D3.1 Integrating data streams to define and map ecosystem types.

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1 Preface

The importance of biodiversity, natural capital and healthy ecosystems and the services they supply has increasingly been acknowledged in diverse policy initiatives (e.g., EU Biodiversity Strategies 2020 and 2030, Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES), Natural Capital and Ecosystem Services Accounting, Intergovernmental Panel on Climate Change (IPCC) and Convention on Biological Diversity (CBD)).

The EU Horizon Research and Innovation Action "Science for Evidence-based and sustainabLe decIsions about NAtural capital" (SELINA) aims to provide robust information and guidance that can be harnessed by different stakeholder groups to support transformative change in the EU, to halt biodiversity decline, to support ecosystem restoration and to secure the sustainable supply and use of essential Ecosystem Services (ES) in the EU by 2030.

SELINA builds upon the Mapping and Assessment of Ecosystems and their Services (MAES) initiative that has provided the conceptual, methodological, data and knowledge base for comprehensive assessments on different spatial scales, including the EU-wide assessment (Maes et al., 2020b) and assessments in EU member states. Knowledge and data for different ecosystem types are increasingly available.

The SELINA project is an initiative addressing the importance of preserving biodiversity and healthy ecosystems. It aligns with key EU policies for protecting ecosystems. This project integrates various elements, including mapping ecosystems and assessing their condition, with a focus on promoting informed decision-making for biodiversity conservation and sustainable ecosystem services across Europe.

The overall objective of Work Package 3 (WP3) "Ecosystem type, biodiversity and condition mapping and assessment" is to develop and test a methodology to map and assess the condition of terrestrial and aquatic ecosystems to support the EU implementation of the System of Environmental Economic Accounting (SEEA EA) and the implementation of the legally binding restoration targets in the Biodiversity Strategy. We, thus aim to contribute to a better integration of ecosystem condition in public and private decision-making on various levels.

Task 3.1 of WP3 focuses on integrating data flows to map ecosystem types, aligning with existing regulations and nature-based solutions. Deliverable 3.1 "Integrating data streams to define and map ecosystem types" provides insights into the use of different ecosystem typologies among the SELINA consortium, bridging national and international levels. It discusses international ecosystem typologies and their significance, while highlighting the need for crosslinks to compare these systems. Indeed, crosslinks allows the alignment of national and international typologies. The concept of ecosystem condition is explored in the context of ecosystem typologies used for specific reporting streams.

In the context of this report, "Ecosystem typology" broadly includes different systems of classification and characterisation of ecosystem types at different scales. The report

is divided into sections that explain the methodology, survey results, and the connection between national and international ecosystem typologies, with the Ecosystem Map of Hungary used as an example of crosslinking and mapping national ecosystem classes to the European Ecosystem Typology for Accounting.

In essence, this report explores the most relevant ecosystem typologies and their role in advancing biodiversity conservation and sustainable use of ecosystem services. It aims to contribute to the SELINA project's goals and to protect our natural capital for future generations.

2 Summary

This report provides a comprehensive analysis of ecosystem typologies used at both national and international levels, emphasising their role in informing conservation and sustainability policies. At the national level we present various ecosystem typologies used in different countries. It begins with a discussion of the methods and data collection processes used in this analysis. The results offer a general overview of national classifications systems and then moves into specifics, detailing country-specific typologies, and ecosystem condition assessments.

The report provides a description of various international ecosystem typologies that are commonly used in EU regulations, such as the Annex I Habitats Directive, Water Framework Directive, Marine Strategy Framework Directive, Corine Land Cover, IUCN-GET (Global Ecosystem Typology), and others. Each of these international typologies offers a detailed description of methods, data and results and its application in ecosystem management. Finally, it explores how these typologies relate to the assessment of ecosystem condition and presents a methodology to crosslink between national and international classifications systems.

3 List of abbreviations

APA	Agência Portuguesa do Ambiente
ARIES	Artificial Intelligence for Environment and Sustainability
ASPNI	Society for the Protection of Nature in Israel
CBS	Central Bureau of Statistics (The Netherlands)
CLC	Corine Land Cover
CLMS	Copernicus Land Monitoring Service
CORINE	Coordination of information on the environment
COS	Carta de Ocupação e Uso do Solo (Portugal)
COSc	Carta de Ocupação do Solo Conjuntural
EAGLE	EIONET Action Group on Land monitoring in Europe
EEA	European Environment Agency
ESA	Environmental Sensitive Area
ETC/ICM	European Topic Centre on Inland, Coastal and Marine waters
EU	European Union
eu_es	European Ecosystem Typology for Accounting
EUNIS	European Nature Information System
FAO	Food and Agriculture Organisation
GDOŚ	General Directorate for Environmental Protection
GES	Good Environmental Status
GET	Global Ecosystem Typology
HELCOM	Baltic Marine Environment Protection Commission – also known as the Helsinki Commission
HRL	Copernicus High Resolution Layer
hu_es	Ecosystem Map of Hungary/Hungarian Ecosystem Typology
IBM	Israel National Terrestrial Biodiversity Monitoring Program
ICNF	Instituto da Conservação da Natureza e Florestas (Portugal)
INE	Instituto Nacional de Estatística (Portugal)
I-NEA	Israel National Ecosystem Services Assessment Project
IOLR	Israel Oceanographic and Limnological Research
IUCN	International Union for Conservation of Nature
IUNG	Institute of Soil Science and Plant Cultivation – State Research Institute (Poland)
JNF-KKL	Jewish National Fund - Forest Department
LCC	Land Cover Components
LCCS	Land Cover Classification Sytems
LCH	Land Characteristics
LPIS	Land Parcel Identification System (Hungary)
LUA	Land Use Attributes
LULUCF	Land Use, Land-Use Change and Forestry
MAES	Mapping and Assessment of Ecosystems and their Services
MECDD	Ministère de l'Environnement, du Climat et du Développement

