interoperability experiments underway within the OGC and the WeObserve Community of Practice on interoperability and standards in CS (2019).</p> <ul style="list-style-type: none"> ● A technical report and a demonstration on how to connect Citizen Science to GEOSS (metadata and data) based on the work done for the Earth Challenge 2020 needs and proposals and the Citizen Observatories; guided by the OGC Citizen Science interoperability experiment (2019). ● A series of lightweight “data profiles” and data collection protocols aligned with Earth Challenge 2020 research questions (2020). 	<p>Global</p>
<p>Goal 3: Increase the use of Citizen Science in GEO by supporting global coordination and collaboration within and beyond GEO</p>	<p>Report analysing of potential contributions of citizen science to the GEO work programme and alignment with other GEO initiatives shared at the GEO plenary (2020).</p> <p>2+ Workshops (side events) advancing the discovery and interoperability of citizen science data at strategic convenings of citizen science associations including CSA and ECSA (2019-2020).</p> <p>Workshop (side event) on the benefits of Citizens Science in GEOSS and the Benefits that GEOSS provides to Citizen Science (2022).</p> <p>Documentation (“case studies report”) of exemplary citizen science projects that can support GEOSS and particularly if citizen science data are combined with EOs (2019), including highlighting successful impacts on public policy at a range levels. In addition, survey of the legal, policy and institutional barriers barriers to the integration of citizen science of national Earth Observation policies and related strategic documents.</p>	<p>United States; Europe</p> <p>Global</p> <p>Global</p> <p>Global</p> <p>Global</p>

Actual and/or intended users of the outputs and the expected types of decisions these outputs are expected to inform

Within GEO, there is a growing understanding and interest in the application of CS data to GEO related activities. Already, several of the GEO flagships embrace citizen science data to varying degrees, namely GEOBON and GEOGLAM. GEOBON via GBIF, relies extensively on citizens to provide upwards of half of its data.

CS data can ultimately provide a great benefit to many users within GEO, providing information useful for uncertainty analysis, validation and verification. Furthermore, certain types of CS data can be used in their own right as a data source. But, while interest and understanding of citizen science within GEO is on the rise, there is a lack of information and resources available to the GEO community. In particular, the full relevance of citizen science to GEO across the programme is unclear. Moreover, citizen science data and supporting resources are not readily available in GEOSS via the GEOSS portal. Hence the intended users of the outputs of the initiative are the variety of potential users of CS data both from the scientific research and public policy (e.g., decision-making) communities within and beyond GEO. Discussions with many experts within GEO point to a real interest in access to such information but a simultaneous lack of understanding on the general value and availability of citizen science data, and on the fitness-for-use or fitness-for-purpose of various individual citizen science data sets.

We will maximize the impact of our activities to a range of users through coordination and partnerships with government users and international NGOs. In particular, our efforts to align citizen science with the Sustainable Development Goals (SDGs) and coordination with the UN-backed Citizen Science Global Partnership will help support and enhance links to UN agencies like UN-Environment, UNESCO, and UNDP.

Expected outcomes, impacts and beneficiaries

Primary beneficiaries from enhanced access to citizen science data include the academic and government and policy communities. On the academic side, we expect to see an influx of peer-reviewed publications including both Earth Observation and citizen science information supported by the activities in this initiative. On the policy side, we expect to ultimately see citizen science data used in SDG reporting by member states, as supported by the UN. One of the planned activities of the Initiative is to identify CS projects/practices that are relevant for GEOSS. Through this activity, we plan to investigate to what extent CS can complement and augment EO to address local and global challenges. Partners of this planned initiative have been undertaking a research project on the relevance of CS to SDG indicators, targets and goals. Preliminary results show that there are substantial synergies between CS and EO relevant to the SDG framework. Initial GEO/CEOS analysis demonstrates the importance of EO for several goals, particularly goals 6 (clean water and sanitation), 11 (sustainable cities), 14 (life below water) and 15 (life on land) (CEOS, 2018). Even though further analysis is needed at the goals level, SDGs 6, 14 and 15 have also been determined as the goals CS can contribute to the most. ,

Some of the working group are already working with UN Environment on a pilot project integrating citizen science data with other sources of information to create an integrated data product that a UN member state will use in SDG reporting for 14.1: “by 2025, prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution.”

