



European Commission

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

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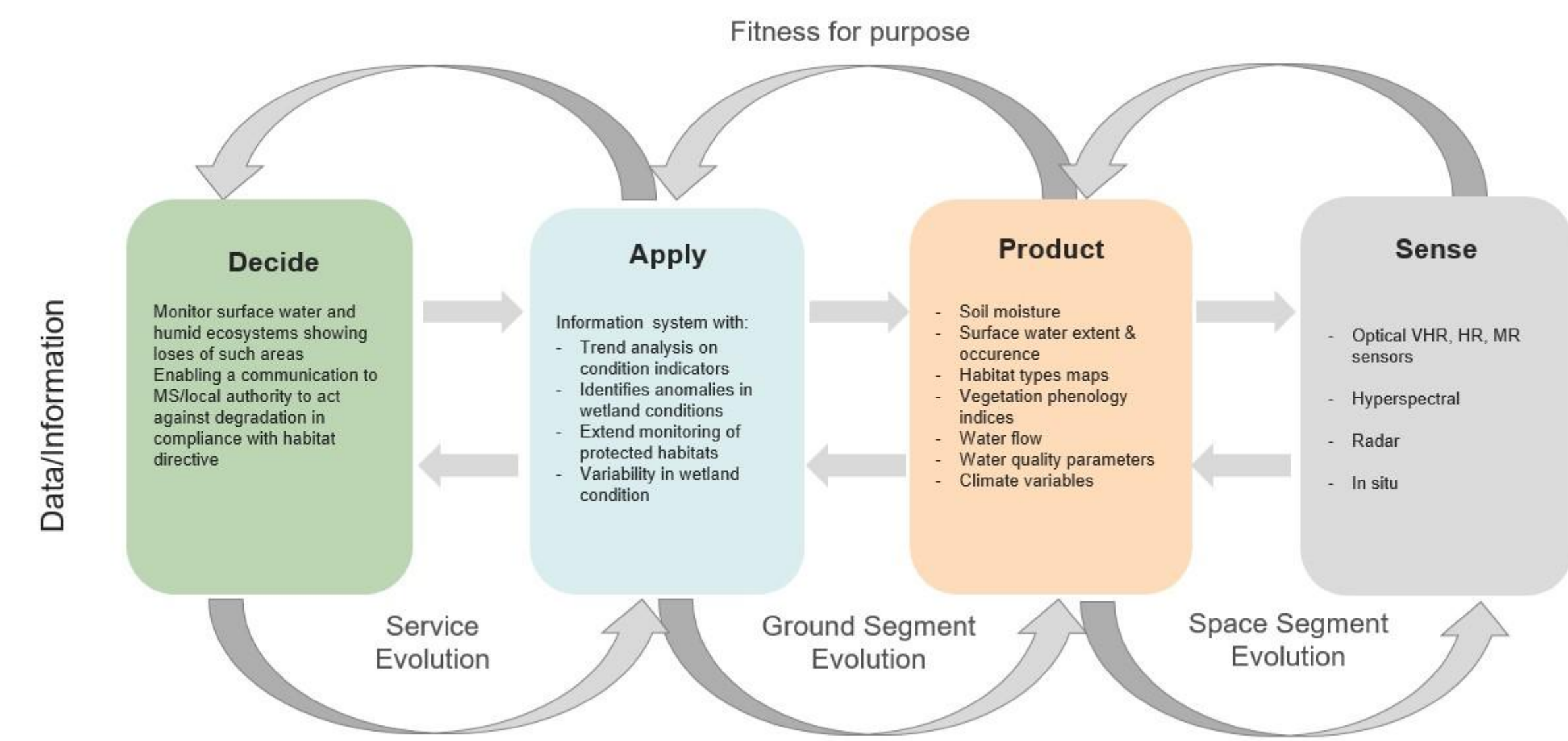
Project Background and Methodology

The Knowledge Centre on Earth Observation (KCEO) has launched an exploratory initiative to assess how Earth Observation (EO), and hydrological modeling can support wetland monitoring within Natura 2000 sites. This work, conducted with the Directorate-General for Environment and the European Environment Agency, emerged from KCEO Deep Dive assessments on Biodiversity and compliance assurance.

This work aims to define technical specifications for a future operational monitoring system that would assist Member States (MS) in their Habitats Directive reporting obligations by detecting early degradation signs and assessing conservation status through combined ecological expertise and EO capabilities.