	Durable
MPNV	Multiple Potential Natural Vegetation s
MSFD	Marine Strategy Framework Directive
NMD	National Land Cover Data (Sweden)
NDVI	Normalised Difference Vegetation Index
NDWI	Normalised Difference Water Index
NFD	National Forest Database
NFI	National Forest Inventory (Sweden)
NGO	Non-Governmental Organisation
NILS	National Inventory of the Landscape in Sweden
NiN	Nature in Norway
NINA	Norwegian Institute for Nature Research
NPA	Nature and Parks Authority (Israel)
OCTOP	Topsoil Organic Carbon Content datasets
OSM	Open Street Map
RESI	River Ecosystem Service Index
SEEA	System of Environmental Economic Accounting
SEM	State Environmental Monitoring (Poland)
SIOSE	Information System for Land Occupation in Spain
SOC	Soil Organic Carbon
WFD	Water Framework Directive
WSL	Snow and Landscape Research (Switzerland)
WUR	Wageningen University & Research
WWPI	Water and Wetness Probability Index
ZNIEFF	Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique

4 Introduction

The primary goal of Work Package 3 (WP3) is to develop and test a methodology for mapping and assessing the condition of terrestrial and aquatic ecosystems in support of the EU's implementation of SEEA EA and legally binding restoration targets. This effort aims to enhance the integration of ecosystem condition into decision-making at both public and private levels, ultimately ensuring the sustainability of the EU economy and human well-being. The process involves defining minimum criteria for ecosystems to maintain high ecological integrity and good ecological condition. WP3 builds upon the EU-wide ecosystem assessment (Maes et al., 2020c) which served as a foundational step in describing and understanding ecosystems and their services in Europe.

Task 3.1, "Integrating data flows to map, assess, and test ecosystem types," aims to operationalise ecosystem mapping and connect it to relevant EU and global typologies and spatial information systems, ensuring alignment with existing regulations and nature-based solutions. This deliverable (D.3.1) focuses on the integration of data streams to define and map ecosystem types. The objective is to provide an overview of the use and uptake of different ecosystem typologies at national (including regional and local) and international level among the SELINA consortium and to identify possible crosslinks among them. In the context of this work, 'Ecosystem Typology' broadly includes different systems of classification and characterisation of ecosystem types at multiple scales, which aims to record commonly associated habitats, species, and other abiotic elements or land management aspects. This also includes 'habitat typologies' and 'land cover classifications', which may be regarded as proxies for ecosystem typologies This scoping exercise under Task 3.1 does not present an exhaustive compilation of ecosystem typologies used at national or international level. The list of ecosystem typologies addressed is largely a result of those as responded in the comprehensive survey on typologies used at national level from SELINA partners, and those identified in the context of EU or international policy.

Section 5.1 of this report describes the methodology and data collection for the typologies used at the national level. The data were gathered through a comprehensive survey distributed to project partners within the SELINA consortium. The primary objective of the survey was to advance Task 3.1. The survey consisted of three main sections: Ecosystem Typologies, Ecosystem Condition, and Data Sources. These sections gathered data on the ecosystem typologies used, the methods and indicators for assessing ecosystem condition, and the data sources employed in each country. The collected data was analysed and synthesised to inform the report's findings. Detailed survey responses can be found in Annex B as fact sheets per country.

Section 5.2 presents the survey results from the SELINA consortium. The section covers the types of organisations that participated, ecosystem typologies used, their scope, compatibility with international typologies, spatial resolution, and data availability. It also discusses ecosystem condition assessments, the range of ecosystems assessed, methods used, and data sources. The section also provides insights into each responding country's typologies and ecosystem condition assessment practices.

Section 5.3 discusses the connections between national and international ecosystem typologies, with a focus on the Ecosystem Map of Hungary. This map, developed for the Hungarian Mapping and Assessment of Ecosystem Services (MAES-HU), provides a detailed hierarchical classification of ecosystems in Hungary, aligning with international standards. The mapping process involves using sectoral databases, image-based predictive mapping, and validation by local experts. The section also describes an exercise that utilises openly available Earth Observation data to map Hungary's ecosystems to the EU Ecosystem Typology for Accounting, providing a detailed methodology for this crosslink between national and international typologies.

Chapter 6 discusses the development of international ecosystem typologies, which originated in the mid-20th century to establish standardised habitat definitions for global environmental agreements. These typologies vary in organisation, focus, and purpose, such as organised lists, hierarchical taxonomies, and object-oriented systems. They range from plant community-based definitions to land cover and land use-focused systems. Crosslinks are vital for translating and comparing these typologies.

Section 6.1 introduces specific international typologies, such as the Annex I Habitats Directive, Water Framework Directive's Broad Types, Corine Land Cover, the IUCN-GET (Global Ecosystem Typology), and others, each serving unique conservation and assessment purposes on a global scale.

Section 6.2 explains ecosystem condition as the quality of an ecosystem in terms of its abiotic and biotic characteristics. It defines "good condition" according to EU Regulation 2020/852 on the establishment of a framework to facilitate sustainable investment, and amending regulation, and discusses various international typologies used for reporting on condition, such as the Habitats Directive, Water Framework Directive, and Marine Strategy Framework Directive. This section highlights the need for a more streamlined approach to assessing ecosystem condition and explores methods for defining ecosystem extent. It also mentions the challenge of aligning national-level ecosystem definitions with the European Typology for Accounting.

Section 6.3 addresses the crosslinking of national and international ecosystem typologies. It highlights that many countries base their national typologies on international ones, with EUNIS, CLC, and MAES being common choices. The need for a comprehensive crosslinking method is emphasised for various purposes, such as national typologies and reporting obligations. The report details the methods and data used for crosslinking, including the EAGLE data model for standardising land-cover information. It outlines the process, from initial visual comparisons to strategies for handling different crosslink types and database design. The results include a final map of Hungary mapped to the European Typology and an evaluation of Level 1 classes. The International typology and dataflow database which gathers lists of international typologies, crosslinks, information on dataflows and links to openly available data sources for mapping ecosystem typologies is available on the SELINA repository (draft version).

