

From Global Conventions to EO Application Needs

A Deep Research & Expert-Validated Framework Using LLMs

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Introduction

Problem

Earth Observation (EO) has immense potential to support evidence-based policymaking — yet **critical policy targets and indicators from global conventions remain poorly mapped** to actual EO data products:

- 100s of international treaties with 1000s of targets and indicators
- Manual extraction is slow, inconsistent, and limited in scope
- Existing analyses focus on single domains (e.g., climate or biodiversity), missing cross-cutting synergies

Goal

To **systematically extract, consolidate, and validate** EO application needs from 32 global conventions using Large Language Models (LLMs), followed by expert review — creating a **robust, auditable, and scalable framework** for the EC4GEO project and GEO. Ultimately bridging the last mile from EO data to policy applications.

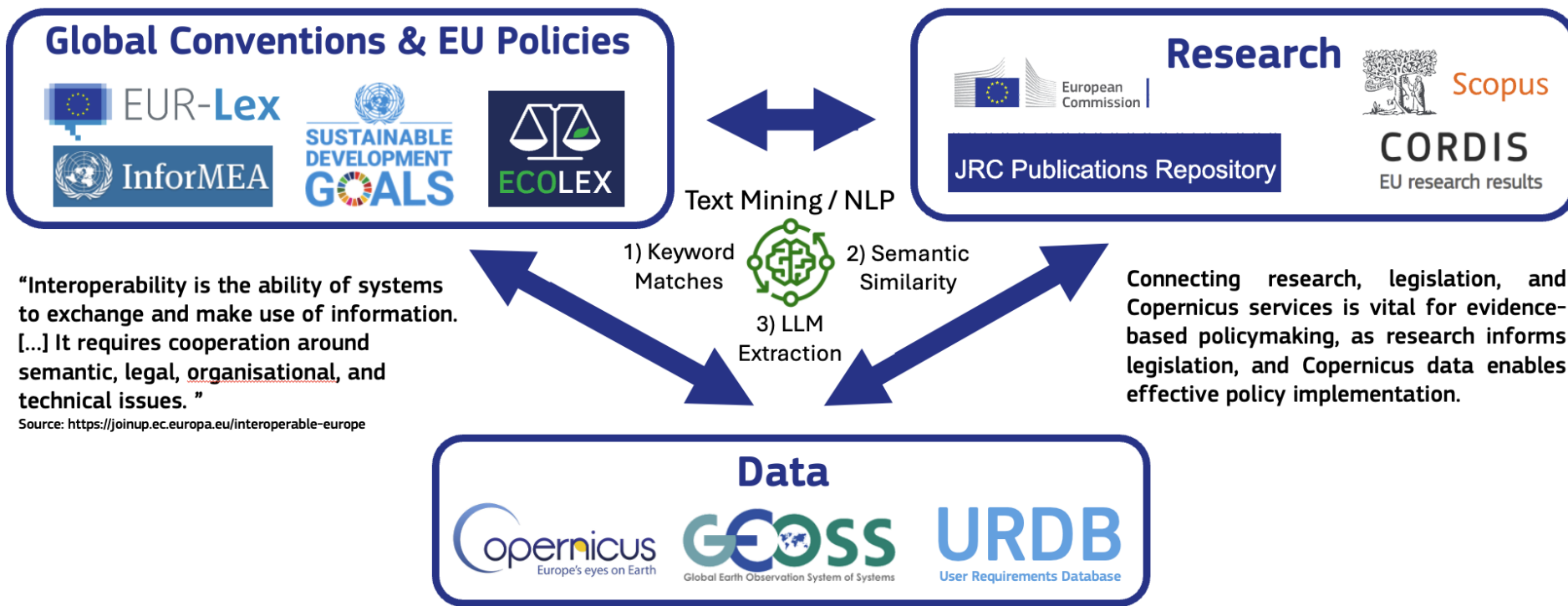


Figure 1: Understanding policy needs and requirements from – KCEO's triangle between policy, research and data.

Results & Outlook

- 32 Conventions
 - 71 Targets
 - 110 Indicators
 - ~240 EO needs
 - ~50 consolidated EO needs
 - All 6 GEO thematic focus areas addressed
 - N SDGs, Targets, Indicators linked to Conventions
 - EC Policies still to be linked
 - All ~240 AI-generated technical requirements reviewed by 26 experts from JRC & EMSA
 - Reliable AI results, only minor refinements required
 - Expert review to be repeated to link existing EO products
- Priorisation possible!

