Implementation Plan for the Earth Observation for Ecosystem Accounting (EO4EA) Initiative

2020 – 2022 GEO Work Program

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1. Executive Summary

Title: Earth Observation for Ecosystem Accounting

Short title: EO4EA

Status: GEO Initiative

Overview – The purpose of the initiative is to further the development and use of Earth Observations for natural capital accounting (NCA) consistent with the set of standards and guidelines put forth by the UN System of Environmental-Economic Accounting (SEEA) and specifically the Ecosystem Accounts (EA). "Ecosystem accounting is a coherent and integrated approach to the assessment of the environment through the measurement of ecosystems, and measurement of the flows of services from ecosystems into economic and other human activity" (SEEA EEA 2012). Ecosystem Accounts rely on spatial data in order to systematically assess the health and status of ecosystems and the benefits of ecosystem flows to human well-being and the economy. Ecosystem accounting is a standardized system that is, by design, reliant on earth observation to achieve its goals at scale. Through partnership, research, and practical application we will advance the application of earth observation to the practice of ecosystem accounting. We envision a future where earth observation systems enable environmental transparency and the value of ecosystems is incorporated into conventional economic measures leading to an important systems-level shift in policy and decision making. There is a significant global demand for ecosystem accounting with the UN Statistical Commission identifying over 80 countries that have indicated their desire to develop these accounts. However, data for many of these countries is unavailable or is not available in a format that allow for account-ready analysis. Our mission is to document, pioneer, develop, and test the methods and tools that will allow earth observation technology to more effectively enable the widespread adoption of ecosystem accounting. To achieve this, our task structure is divided into 4 workstreams: case studies and synthesis, ecosystem extent and condition, ecosystem service assessment, and capacity building. The four workstreams closely align to the UN-SEEA to better inform the development of statistical standards and many of the initiative activities will span multiple workstreams. Built around our these workstreams, the headline deliverables for EO4EA are to 1) review and contribute to the development of methods and standards, 2) test and apply EO data and algorithms for the purpose of ecosystem accounting, and 3) develop data platforms and resources to amplify our result and facilitate ecosystem accounting at scale. EO4EA advances GEO principles by facilitating the exchange of experiences and joint product development, creating a strong connection to users via the SEEA, breaking down barriers to data and method integration, aligning with other international efforts in earth observation but particularly within the GEO community, and explicitly increasing the use of EO for decision making. EO4EA will leverage the unique advantages of GEO to help countries standardize and repeat their assessment of natural capital, and their progress towards the Sustainable Development Goals.

Planned activities – Table C

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2. Purpose

The SEEA is the internationally accepted statistical framework to measure the environment and its interactions with economy and as such, it is a fundamental planning policy tool for national governments aspiring towards sustainable development. The SEEA produces integrated information by taking basic economic, environmental and social data and translating them into accounts which in turn produces nationally recognized indicators and this includes global reporting for various framework conventions, including the SDG's, a GEO priority. Currently, the SEEA supports 40 indicators for 9 SDGs and currently targeting for > 50 countries to deploy experimental Ecosystem Accounts by 2020.

The goal of Ecosystem Accounts is to assess ecosystems and link the services they provide to economic and other human activity thereby providing national government with the statistical information on their value, and how that might lead to more effective natural resource decisions. Broadly speaking, accounts are divided into two primary components; the physical accounts and monetary accounts (see figure 1 below). The physical accounts seek to quantify the extent and condition of ecosystems, often referred to as the stock, and the supply and use of services provided by those ecosystems, often referred to as the flow of ecosystem services. The monetary accounts use this information on the flow of ecosystem services to derive the monetary values that ecosystems provide to the economy.