Alignment with the SDGs will help drive improved decision making processes on national and international policy levels. Bringing citizens into the process of contributing to SDG monitoring can also increase levels of awareness and support decisions in people’s daily lives.

3. Background and Previous Achievements (3 pages)

The GEO Community Activity ‘Earth Observations and Citizen Science’ has been active during the 2017-2019 period of the GEO Work Programme. This community has been consistently active and working in structured ways with monthly telcos, meetings at GEO events, and ad hoc F2F meetings etc., resulting in the following outputs:

Three major sets of near-term actions were established for the 2017-2019 period. The current achievements are listed next to each action in italics:

Scoping and initiation of a global GEOSS Citizen Science inventory – reviewing already existing Citizen Science projects that are of relevance to GEOSS and providing access to the most relevant information

- Produce a collection of exemplary Citizen Science projects that can be of use in GEOSS: *a study, funded by the JRC, has resulted a collection of over 500 CS projects in the environmental domain. This has been made public.*
- Report on which Citizen Science projects can provide inputs for monitoring and supporting the SDGs: *an international workshop was held at IIASA in 2018 bringing together experts from the SDG and citizen science community. A publication is in progress.*

Analysing existing Citizen Science projects that are relevant for GEOSS and specifying recommendations for Citizen Science to cover gaps in in-situ observations: *this work is ongoing.*

Providing guidelines for using and managing Citizen Science in GEOSS – Part 1: use of existing standards for data collection and management:

- Conduct interoperability experiments and recommend how to offer access to Citizen Science through GEOSS: *this work is ongoing within the OGC supported by members of the activity and WeObserve and the Wilson Center. Earth Challenge 2020 was introduced to the OGC IE in order to support alignment with the citizen observatories.*
- Conduct interoperability experiments and produce recommendations on a single sign on

mechanism: *these efforts are continuing, particularly within the LandSense CO and the NextGEOSS projects.*

The activities of this GEO Community Activity (CA) have matured and generated a critical mass of committed members and practitioners as well as supporting project resources such that this CA is now ready to transform into a GEO Initiative, with a detailed work programme and more ambitious goals. Through this GEO Initiative we intend to leverage pilot activities to help citizen science scale globally through the GEO platform.

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

Another activity that the initiative will undertake is providing guidelines for using and managing CS in GEOSS through implementing standards for interoperability. GEOSS links together the existing and planned observing systems and supports the development of new systems to address data gaps. In order to achieve the synergies and avoid duplications between diverse CS initiatives, it is crucial to develop standards that allows data to be interpreted and shared. Therefore achieving interoperability of data within CS and integrating it into the broader GEO “system of systems” would serve broader SDG monitoring efforts. The work of this initiative will primarily target the SDG framework, but it will include suggestions for generalizations and applicability to other policy frameworks, such as the Paris Agreement and Sendai framework

The initiative is striving to demonstrate the added value of citizen science for GEO and GEOSS. Within GEO, there is a growing understanding and interest in the application of CS data to GEO. Already, several of the GEO flagships embrace citizen science data to varying degrees, namely GEOBON and GEOGLAM. GEOBON via GBIF, relies extensively on citizens to provide upwards of half of its data. While interest and understanding of citizen science within GEO is on the rise, there is a lack of information and resources available to the GEO community. In particular, citizen science data is not readily available in GEOSS via the GEOSS portal. This initiative is attempting to remedy this situation by mobilizing vast amounts of citizen science data that would be of high value for the GEO community.

5. Stakeholder Engagement and Capacity Building (2 pages)

Description of **key organizations and stakeholders, particularly at the international level**, which are relevant to this Initiative (operating environment of the Initiative).