Methodology

Data Sources: 32 Global Conventions

Convention on Biological Diversity
Kunming-Montreal Global Biodiversity Framework
Convention on International Trade in Endangered Species (CITES)
Convention on Migratory Species (CMS)
Agreement on the Conservation of Gorillas and their Habitats
Agreement on the Conservation of Albatrosses and Petrels (ACAP)
Agreement on the Conservation of Seals in the Wadden Sea
World Heritage Convention
The Convention on Wetlands (Ramsar Convention)
United Nations Framework Convention on Climate Change (UNFCCC)
Kyoto Protocol
Paris Agreement
Vienna Convention for the Protection of the Ozone Layer
Montreal Protocol on Substances that Deplete the Ozone Layer
Convention on Long-Range Transboundary Air Pollution (CLRTAP)
Kyiv Protocol on Pollutant Release and Transfer Registers

Stockholm Convention on Persistent Organic Pollutants (POPs)
Minamata Convention on Mercury
Basel Convention on Hazardous Wastes
UNEP Mercury Air Transport and Fate Research Partnership (UNEP F&T)
United Nations Convention on the Law of the Sea (UNCLOS)
Agreement relating to the Implementation of Part XI of UNCLOS
Agreement on Marine Biol. Div. of Areas b. Nat. Juri. (BBNJ / High Seas Treaty)
International Conv. for the Prevention of Pollution from Ships (MARPOL)
International Convention for the Conservation of Atlantic Tunas
United Nations Convention to Combat Desertification (UNCCD)
The Water Convention (Transboundary Waters)
UN Watercourses Convention
United Nations Human Settlements Programme (UN-Habitat)
New Urban Agenda (Habitat III)
Sendai Framework for Disaster Risk Reduction
UNEP Governing Council / United Nations Environment Assembly (UNEA)

Deep Research

The conventions are often brief, but their implementation is dispersed across ancillary documents, such as various (national) adaptation plans and appendices, rendering them inaccessible without expert knowledge. Hence, we decided to use an agentic deep research pipeline with human verification steps.