5 Review of Ecosystem typologies used at national level in the EU.

Ecosystem typologies at the national level within the European Union are frameworks used by individual countries to classify and assess their unique ecosystems. These typologies often vary due to the ecological diversity across Europe, and they are designed to address specific environmental, and conservation needs of each country. For example, Germany uses a detailed classification system for biotope types, which includes various natural and semi-natural habitat types. France employs a system known as "Zones Naturelles d'Intérêt Écologique, Faunistique et Floristique" (ZNIEFF), which focuses on areas of ecological, faunal, and floral importance. Spain's classification system is called SIOSE (Information System for Land Occupation in Spain) which is a national approach to land cover and land use mapping, providing detailed information on various ecosystems within its territory. The Finnish Environment Institute (SYKE) has developed a habitat type classification system, which is used for assessing the status of habitats, especially in relation to forest and agricultural lands.

Ecosystem typologies used at national level may also be based on typology systems developed to address broader EU or Global policy needs. For example, national systems may be based on the Annex I habitat list for which conservation status reporting is required under the EU Habitats Directive (European Commission, 1992) or the MAES typology for the purpose of the EU-wide ecosystem assessment process (Maes et al. 2020b).

These national-level typologies are tailored to the specific ecological contexts of each country and are essential for effective environmental management, conservation planning, and policy formulation. They help in understanding the distribution, condition, and trends of various ecosystems, which is vital for biodiversity protection and sustainable use of natural resources.

5.1. Methods and data

5.1.1. Data Collection

The data presented in this report were gathered through a comprehensive survey distributed among the project partners in the SELINA consortium in February 2023 (see Annex A for details). This survey was integral to progressing Task 3.1 of the project, which emphasises the integration of data streams for the mapping, evaluation, and examination of various ecosystem types. Its primary aim was to acquire a deeper understanding of the ecosystem typologies and the data sources utilised by the countries participating in SELINA. Additionally, the survey sought to evaluate the overarching perspective on the condition of ecosystems. The survey consisted of three primary sections:

1) Ecosystem Typologies
This section sought to identify the typologies of ecosystems utilised in the countries participating in the project. It also intended to collect relevant data concerning the

sources of information and the methods used to assess the condition of these ecosystems. The questions included in this section covered:

- The name of the ecosystem typology or typologies used in each country.
- The scope of the typology or typologies.
- Compatibility with international classifications, if applicable, specifying which classification systems.
- Spatial resolution of the typology units.
- Availability of digital-format maps of the typology.
- References related to the ecosystem typologies.

2) Ecosystem Condition
This section aimed to capture information regarding the assessment of ecosystem condition beyond the mandatory assessments required by EU directives (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD)). For each ecosystem assessed, the survey collected details on:

- The specific indicators implemented for assessing the condition of ecosystems, including any defined thresholds or reference levels for each indicator.
- Methods employed to assess ecosystem condition.
- Software, models, or tools used in the assessment process.
- References related to the assessment of ecosystem condition.

3) Data Sources
In this section, respondents were asked to provide information about data sources utilised in their respective countries. The following details were sought:

- Name of the data set.
- Data provider.
- Spatial coverage.
- Spatial resolution.
- Temporal resolution.
- Year of the first available data.
- Year of the latest available data.
- References related to the data sources.

The data collected from the survey responses were analysed and synthesised to compile the information presented in this report. The responses were consolidated to gain insights into the integration of data flows for ecosystem mapping, evaluation, and testing. Detailed responses, organised as individual fact sheets for each country, are provided in Annex B for further reference.

5.2. Results

Responses were received from the European Union and thirty distinct countries within the SELINA consortium, including separate responses from Portugal and The Azores (32 responses in total). Most of these responses were comprehensive and well-detailed and

offered a broad perspective on ecosystem typologies among the partners. Nevertheless, it is important to note that responses from Ireland require additional information regarding the assessed ecosystems, the indicators employed, and the sources of data used (see Figure 1).

In the following sections, we explore these insights, uncovering patterns and trends in how the consortium members approach ecosystem typologies.

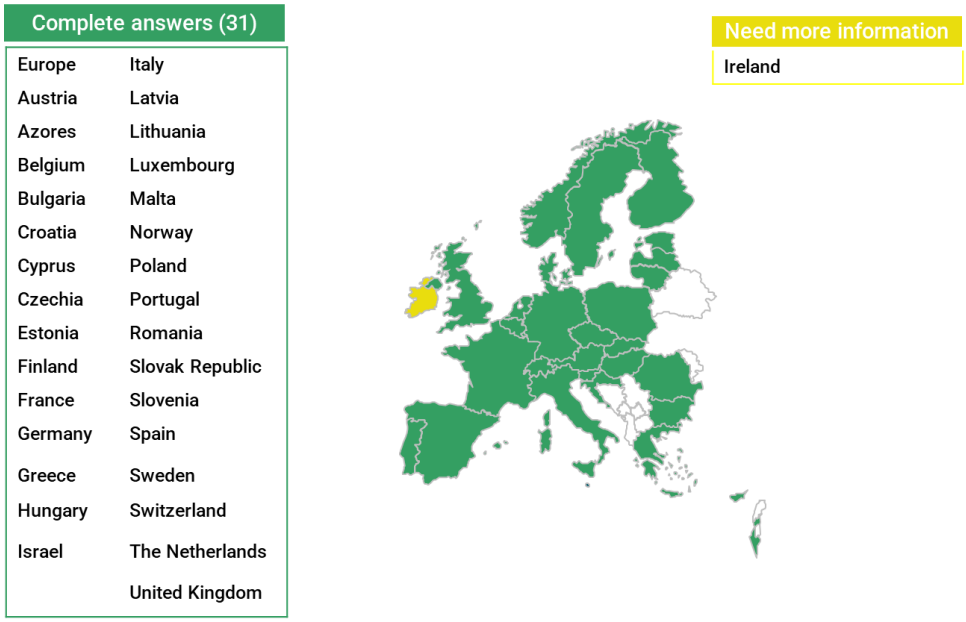


Figure 1. Overview of survey respondents to identify ecosystem typologies at national level.