A **systematic 5-step approach** ensures effective alignment between policy needs and technical solutions:

- **Policy context** - Collecting and assessing users' needs across the policy cycle
- **Application needs** - Co-design process defining qualitative requirements including parameters and analytical methods
- **Technical requirements** - Translating policy-driven needs into technical specifications
- **Fitness-for-purpose analysis** - Evaluating existing products and services meeting necessary technical criteria
- **Gap analysis** - Developing recommendations to enhance Copernicus and research efforts, bridging capability gaps



Policy Context: Habitat protection

Our study specifically address the needs of the Habitat Directive which mandates protection of 232 Habitat types (Annex I) and thousands of non-bird species (Annex II – fauna and flora) across Europe.

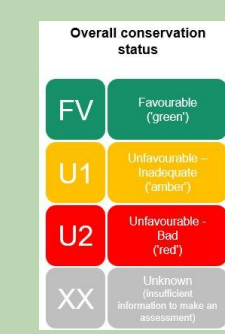
Ten major **Humid Habitat groups** have been defined based on NRL annexes. There are 3 key monitoring and reporting obligations:

- **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)

These obligations rely heavily on field surveys and require the use of EO to automate the monitoring and reporting

There are important synergies with other Legislations that have similar requirements:

- **The Common Agricultural Policy (CAP):** Farmers are required to allocate a minimum of 4% of their arable land to non-productive areas and landscape features, providing a practical framework for wetland restoration initiatives.
- **The Nature Restoration Regulation:** Member States are required to implement restoration measures to improve and re-establish habitats listed in Annex I of the Habitats Directive
- **The EU Carbon Removal & carbon farming Certification Regulation (CRCF)** creates voluntary certification standards for carbon farming, afforestation, reforestation, and peatland restoration (monitoring rewetting and revegetation and possible threats)



Fitness For Purpose Assessment

Value Chain			Requirements for EO products			Application
Indicators	Products	Data source	Spatial Resolution	Temporal Resolution	Temporal Extent	
Surface water extent & occurrence	CLMS Water & Wetness	Optical & RADAR	10 m	3 years	2015 - 2018	Assessing declining water presence and hydroperiod variations for potential wetlands
	Dynamic world	Optical images	10 m	Daily	2012- 2018	
	Upcoming JRC GSWE	Landsat	30 m	Monthly	1984 - present	
Water flow	CEMS GFM	Sentinel 1	10 m	Daily	1979- present	Hydrology modelling & indicator of wetlands conditions
	GloFAS	Reanalysis	9 km	Daily	2011- present	
Water Level	Surface water level (SWL)	CryoSat, S 3...	1 km	Monthly		Hydrology modelling & indicator of wetlands conditions
	CLMS water level	Optical images	Vector	-	2002- present	
	Open Altimetry	ATLAS/ICESat-2	-	-	-	
Water quality	CLMS water quality	Sentinel 2	100 m	10 days	2019- present	(turbidity, total suspended matter, chlorophyll-a, trophic state index, and floating cyanobacteria) for identify status of humid habitat
	NASA -Stream	Landsat	30 m	6-16 days	2002- present	
Ground movements	CLMS EGMS	RADAR (InSAR)	100 m	Annually	2018 - 2022	Surface motion patterns, proxy of peatland's condition
Soil Moisture	CLMS SSM	Radar	1 km	Daily	2014 - Present	Crucial for assessing drainage impacts, drought risk and rewetting success. Compute regional trends and anomalies & event attribution
	C3S SSM	Radar	1 km	Daily	2014- present	
Meteorological variables	ERASLAND	Reanalysis	10 km	1 hour	1950 - present	Drought stress and water availability
	CERRA Land	Reanalysis	5.5 km	3 hours	1984 - present	
	USGS LST	Landsat	30 m	8-16 days	1982-present	
Land Cover /Land Use	Upcoming CLMS LCFM	Sentinel	10 m	Monthly	2020 - present	Trend analysis of environmental conditions and detection of disturbances
	CLMS CLC plus Backbone	Sentinel 2	10 m	Annual	2020 - 2026	
Vegetation Characteristics	CLMS NDVI, LAI, PPLFAPAR	Sentinel 2	10 m	Daily	2016- present	Trend analysis of environmental conditions and detection of disturbances
	CLMS Tree cover density	Sentinel 2	10 m	3 years	2015/2018/2021	
	CLMS Phenology	Sentinel 2	10 m	Annual	2014 - present	
Topography	Copernicus DEM	S3 & PROBA-V	10m with restricted data access policy	One time acquisition	2014 - present	Potential wetlands / train and validation of data-driven algorithm

Application Needs

Based on the directive's specific needs, we identified the following monitoring requirements for EO outputs and analysis:

