



EC-ESA Joint Earth System Science Initiative



22-24 November 2023 | ESA-ESRIN, Frascati, Italy

BIODIVERSITY WORKSHOP Session Summaries



ESA UNCLASSIFIED - For ESA Official Use Only



→ THE EUROPEAN SPACE AGENCY

Objectives of the Biodiversity Workshop



- *To take stock of Biodiversity policies, initiatives, observation and science networks globally and in the EU.*
- *To enhance awareness of biodiversity projects (with EO components) within ESA and the EC.*
- *To advance the development of an EO Science Agenda for Biodiversity.*
 - to discuss how to **advance the use of satellite observations in biodiversity science and monitoring.**
 - to **review the major science questions and policy priorities** where EO systems play a crucial role.
 - to **address knowledge and observation gaps in biodiversity.**
 - to **review the recent advances in the use of Earth Observation in biodiversity science and monitoring,** and identify **gaps in data, methodologies and technologies** where further R&D efforts should be made.
 - to **define the key research priorities that will drive our collective efforts in the coming years.**
- *to improve the collaboration between ESA-EC funded projects on biodiversity.*
 - to **improve the collaboration between ESA and EC funded projects on biodiversity**
 - to propose new and **more effective ways of cooperation,** including **knowledge sharing and calls for collaborative development.**

Programme of the Biodiversity Workshop



DAY 1 – Wednesday 22 November

14:20 - 16:00 **Session 1:** Biodiversity Policies and Initiatives - Part 1

16:20 – 18:00 **Session 2:** Biodiversity Policies and Initiatives - Part 2

DAY 2 – Thursday 23 November

09:00 – 11:00 **Session 3:** ESA – EC Biodiversity Projects - Part 1

11:30 – 13:20 **Session 4:** ESA – EC Biodiversity Projects - Part 2

14:20 - 16:00 **Session 5:** Biodiversity EO Science Agenda - Part 1

16:20 – 18:00 **Session 6:** Biodiversity EO Science Agenda - Part 2

DAY 3 – Friday 24 November

09:00 – 10:30 **Session 7:** ESA – EC Biodiversity Projects – Connecting the dots.

10:30 – 11:00 **Session 8:** Biodiversity Sessions wrap-up



Biodiversity Workshop

Sessions 1-2: Biodiversity Policies and Initiatives



Session 1: Biodiversity Policies and Initiatives – Part 1

Wednesday 22 Nov 14:20. Chairs: Petteri Vihervaara (SYKE) and Marc Paganini (ESA)

ESA Welcome (M. Paganini, ESA ESRIN)	5'
EC Welcome (Gilles Doignon & Bastian Bertzky, EC DG-RTD)	5' ®
Workshop Objectives and Programme (M. Paganini, ESA ESRIN)	10'
<hr/>	
CBD Kunming-Montreal GBF & Monitoring Framework (Jillian Campbell, CBD secretariat)	12' ®
EU Biodiversity Strategy for 2030 and Nature Restoration Law (Anne Teller, DG ENV)	12' ®
Support of EO to the EU Habitats Directive (Bruno Combal, DG ENV)	12' ®
<hr/>	
EC Knowledge Centre on Biodiversity – KCBD (Gregoire Dubois, & Camino Liquette, DG JRC)	12' ®
BioAGORA, Science Service for Biodiversity (Kati Vierikko, SYKE)	12' ®
Biodiversa+, European Biodiversity Partnership (Petteri Vihervaara, SYKE)	12'

® *presentation done remotely*



Biodiversity Workshop

Sessions 1-2: Biodiversity Policies and Initiatives



Session 2: Biodiversity Policies and Initiatives – Part 2

Wednesday 22 Nov 16:20. Chairs: Susanne Thulin (Brockmann Geomatics) and Marc Paganini (ESA)

EUROPABON (Bruno Smets, VITO)	12'
The European Biodiversity Monitoring Coordination Centre (Camino Liquette, DG JRC)	12' ®
Knowledge Centre on EO (KCEO) Biodiversity Deep Dive (Mark Dowell, DG JRC)	12' ®
EEA activities on Habitat Mapping, progress and challenges (Jan Eric Petersen, EEA)	12' ®
<hr/>	
GEOBON and GBiOS (Andrew Gonzalez, Mc Gill University)	12' ®
FutureEarth Biodiscovery (Cornelia Krug, UZH)	12'
CEOS and Biodiversity (Gary Geller, NASA / JPL)	12' ®