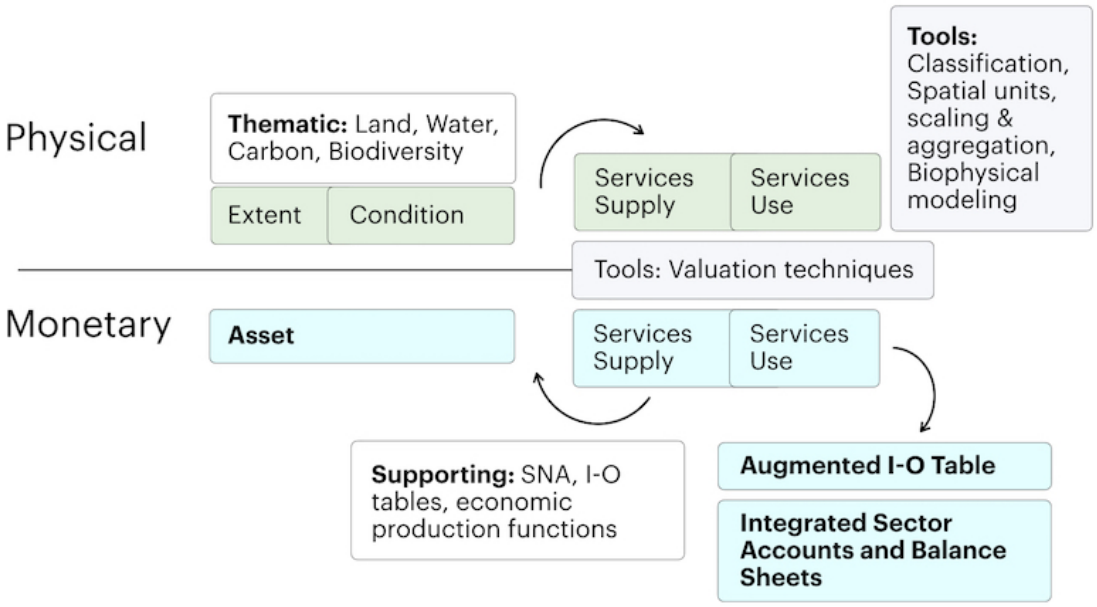

Figure 1: Basic Structure of Ecosystem Accounts

A critical characteristic of the Ecosystem Account approach is the reliance on spatial data in order to systematically assess the health and status of ecosystem and the benefits of ecosystem flows to human well-being and the economy. This characteristic underlies the raison d'etre of EO4EA and success for global uptake at scale for 50-100 countries in the next 5 years relies on a more effective linkage with earth observation to support the physical component of ecosystem account. Figure 1 illustrate that the

biophysical side of the accounts appeal to the core competencies of the geospatial community and GEO goals in particular, and yet that connection between the natural capital accounting with the earth observation communities is not yet mature. The EO4EA initiative expects to rapidly close that gap and in doing so, provide at least 50 governments with more effective tools to aid development planning and assessment, and to inform management and policy options for any activity which will use or impact a country's stock natural capital or substantial flows of ecosystem services from those stocks.

The purpose of the initiative is to further the development and use of earth observations for the natural capital accounting (NCA), based upon and consistent with the UN System of Environmental Economic Accounts (SEEA) – Ecosystem Accounts (EA). The initiative includes participants from both the Earth Observation and Ecosystem Accounting communities in order to facilitate the interdisciplinary approach needed to address key challenges. Ecosystem Accounts are designed to provide a better understanding of the interaction of environment and natural resources with the economy and the broader societal benefits, generating results useful to land and resource managers, project designers, and policy makers. Using a systematic and repeatable accounts-based approach allows the state and trends of resource stocks and conditions to be tracked over time, which enable post account assessments such as the efficacy of programs, projects, and policies.

EO4EA will compile information on current Ecosystem Accounting efforts across varied themes and scales to synthesize our understanding of how earth observations (EOs) has be utilized in ecosystem accounts. It will further assess the gaps in available earth observation systems, and issues associated with sampling, temporal and spatial resolution, classification, data interpretation, and information processing, in order to identify further research needs. EO4EA will assess how EO can more effectively contribute to monitoring and assessing ecosystem extent and condition. It will also look at how EO can more systematically contribute to the measurement and monitoring of ecosystem services. These efforts will be shared with the UN Committee on Environmental and Ecosystem Accounts (UN-CEEA) as they revise the technical guidelines on the SEEA-EA to elevate it to a globally accepted statistical standard.

The upcoming revision of the SEEA EA guidelines (hitherto referred to as the *revision*) in 2020 is a key target for the initiative as it will provide an opportunity to directly integrate our findings into official United Nations Statistics Division (UNSD) recommendations. EO4EA made a strategic decision to wait for a substantive stage for the revision of these guidelines (drafts completed in April of 2019) to provide us with a better understanding of how EO4EA can contribute to the EO related needs of the ecosystem accounting community. A primary goal of our work will be to provide input and testing for the methods that are being developed during the revision, with a focus on how EO data and the EO community can contribute to ecosystem accounting at scale.