The United Nations. A number of UN agencies are exploring citizen science through strategic convenings, resource development, and capacity strengthening and mobilization. For example, UN-Environment has hosted a number of strategic convenings, elevated demonstration projects through platforms like UN Environment Live/ Situation Room and MapX, and co-founded the Citizen Science Global Partnership. Additional activities are planned for the 4th UN-

Environment Assembly (UNEA4), in Nairobi, Kenya, in March 2019. UNESCO provided early financial support for the Citizen Science Global Partnership by sponsoring a strategic planning meeting, and is interested in exploring a collaboration aligning citizen science to the SDGs. Other UN Agencies, including UNDP, have expressed interest in elevating the value of citizen science. This GEO Initiative can help offer more concrete opportunities for engagement.

Government collaborators, including UN Member States and the European Commission. The EC, various European countries, and the US are already supporting citizen science through policy and implementation. Additional government collaborators will be engaged through partnerships with UN agencies and through the work of existing government partners. For example, UNEP will engage UN member states through the process of drafting and passing resolutions. Outside of GEO, the U.S. Department of State is in dialogue with other governments, including in India and China, on how to leverage Earth Challenge 2020 to help support the provision of open and well-managed citizen science data. Earth Challenge 2020 is also bringing on government partners such as the European Space Agency (ESA) to ensure more global coordination.

Other NGOs. Numerous NGOs are working to elevate citizen science. Chief among these are the already-established Citizen Science Associations (ECSA, ACSA, CSA) and emerging networks such as other geographical associations and the Citizen Science Global Partnership, as described above. Earth Day Network is an international NGO with offices in the US and India that seeks to leverage citizen science (through Earth Challenge 2020) to elevate the impact of the modern environmental movement, including by making it more participatory. The World Bank, through the Connect4Climate Initiative, is also embracing citizen science under the Earth Challenge 2020 umbrella.

Private Sector collaborators. Members of the private sector increasingly recognize the value of citizen science for producing data at scales and resolutions not otherwise available while achieving broad social gains. Earth Challenge 2020 private sector partners include Esri and Amazon, who seek to help elevate citizen science through technology; in kind support for strategic planning, development, and design; and/or, direct financial support. In addition, a range of companies working with Earth observations are interested in helping develop the resources required to create an open and interoperable network of citizen science data that can be used for validation through ground truthing.

Strategy for **engaging stakeholders in the co- development / co- production of the Initiative**, including determining user needs, and for building individual, organizational, and institutional capacity to use the outputs of the Initiative.

Determining user needs.

- Existing projects and initiatives will work with their stakeholder communities to develop use cases for driving the goals of this initiative forward. Earth Challenge 2020, for example, is one short-term opportunity to develop 6 use cases around the Earth Challenge 2020 research questions. In the longer term, more extensive use cases can be developed for a wide range of Sustainable Development Goals.
- Leverage convenings of the citizen science community such as the biannual conferences hosted by ECSA and CSA. Activities are already planned for the upcoming CitSci '17 conference in Raleigh, North Carolina, USA.
- Work with GEO community through workshops and other events at convenings like the GEO plenary. These efforts will be ongoing, and various contributors to the GEO initiative will represent our collective work at a range of events and convenings.

Building individual, organizational, and institutional capacity. The goals of this initiative are primarily designed to build capacity at the organizational and institutional level.

- Organizational capacity building will be realised through the provision of tools including to support open and properly managed citizen science data, and through additional open science resources...
- Institutional capacity building will be achieved by working within the GEO community.
- This initiative will also support individual capacity building through various contributing projects (WeObserve communities of practice, etc...)

6. Governance (2 pages)

Description of the governance structure for the Initiative, including the mandates of steering/advisory/management committees, if applicable.