® *presentation done remotely*



Biodiversity Workshop

Sessions 1-2: Biodiversity Policies and Initiatives



KEY MESSAGES

- CBD KM-GBF overarching Goals A and B are directly informed by biodiversity observations from Space.
- Global and EU policy makers are calling for EO solutions that meet their monitoring and reporting needs.
- At global level, GEOBON is best suited to guide EO support and channel to CBD.
- The plurality of Global/EU initiatives makes it difficult to prioritise the collective contribution of the EO community to biodiversity policies.
- Both the EC and ESA are committed to supporting GEOBON in the development of the Global Biodiversity Information System (GBIOS) and GEO in the development of the Global Ecosystem Extent Atlas.

RECOMMENDATIONS

- Conduct in-depth analyses of the GBF Targets and Indicators to be supported by EO solutions.
- EO community to be well connected to the CBD GBF AHTEG on Indicators (headline indicators).
- Explore opportunities to be involved in IPBES assessments.
- At EU level, KCBD and BMCC are key initiatives to connect with for biodiversity monitoring (RS enabled EBVs).
- Needs for capacity building at national scale (for example through Biodiversa+).



Biodiversity Workshop

Session 3-4: ESA / EC Biodiversity Projects



Session 3: ESA / EC Biodiversity Projects – Part 1

Thursday 23 Nov 9:00 Chairs: Nikolina Mileva (ESA) and Marc Paganini (ESA)

EC GUARDEN (Pierre Bonnet, CIRAD)	15'
EC NATURE FIRST (Linda van Duivenbode, dotSPACE)	15'
EC NATURA CONNECT (Luigi Maiorano, Sapienza)	15'
EC AD4GD (Joan Maso, CREAM)	15'
EC FAIRiCUBE (Stefan Jetschny, NILU)	15'®
ESA PEOPLE Ecosystem accounting (Bruno Smets, VITO)	15'
EC B-Cubed (Andrew Rodrigues, GBIF)	15'
ESA EO4DIVERSITY (Roshanak Darvishzadeh, ITC)	15'

® presentation done remotely

7



Biodiversity Workshop

Session 3-4: ESA / EC Biodiversity Projects



Session 4: ESA / EC Biodiversity Projects – Part 2

1h50

Thursday 23 Nov 11:30 Chairs: Nikolina Mileva (ESA) and Marc Paganini (ESA)

EC EarthBridge (Anna Cord, TU Dresden)

15' [®]

EC FREEDLES (Miina Rautiainen, Aalto University)

15'

EC OBSGESSION (Petteri Vihervaara, SYKE)

15'

EC MAMBO (Alexis Joly, INRIA)

15' [®]

ESA BIOMONDO (Petra Philipson, Brockmann Geomatics)

15'

ESA BiCOME (Victor Martinez Vicente, PML)

15'

EC MARCO BOLO (Pedro Junger, Ecole Normale Superieur)

15'

[®] *presentation done remotely*



Biodiversity Workshop

Session 5-6: Biodiversity EO Science Agenda



Session 5: Biodiversity EO Science Agenda – Part 1

Thursday 23 Nov 14:20 Chairs: Susana Baena (WCMC), Jelle Lever (EAWAG) and Marc Paganini (ESA)

- Refining the ESA Science Strategy on Biodiversity and Ecosystems (Martin Herold, GFZ) 12' [®]
- Terrestrial Ecosystems EO Science Agenda - EO4DIVERSITY (Susana Baena, UNEP WCMC) 12'
- Advancing terrestrial biodiversity monitoring with Satellite Remote Sensing (Joris Timmermans, Technical University of Delf) 12'
- Freshwater Ecosystems EO Science Agenda – BIOMONDO (Jelle Lever, EAWAG and WSL) 12'
- EUROPABON perspectives on EO for biodiversity monitoring and assessment (Henrique Pereira, IDIV) 12' [®]
- Coastal Ecosystems EO Science Agenda – BiCOME (Victor Martinez Vicente, PML) 12'
- Biodiversity assessment and processes with Earth Observations: trends and futures (Maria Santos, University of Zurich) 12'
- NASA Biological Diversity and Ecological Forecasting report on Current State of Knowledge and Considerations for the next decade (Gary Geller, NASA / JPL) 12' [®]
- Quantifying impacts from space: Theory-driven approaches for biodiversity monitoring (Leon Hauser, University of Zurich) 12' [®]