5.2.1. General overview

This section presents a general overview of the key findings and trends from the survey, offering insights into how the consortium approaches ecosystem typologies, including methods and data sources to assess ecosystem condition.

Respondent Profile

The 32 respondents originated from research and development institutions, comprising a substantial 79% of the total respondents. Private businesses represented 8% of the participants, while administrative organisations accounted for another 8%. Additionally, 5% of respondents belonged to other organisations, including non-governmental Organisations (NGOs) (see Figure 2).

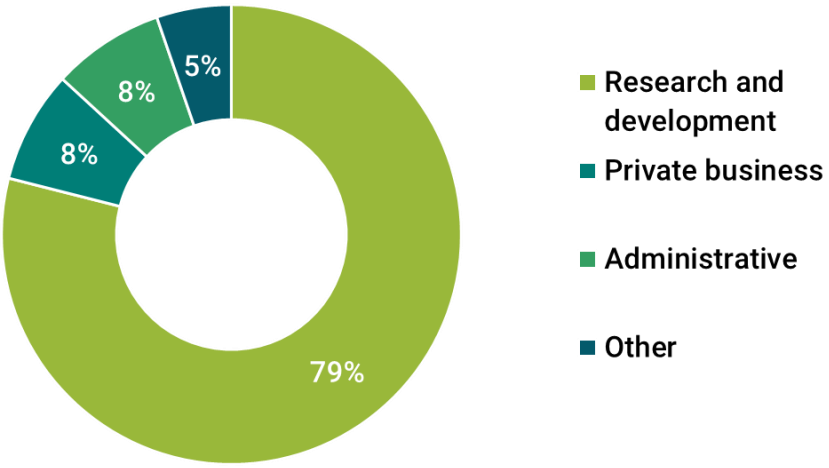


Figure 2. Type of organisation answering the survey

Ecosystem Typologies Used

Figure 3 illustrates that the National Ecosystem (Habitat Classification) emerged as the most frequently mentioned typology, with a notable count of seventeen respondents adopting it. Following this, international typologies such as the Mapping and Assessment of Ecosystems and their Services (MAES) and the European Nature Information System (EUNIS) were also commonly cited, with 13 and 10 mentions, respectively.

In addition to these, respondents also reported several other ecosystem typologies, though with less frequency. These included Coordination of information on the environment (CORINE) (6 mentions), Helsinki Commission (HELCOM) underwater biotopes (3 mentions), and Natura 2000, IUCN-GET (Global Ecosystem Typology), and Habitats directive Annex 1 (2 mentions each). Additional responses included vegetation type, Red List of endangered biotope types, each with varying levels of representation. Other respondents highlighted the utilisation of broader classifications and data sources related to ecosystem assessment, including the European Ecosystem Typology for ecosystem accounting and Land Use, Land-Use Change and Forestry (LULUCF).

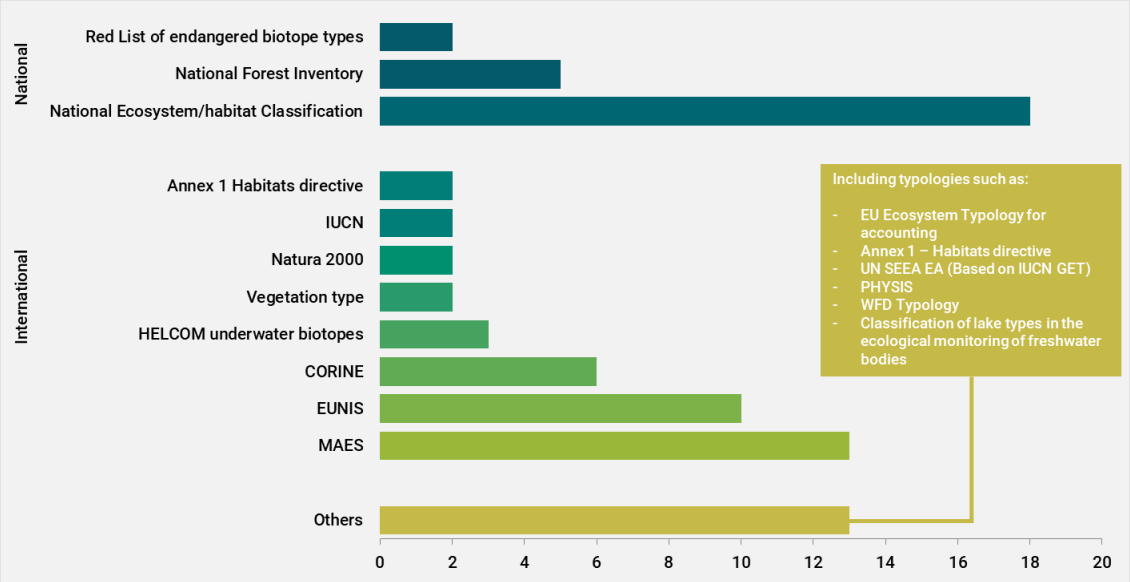


Figure 3. National and international ecosystem typologies used by the 32 respondents; the X-axis presents the times the typologies were mentioned by the respondents (multiple typologies per respondent possible).

Scope of utilised Typologies

The survey sought information from respondents regarding the scope of the ecosystem typologies they utilised. The results revealed that 52% of the typologies mentioned by the respondents have a national scope, emphasising their relevance at the country level. Additionally, 31% of the typologies have an international scope, reflecting their engagement in global ecosystem assessment efforts. Furthermore, 17% of the typologies have a subnational focus. This underlines the importance respondents place on regional specificity, acknowledging the diverse ecological nuances within smaller geographical areas, as depicted in Figure 4.

