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Prototyping a Policy-Driven EO Service for Monitoring Critical Wetland Habitats in Natura 2000 Sites

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EC Knowledge Centre on EO

Deep Dive Assessments on Specific Policy Areas: Biodiversity, Urban Climate Adaptation & Compliance Assurance with 7 policy DGs

Survey across 15 EC DGs (66 units)

Policy Uptake and Coherence

Enhancing the uptake of EO in EU policy translating needs into technical EO products requirements

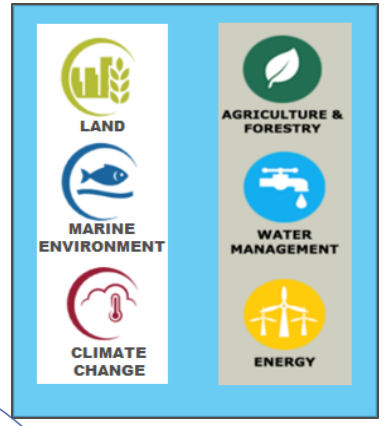
KCEO

Mainstreaming R&I

Analysing & prioritising research needs; Strategy of research investments

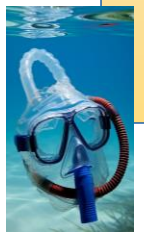
Focused entry point
Inclusiveness & Transparency
Dialogue with external partners, international organisation and society

Copernicus Services



[Strategic Research and Innovation Agenda for EO]

Shallow Dive assessment on reporting burden



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KCEO Deep Dive assessment on Biodiversity

MONITORING OF THE EU BIODIVERSITY STRATEGY (BDS) TARGETS

NEEDS: High-resolution (HR) and long-term indicators on a yearly basis to effectively monitor progress towards the targets outlined.
STATUS: Two online tools for tracking and reporting the progress of the BDS implementation: Actions tracker and Dashboard.
GAPS:
- Lack of yearly HR maps to track changes.
- Absence of suitable ground-based biodiversity data for training and validation.

MONITORING OF URBAN GREEN SPACES

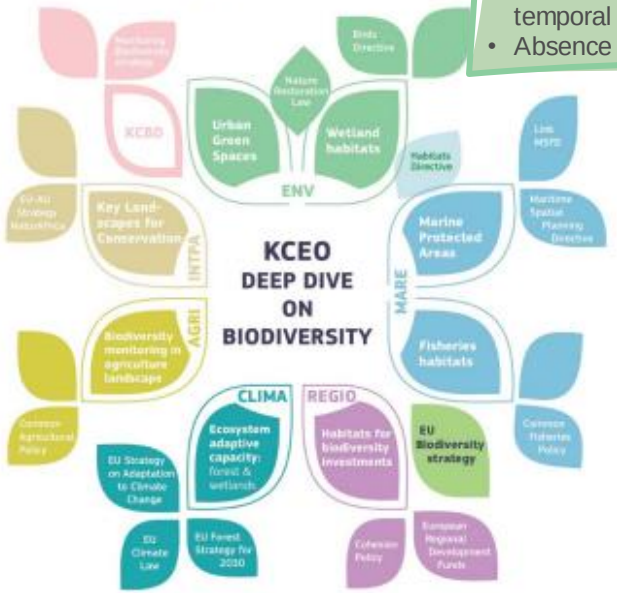
NEEDS: Multitemporal HR maps covering various types of urban green infrastructures.
STATUS: Urban Atlas and Small Woody Features, among others, partially fulfil the need.
GAPS:
- Inadequate temporal frequency, thematic granularity, and spatial coverage.
- Geometric inaccuracy.

BIODIVERSITY MONITORING IN KEY AFRICAN LANDSCAPES FOR CONSERVATION AND DEVELOPMENT (KLCDs)

NEEDS: Detailed indicators, encompassing performance monitoring and accountability measures to support the conservation of ecosystems and the expansion of the protected areas network, while fostering livelihoods and human development.
STATUS: EO products integrated in the AKP provide a baseline for monitoring across the selected KLCDs. A user-friendly tool will be developed in the context of NaturAfrica and the Regional Centres of Excellence Programme.
GAPS: Insufficiency in integrating ancillary data, including socio-economic information derived from UNESCO and EU Delegations.

BIODIVERSITY MONITORING IN AGRICULTURE LANDSCAPE

NEEDS: Indicators for biodiversity monitoring and evaluation to meet the 10% target for High Diversity Landscape Features.
STATUS: SWF and LUCAS Landscape Features module partially address the needs.
GAPS:
- Lack of integration between SWF and LUCAS module.
- Absence of independent and traceable quality assessment of SWF with respect to policy requirements.
- Inadequate frequency and latency of available products.