The timing of the revision presents an enormous opportunity to GEO where an Initiative is closely coupled to a major developmental period for its targeted group of users and seeing this, we have aligned the dialogue, stages and timing of our activities accordingly. Because we are supporting the development of international standards for ecosystem accounting, early effort will go into review and revision of the proposed methodology; where and how earth observation plays a role, the indicators, and whether EO4EA, or efforts in the larger GEO community can address these indicators. The specific products will be our contributions to the revision. The subsequent stage for EO4EA is to move into testing of the proposed ecosystem type classification (which takes advantage of the work conducted by

GEO-ECO and Roger Sayre, a steering committee member) and indicators. Finally, we propose designing the co-development of databases that provide globally consistent information to enable the proliferation of ecosystem accounting, and a platform to access products, methods, algorithms and other resources. EO4EA in partnership with SEEA and the UN Global Working Group for Big Data, will work directly with the National Statistics Offices (NSO's) and Space Agencies as they are the principal users and authors of national accounts but will necessarily work with a wide range of stakeholders. The UNSD is on the EO4EA steering committee and has endorsed this effort, thereby providing us with a policy mandate and in June of 2019, the UNSD formally presented EO4EA to The UN Committee of Experts on Environmental-Economic Accounting (UNCEEA), the intergovernmental body charged with providing overall vision, coordination, prioritization and direction in the field of environmental economic accounting and supporting statistics.

To date, over 80 countries have compiled broader SEEA accounts, which represents a 28% increase of countries with programs from 2014 and 2017. (Source: UNSD). This positive trend illustrates the growing demand for this information (and country investment to obtain it) and provides further opportunities for EO4EA to simultaneously augment its activities and engage important user communities. To reach this target at scale, earth observation and an accompanying strategy to elevate these efforts are needed. EO4EA will play a critical role in this and the global natural accounting community recognizes importance of this group in leveraging earth observation to accounting. The primary end-user is regional and national government who are seeking to develop ecosystem accounts as a means of building considerations of nature directly into their statistical systems. Several member countries, including Mexico, Canada, United States, Netherlands, Australia, and Indonesia have already developed, or are in the process of developing, pilot accounts. Despite the focus on ownership and deployment by governments, other end-users, including academic institutions, NGOs, and private corporations also benefit greatly from the accounts, and can contribute in significant ways.

The longer-term goal of the EO4EA initiative is the development of methodological guidance on using EO to measure and monitor ecosystem extent, ecosystem condition, and ecosystem services for the purpose of ecosystem accounting. To this end, the initiative will: synthesize exist examples of ecosystem accounting at the regional and national level; pilot ecosystem accounting efforts; advance the science of EO to support ecosystem accounting; publish guidance and methodological documents; and provide capacity building to support ecosystem accounts.

CASE STUDY: LIBERIA

An example of the kind of testing that brings these elements together is the ongoing work in Liberia where the Government of Liberia, Conservation International, and NASA are developing an ecosystem extent map based on the revised SEEA guidelines. The product combines a SEEA compliant landcover map (see Figure 2) which generates a SEEA land account; with mapping of ecosystem types using Generalized Dissimilarity Modeling (GDM) to ascertain biological uniqueness based on paired site comparisons, then modeled using environmental attributes.