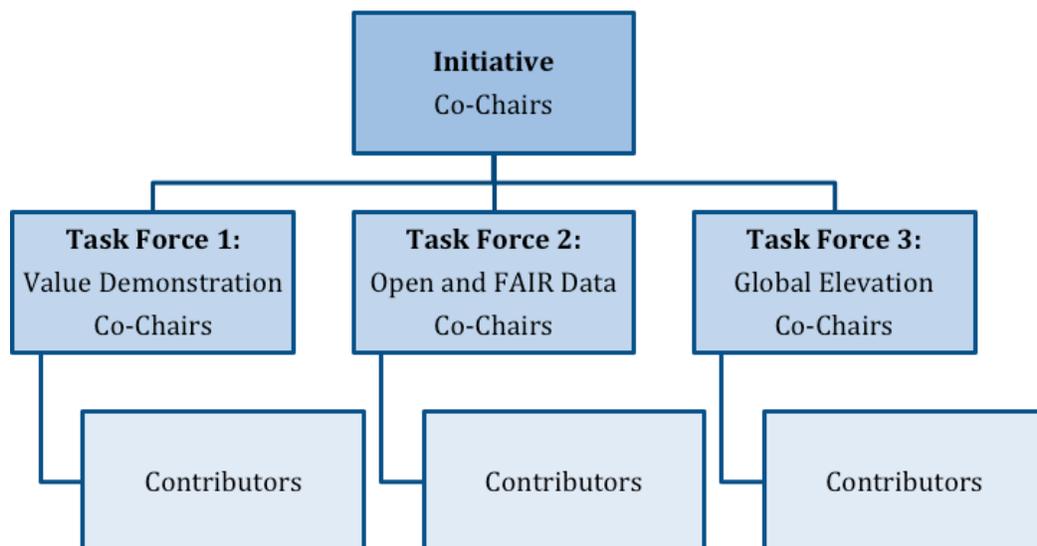


Figure 1. Schematic overview of governance structure.

Description of the roles of key leadership positions:

The initiative will be lead by rotating co-chairs, changing on an annual basis.
Three task forces will be established.

Strategy for communication with participants and stakeholders, including the main communications channels used:

Communication will occur via a variety of channels - namely side events, social media, workshops, meetings, etc.

Monitoring and evaluation activities to be undertaken within the Initiative or required by funders/contributors, including how the effectiveness of user engagement and capacity building activities will be assessed. Include a brief description of how the results of the monitoring and evaluation activities will be shared with the GEO community:

Results from the initiative will be compared with the planned goals and actions at regular intervals, and reported to the community via the GEO initiative website.

Risk management: description of the key risks that could prevent the full realization of the intended outcomes of the Initiative and the strategy for managing and/or mitigating the identified risks:

With any in-kind initiative such as this, the risk is that people are only able to provide limited effort due to time and financial constraints. One of the mitigation strategies is to include

numerous people from different organisations who can contribute their time and resources.

7. Resources (1 page)

The initiative has at its disposal numerous sets of resources, including but not limited to the following:

- WeObserve is a Coordination and Support Action financed by the European Union on the Horizon 2020 program that started in 2018 and will continue until Nov 30th 2020. The work package 4 has the specific objective to support the GEOSS Work program.
- Earth Challenge 2020 has pilot funding from a range of sources including Amazon, the Alfred P. Sloan Foundation, and National Geographic Society. Through these resources and additional partnerships, Earth Challenge 2020 has committed to publishing an open API that can help connect the resulting data to GEO resources.
- The European Research Program contains, and will contain in the future funding for citizen science projects. This is potentially spreading beyond GEO specific calls, and will now come in the form of various thematic calls, including among others health.
- Continuity of the contributions to citizen science has been proven for over a decade with the launch of the Geo-Wiki in 2009 and similar initiatives, the pioneering citizen observatories, the current citizens observatories, and many other projects including NextGEOSS, etc.
- An approximate total of 500,000 USD are the estimated resources required to implement the proposed activities for the 2020- 2022 period, including financial, in-kind participation, and other in-kind resources (e.g. data, equipment, computing capacity, office space).
- Beyond the existing set of resources via various research streams the initiative will develop a strategy for mobilizing additional resources, to meet gaps in confirmed contributions and to support future requirements. Here the Earth Challenge will be able to contribute expertise and findings.
- Currently there is limited commercial sector engagement in the Initiative. The initiative will discuss a strategy for engaging commercial sector organizations in the future.