MONITORING WETLAND HABITATS

NEEDS: HR maps of delineating wetland habitats and long-term indicators for assessing overall conditions and changes.
STATUS: Land cover map on riparian zones, a dataset on long-term dynamics of surface water, and in-situ soil moisture observations.
GAPS:
- Lack of common definition for wetlands, based on generalized, objective, and measurable criteria.
- Insufficiency in geographic coverage, thematic granularity, spatial and temporal consistency, and lack of a long-term record.
- Absence of a user-friendly platform to facilitate products accessibility.

Prototyping a Policy-Driven EO Service for wetlands Monitoring

MONITORING ESSENTIAL FISH HABITATS AND VULNERABLE MARINE ECOSYSTEMS, & MARINE BIODIVERSITY

NEEDS: HR maps for assessing marine protected areas (MPAs), characterising fisheries resources and identifying vulnerable ecosystems.
STATUS: EMODnet and the Copernicus Marine Service partially address the needs.
GAPS:
- Lack of centralised and easy access to satellite and in-situ national data.
- Absence of informative indicators on species richness and abundance hotspots, overlaps between hotspots and MPAs, and areas impacted.
- Insufficient spatial and temporal resolutions.

MONITORING ECOSYSTEMS HEALTH TO SUPPORT BIODIVERSITY INVESTMENTS

NEEDS: Monitoring system to guide and assess EU investments in biodiversity and ecosystems.
STATUS: Available EO products partially address the needs.
GAPS:
- Insufficient generation of targeted indicators, such as phenology or productivity indices.
- Lack of operationality.
- Inconsistencies and gaps in the time series.
- Coarse thematic granularity of land cover maps, limiting a comprehensive understanding of ecosystems.

MONITORING SHIFTS IN GEOGRAPHIC RANGES, DISTRIBUTION AND CONDITIONS OF SPECIES POPULATION AS A FUNCTION OF CHANGING CLIMATE

NEEDS: Assessment of the impacts of Climate Change on ecosystems' functions and structures, on species abundance and distribution.
STATUS: Climatic data products are suitable for bioclimatic models.
GAPS:
- Low spatial resolution of EO products.
- Lack of operationality in combining bioclimatic modelling technologies with bioclimatic products (under development by C3S).
- Insufficiency in parametrising biological processes to be included in models.
- Inaccuracy and lack of performance assessment of bioclimatic models.

ASSESSMENT AND MONITORING OF EU FOREST HEALTH

NEEDS: A forest monitoring system to alert about disturbances, assess the impact of climate change on biodiversity, and predict disturbance risks.
STATUS: Copernicus CLC+ Backbone and High Resolution Layer Forest, among others, partially address the needs.
GAPS:
- Lack of HR yearly maps on forest status and changes.
- Insufficient delineation of forest types.
- Insufficient integration of ground and satellite data.
- Limited access to and use of training and reference data for accuracy assessment of Copernicus products.

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Habitat protection - Policy Context

Habitat Directive: Protects 232 Habitat types (Annex I) and thousands of non-bird species (Annex II – fauna and flora)

Humid habitats: a list of 10 major groups has been defined based on NRL annexes

Three key provisions requiring geospatial monitoring:

- Article 4.4: MS must identify Habitats to protect, and protect a sufficient proportion in Natura 2000 sites (Site designation)
- Article 6.2: MS must prevent degradation within Natura sites (Compliance)
- Article 17: MS must report every 6 years on conservation status across their entire territory (Monitoring)

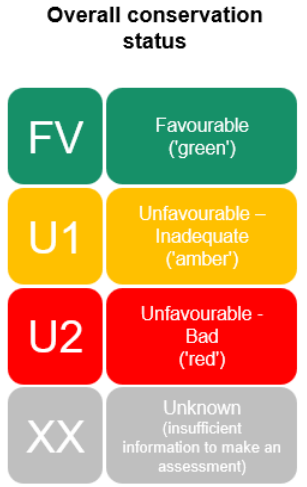
EO is needed to automatise the monitoring and reporting

EU GRASSLAND WATCH

Synergies with other Legislations: The Birds Directive, The Nature Restroration Law, The Forest Monitoring Law, The CRCF, The WFD and the MSFD, the CAP, LULUCF

Annex I Humid Habitat Types

Habitat Group	Number of Types
Coastal and salt habitats	11
Rivers and lakes	20
Temperate heaths	2
Peat grassland	1
Alluvial meadows	4
Sphagnum acid bogs	6
Calcareous fens	4
Boreal mires	2
Bog woodland	2
Alluvial/riparian forests	8



