System of Environmental Economic Accounting

Earth Observations for Ecosystem Accounting
Brainstorming Discussions (2 hours)

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Objectives of the discussions

- Review the **opportunities and challenges** to integrate Earth Observation in SEEA-compliant global/national accounting on ecosystem extent, condition and services.
- Address the **general and account-specific data and infrastructure needs** that are required to facilitate country appropriation of Earth Observation technology in national accounting.
- Identify **opportunities for partnership** to advance the EO uptake in support to the implementation of SEEA ecosystem accounting.
- Prioritize **actions for R&D activities** (as an input to a UNCEEA roadmap and program of work on Ecosystem Accounting).

Organisation of the discussions

- 6 short sessions of 20 minutes
    1. EO for Ecosystem accounts (opportunities and challenges)
    2. EO for Ecosystem Extent
    3. EO for Ecosystem Condition
    4. EO for Ecosystem Services and Thematic Accounts
    5. EO enabling infrastructures (tools and platforms)
    6. Next Steps

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Part 1: Ecosystem Accounts

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Opportunities (1/2)

- SEEA EEA expected to become an **international statistical standard in 2021.**
- SEEA recognized as an **important framework to support SDGs and MEAs** (CBD Post 2020 Biodiversity Framework, UNCCD LDN, UN Decade for Ecosystem Restoration, UNFCCC, UN Decade on Ocean). SEEA EEA can provide an underlying framework for countries to implement these international agreements.
- **Increasing uptake by countries** (40+ countries approximately compiling SEEA ecosystem accounts).
- **Private sector** is interested in the contextual information that ecosystem accounts can provide and working towards alignment of business accounts.
- **The European Commission** will propose a European directive on ecosystem accounting.
- **Ecosystem Accounts are inherently spatial**, hence the importance of EO.
- **EO has been considered earlier (enough?)** in the development process of the ecosystem account methodologies (lesson learned from the SDGs)

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Opportunities (2/2)

- The **time is right to bring together expertise from different disciplines** (including EO experts) to develop datasets and tools that allow easy compilation of ecosystem accounts
- The **advent of dense EO data streams** at appropriate scales combined **with the emergence new big data technologies** offer unprecedented opportunities for countries to efficiently manage and monitor the state of their ecosystems.
- The **EO community is largely engaged on the sustainable development** agendas (SDGs, Paris Agreement, Sendai Framework, Post 2020 Biodiversity Framework).
- **Emergence of global EO datasets** (land cover, human settlements, forest, surface water, inland and coastal water quality, etc.) with different characterics and accuracy.
- **GEO can be used as a enabling framework** to leverage existing data/tools/expertise of the EO community on ecosystem accounting (**GEO EO4EA** but also **GEO BON** working groups on ecosystem structure and functions and on EBVs).

Challenges and Needs (1/4)

- **Classifications are the backbone of ecosystem accounts**: challenge is to develop recognised and adopted classifications framework for all accounts.
- Requires **integration of many existing strands of expertise** including statistics and national accounting, ecology and natural science, and geo-spatial and Earth Observation.
- **EO integration into national statistics** is improving but not fast enough. It requires a change of mindset in NSOs to use EO and big data more widely.
- Needs for **alignment with other international environmental processes**. Many other organisations are developing their own methods, processes and reporting systems (e.g. UN custodian agencies for the SDG indicators, CBD with the Post-2020 biodiversity strategy Indicators).
- Can the **Ecosystem Accounts be used as a conceptual framework underpinning** the development of ecosystem-related indicators from other international agreements (SDGs, Post-2020 Biodiversity, Climate Change, Ocean, etc.)

Challenges and Needs (2/4)

- Need for **practical guidelines (including datasets and tools) to help countries integrating EO** with national ecosystem accounting.
- Need for **global datasets on ecosystem accounts**, which can be used as global "default data" by countries and can be combined with national data sets where available.
- Need for more **SEEA "Accounts Ready Data"** (datasets according to the agreed definitions and classifications).
- Consistency between **Simplified/Default Accounts** (based on public global datasets largely from EO) with respect to **Detailed/Refined Accounts** (based on heterogenous national data including EO).
- Need to **adopt a Tier approach depending on data available and capacity** at country level (different profiles of countries, different needs)
- Need to **adopt a data flow strategy similar to the SDGs,** including the generation of global default data sets to be provided to the countries to obtain their buy in.