[®] presentation done remotely

9



TOPICS DISCUSSED

- Characterisation of the status and trends of biodiversity and related ecosystem services.
- Characterisation of ecosystem integrity (including ecosystem health conditions and ecosystem degradation) and resilience to the main direct drivers of changes.
- Understanding of the adverse impacts of climate change on biodiversity and ecosystem functioning.
- Modelling of evolutionary changes of biodiversity and prediction of trajectories (what if scenarios).
- Pathways of transformative changes and the effects of “Nature-Based Solutions” with respect to “no intervention scenarios”.
- Prioritisation and monitoring of conservation & restoration actions (inside and outside of protected areas).
- Integration of Earth Observation into ecological modelling (biogeochemical / process-based models and statistical models).
- Access to and collection of field data (e.g., GBIF repositories) needed to calibrate/validate EO-based biodiversity parameters.

KEY MESSAGES

- Biodiversity is a multi-faceted subject (complex interplay of local ecological processes with global implication/significance).
- Mismatch between what we collect in terms of in-situ observations and what are the hotspots of biodiversity.
- In-situ data can be a bottleneck that limits the use of Earth Observation.
- We need satellite remote sensing complemented with local observations, and knowledge to assist interpretation.
- What are the biodiversity information we need to inform the KM-GBF Goals and Targets?
- 30% of Essential Biodiversity Variables (EBVs) can be informed directly or indirectly by EO.

RECOMMENDATIONS (part 1)

- **What are the key Science Questions to be addressed?**
 - How does **evolutionary and biogeographic legacy** (historical development of species and their distribution) influence the current functioning of ecosystems?
 - How is the **global distribution of plant functional traits and diversity** changing?
 - **Ecosystem resilience to global changes** (use of ecological models is key).
 - Past and present **human modifications of land** and their consequences on biodiversity.
 - Inferring **below ground processes** from above ground information.

RECOMMENDATIONS (part 1)

- **What are the key Science Questions to be addressed?** (CONTINUED)
 - Methods that address the **fundamental of biodiversity** (rarity and uniqueness).
 - **Comprehensive understanding of the drivers of biodiversity changes** (direct and indirect), their interactions and feedback mechanisms with biodiversity state variables, including all PESTEL indirect drivers (Political, Economic, Social, Technological, Environmental, and Legal).
 - **Causal mechanisms driving changes in biodiversity** to be better understood and changes factors attributed (biodiversity change detection and attribution).
 - **Vulnerabilities of ecosystems to biotic and abiotic stressors** including climate change aspects, such as droughts, forest mortality (e.g., bark beetle infestations), habitat degradation, heat waves. Length of these events and occurrences.
 - Quantify **ecosystem degradation / ecosystem health** in the past and present, detecting changes and tipping points.
 - Analyse the **influences of ecosystem restoration actions** on ecosystem traits and related ecosystem functioning (e.g., assessment of ecosystem restoration and management projects / initiatives with EO data).
 - Dedicated efforts on **understudied ecosystems and study areas**: wetlands; freshwater phytoplankton phenology; ground truth measurements in the Global South; wildlife/environmental crime; habitat connectivity in all realms (terrestrial, freshwater and marine).

RECOMMENDATIONS (part 2)

- **What are the research needs in terms of analytical / methodological development?**
 - Monitoring of **ecosystem/plant functional traits** and understanding better the link between **ecosystem functioning** and **spectral diversity** (e.g., “spectral species” concept).
 - **Biodiversity Digital Twins** to study what-if scenarios and evolutionary trajectories (process-based models enabling Digital Twins).
 - **Improvements of physical models (i.e., process-based models) and their use**, including hybrid approaches that integrate data driven AI, enhancing the accessibility of models and the inter-model operability (“model web” concept), and introducing model standards.
 - **Better Integration of EO observations within ecological models** for a better assessment of biodiversity footprints, combining process-based models (e.g., radiative transfer models for the interaction of electromagnetic radiation with ecosystems, biogeochemical models for the cycling of elements and nutrients within ecosystems) and AI for improved integration of in-situ and EO observations.
 - **Improve data interoperability** (e.g., metadata specification, common standard for data formats, accessibility via APIs, data harmonization and integration, harmonization of ecosystem/habitat classification).
 - **Improve model interoperability** (e.g., standardization of model interfaces compatible with multiple modeling frameworks and platforms, and which can facilitate the seamless integration of different models)