- **Coverage & Resolution:** Comprehensive territorial monitoring, prioritizing Natura sites to detect localized changes at high resolution, alongside broader regional assessments at medium resolution
- **Temporal Aspects:** Trend analysis using historical baseline (1992/2000) with annual monitoring to identify early degradation signs
Implement anomaly detection to assess environmental condition deviations
- **Key Elements to Monitor:** Track protected site boundaries, habitat extent and conditions, degradation signs—differentiating between human-induced and climate-driven impacts, while accounting for natural wetland variability
- **Data Integration:** Combine EO data with field measurements, local expertise, and modeling for holistic assessment.
- **Access Platform:** Develop user-friendly web application for local experts to extract policy-relevant information

Ecological Characterisation and Selection of key EO proxy parameters

Working closely with the Knowledge Centre on Biodiversity (KCBD), we are analyzing the ecological characteristics of selected EU wetland habitats to understand their proper functioning and identify key pressures and threats leading to degradation.

- **Good functioning:** Ecosystem's ability to maintain natural processes and provide essential services supporting biodiversity, water quality, and environmental health
- **Pressure and Threats leading to degradation:** Distinction between deterioration levels including direct human activities and broader environmental changes affecting ecosystem structure, function, and resilience

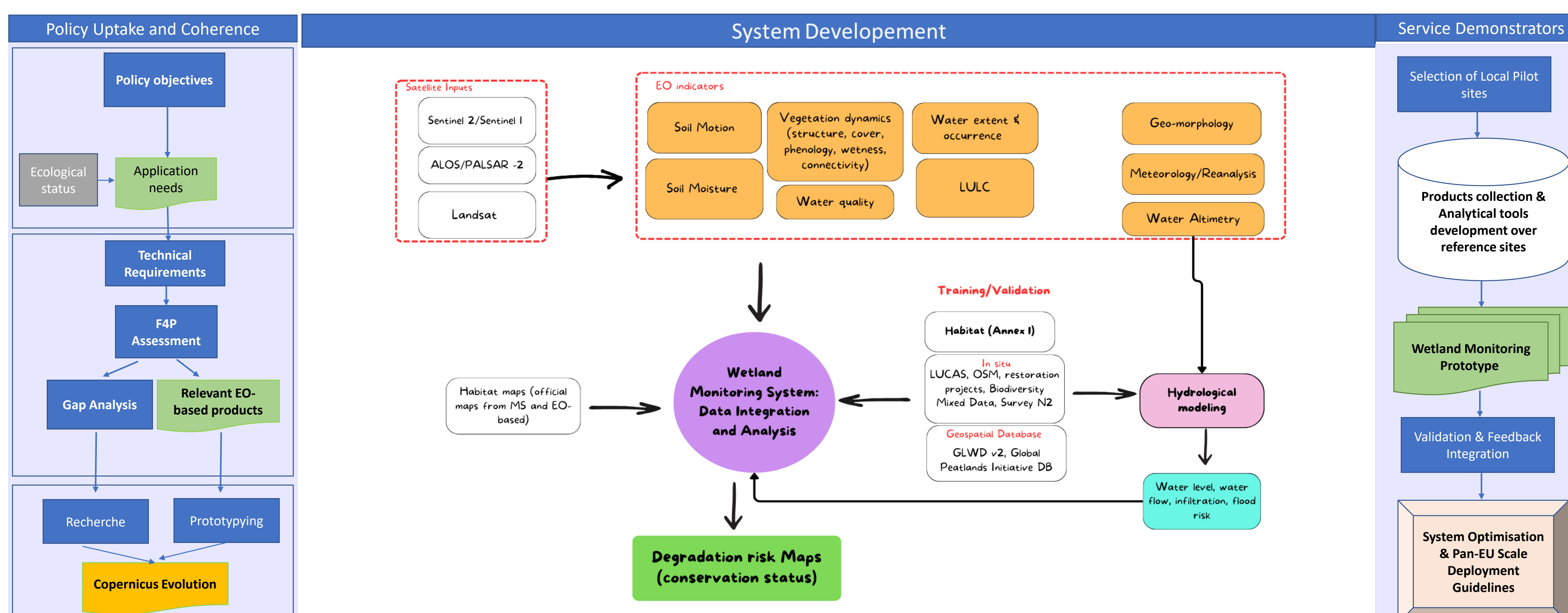
This foundational work ensures monitoring efforts focus on the most relevant indicators while accounting for natural wetland variability across European landscapes.