Challenges and Needs (3/4)

- **Transferability** of methods is key to the process.
- **Uncertainties** of ecosystem accounts need to be estimated.
- **International consistency/comparability of national accounts** is a challenge but can be achieved using the reference classification Global Ecosystem Type classification which will require countries to map their national classification schemes reflecting national specificities for international reporting while maintain their national classification for national purposes
- Work on **Ocean accounts** just started. The EO community is part of the process.
- Work on **Biodiversity accounts** just started. Biodiversity comprises ecosystem, species and genetic diversity. There is a need to go beyond ecosystem accounts and work is on-going to develop a whole encompassing biodiversity accounts

Challenges and Needs (4/4)

- **How to make EO datasets available for statistical development** ?
- **Develop tools** that allow integrating national and global data sets (e.g. ARIES for SEEA), that are easy to use, yet transparent.
- **Develop platforms to disseminate** the data, also linked to economic information and agreed indicators and aggregates.
- **How can we have an operational infrastructure (data factory)** for creating these accounts on a regular basis.
- **Data are cumbersome/time consuming for non-EO experts to use**. Need ways to more seamlessly link data to models. The FAIR principles provide a good aspiration. Data are often reasonably findable and accessible, but interoperability and reusability are often lagging, which leads to this problem.
  https://esto.nasa.gov/files/solicitations/AIST_18/ROSES2018_AIST_A41_awards.html#huffer

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Part 2: Ecosystem Extent

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Existing resources *(available or under development)*

- **Well defined classification framework adopted for ecosystem mapping:** IUCN Global Ecosystem Typology.
- **Increased temporal, spatial and spectral resolutions of EO data streams** gives new opportunities to map and monitor ecosystem extent at appropriate scales (**high resolution, yearly if not seasonal updates**).
- Many EO initiatives have been launched to develop **large scale LC/LCC datasets** (generic or specific) with automated methods.
- Many EO initiatives are developing **open source and free of charge software** for LC/LCC (generic or specific).
- **IUCN** is developing global map on ecosystem extent using stacked maps at the level of Ecological Functional Groups (EFG)

Challenges, obstacles and issues (1/2)

- Need to address how EO can support the **classification of the 3 main types of ecosystems** (terrestrial, freshwater, coastal / marine).
- Most of **EO global datasets on ecosystem extent are using LC/LU classification.**
- **Can EO go beyond LC/LCC and support ecosystem types classification** (e.g. functional types)? Need to go beyond simple land cover .
- **Need to address how national ecosystem classifications based** on IUCN Global Ecosystem Typology can make use of existing national **Land Cover classifications.**
- **Needs for Crosswalks** between IUCN Global Ecosystem Typology and **national (ecological) classifications** (expected that countries will use their national ecosystem classification) => testing under way.
- Countries have **different projection systems** and **different spatial units.**
- Need cookbooks to convert EO products with LC datasets to produce ecosystem type maps in different parts of the world. Need to automate that process using modeling tools.

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Challenges, obstacles and issues (2/2)

- **How to deal with technological development of sensors** on the one hand and the need for consistent time series on the other?
- How to produce **Land Cover data globally** on a regular basis ?

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Part 3: Ecosystem Condition

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Ecosystem type	Main groups of indicators and examples
Generic indicators – can be applied to all **terrestrial** ecosystem and vegetation types	• **Indicators on the structure and composition of the vegetation** such as tree canopy cover, understorey strata, leaf area • **Outright loss or conversion of natural vegetation cover** to intensive uses (linked to ecosystem extent, but is also used as an indicator of condition) • **Landscape indicators** including landscape type, natural land parcel size and spatial configuration • **Air, water and soil quality indicators** such as nitrogen content, heavy metal content, concentrations of different air, water and soil pollutants • **Species-based indicators** such as naturalness of biota, species richness, red-listed species, conservation status of species • **Biomass/carbon indicators** • **Other characteristics** amongst which annual rainfall, annual number of growing days • **Pressure indicators** such as lack of weeds, depth to groundwater table, degree of fragmentation • **Indicators on the access to ecosystems** such as distance to ecosystems, population density • **Indicators related to protection measures**, such as sites of special interest

+ for forest and woodland	• **Specific forest indicators** such as extent of tree species type and volume, age, biomass of the timber stock • **Spatial configuration** of the forest
+ for urban areas	• **Specific urban indicators** such as access and proximity of green space as well as indicators related to protection measures (special designation of sites of interest)
+ for mountains, moorlands and heathlands	• **Specific indicators** include the particular **management** of these ecosystem types such as managed burning, length of trails, volume of sheep grazing
+ for grassland	• **Specific indicators** include the particular **management** of these ecosystem types such as cutting and grazing intensity