- **What are the needs in terms of analytical / methodological development ?** (CONTINUED)
 - **Enhancing across-scale information to understand biodiversity at all scales:** long term time series at fine spatial scale and high temporal frequency, which allows to move from patterns to a better understanding of the underlying ecological processes, and to study long-term trends.
 - **Estimation of uncertainty budget** (including positional and temporal uncertainties of in-situ observations) and consideration of existing quality standards (e.g., ISO19139, GEOlabel) and tools (e.g. UncertML, QualityML)
 - **Internationally coordinated programme(s) to collect and curate in-situ data, tailored for Earth Observation applications**, addressing the following key issues:
 - Set up field campaigns to ensure a better match of in-situ biodiversity measurements with satellite data;
 - Specification of in-situ data collection protocols;
 - Application-ready in-situ data (in-situ data suitable to train and calibrate EO solutions and models);
 - Spectral libraries that link state variables of biodiversity to satellite observations;
 - Recurring in-situ biological observations from understudied zones;
 - Unlock the potential of data generated by local and regional administrations;
 - Create public habitat validation network;
 - Complete and curate the European Vegetation Archive.

- **What are the needs in terms of analytical / methodological development ?** (CONTINUED)
 - Explore **synergies between EO sensors for biodiversity science and applications.**
 - More **high level EO data products for biodiversity** addressing both biotic and abiotic aspects:
 - Threats/pressures on biodiversity (e.g., Land Use intensity such as grassland grazing and crop rotation),
 - Essential Biodiversity Variables (EBVs) on ecosystem structure (e.g., live cover fraction maps aligned with EUNIS ecological taxonomies, vegetation structure of grasslands, shrubs, trees; ecosystem fragmentation) and ecosystem function (e.g., biochemical traits of vegetation, functional diversity, phenology);
 - **Real time change detection of habitat changes;**
 - Use of **FLEX fluorescence** and **High-Resolution thermal imagery** in biodiversity applications;
 - Maximise the use of systematic (in time and in space) observations from **Space-based hyperspectral imagers** for the retrieval of ecosystem/plant functional traits and other biophysical variables (e.g., CHIME-based fAPAR)
 - **Optical polarimetric sensors** (like SPEXone) for biodiversity applications;
 - Follow-up of GEDI/ICESat-2, advancing towards global and repeated **Space-based LiDAR observations;**

TOPICS DISCUSSED

- Enhance collaboration and ensure an effective cooperation between the different biodiversity projects within the EC and ESA.
- Collaborative calls between ESA and EC projects.
- How to improve the knowledge sharing between biodiversity projects in the use of Earth Observations?

KEY MESSAGES (part 1)

- **Need for a collaborative effort** to ensure that all the investment into satellite missions and biodiversity research is translated into user-friendly data products that are regularly updated, easy to use and improved over time?
- **Many opportunities are expected from upcoming new satellites such as the Copernicus Expansion Missions.** However, the current R&D landscape is fragmented, posing a risk that the biodiversity community may not be optimally prepared to harness the capabilities of these new satellites.

KEY MESSAGES (part 2)

Enhance collaboration and exploit synergies to advance the use of EO in Biodiversity:

- **Improve coordination:** long term commitment in bringing EO application development for biodiversity into operation, group Biodiversity projects into **Biodiversity Clusters**.
- Setup **Biodiversity Task Force to drive science agenda**.
- Organize **science workshops and/or hackatons** (with Biodiversa+ support): GEOBON, IPBES stakeholder day (Dec24)
- **Biodiversity Research Challenges**.
- **Biodiversity Summer schools**.
- Ensure **transfer knowledge to Global South**.

Virtual Lab environment to progress Biodiversity Science

- **Connecting technologies** : BON-in-a-Box, OpenEO, ARIES modelling,
(e.g., integration of EO workflows in **GEOBON BON-in-a-Box pipelines**, leveraging the wealth of open source software, data and model workflows)
- **Virtual Research ‘converged’ Environment** according to FAIR principles (sandbox)