Compatibility with International Typologies

The survey also probed into the compatibility of national or subnational typologies used by respondents with established international frameworks. The results revealed that EUNIS and CORINE were the most frequently acknowledged international typologies in this context. Thirteen respondents confirmed their compatibility with their chosen national or subnational typologies. MAES followed closely, with ten respondents indicating its alignment with their ecosystem assessment practices.
Additionally, the IUCN Global Ecosystem Typology (IUCN-GET) was referenced by four respondents as being compatible with their practices. Three respondents cited the Habitats Directive Annex I. Furthermore, the European Ecosystem Typology for ecosystem accounting, and Natura 2000 were each mentioned by one respondent as compatible international typologies.

These findings underscore the varied degrees of compatibility between national and international typologies within the SELINA consortium. This diversity reflects the range

of approaches and perspectives employed in ecosystem typology efforts across different regions and scales.

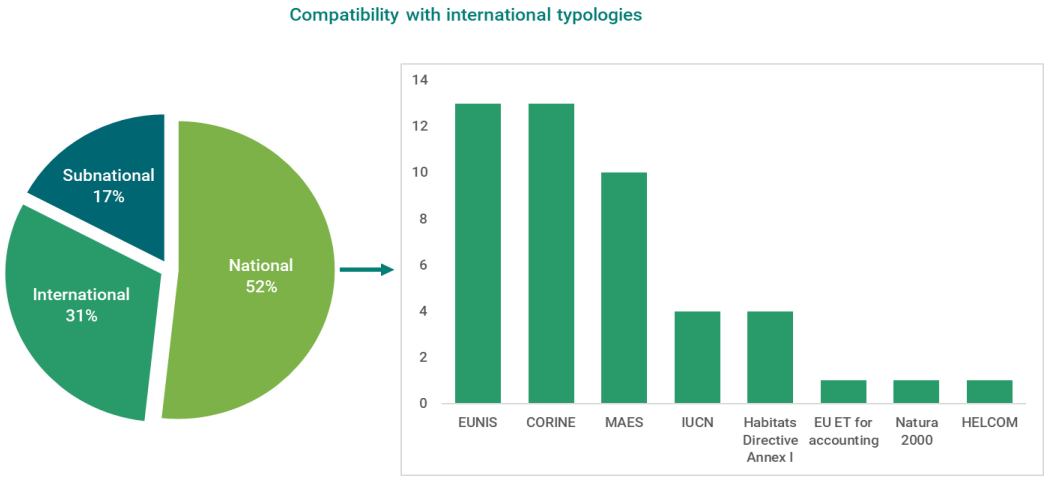


Figure 4. Scope and compatibility of the ecosystem typologies; Y axis presents the number of respondents (multiple typologies per respondent possible)

Spatial resolution and availability of data in digital format

In the survey, respondents were asked about the spatial resolution of the typology units employed by their country, leading to insightful results. The majority, comprising 64% of respondents, reported the use of typologies characterised by fine spatial resolution (approximately 1km x 1km), emphasising the detailed nature of their assessments. In contrast, 24% of respondents indicated the use of typologies with a coarser spatial resolution, potentially reflecting broader-scale ecosystem evaluations. Whereas 11% of respondents mentioned that their typologies were not mapped, signifying variations in the availability of geographical data for certain ecosystem assessments.

Furthermore, respondents were asked about the availability of digital maps corresponding to their typologies. Twenty-eight respondents confirmed the presence of digital typology maps, underscoring the accessibility and utility of digital spatial information in their ecosystem assessment processes. However, five respondents indicated the absence of digital typology maps, suggesting potential limitations in data availability or usage. Additionally, four respondents reported uncertainty regarding the availability of digital maps, highlighting the need for further exploration and accessibility considerations in some cases.

Assessment of ecosystem condition

In the survey, respondents were asked about whether ecosystem condition assessments had been conducted in their respective countries, extending beyond the obligatory evaluations mandated by EU directives, which include assessments stipulated by the Habitats Directive, Marine Strategy Framework Directive, and Water Framework Directive. The responses revealed a considerable proportion, comprising 65% of the respondents, indicating that ecosystem condition assessments had indeed been

undertaken beyond the obligatory EU directive assessments. Furthermore, 19% of respondents expressed uncertainty regarding such assessments, indicating a need for greater clarity or awareness in this regard. Additionally, 16% of respondents mentioned that no ecosystem condition assessments had been conducted beyond the obligatory EU directives' assessments, highlighting variations in the extent and scope of ecosystem evaluation efforts across the 32 respondents (see Figure 5.).

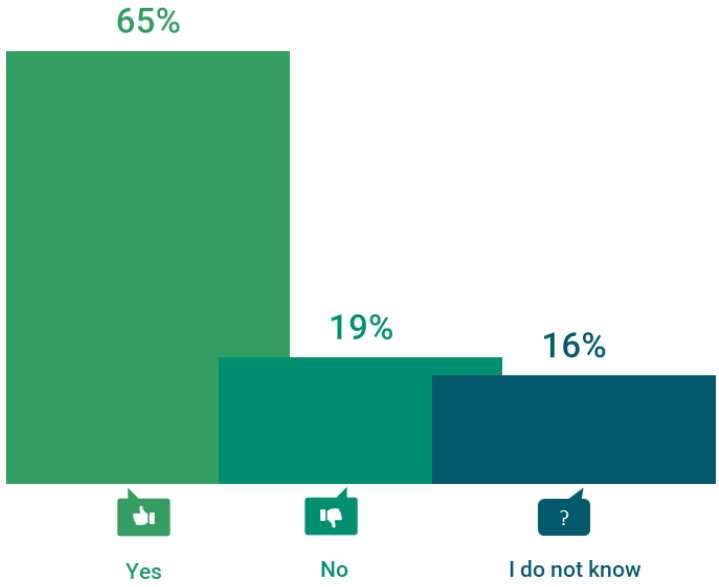


Figure 5. Ecosystem condition assessed beyond the mandatory EU directives.