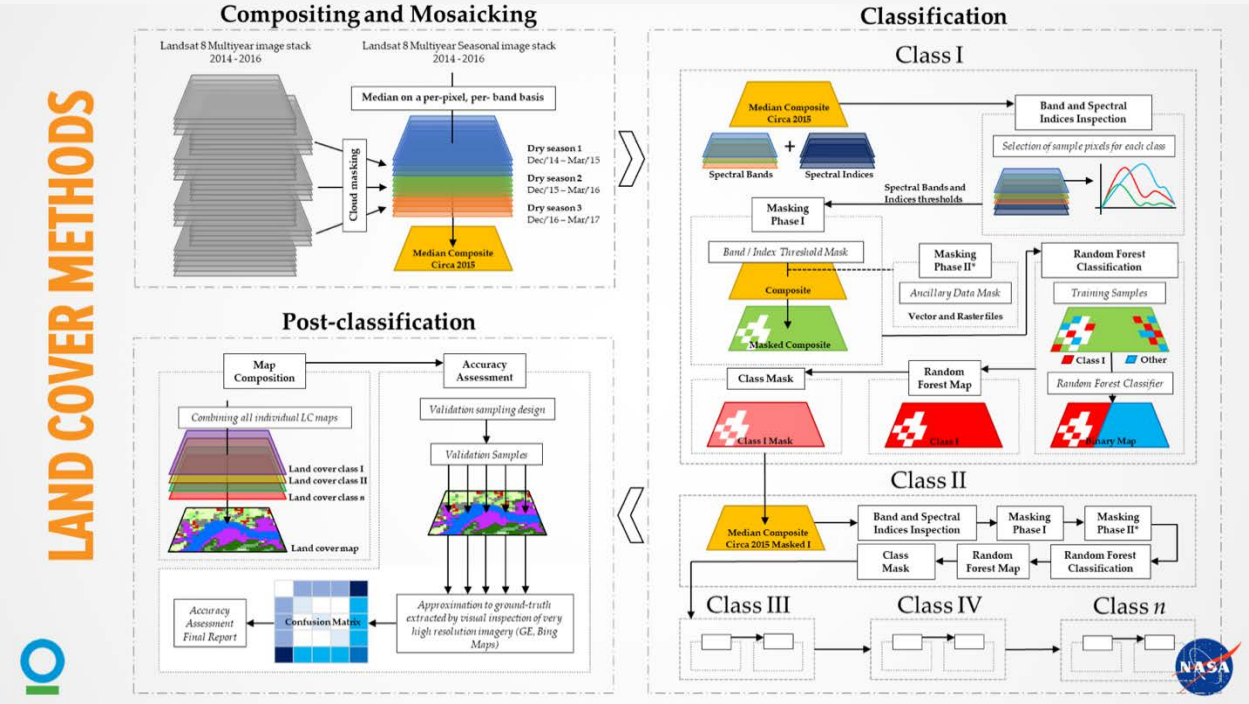

Figure 2. SEEA compliant approach to develop land accounts in Liberia

The resulting extent account will be used to drive ecosystem services assessments and accounts as part of Liberia's GEF-funded project to formalize a program of ecosystem accounting and national statistics (including SDG indicators). The product is also formally slated into government sanctioned programs for the spatial planning of biodiversity, ecosystem services, and sustainable production options at the landscape level. EO4EA will use the results to cross compare scale issues against Roger Sayre's global product (GEO-ECO), fused with the IUCN Red List of Ecosystems, an effort sanctioned by UN-SEEA to provide global ecosystem maps. It is hoped that this comparative study will provide guidance to countries how to best utilize the global product as a starting point to develop their own national level maps. These efforts in Liberia will be accompanied by training/capacity building as well as the development of an accounting data infrastructure within the ministries of the Liberian government.

3. Background and Previous Achievements

The EO4EA initiative is new within GEO and is continuing to develop, however, there have been numerous achievements over the past year, most notably progress on various individual government ecosystems accounts and are part of EO4EA including Australia, US, Canada, Liberia, Mexico, Netherlands, Indonesia, to name a few. These efforts are not yet complete but EO4EA has benefited from the participation of these representatives to discuss the EO challenges of EA and to sharpen the goals of EO4EA based on their experience. (Examples of these projects in progress can be found in the links below)

The EO4EA initiative hosted and participated in numerous key meetings this year including:

- The Forum of Experts in SEAA Experimental Ecosystem Accounts hosted by the UNSD
- Co-hosting the Natural Capital Assessment and Accounting side event at the 6th GEF General Assembly along with the most important agencies mandated to spearhead NCA.
- NASA funded workshop on EO for ecosystem service assessment at the University of Minnesota
- The UN Statistics Commission's London Group on Environmental Accounts in Dublin
- EO4EA side event at the GEO Plenary in Kyoto
- The Third Natural Capital Policy Forum in Paris
- Full EO4EA meeting in Washington DC to solidify ties to the SEEA revision process and solicit input into this workplan

Members also published three key synthesis reports over the course of the past year. UNEP-WCMC published a reported entitled "Technical proposal on opportunities for using earth observation data in KIP-INCA" which examined how ESA Copernicus product could be used to support ecosystem accounting in the European Union. To compliment the report, WCMC also published a database of the Copernicus products and provides an interactive tool to link data products to the extent, condition, and services accounts (link). The major synthesis entitled, "Earth observation for official statistics: Satellite imagery and geospatial data task team report", was authored by the United Nation, Australian Bureau of Statistics, Queensland University of Technology, the Queensland Government, Commonwealth Scientific and Industrial Research Organization, the National Institute of Statistics and Geography (INEGI) in Mexico and Statistics Canada. The report was produced as an input to the United Nation Working Group on Big Data for Official Statistics and outlines the current and potential future applications of earth observation to support national statistics, including SEEA. Finally, a third report was written by the government of Australia, entitled "Earth Observation for Environmental-Economic Accounting", which focuses specifically on how EO data could be used to inform the Australia ecosystem accounts. These three reports highlight the increasing role of earth observation data in environmental accounting and represent significant progress toward the Case Study and Synthesis workstream in EO4EA. Additionally, EO4EA members contributed to peer reviewed publications on natural capital accounting in the United States (link) and the role of earth observation in ecosystem service assessment (link).

