**CEOS Ecosystem Extent Task Team Proposal (Two-Year Focus)**

**“Ecosystem Extent and the Coming Revolution in Biodiversity Monitoring from Space”**

NOTE: This draft Ecosystem Extent Task Team proposal complements the Terms of Reference presented for consideration at the 2022 CEOS Plenary.

**INTRODUCTION**

Ecosystem extent quantifies the distribution of ecosystems and is a core piece of information needed by natural resource management organizations everywhere, including numerous Multilateral Environmental Agreements, national governments, NGOs, and other organizations. Tracking change in ecosystem extent over time is essential to identifying and responding to the cause of change and to managing its impacts on biodiversity and society. Land cover is more commonly available than ecosystem extent and is often used as a surrogate, but land cover can include non-ecosystem classes and is often combined with land use. Creating an ecosystem extent map is a classification task that depends on the ecosystem characteristics used, the statistical methodology, the nature of input datasets, and other information. There are many ways to create such maps and standardization is limited, in part because the needs of users varies widely.

Forthcoming observations will go far beyond those of the past in terms of spatial, temporal, and spectral resolution and in the range of observation technologies used. This will enable observation products that greatly extend the ecologically relevant information that is available and thus the ability to monitor ecosystem extent and other essential biodiversity variables. Additionally, advances in technology such as artificial intelligence and cloud computing, as well as continuing improvements in in situ data such as bioacoustics, will enable much more value to be extracted from current observations; for example, multi-sensor and multi-temporal approaches are now much more practical but as yet only barely tapped.

The CEOS SIT Technical Workshop held in Frascati, Italy, on Sept. 13-15, 2022, gave its approval to bring to the 2022 CEOS Plenary a proposal to form a CEOS Task Team to assess the utility for mapping Ecosystem Extent from the new space-based observations that will become available in the next 10 years.

**TASK TEAM ACTIVITIES**

The Task Team will explore ways to utilize this expanded suite of observations and enabling technology in two related streams:

Stream 1 aims to develop a white paper (25 pages or less) that will provide an integrated international perspective on how current and forthcoming space-based Earth observations can be combined with advancing technology to support biodiversity mapping and monitoring with a focus on ecosystem extent. The white paper is expected to focus on two key stakeholders--the Convention on Biological Diversity (CBD) and the UN System of Environmental Economic Accounting (SEEA), however, the results will benefit a variety of other international stakeholders that need to map and monitor ecosystem extent.

Stream 2. The purpose of stream 2 is to demonstrate the use of EO for ecosystem extent mapping and monitoring. The range of options is wide and the scope and details will be determined by the Task Team, leveraging as much as possible existing initiatives. Several examples that may be considered follow:

1. Select several specific sites and assemble existing observations available for those sites to generate sample products. Site selection criteria could include EO and in situ data availability, ecosystem knowledge, and local partnership potential, for example. This can be combined with the next item.
2. Develop a data cube incorporating the full range of sensor types available; this could then be used to explore techniques and assess potential to create ecosystem maps. This has ties many existing activities.
3. Identify EO data gaps and key areas where EO data can be nationally contextualized to strengthen national target tracking (e.g., for supporting National Indicator Reporting Toolkits).

To accomplish its two-year purpose and objective, this effort must garner appropriate support from CEOS agencies and partners. The Task Team’s leadership will engage CEOS agencies and partner organizations to this end.

**POTENTIAL ROLE FOR CEOS**

As a forum for national and international organizations focused on space-based EO, CEOS is uniquely positioned to explore how capabilities from existing and forthcoming missions, particularly when combined with advancing technologies, can enhance biodiversity measurement from space and support user needs for mapping ecosystem extent. CEOS can also facilitate the development of observation strategies that maximize the value of agency assets.

Integrating the complementary perspectives provided by new visible, infrared, and radar satellite capabilities with an increasing number of in situ observations and advancing technology provides new opportunities for global monitoring of ecosystem state and for understanding change at local, regional, and global scales (see list of instruments and missions below). Different instruments characterize different key and complementary aspects of ecosystems, specifically: structure (radar and lidar), composition (optical--multispectral and especially hyperspectral), and function (radar, lidar, multispectral, hyperspectral). These instruments are operated by different organizations and international collaboration is essential to develop the needed products and maximize the global benefits from these missions, instruments, and measurements.