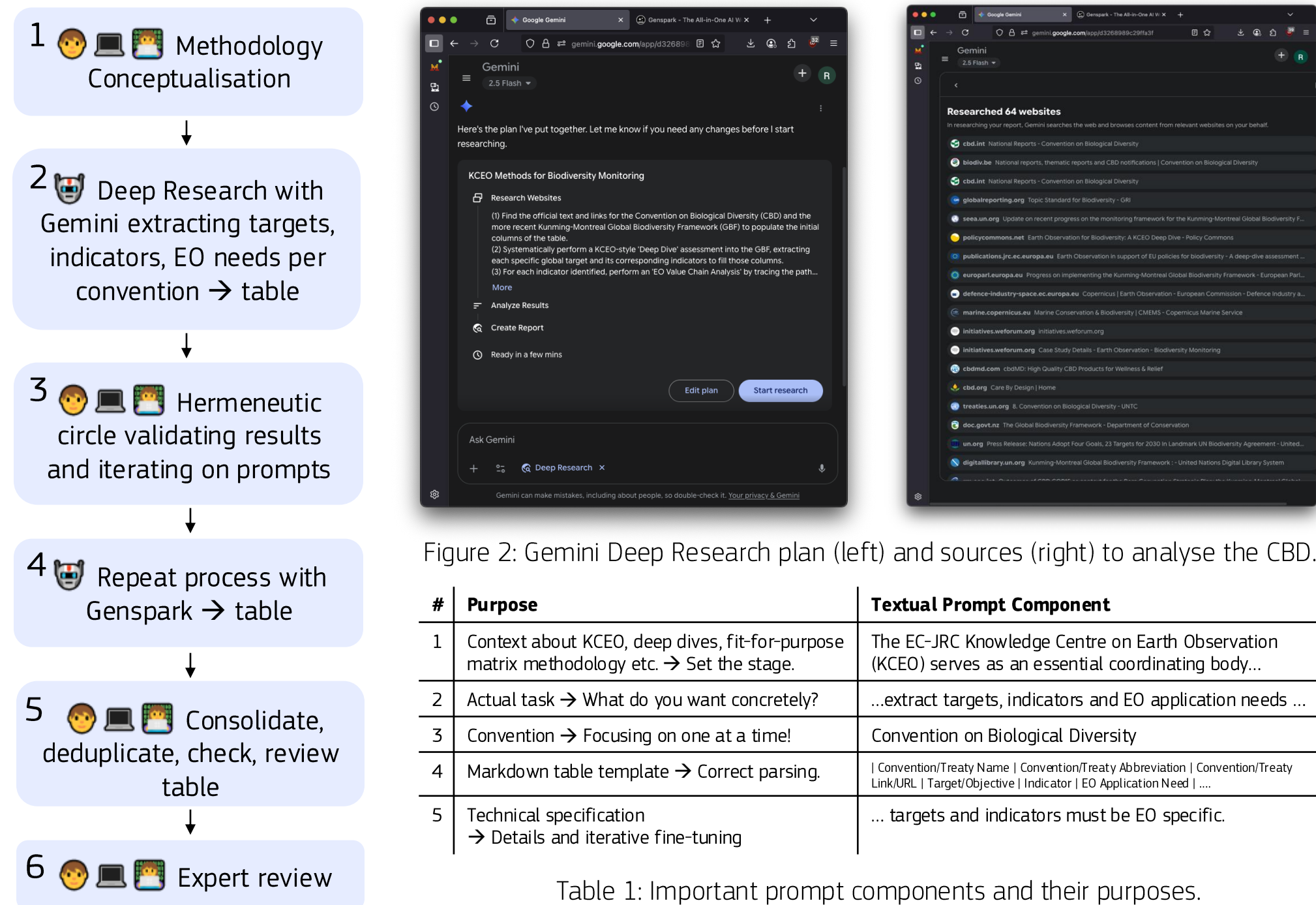


Figure 2: Gemini Deep Research plan (left) and sources (right) to analyse the CBD.

#	Purpose	Textual Prompt Component
1	Context about KCEO, deep dives, fit-for-purpose matrix methodology etc. -> Set the stage.	The EC-JRC Knowledge Centre on Earth Observation (KCEO) serves as an essential coordinating body...
2	Actual task -> What do you want concretely?	...extract targets, indicators and EO application needs ...
3	Convention -> Focusing on one at a time!	Convention on Biological Diversity
4	Markdown table template -> Correct parsing.	[Convention/Treaty Name Convention/Treaty Abbreviation Convention/Treaty LinkURL Target/Objective Indicator EO Application Need ...]
5	Technical specification -> Details and iterative fine-tuning	... targets and indicators must be EO specific.

Table 1: Important prompt components and their purposes.