(For further information on achievements and products , we refer you to the side event presentation EO4EA sponsored at the GEO Week in Kyoto where we highlighted just those cases by members of EO4EA that were present: the Mexico, Liberia, the US and case studies from the European Union. The side event was recorded and can be found here)

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

The EO4EA initiative is fully grounded in the GEO Strategic Plan 2016-2025, seeking to "improve the effectiveness of GEO's actions, to broaden engagement and collaboration of stakeholders," as called for by the 2014 GEO Ministerial Summit. This initiative will include stakeholders and users as active partners across the public, private, academic and NGO sectors. These partners include environmental and ecosystem accountants, statisticians, environmental and ecological economists, geographers, geo-spatial data experts, and ecologists.

The Initiative also responds to the Mandate of the GEO Mexico City Declaration of 2015. Specifically, the initiative - will be an active collaboration "with statistical agencies and others to integrate Earth Observations with social and economic data to multiply their collective value and to contribute solutions that are linked from the global to local levels." Both GEO and EA, share a systems level approach to help achieve this mandate. GEO approaches the contribution of earth observations to SBA's from a systems-level, while ecosystem accounting is globally regarded as the systems-level solution to assessing the contribution of ecosystems to human well-being and the economy. Ecosystem accounting was also identified by the 38th Executive Committee as one of the 5 GEO Engagement Priorities for 2017-2019. EO4EA will contribute to many of the "societal benefit areas" identified by GEO and will also contribute to the implementation of the 2030 Global Goals for Sustainable Development (SDGs). SEEA supports at least 40 indicators of the SDG's (more are yet to be identified via the SEEA revision process). We will crosswalk this with the indicators identified by GEO-SDG as those that might be measured via EO. Ecosystem Accounting provides value to not only tracking SDG indicators but also planning and spatial planning of SDG goals, an issue we hope to explore via this initiative. It should be noted there is a great deal of momentum building a case to not only develop resources for countries (and in particular, the National Statistics Offices) to more easily conduct accounting and as a related benefit, to closely couple SEEA and the System of National Accounts with SDG indicators reporting. This includes the development of global spatial databases that NSO could utilize as starting points for more refined national products. This provides an additional rationale and mandate on the repository function that EO4EA hopes to build and is mentioned below in the technical section.

EO4EA will have significant overlap and synergies with several existing GEO initiatives and flagships, due to the interdisciplinary and wide-ranging scope of ecosystem accounting. The success of EO4EA will depend on collaboration with other GEO programs. At the GEO Plenary in Kyoto a meeting was set up with GEOBON to discuss synergies and opportunities to work together. Some of the key areas of overlap were around the Essential Biodiversity Variables (EBVs), specifically those related to ecosystem structure, function, condition, and ecosystem services. Another GEO initiative that EO4EA is working with is GEO-ECO (Roger Sayre is on the steering committee of both EO4EA and GEO-ECO) whose commissioned ecosystems are preliminarily recognized as the global UN SEEA ecosystem map and the classification reference standard. EO4E will be evaluating this for use in two EO4EA activities in Africa and West Papua. A related EU funded project, Ecopotential, is using the work of GEO-ECO and applying it specifically to Europe. Much of the collaboration between GEO initiatives will be driven by our steering committee and individual members who are also involved in other GEO initiatives, such as the connections with GEO-ECO and GEO-BON. The GEO secretariat and regional GEOSSs will also plan a key role in engaging with member countries and communicating the outcomes of the initiative.

Much of the ecosystem accounting work to date has focused on terrestrial ecosystems, however, there is a desire to expand to coastal and marine ecosystems in the future. This will require close collaboration with other GEO groups, such as Blue Planet (who attended our last EO4EA meeting) to better understand the contribution of EO in these biomes. Finally, there is significant overlap between the EO4EA initiative and the EO4SDG flagship, since in many cases achieving the SDGs will require greater environmental stewardship and robust monitoring. EO4EA could do more to align our efforts with the SDGs by mapping indicators or sub-indicators that could be derived from ecosystem accounts. The GEO plenary is an ideal venue for convening with other GEO Flagships and Initiatives because it provides a platform for highlighting our respective work and identifying avenues for collaboration. EO4EA will be leading a side event at the GEO Plenary in Canberra and will be reaching out to specific members from other GEO initiatives to attend.

5. Stakeholder Engagement and Capacity Building

Engaging with stakeholders across multiple disciplines and many institutions, including government, NGO and academic, is critical to ensure the success of the initiative. This engagement will happen across multiple platforms including GEO events, UN meetings, and direct engagements with our members. Additionally, EO4EA will seek to bring new countries into our membership to better deliver benefits to support national and subnational ecosystem accounting. To date much of the capacity building has been conducted by international institutions such as the SEEA and World Bank, given the nature of the work. Therefore, the role of EO4EA is to create the linkages and underlying EO data that supports capacity building efforts by co-designing materials and providing products to facilitate the adoption ecosystem accounts.