Rivers, open waters, lakes, reservoirs	• **Physical indicators about the hydrology** such as physical form, flow, reservoir stock • **Indicators on the instream and riparian habitats** • **Indicators of chemical and ecological water quality** including single indicators such as concentrations or composite indicators such as surface water status • **Species-based indicators** such as macro-invertebrate diversity • **Accessibility indicators**
Wetlands	• **Physical indicators** on the size and shape of wetlands • **Carbon and nitrogen stock indicators** (including wetland soils) • **Species-based indicators** such as wetland birds • **Chemical water quality indicators** • **Accessibility indicators**

Marine inlets, transitional waters and coastal ecosystems Shelf and ocean ecosystems	• **Loadings** of nutrients, sediment or pollutants to sea • **Chemical water quality indicators** such as dissolved oxygen, Chlorophyll-a, turbidity, nutrient concentrations • **Bathing water quality indicators** • **Extent of specific habitats** such as seagrass habitats or coral reefs • **Species-based indicators** such as fish diversity and abundance or conservation status • **Access to coastal zones** and margins

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Existing resources *(available or under development)*

- **List of variables/indicators for measuring the conditions of ecosystems** well advanced (not yet finalised? Flexibility to include new indicators?)
- **Spectral content and short revisit time of HR multi-spectral observations** allows to capture better the status of ecosystems at appropriate scales (e.g. phenology of vegetation, crop/grassland management, changes to costal eutrophication, seasonality of wetland inundation regimes)
- Thanks to the recent advances in satellite observations, **new areas of research on the use of EO for ecosystem conditions** have been opened (e.g. moving from forest classification to forest degradation).
- Methods for Land Cover changes are now addressing also the **changes to the status and conditions of ecosystems**.
- The **GEO BON Working Groups on ecosystem structure and function** are developing Ecosystem-related EBVs (structure, function and composition) that can serve the derivation of indicators on ecosystem conditions (addressing health and integrity).

Challenges, obstacles and issues (1/2)

- **Ecosystem Conditions** assess the "quality of ecosystems" (ecological integrity) with respect to **ecosystem structure, function and composition** covering both **biotic and abiotic variables** -> long list of indicative condition indicators.
- **Issues on how to define the reference conditions** (natural/pristine or beginning of the accounting period) -> availability of EO to assess reference conditions can be an issue since depending on EO legacy data.
- **Alignment between the Ecosystem Condition indicators and the GEO-BON EBVs on ecosystem structure and function** (and the post-2020 Biodiversity Indicators) needs to be addressed.
- **Monitoring ecosystem conditions at appropriate scale** is still a challenge for some types of ecosystem -> Need to analyse **which of these ecosystem condition variables/indicators can be derived from EO** on a regular basis?
- At which **scales** can EO support the monitoring of ecosystem conditions?

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Challenges, obstacles and issues (2/2)

- What should be the **criteria for prioritization the Ecosystem Condition Indicators** (important also to prioritize the EO R&D activities)?
  - Policy relevance
  - Data availability
  - Links to global indicators
- There is potentially a large scope for EO products but needs to be used **in combination with species-based metrics and in situ measurements**.
- Needs to find a **compromise between simple and rapid assessment based on remote sensing products and accuracy needed for accounting**
- **Bottleneck are derived products** (available research and development capacity between providers of data and users of accounts/condition data) -> Derived products need to be well defined (e.g. thematic content, annual/seasonal, spatial resolution, latency, etc.). How different from Account Ready Data?

Part 4: Ecosystem Services and Thematic Accounts

Existing resources *(available or under development)*

- **Ecosystem Service and thematic Accounts are a priority for most countries** (strongly encouraged by other policy frameworks such as UNFCCC on GHG emissions)
- **Conceptual Framework for Ecosystem services** well established:
  - <u>Provisioning</u>: Crops, Fish, Timber, Water supply
  - <u>Regulating</u>: Carbon sequestration/storage, erosion control, air filtration, water regulation and filtration, pollination, pest control
  - <u>Cultural services</u>: Nature based recreation/tourism, amenity services
- **Multiple global data sets** for estimating ecosystem services exist (similar datasets to those used in ecosystem extent and condition)
- **Recent progresses in Machine learning (AI) and process modelling** offers huge opportunities to advance the use of EO in ecosystem modelling.
- **Modelling Tools and Platforms** (e.g. ARIES for SEEA) start to be available (some in open source) to estimate ecosystem services accounts.