When asking respondents about the ecosystems assessed, we obtained a diverse range of responses that show the breadth of ecosystem evaluation efforts within the SELINA consortium:

Terrestrial Ecosystems:

- Woodland and Forest Ecosystems: These emerged as the most frequently assessed, with twenty-five mentions, highlighting their significant presence and ecological importance.
- Croplands and Grasslands: These ecosystems were also commonly evaluated, receiving fifteen and fourteen mentions respectively, indicating their relevance in terrestrial assessments.
- Urban Ecosystems: These garnered eleven mentions, reflecting the growing interest in understanding urban ecological dynamics.
- Sparsely Vegetated Land: Assessed by six respondents.
- Heathland and Shrub Ecosystems: Eight respondents focused on these ecosystems (see Figure 6 for more details).

Freshwater Ecosystems:

- Rivers and Lakes: Both these ecosystem types were frequently evaluated, with fourteen mentions each, underscoring their ecological significance and the attention they receive in ecosystem assessments.

Marine Ecosystems:

- Shelf Ecosystems: Received nine mentions, indicating their importance in marine environmental studies.
- Coastal Ecosystems: Assessed by six respondent countries, highlighting the diversity in marine ecosystem studies.
- Open Ocean and Marine Inlets/Transitional Waters: These were mentioned four and three times respectively.

Additional Ecosystem Categories:

- Soil and mountain ecosystems were mentioned three times, indicating their ecological significance.
- Various other ecosystems such as natural habitats, cultural biotopes, semi-natural open areas, and miscellaneous ecosystems were each mentioned once.
- Specific ecosystems like arid and mountain ecosystems, valleys and their water catchments were assessed once each.
- Protected areas, natural habitats, and rocky ecosystems each received two mentions.

These responses illustrate the broad spectrum of ecosystem types that are being assessed by the 32 respondents, ranging from terrestrial to marine, and encompassing both specific and diverse ecological categories.

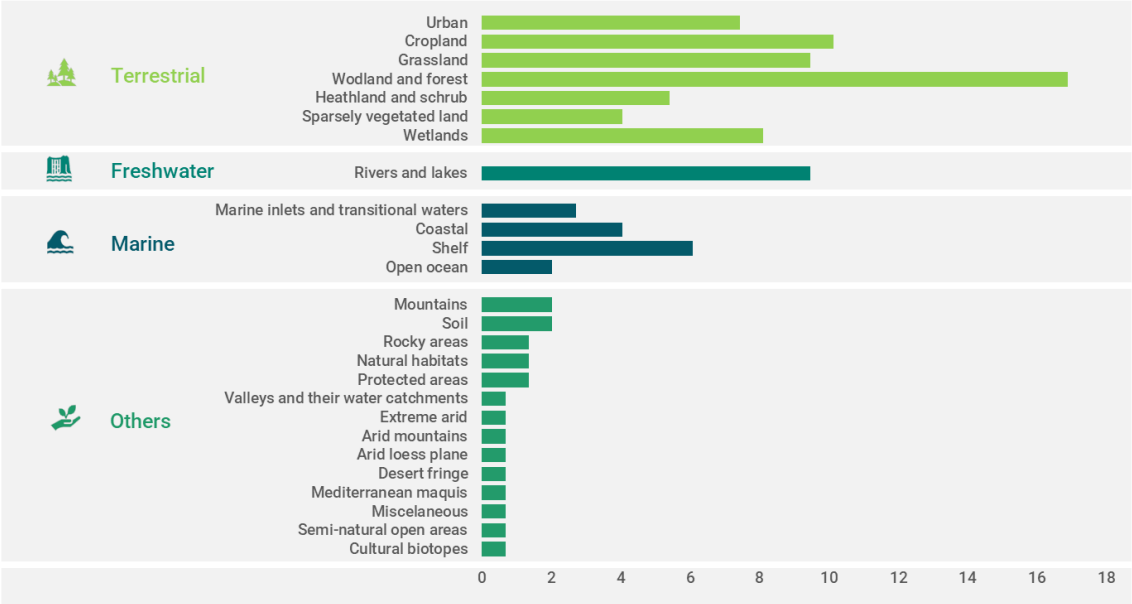


Figure 6. Assessment of condition per ecosystem type.

When surveying respondents about the methods employed to assess ecosystem condition, a comprehensive range of approaches emerged within the SELINA consortium:

- Comprehensive surveys or statistically robust estimates: A significant majority, accounting for 61% of the respondents, used this approach as their primary

methodology for ecosystem condition assessment. This preference underscores the importance placed on rigorous and systematic data collection and analysis in ecological studies (as shown in Figure 7).

- Extrapolation from limited data: About 26% of the respondents indicated that their assessments often relied on extrapolating from a limited dataset. This method points to the adaptability and resourcefulness of researchers in environments where comprehensive data might not be readily available.
- Relying on expert opinion: Around 10% of respondents reported primarily depending on expert opinions for their assessments, particularly in contexts with limited data availability. This highlights the crucial role of experienced judgement and expertise in interpreting ecological data and making informed assessments.
- Insufficient or no data situations: A smaller segment, constituting 3% of the respondents, acknowledged encountering scenarios where insufficient or no relevant data were available for their ecosystem assessments. This response shows the ongoing challenges and limitations faced in the field of ecosystem assessment, particularly in terms of data acquisition and availability.

These varied methodologies reflect the range of strategies and tools employed by the consortium members in ecosystem condition assessment, illustrating their adaptability and commitment to understanding complex ecological systems under varying conditions and constraints.