“Implementation and capacity building” is one of the 4 primary workstreams in the initiative (see Technical Synopsis below). Capacity building is a high priority for the ecosystem accounting community at the individual, organizational, and institutional level, and will be carried out by our members and partners. Capacity building activities will be conducted are multiple level and for multiple audiences:

1. Conduct training and workshops to convey theory, practice, and methods for ecosystem accounting. Though individual capacity building activities are typically built into the discrete projects that comprise EO4EA, the initiative will enhance those efforts by collating experiences and providing tool and best practice guidance.
2. Develop and consolidate a “library” of tools, guidelines, and manuals specifically for incorporating EO data into ecosystem accounts and consolidated into a single Knowledge Hub, though partnership with GEO or the UN Big Data Initiative.
3. Conduct institutional capacity building, enabling the collaboration between governments and institutions to implement, iterate, and improve ecosystem accounting within the UNSD-SEEA. GEO and the EO4EA partners organizations, such as the United Nations, provide the mandate and direction to conduct institutional-level capacity building and pilots are underway in Liberia, Indonesia and others this year.

The goal of such capacity building activities will be to ensure that using EO, any institution developing ecosystem accounts has the tools, data, and methods to begin the process, with defined pathways for improvement and continued development. At a minimum there will be a need for a menu of options that will be able to be applied to cover the varying degrees of technical capacities and sophistication of implementing governments. It is acknowledged by the initiative that at this point much of the capacity building that has been done has been indirect and the goal of these efforts is aspirational for a later stage of EO4EA's life cycle. As outlined in the earlier section, much of the initial work is necessarily focused on review and synthesis in for the SEEA 2020 revision. As the ecosystem accounting community, and EO4EA, moves into the testing phase of these methods, capacity building will become a more integral part of our work to support governments and NSOs seeking to implement the guidance from the SEEA. It would therefore be premature to articulate the specific capacity building activities before these elements are in place, but we anticipate a rapid design phase for capacity building as the revision finalizes in 2020.

6. Governance

The governance of EO4EA will be led by the Secretariat, Conservation International, and a steering committee comprised of experts in ecosystem and environmental accounting from Governments, International Organizations, NGOs, academia, and private sector. The initiative is still very new and currently the governance structure is evolving. The issue of governance will be revisited during the EO4EA general meeting in June 2019.

Until then, the steering committee is the primary governing force within the initiative and will provide direction and review progress on the workstreams on a biannual basis, identify opportunities for funding or capacity building, and report on key developments within the field. Steering committee membership is ad hoc and voluntary and will include representatives from several countries and institutions. Beyond the steering committee there is also a broader community of practice. The community of practice is invited to self-identify to be informed of progress of the initiative. There will be an annual meeting with the broader community of practice report on the progress of the initiative and to invite members to contribute to the workstreams.

Currently, the Secretariat and steering committee coordinate the four workstreams but as of June 2019 we are looking to the workstream leads to take on more of the function and lead development within their areas of research. The Secretariat will work closely with those leads to address issues of integration, overlap, and amplification.

Our membership, especially on the steering committee, is North American and European centric at this stage. However, there is an increasing push to bring in members from South America, through supporting NCA in Peru and participation by Brazil, and Africa, specifically the member nations of the Gaborone Declaration for Sustainable Africa (GDSA) which has stated natural capital accounting as one of three guiding principles.

EO4EA is small but growing and the need to change its current governance structure will be addressed in the next meeting. In the meantime, we will commit to articulating our governance structure in the next build of the EO4EA website.

7. Resources

Currently the initiative has funding from NASA to maintain the Secretariat for 3 years. During this time, Conservation International will seek to expand the membership of the initiative, develop opportunities for joint fundraising, and coordinate with the broader GEO community to identify synergies among the EO4EA workstreams and other GEO initiatives and workstreams. For the first year of this workplan there will be an initial focus to engage and invite developing countries to join the initiative.

There has also be in-kind support from several member countries and institutions. NASA has also funded CI to undertake work in Indonesia and funded the University of Colorado to pilot ecosystem accounts in the U.S. There has also been support by programs such as World Bank WAVES for implementing environmental and ecosystem accounts in several countries.