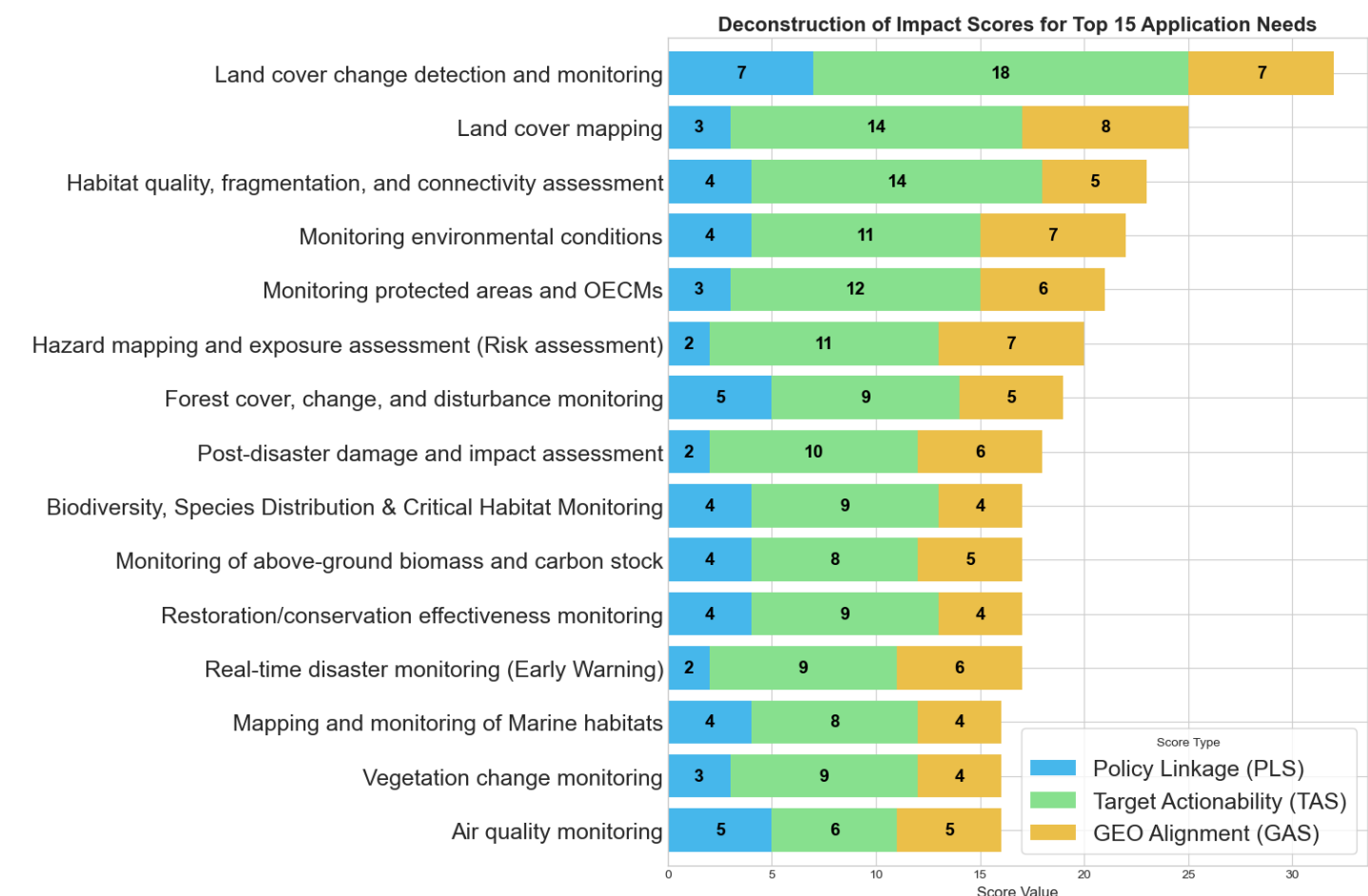


Figure 2: A preliminary quantification of EO needs references to conventions, convention targets and Post-2025 GEO Work Programme. Work in progress.