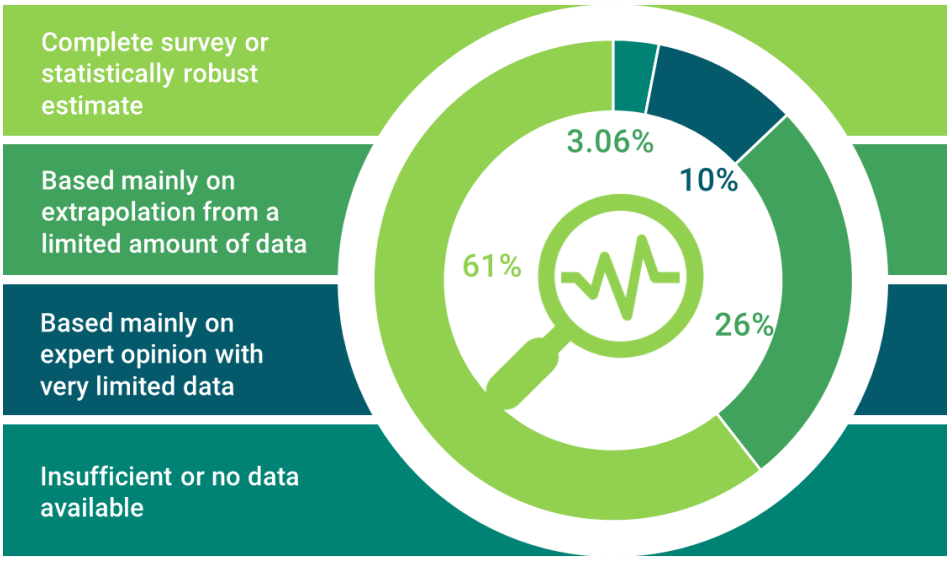


Figure 7. Types of methods used to assess ecosystem condition.

Data sources

In our survey, respondents provided insights into the sources of data used for assessing ecosystem condition across the SELINA consortium. The findings highlight the diversity and range of data sources utilised:

- National data sources: A substantial majority, 89% of the sources reported are national. This reliance on national data sources reflects the importance assessing ecosystems specific to each country. The respondents cited a variety of national institutions as their data providers, indicating the extensive network involved in ecosystem data collection and analysis. These institutions include environmental agencies, research centres, forest monitoring programs, and statistical offices, among others.
- International data sources: 11% of the sources reported are international. While this could demonstrate the collaborative transboundary nature of some ecosystem assessment efforts, it may also be an indication of the lack of data available at national level and therefore a reliance on international data. The international sources mentioned include organisations and programs such as the European Environment Agency (EEA), the Copernicus program, the Joint Research Centre (JRC), and other global institutions. These international sources are crucial for providing a broader perspective and enabling comparative studies across different regions and ecosystems.

The range of data sources, as indicated by the respondents, underscores the collaborative and interdisciplinary nature of ecosystem assessment practices within the SELINA consortium. It also highlights the significance of both national and international partnerships in fostering a comprehensive and shared understanding of ecosystem condition (as illustrated in Figure 8).

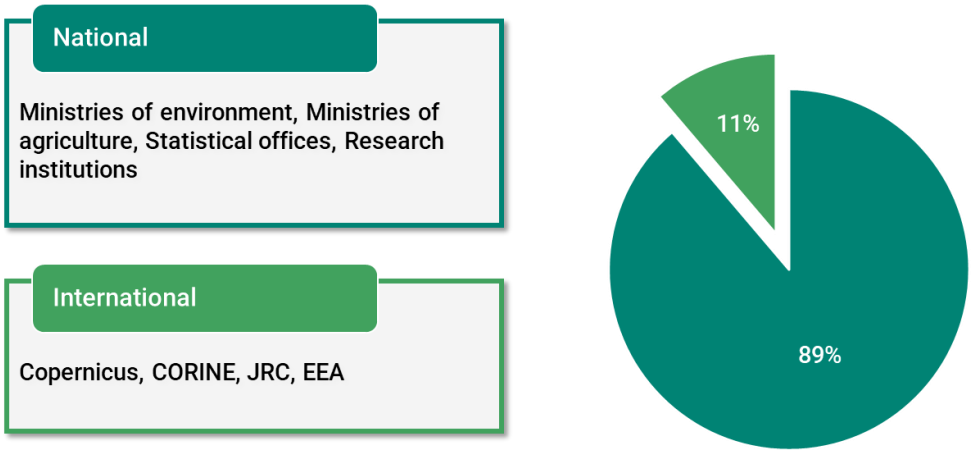


Figure 8. Data sources for ecosystem condition assessments.

5.2.2. EU- and Country-specific typologies and condition assessments

This section presents brief summaries of survey results from each respondent (EU, 29 countries and the Autonomous Portuguese Region of the Azores). These snapshots provide insights into each country's ecosystem typologies and condition assessment practices.

Europe

In Europe, the ecosystem typologies used include MAES (Maes J et al., 2013) and CORINE (European Environment Agency (EEA), 2021). These typologies operate on an international scale, demonstrating their broad applicability and relevance across borders. The spatial resolution of these typologies is fine, facilitating detailed assessments of ecosystem condition. Moreover, digital maps of these typologies over time are readily available, enhancing accessibility and usability.

Beyond the obligatory assessments mandated by EU directives, ecosystem condition assessments have been actively conducted in Europe. The European Commission plays a pivotal role in overseeing these assessments at the EU level, ensuring comprehensive evaluations of various ecosystem types. These assessments cover a wide range of ecosystems and employ an extensive list of indicators, with an emphasis on model-based methodologies. Diverse software, including Python, R, ArcGIS, and Google Earth Engine, along with various models and tools, are leveraged to assess ecosystem condition. Valuable references, such as the publication from Maes et al (2020) provide further insights into these assessment practices. More recently, the European Commission is trying to align the condition assessment with the UN SEEA EA (Maes et al., 2023; Sara Vallecillo et al., 2022)

Austria

Austria employs a comprehensive range of ecosystem typologies to inform its ecosystem assessments. These include well-established systems such as EUNIS, MAES, and the national Rote Liste gefährdeter Biotoptypen Österreichs (Red List of Endangered Biotope Types in Austria) (Essl et al., 2002). These typologies are used at both national and subnational levels, ensuring compatibility with international classifications, especially the Habitats Directive Annex I.