The steering committee has already identified that joint fundraising will need to be a major effort over the next year or two in order to promote the applied research elements of this workplan for the individual workstreams. Opportunities for joint fundraising will include research grants from space agencies such as NASA and ESA to develop methods and apply novel EO data. The initiative will also seek to engage with multilaterals, such the Green Climate Fund (GFC), the Global Environmental Facility (GEF), and the World Bank, all of whom have committed to incorporating the value of natural capital into their project design and funding priorities. GEO will be a key platform for engaging with these institutions and connecting the initiative with other ongoing activities and opportunities.

8. Technical Synopsis

Earth Observation enables much of the approach, feasibility, and options for standardization of ecosystem accounting. The importance of this group to leverage earth observation to accounting requires that EO4EA interact with a wide range of EO data relevant to the accounts. it is hoped that standard approaches to ecosystem assessment, using the architecture of accounting, not only provides countries with the tools for systematically tracking their natural capital, but also provides a fundamental change in understanding in how to better ecosystem planning and management.

The delay in formulating a technical approach for the EO4EA initiative was a conscious decision to closely couple our effort to SEEA, the body that provides us with the policy mandate. Technical development of EO4EA should be driven by the significant development in the SEEA Ecosystem Accounting working groups to re-define key technical approaches, spatial units, proposed classification schemes, approaches towards ecosystem services, etc. With that process underway, the discussion on the link with EO has advanced significantly.

EO4EA technical activities are accordingly sequenced in the workplan and will be divided across 4 workstreams which mirror the structure of the accounts and its corresponding EO challenge.

1) Case studies and synthesis

2) Ecosystem extent and condition

3) Identification, measurement, and monitoring of ecosystem services

4) Implementation and capacity building.

Each workstream will have a workstream lead, who will also participate on the steering committee, responsible for organizing the research agenda within the workstream. The workstream leads will also be responsible for reporting on progress and documenting successes within their workstreams. The key research questions associated with each workstream are presented on the EO4EA website and will evolve and the standards and science continue to develop.

Activities can be found in Table C but we provide here a brief synopsis of those workstreams:

Workstream 1: Case Studies and Synthesis seeks to highlight case studies and applications of ecosystem accounting. Of the 80 countries that have compiled some kind of SEEA account and looking forward to those 50 countries that hope to implement EA specifically, we don't know how many are using earth observation. EO4EA aims to shed light on those successful examples to inform other countries developing their earth observation strategy to conduct accounting. Information on the use of EO in Ecosystem Accounts will be available through the new EO4EA website. Additionally, a synthesis will focus on how earth observation data has been used in various case studies at national and subnational levels. The workstream will compile and synthesize case studies and results to inform the development of new methods and applications.

There is a vast amount of EO data already available, but little guidance on how it can be effectively applied for ecosystem accounting. The identification of the most appropriate dataset and data sources and maintaining them over time will be one of the first major accomplishments for this initiative. A good example of this from our contributors at the European Environment Agency and WCMC is the report and interactive tool matching Copernicus resources with relevant applications in the ecosystem accounting framework, however, this only represents a small fraction of the EO data available. The two agencies (both workstream leads and steering committee members) have graciously contributed this study to EO4EA. (Appendix A). The key milestones for this workstream in the next year will be to catalogue and highlight case studies through the EO4E website. Collecting this information in a library or linking it through the website will allow for additional analysis to be performed to identify gaps and trends.

Workstream 2: Ecosystem Extent and Condition will develop and test methods for delineating ecosystem extent and assessing ecosystem condition. The ecosystem extent account provides the foundation for ecosystem accounting and is critical for the characterization of ecosystem services. Ecosystem condition reflects the vitality of ecosystems and their ability to provide ecosystem services. The workstream will focus on technical application of earth observation data to support the ecosystem extent and condition accounts and much of EO4EA's early focus will be placed here as the foundational effort that enables the other sequential elements of the account. We note here that there is a need to better connect the accounting community to existing initiatives including GEO, particularly on extent and condition. The GEO Plenary is one venue for this and might warrant a side meeting with members of GEO-BON and GEO-ECO to coordinate our efforts. One key development in the SEEA is the proposed draft for classification and spatial units released for early review in April 2019. With this, EO4EA will review these to provide insight on the earth observation components.

Over the past couple of years, there are many examples of this workstream where ecosystem extent accounts have been generated using EO including the Netherlands, Peru, Canada, Australia, Rwanda, just to name a few. The SEEA and EO4EA have drawn heavily from these experiences to inform the revision process to improve methods, approaches and classification systems for the delineation of ecosystems. The key milestones in the next 2 years for this workstream will be to pilot the ecosystem extent and condition methods that are being developed through the SEEA and to publish the outcomes in either peer-reviewed journals or through official government grey literature.