8. Technical Synopsis (2 pages)

Description of the principal data sets used by the Initiative

In this group we will not create data but we will utilize all available and suitable datasets wherever possible. Data will include but not be limited to the following sources: GEOSS, DIAS, Copernicus and more. We will rely primarily on open data (i.e. Landsat, Sentinel).

Citizen Science datasets will come from a variety of different sources. Starting in Europe we will look to the active Citizen Observatories which are currently producing new data sets (Scent, GroundTruth2.0, LandSense and GROW). However there are a plethora of existing CS datasets which we can already utilize. The following provides an example of these, sourced from Google Datasets (searching for 'citizen science'):

Data
<p>The science of citizen science doi.pangaea.de Published Aug 24, 2016</p>
<p>Qualitätskriterien für Citizen Science Projekte auf Österreich forscht explore.openaire.eu Created 01.02.2018</p>
<p>Citizen Science researchdata.ands.org.au Published Feb 19, 2019</p>
<p>Marine species citizen-science observations from NatureWatch NZ obis.org</p>
<p>Data for: Citizen Science Benefits Coral Reef Restoration Activities data.mendeley.com Updated Nov 6, 2017</p>
<p>Web-based Biodiversity Citizen Science Database (assembled 2012) doi.pangaea.de Published Dec 15, 2014</p>
<p>Data from: Occupancy models for citizen-science data datadryad.org Published Feb 6, 2019</p>
<p>Scuba Diving Marine Citizen Science data.mendeley.com Updated Jul 17, 2018</p>

Description of the key methods used to transform the source data into the products and/or services

In this group we will provide a methodology based on internationally recognized standards to integrate data into GEOSS. This methodology will be based on the use of internationally recognized standards such as SOS and WFS that will be linked to the GEOSS Platform. We will also provide lightweight data models that will permit us to integrate Citizen Science projects into a single dataset that will scale in spatial and temporal coverage. We will also provide recommendations on how to address the data management principles base on using standards. For example, how to assess and document data quality.

Description of any significant scientific or technical issues that will be addressed and resolved by the Initiative and the strategy to address them.

Citizen Science delivers data in many data models and data formats. Lightweight data models for the different SBAs need to be defined as a minimum common denominator that all Cit Sci projects can adopt to contribute to responding key scientific question Particular care will be taken to provide controlled vocabularies and taxonomies that can be used to disambiguate CS data set descriptions and their content. Current he data management infrastructures are often local and consequently we see a long tail of CS data that is highly heterogeneous in terms of data formats, access possibilities, as well as, conditions for access and re-use. The work of this initiative will contribute to the improved availability and access to such CS datasets in an homogeneous way. GEOSS could provide support for the big tail and in exchange CS will gain visibility in GEOSS. This will require developing approaches to describe, publish and harvest metadata about existing and emerging datasets with the goal to register more data sets from CS in the GEOSS Data Core. Recommendations on licensing will be included.

We shall consider both future projects and legacy data. Future projects should follow recommendations to improve the interoperability and re-use of newly collected data, including the application of the newly developed controlled vocabularies and taxonomies. For already existing CS initiatives and legacy data, we will propose approaches and tools to annotate datasets with controlled vocabularies in a way that third parties can better evaluate re-use potentials and are provided with sufficient knowledge to transform and integrate appropriate data sources into their solutions.