-> **Key EO proxy parameters for monitoring wetland ecosystems and their changes have been identified**

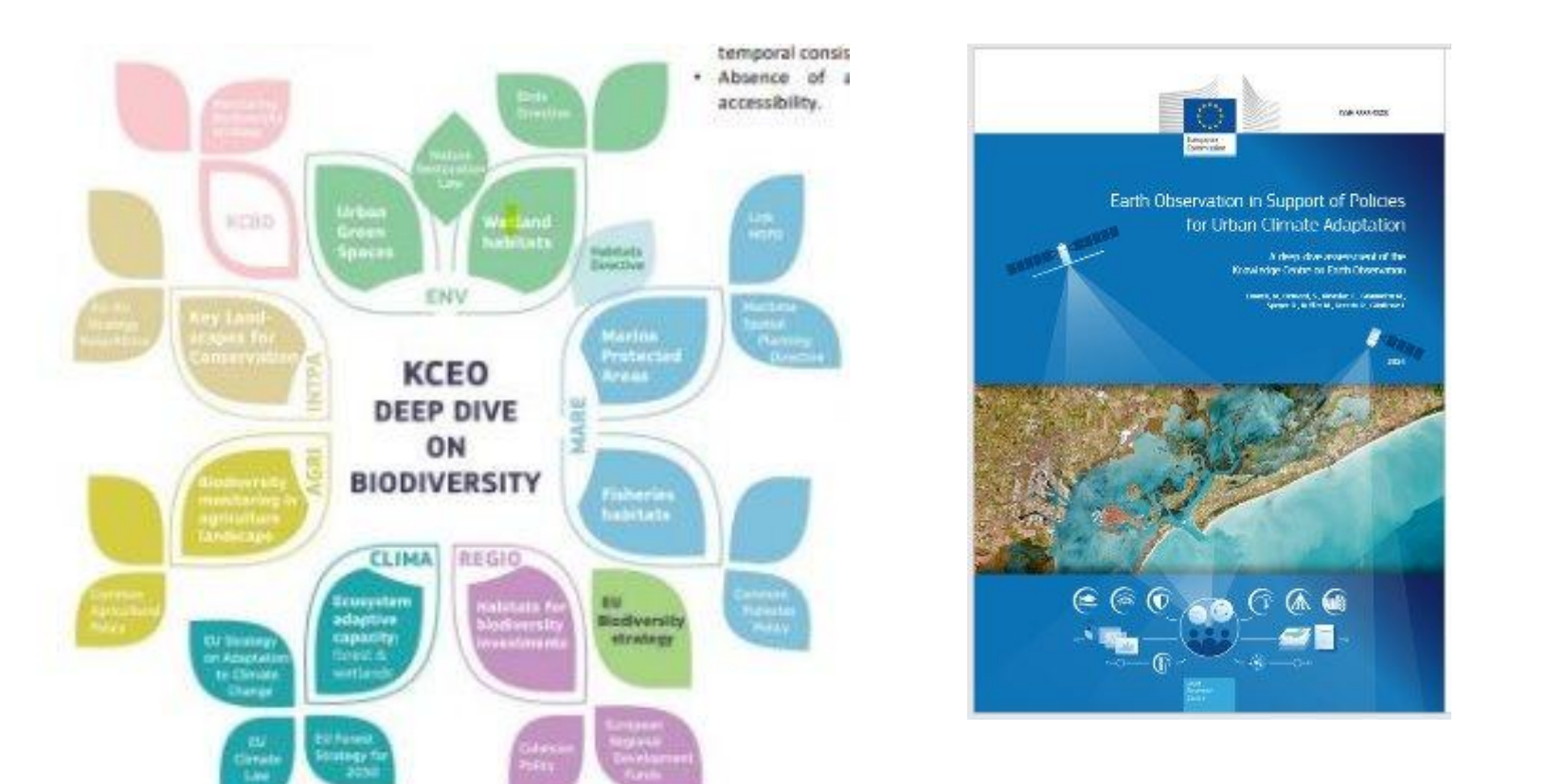
Gap Analysis

- 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 and standardization for monitoring analysis
- Need to address data accuracy and uncertainty due to insufficient in-situ reference data
- Establishing connections between habitat characteristics and EO signals is challenging due to EU landscape variability
- Need to integrate multiple data sources: EO, ecological expertise, in-situ measurements and modeling
- Need for user-friendly platform to improve accessibility and enable local/regional analysis

From Assessment to Prototyping



For an in-depth exploration, please visit our website for a Deep Dive into Biodiversity



Stay tuned for KCEO Glossary updates, and register for the KCEO Glossary Github repository