Treaty	Nar	Treaty	Abbr	Target	Indicator	EO Application Need	SDG number	SDG target	nu	SDG indicator	GW	Focus Area	Spatial resolu	tempo	Res	Temporal Res	Geographical Res	Period of Obs	EO Outputs
Convention CBD				Target 1 (from table): Plan and Manage all Areas To R Biodiversity Barometer.		Land cover classification	15	15.9	15.9.1	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	National	Not specified, Land cover m				
Convention CBD				Target 2 (from table): Restore 30% of all Degraded Ecos		Land condition monitoring	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Not specified, Time-series o				
Convention CBD				Target 2 (from table): Restore 30% of all Degraded Ecos		Degradation assessment	15	15.1, 15.2, 15.15.1, 15.15.2	Water and Land Sustainability: 30m	10m	Annual	Annual	Annual	National	Not specified, Time-series o				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Component Indicator: Priority retention of intact/	Change detection analysis	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Biennial	National	Reg Baseline (e.g., Maps of inta				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator 1.1: Percent of land and seas co	Land cover monitoring	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Land cover m				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator 1.1: Percent of land and seas co	Ecosystem extent mapping	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Land cover m				
Convention CBD - KMG				Target 2: Ensure that by 2030, at least 30 percent of a	Headline Indicator 2.2: Area under restoration.	Baseline mapping and assess	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Convention CBD - KMG				Target 2: Ensure that by 2030, at least 30 percent of a	Headline Indicator 2.2: Area under restoration.	Monitoring changes in ecosys	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Seasonal	National	Reg Baseline (e.g., Distribution n				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator 1.1: Percent of land and seas co	Change detection analysis	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Land cover m				
Convention CBD - KMG				Target 2: Ensure that by 2030, at least 30 percent of a	Headline Indicator 2.2: Area under restoration.	Assessing effectiveness of re	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Distribution n				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator A.1: Red List of Ecosystems.	Ecosystem extent mapping	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Biennial	National	Reg Baseline (e.g., Ecosystem ex				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator A.2: Extent of natural ecosystem	Ecosystem extent mapping	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Biennial	National	Reg Baseline (e.g., Ecosystem ex				
Convention CBD - KMG				Target 1: Ensure that by 2030, all land and sea areas a	Headline Indicator A.2: Extent of natural ecosystem	Land cover monitoring	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Biennial	National	Reg Baseline (e.g., Ecosystem ex				
Convention CBD - KMG				Target 2: Ensure that by 2030, at least 30 percent of a	Headline Indicator 2.2: Area under restoration.	Land use change detection	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Convention CMS				Conserve migratory species throughout their entire ra	Red List Index (for migratory species) / Trends in h	Analyzing land infrastructure	13, 14, 15	14.1, 14.5.1, 14.11, 14.21, 1	Ecosystems, Biodiversity, and 10m	1-5m	Annual	Project-specific	National	Annual	Varies by ind	Varies by ind	Varies by ind	Varies by ind	Varies by ind
Convention CMS				Goal 3: Improve the conservation status of migratory	Living Planet Index (for migratory species)	Land use change detection	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Convention CMS				Goal 3: Improve the conservation status of migratory	Living Planet Index (for migratory species)	Land use change detection	15	15.1, 15.2, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Governing UNEP GC / U				Setting the global environmental agenda and promoti	Various environmental indicators addressed in UN EO data is extensively used	N/A	All Targets	All Indicators	Core Data, Knowledge, and 10m	10m	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual	Annual
Kyoto Prot KP				Achieve legally binding commitments for Annex I	Part Changes in national GHG emissions and removals	Monitoring land cover change	13, 15	13.2, 13.3, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Paris Agree PA				Enhance adaptive capacity, strengthen resilience to	Indicators related to observed climate change imp	Land use change detection	13, 15	13.2, 13.3, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	Reg Baseline (e.g., Maps identify				
Paris Agree PA				Enhance adaptive capacity, strengthen resilience to	Indicators related to observed climate change imp	Mapping vegetation health	13, 15	13.2, 13.3, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Monthly	National	Reg Baseline (e.g., Maps identify				
Stockholm Stockholm Co				Protect human health and the environment from per	Elimination/Restriction of production and use of i	Environmental monitoring	3, 6, 11, 12, 13.9, 6.3, 11.6, 3.9.1, 3.9.2, 3. One Health	30m	10m	Annual	Annual	4-yearly	National	Reg National base Land cover ch					
Stockholm Stockholm Co				Protect human health and the environment from per	Elimination/Restriction of production and use of i	Environmental monitoring	3, 6, 11, 12, 13.9, 6.3, 11.6, 3.9.1, 3.9.2, 3. One Health	30m	10m	Annual	Annual	4-yearly	National	Reg National base Land cover ch					
Stockholm Stockholm Co				Protect human health and the environment from per	Elimination/Restriction of production and use of i	Environmental monitoring	3, 6, 11, 12, 13.9, 6.3, 11.6, 3.9.1, 3.9.2, 3. One Health	30m	10m	Annual	Annual	4-yearly	National	Reg National base Land cover ch					
United Na UNCCD				Strategic Objective 1: To improve the condition of aff	SO 1.3: Trends in land cover / Land cover change /	Land cover classification and	15	15.1, 15.3, 15.15.1, 15.3.1	Water and Land Sustainability: 30m	10m	Annual	Annual	4-yearly	National	Sub Baseline (e.g., Land cover m				
United Na UNCCD				Strategic Objective 1: To improve the condition of aff	SO 1.3: Trends in land cover / Land cover change /	Land cover classification and	15	15.1, 15.3, 15.15.1, 15.3.1	Water and Land Sustainability: 30m	10m	Annual	Annual	4-yearly	National	Sub Baseline (e.g., Land cover m				
United Na UNCCD				Strategic Objective 1: To improve the condition of aff	SO 1.3: Trends in land cover / Land cover change /	Vegetation monitoring	15	15.1, 15.3, 15.15.1, 15.3.1	Water and Land Sustainability: 30m	10m	Annual	Annual	4-yearly	National	Sub Baseline (e.g., Maps of pote				
United Na UNCCD				Strategic Objective 1: To improve the condition of aff	SO 1.3: Trends in land cover / Land cover change /	Land cover mapping and cha	15	15.1, 15.3, 15.15.1, 15.3.1	Water and Land Sustainability: 30m	10m	Annual	Annual	4-yearly	National	Sub Baseline (e.g., Land cover m				
United Na UNFCCC				Stabilization of greenhouse gas concentrations in the	CO2 emissions and removals / Essential Climate V	Land use change monitoring	13, 15	13.2, 13.3, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	Global	Natio 1990 or count Atmospheric				
United Na UNFCCC				Stabilization of greenhouse gas concentrations in the	CO2 emissions and removals.	Land use change monitoring	13, 15	13.2, 13.3, 15.15.1, 15.15.2	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	Global	Natio 1990 or count Atmospheric				
United Na UNFCCC				Climate change mitigation / GHG emissions reduction	Implementation of national mitigation actions.	Land use monitoring	7, 13, 15	7.2, 7.3, 13.2, 7.2.1, 7.3.1, 1	Ecosystems, Biodiversity, and 30m	10m	Annual	Annual	Annual	National	1990 or count Renewable er				

Table 2: A table excerpt of 33 rows for different conventions like the CBD or UNCCD. Each convention can contain multiple targets (violet). For each target, at least one indicator can be identified that points to a concrete EO application need (light blue). This EO need is linked to SDGs and GEO focus areas (orange and green). For each need, we defined the concrete technical requirements, later reviewed by 26 experts from JRC & EMSA (dark blue).