**FUTURE INSTRUMENTS AND MISSIONS IN DEVELOPMENT**

**RELEVANT TO ECOSYSTEM EXTENT MAPPING AND OTHER MEASURES OF BIODIVERSITY (TBC)**

|  |  |  |
| --- | --- | --- |
| **Instrument/Mission** | **Agencies** | **Type** |
| Biomass | ESA | Radar |
| CHIME | EC/ESA | Hyperspectral |
| Mass Change | NASA, ESA, DLR | Mapping mass |
| Surface Biology and Geology | NASA, ASI | Hyperspectral VSWIR, Multispectral TIR |
| Flex | ESA | Chlorophyll fluorescence |
| LSTM | EC/ESA | Thermal Infrared |
| NISAR | NASA, ISRO | Radar (L-band) |
| PACE | NASA, SRON | Ocean color, Hyperspectral |
| ROSE-L | EC/ESA | L-Band SAR |
| SWOT | NASA, CSA, CNES, UK Space Agency | Water, and Ocean topography |
| MOLI | JAXA | Lidar |

**\*** More instruments and missions could be contributed by other agencies

**EXISTING INSTRUMENTS AND MISSIONS**

**RELEVANT TO ECOSYSTEM EXTENT MAPPING AND OTHER MEASURES OF BIODIVERSITY (TBC)**

|  |  |  |
| --- | --- | --- |
| **Instrument/Mission** | **Agencies** | **Type** |
| ALOS | JAXA | Radar |
| ASTER | Japan Space Systems, NASA | Multispectral |
| ECOSTRESS | NASA | Multispectral |
| EnMAP | DLR | Hyperspectral |
| GEDI | NASA | Lidar |
| GOES-16 | NOAA | Multispectral, geostationary |
| Landsat | NASA/USGS | Multispectral |
| MODIS/VIIRS | NASA/NOAA | Multispectral |
| PRISMA | ASI | Hyperspectral |
| Sentinel-1 | EC/ESA | Radar (C-band) |
| Sentinel-2 | EC/ESA | Multispectral |
| TanDEM-X | DLR | Radar |

**\*** More instruments and missions could be contributed by other agencies

**PROPOSED TASK TEAM CO-LEADS (to be confirmed at plenary)**

CSA - Marie-Josée Bourassa

NASA - Gary Geller

Co-lead #3

Prior to the CEOS Plenary the co-leads will engage with some key potential stakeholders and also start populating the preliminary Task Team; this engagement activity will continue after Plenary to further develop this initial proposal and populate the Task Team’s membership. A draft Terms of Reference to formally establish the Task Team has been submitted for endorsement at Plenary.

**TIMELINE AND APPROACH**

**Stream 1**

* 2023: Potential workshop in Montreal (location of CSA, CBD, and GEO BON Secretariat). Purpose and objectives of workshop to be defined by CEOS telecon discussions.
* Jan-Aug. 2023: Task Team to assemble a white paper outline and assign responsibilities, then develop an initial draft prior to the Sept. 2023 SIT Technical Workshop; a side meeting at SIT-38 can facilitate this process.
* Sept.-Nov. 2023: Task Team completes Stream 1 and finalizes the white paper for presentation at the 2023 Plenary hosted by GISTDA in Thailand. The Task Team will also make recommendations for future CEOS activities under the CEOS Work Plan.

**Stream 2 (Notional)**

* Task Team begins exploring ideas for a demonstrator in parallel with Stream 1. The scope and focus of the demonstrator will depend on the expertise and resources of the Task Team.
* 2023-2024: Task Team develops the concept for a demonstrator and begins implementation, all in conjunction with appropriate stakeholders. Progress is presented and discussions held at appropriate CEOS meetings.
* June-Aug. 2024:
  + Task Team begins demonstrator finalization and prepares materials to present at SIT Technical Workshop
  + Task Team develops a proposal for future CEOS support for Biodiversity, (i.e., what is the proposed framework, e.g., a WG, VC, federated approach, or other).
* Sept. 2024:
  + Task Team presents initial demonstrator at SIT Technical Workshop.
  + At SIT Technical Workshop, Task Team vets draft recommendations for future CEOS support for Biodiversity, including, as required, Terms of Reference, proposed co-leads, and the agencies that have named a POC to be an active member of the proposed framework.
* Sept.-Nov. 2024:
  + Task Team finalizes demonstrator and stream 2, and prepares for presentation at Plenary
  + Task Team makes recommendations for future CEOS support for Biodiversity activities, including those beyond the Ecosystem Extent Demonstrator, for inclusion in future CEOS Work Plans.
* Nov. 2024: Presentation on the two-year Task Team effort at the CEOS Plenary hosted by CSA in Canada. The Task Team will also ask for plenary endorsement of the finalized proposal for future CEOS support for Biodiversity, including, as required, Terms of Reference, proposed co-leads, and the agencies that have named a POC to be an active member of the proposed framework.