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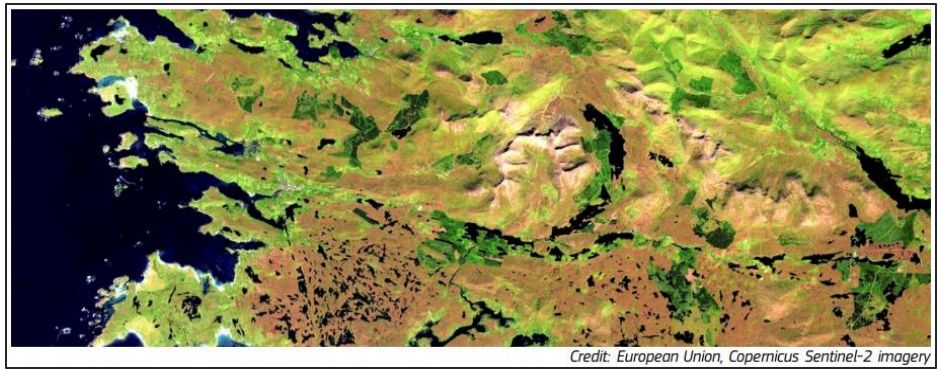
Requirements for EO-derived outputs and analysis

- Coverage & Resolution: Full territorial monitoring with focus on Natura sites to detect local changes (HR), along with regional analysis of environmental conditions and climate impacts (MR).
- Temporal aspects: Trend analysis from historical baseline (1992/2000) with annual monitoring to track early signs of degradation, Anomaly detection of environmental conditions.
- Key Elements to Monitor: Protected site boundaries, habitat extent and conditions, signs of degradation (human vs climate impacts), accounting for natural wetland variability.
- Data Integration: Integrate EO data with field measurements, local expertise, and modeling.
- Access Platform: Develop user-friendly web application for local experts to extract policy-relevant information.

From assessment to prototyping


Credit: European Union, Copernicus Sentinel-2 imagery

Design an operational geospatial information system to monitor critical wetlands, detect degradation, and assess conservation status within Natura 2000 sites, through the following steps:

- **Ecological Characterisation**: Analyse European wetland habitats (part of Annex1) to understand their ecological functioning and identify key pressures and threats leading to degradation.
- **EO-based indicators:** Identify relevant EO-based products for selected habitats using reference sites. Prioritize wetland types based on degradation levels (per Article 17 of the Habitats Directive), relevance beyond the Directive, and biodiversity value.
- **Analytical tools:** Design dedicated spatial and temporal analytical tools for policymakers and conservation managers, integrating EO technologies, ground-truth data and modelling.

From Ecological function to observable indicators

Ecological Status Assessment: Characterizing various European wetland habitats (part of Annex1), their ecological functioning, and main pressures and threats leading to degradation

Good functioning: Ability of the ecosystem to maintain its natural processes and provide essential services that support biodiversity, water quality, and overall environmental health.

Pressure and Threats leading to degradation: Distinction between different levels of deterioration including direct human activities and broader environmental changes affecting the structure, function, and resilience of ecosystems, i.e. *agriculture intensification, urban development & habitat fragmentation, water management practices, invasive species, water pollution, climate change impacts.*

- Support of expert's network through Science Service for Biodiversity & Workshop organisation (End 2025)
- Based on reported pressures and threats (Art17)
- DG ENV study on monitoring and assessing the condition of various habitat types (ongoing)

bioagora

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Key EO proxy parameters

- **Selection of relevant indicators** that can be observed through EO and modeling
  - ➢ To be refined with ecological knowledge of specific pressures and threats

- **Fitness for purpose** (for each indicator needed):
  - ➢ Define the minimum & optimum technical requirements based on application needs
  - ➢ List the available products based on various criteria (spatial and temporal resolution, thematic content, geographic and temporal coverage, spatio-temporal consistency)

Based on SEPLA project analysis (Milenov et al. 2023) & DD assessment on Biodiversity & Compliance Assurance

- **Next: Prototyping** on selected reference sites

Soil
- Soil moisture
- Ground movement monitoring

Hydrology
- Surface water presence & seasonality
- Hydrological modelling

LC/Vegetation Characteristics
- Land cover/use & changes
- Vegetation indices and phenology
- Vegetation structure

Environmental and climate impacts
- Water quality
- Fire occurrence and risk
- Meteorological and climate variables

Challenges and recommendations

- EO Products for monitoring:
  - Lack of HR products and consistent annually updated long-term records for trend analysis
  - Need for developing wetland-specific change analysis methods
- Lack of detailed outline of habitats (needed for pixel aggregation in monitoring analysis)
- Need for addressing data accuracy and uncertainty issues due to insufficient in-situ reference data (CalVal)
- Establishing clear connections between habitat characteristics to EO signals is challenging due to significant variability across the EU's diverse landscapes
- Need to integrate multiple data sources: EO (from various sensors), ecological expertise, in-situ measurements and modeling techniques
- Need for a user-friendly platform to improve products accessibility and enable analysis at local and regional scales

Thank you

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