9. Policy (2 pages)

Description of any direct policy mandate received from an international body

The United Nations (UN) recognizes the value of citizen science, and is beginning to support it both operationally and through international policy mandates. In December 2017, United Nations Environment Programme helped launch the Citizen Science Global Partnership, a network-of-networks seeking to advance citizen science for a sustainable future, at the third United Nations Environment Assembly (UNEA3). According to a formal statement of the Science and Technology stakeholder group, *“Professional science alone cannot provide information at the scales and resolutions necessary to understand environmental change. The dominant culture of scientific expertise does not account for different ways of knowing, and often fails to engage the public. Thus, we strongly support the establishing of a Global Citizen Science Coalition. Citizen science emphasizes collaborative intelligence and co-creation to facilitate scientific and community-based solutions. Citizen science also provides active and meaningful ways to integrate of local and indigenous knowledge.”* The Citizen Science Global Partnership is working with UN Environment on a draft resolution that mentions citizen science to be proposed during UNEA4. The United States and European Commission, potentially through an EU member, have been identified as potential sponsors for a resolution that covers citizen science.

National Policy Mandates

In addition, an increasing number of policy mandates discuss citizen science at the national level, either through coordinated or agency-specific approaches. Within the United States, a wide range of initiatives initially spearheaded by the Obama Administration’s Office of Science and Technology Policy (OSTP) established the value of “Addressing Societal and Scientific Challenges through Citizen Science and Crowdsourcing.” These high-level policies outlined key principles that a range of federal agencies should apply to take advantage of citizen science and crowdsourcing, and instructed agencies to take two specific steps to ensure appropriate application. The legacy of these policy initiatives was ensured by the inclusion of a section on citizen science in the reauthorization of the America COMPETES Act by the U.S. Congress in 2018. In addition, high-level policy by environmental protection agencies including the U.S. Environmental Protection Agency (EPA) and the Scottish Environmental Protection Agency (SEPA), among others, identify citizen science as a strategic priority and/or issue mandates for coordination and cooperation.

Policies for Citizen Science and Earth Observation

As recognized by national policy mandates including the first US National Strategy and Implementation Plan for Civil Earth Observations, citizen science and crowdsourcing enable the public to make meaningful contributions to scientific and engineering research and monitoring. These approaches, when combined with Earth Observation, can produce accurate data to inform a wide range of management and policy issues while encouraging civic partnerships with government organizations at all levels: (1) through local scale activities, as demonstrated through

drinking water quality monitoring; (2) through national or supranational scale activities; and, (3) through local-to global scale activities, including the inclusion of participatory monitoring and management in international biodiversity assessments.

Such early international policy mandates, national policy mandates at the cross-cutting or agency specific level, and policies explicitly addressing citizen science and Earth Observations set valuable precedents for how policy can help citizen science scale. Yet, these examples are consistently documented, which prevents stakeholders seeking to write and secure support for citizen science at a range of policy levels to benefit from success stories and lessons learned. Further, the impact of citizen science on policy is often constrained by legal, policy, and institutional barriers, which consider issues including privacy, physical and intellectual property, data quality assurance (or “fitness for use”) data annotation, and organizational cultural change, among others.

The GEO Citizen Science working group will leverage early precedents to fill these gaps by documenting and sharing a range of policy initiatives. Contributors to this initiative will also examine the legal, policy, and organizational challenges to conducting citizen science in support of augmenting and enhancing Earth Observation through GEOSS, including strategies for improving bureaucratic processes to increase the impact of citizen science on policies and practices.

Data Policy

The aim of the initiative is to ensure that CS data becomes accessible to the GEO community via a variety of channels - including the GEOSS portal. Our data policy will be developed over time to ensure that this aim is achieved.

Policy of the Initiative regarding data availability, including degree of adherence to the GEOSS Data Sharing Principles and GEOSS Data Management Principles.

If key datasets are managed by the Initiative, a description of how the data are/will be managed.

Description of how the outputs of the Initiative, and the methods used to produce them, may be accessed, including relevant URLs or permanent identifiers . Please indicate whether this information is discoverable and accessible via the GEOSS Platform.

Strategy for longer- term preservation of data and information produced by the Initiative.

Tables (use downloadable spreadsheet for data entry) updated annually

A. Individual Participants

B. Confirmed Contributions

C. Task / Work Package Structure

D. Deliverables / Milestones

Annexes (additional annexes may be added as required)

I. Acronyms and abbreviations

II. List of key scientific references describing the basis for the work of the Initiative

III. Brief CV of Project Leader(s)