Workstream 3: Identification, Measurement, and Monitoring of Ecosystem Services will advance ecosystem service identification, measurement and monitoring through the application of earth observation. The methods developed will seek to directly or indirectly assess the provision of ecosystem services and the value that they provide. The workstream will explore the wide range of approaches and tools that can be used to measure and model ecosystem services and identify how earth observation data can be used to inform such estimates. One key development from the SEEA revision process is a deeper focus on a 11 select ecosystem services, articulated through issue papers that will allow us to better tie in EO observation (link). In the last EO4EA meeting, our group decided that these ecosystem services will be the focus of our efforts.

The linkages between EO and ecosystem services was further advanced by a NASA funded working group that specifically sought to identify how EO data could be applied to ecosystem service assessment. The resulting paper was published in Science of the Total Environment (link) and one of the PIs from the study has joined the EO4EA steering committee and will co-lead the workstream to ensure tight coordination with ongoing developments in the ecosystem service community. The key milestones over the next 2 years will to implement ecosystem assessments within the EA framework, which has very specific definitions for ecosystem services and how they relate to accounts, and identify where the application of EO data could be used to strengthen the biophysical modeling or monitoring of services.

Workstream 4: Implementation and Capacity Building will lead the capacity building, pilot testing and implementation of ecosystem accounting at the subnational and national scale. Support will be given to governments and partners seeking to implement ecosystem accounting and integrate it within the system of national economic accounts. The workstream will focus on identifying barriers to implementation, developing materials for outreach and education, and advancing the application of ecosystem accounting with earth observation. In terms of capacity building Workstream 4 will be better defined as the SEEA revision process and Workstreams 1-3 are more mature. Training and capacity building in SEEA are well established and we would likely work directly with SEEA and the World Bank on the possibility of including EO specific training. The key milestone for this working group over the next 2 years will be developing technical guideline for implementing ecosystem accounts. The technical documentation will be made available through the EO4EA website and in-person trainings will be given in at least two countries.

Finally, the key challenge that the larger natural capital accounting community and thus, this initiative will face is *how to operationalize the use of EO data for ecosystem accounting*. In order to serve ecosystem accounting users and ensure cross-cutting solutions, data access and repeatability via data cubes and cloud storage/processing is a key target that will be addressed in conjunction with SEEA in the latter stages of this work plan.

Bringing together data on a platform that is accessible to the ecosystem accounting community and ensuring that countries have access to resources needed to update those datasets (and therefore the account) over time is a key technical challenge. The EO4EA community made some decisions on this in the May 2019 meeting: As the SEEA finalizes its revision of the ecosystem account, one area of focus for the initiative will be making EO data more accessible for ecosystem accounts via repositories, i.e., the provision of global databases and a knowledge hub to support the needs of the ecosystem accounting community and in particular, developing countries. This gives countries a starting place in the complex chain of development to generate accounts. However, national level assessments require refined resolutions and context specific analyses so bridging globally consistent and nationally relevant scaled data will be an important focus of our technical effort this year.

This will naturally be a supportive effort between many organizations including UNSD and the UN Big Data Initiative where we join in their efforts and they join in ours so that we can craft a knowledge hub utilizing our respective strengths. The UN Big Data Initiative in particular is working on pilots to provide algorithms so that some of the analyses might be replicated and EO4EA is committed to helping this effort.

9. Data Policy

It is anticipated that many key data sets, including satellite data on vegetation, land-use, moisture, topography, climate, urbanization, and human impact, already exist but need to be integrated in a way that they can provide essential and relevant information needed for the development of ecosystem accounts. A key purpose of the initiative is to identify critical data gaps; both in terms of data that needs to be collected, potentially by new or planned sensors, and in terms of how existing data may need to be modified or processed to be applicable for ecosystem accounting. The taskforces will proceed with their initial efforts to clarify what key datasets will be used or created, to measure and monitor ecosystem extent and condition and to track flows of ecosystem services. We will seek to adhere as fully as possible to the GEOSS Data Sharing and Data Management Principles, to contribute new data sets developed to the GEOSS Data CORE and to seek appropriate interoperability of the Earth Observation data used with the GCI (GEOSS Common Infrastructure). EU partners will also need to comply with recent EU data and privacy regulations.

EO data in general, but specifically for accounting is indispensable in the 100 countries, including developing countries who want to create accounts and EO4EA intends to radically advance this issue of data sharing. Many countries have produced extent accounts, issued as reports, not as datasets and this is an issue we hope to address. In the last EO4EA meeting held May 2019, the attendees discussed formalizing EO4EA's role in helping to create a repository function in close coordination with SEEA and the UN agencies, hence the addition to the workplan.

We are working on the EO4EA website which we hope to go live with added functionality by September 2019.