Existing resources *(available or under development)*

- The **EO community is largely active in studying Earth System Cycles** (carbon cycle, water cycles, GHG emissions) and consequently in global accounts.

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Challenges, obstacles and issues (1/2)

- Ecosystem Services is a **new but increasing area of research in Earth Observation** (but still there is a lack of understanding of what can be done with EO data)
- Needs to **connect the EO community with the ecosystem service modelling community.**
- Need to **address different approaches to the ecosystem service accounting**:
  - Downscaling/spatial attribution for provisioning services.
  - Modelling/spatial interpolation for regulating and cultural services.
- **Lack of capacity / expertise** (for example to do the modelling) in countries. Producing accounts on some ecosystem services require strong expertise such as modelling regulating services -> Capacity Building programs needed
- **Difficulties for countries to access to data** (including EO) as input to their Ecosystem Service Accounts.

Challenges, obstacles and issues (2/2)

- **What scale should be used**? Regional, national or subnational?
- **Priority ecosystem services?** Which services can be compiled using global data sets? At which scale?
- Requires **integration of EO with other spatial datasets.**
- To **achieve higher-level AI objectives** (i.e., machine reasoning that automates data and model assembly, making ecosystem accounts construction and access to recent EO products by non-technical experts feasible), greater consensus is needed on semantics and approaches to collaboratively sharing data and models (that go beyond the typical data archive or code repository)

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Part 5: Enabling infrastructures

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Existing resources *(available or under development)*

- ARIES presented an excellent **integrated platform to develop ecosystems accounts** using different data sources and models.
- The EO Community is massively investing in **cloud-based platforms with collocated EO data** for satellite data processing but also for data analytics (e.g. GEE, AWS, Copernicus DIAS, ESA Thematic Exploitation Platforms, VITO platforms).
- **Platform services interoperability** is based on agreed standards (such as OGC standards WMS, WCS, WPS) with allows integration in an ecosystem of platforms.
- Most Space Agencies and Commercial operators are **populating cloud-based platforms with their satellite data collections** for an easier and cost-effective access.
- Space Agencies are moving toward **the provision of Analysis Ready Data (ARD),** which removes the EO pre-processing burden for the users.
- The **open source community** is active both on the EO processing (EO software toolboxes) and on the ecosystem modelling.

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Challenges, obstacles and issues (1/2)

- **Access to volume of satellite resources via download strategy is prohibitive** -> change to "move the user to the data" paradigm supported by platforms installed in cloud environments where the data is readily accessible for processing.
- **Proliferation of cloud platforms** (EO processing and data analytics) -> difficulties for countries to understand where to go.
- **Need an optimised approach to platform integration that maximises performance and minimise cost** -> process the data where it is located (data curation by the data producers).
- To be successful and sustainable on a long-term basis, **higher-level global layers might need to be available virtually, i.e. computed on-the-fly**.
- **Build collaborative and shared data platforms** -> to engage a wide community of users and mutualise the costs.
- How to **move from a R&D platform to an operational and sustainable platform** ? Need to address technical, financial and institutional issues.

Challenges, obstacles and issues (2/2)

- We need an **national/regional/global data factories** that integrate with each other and support regular production of accounts and support national statistical offices

Part 6: Next steps

Next steps

- Develop a **programme of work (Roadmap)** with short and medium term priorities.
- Define further the concept of **Account-Ready Data.**
- **Prioritize actions with EO best practices** for fast success stories with subset of ecosystem accounts (extent, conditions, services) ready for EO uptake.
- Develop strategy for the **development of interoperable data platforms** (integration of data providers platforms and integrated modelling systems such as AIRES) to enable countries compiling their accounts using global EO datasets combined with national data
- Develop **strong partnership** to advance the application of earth observation combined with national data to compile SEEA Ecosystem Accounts.
- Establish a group possibly led by **GEO EO4EA** under the auspices of UNCEEA, which will be responsible to develop a roadmap and a programme of work including priority setting for the development of **a set of EO variables/indicators** across countries and expand coverage over time. This group should build on existing initiatives (e.g. GEOBON) and its work should be to be integrated and disseminated through ARIES for SEEA.

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