The spatial resolution of these typology units varies depending on the specific typology and the ecological context, with some offering fine-grained details while others provide coarser-grained overviews. Digital maps of these typologies are readily available, making them accessible for various applications and assessments.

Austria's efforts extend beyond the mandatory EU directives when assessing ecosystem condition. The responsibility for assessing ecosystem condition primarily lies with the Federal states of Austria and the Umweltbundesamt (Environment Agency of Austria).

Several key ecosystems have been subjected to assessment, though specific indicators, threshold or reference levels definitions, and assessment methods vary. For example, assessments for agricultural soils are ongoing, but details about indicators and thresholds are not provided. Forest ecosystems are evaluated considering parameters such as forest structure, volume, carbon stock, and forest damage, yet again, specific thresholds remain unspecified. Lakes are assessed for water quality, though details about the indicators used and associated thresholds are not available.

Data sources for these assessments are drawn from various providers and cover a wide range of spatial and temporal resolutions. Notable sources include IACS agricultural parcels, provided by AMA - Agrarmarkt Austria, offering a high spatial resolution based on digital vector data. Forest inventory data, managed by BFW - Austrian Research Centre for Forests, presents irregular intervals in terms of spatial resolution. Water quality data for lakes is managed by AGES - Austrian Agency for Health and Food Safety GmbH, with assessments conducted at periodic intervals.

The Azores

The Azores employ a specific ecosystem typology derived from the most updated and accurate regional land cover survey, which adapts the CORINE-compatible national nomenclature to the reality of the archipelago. The spatial resolution of the typology units is defined as fine resolution, and digital maps of the typology are available. This Land Cover Survey (COS.A/2018) was last conducted by the Regional Directorate of the Environment in 2018 (RDEA - Regional Directorate of the Environment of the Government of the Azores, 2018).

Ecosystem condition assessments in the Azores are generally conducted by the Regional Directorate of the Environment, aided by research outputs from the University of the Azores, primarily focusing on the forest ecosystem, freshwater lakes, croplands, and grasslands. On the latest comprehensive inventory of forest ecosystems, various indicators were used for assessment, such as Tree Cover, Tree Height, Tree age, Canopy stratification level, Biotic/Abiotic condition, Cultivation state, Forest connectivity, and Species composition. Assessments of other ecosystem types can be found scattered throughout multiple research publications dealing mostly with monitoring of physical, chemical, and compositional state characteristics. However, information regarding the definition of thresholds or reference levels for these indicators is often unavailable.

The data sources used for the latest ecosystem mapping in the land cover survey include SPOT6/SPOT7, WorldView-III/WorldView-IV, and administrative maps by the Portuguese General Directorate of the Territory, offering comprehensive spatial coverage with a spatial resolution of twenty metres. The methods employed for assessing forest ecosystem condition encompass Dendrometric field measurements, Aerial photos, Cartographic maps, and GIS software processing. The data sources used specifically for the forest inventory include georeferenced field observations, aerial photos, and Portuguese cartographic maps, providing spatially explicit coverage at 500 m^2 resolution. These forest assessments have been conducted once every decade, with data available from 2007 and 2018.

Belgium

Belgium employs a specific ecosystem typology based on spatial data available within its national boundaries and is compatible with international classifications (Poelmans Lien et al., 2023). The typology units exhibit fine spatial resolution, and digital maps of this typology are readily accessible.

In terms of assessing ecosystem condition beyond mandatory EU directives, Belgium has engaged in preliminary testing by INBO on water bodies' condition, though this has remained at a pilot stage and has not been widely implemented. The tested indicators include nine physicochemical variables and a set of 30 freshwater macroinvertebrate taxa, with water quality assessed based on biota, complete with defined thresholds or reference levels. The evaluation is primarily based on expert opinion with very limited data and utilises the R programming language. However, as of now, there is no specific reference provided for this assessment.

Regarding data sources, Belgium relies on a variety of datasets from different providers. These include the Biologische waarderingskaart (biological value map) and Natura2000 habitatkaart (habitat map) provided by INBO (Flanders), the Soil map from DOV, and the Land use map from the Environment department. Each of these datasets have wide spatial coverage and varied spatial resolutions. Temporal resolutions range from bi-annual to annual updates, with data availability spanning from as early as 1972 to the latest available in 2022. Additionally, linear features on farmland data are available for Flanders. Different datasets, including those related to heritage, landbouwgebruikpercelen (crops and production method), ecosystem services maps, and different emission maps (air, water) such as PM2.5, N, and NO_2 are also accessible. Information on the percentage of FSC-PEFC labelled forest areas is available and updated annually.

Bulgaria

In Bulgaria, the ecosystem typologies primarily used are MAES, CORINE, and EUNIS, with a national scope. The spatial resolution for these typology units is fine. Digital maps of these typologies are available upon request from the Bulgarian Ministry of Environment and Water. The national framework for mapping and assessment of ecosystem condition and ecosystem services is divided into 9 separate methodologies focusing on the 9 ecosystem types represented in the country (Apostolova et al., 2017b, 2017a; Karamfilov et al., 2017; Kostov et al., 2017; Sopotlieva et al., 2017; Uzunov et al., 2017; Vassilev et al., 2017; Yordanov et al., 2017; Zhiyanski et al., 2017).

Moreover, Bulgaria has gone beyond the mandatory EU directives in assessing ecosystem condition. Multiple organisations, including the Bulgarian Ministry of Environment and Water, the Institute of Biodiversity and Ecosystem Research, the Forest Research Institute, and the National Institute of Geophysics, Geodesy, and Geography, participate in these assessments.

Mapping and assessment of all nine ecosystem types have been performed but only for the territories of the country falling outside the Natura 2000 network. Each mapping and assessment exercise uses a specific set of indicators and methodologies, primarily relying on qualitative and quantitative monitoring, geospatial, statistical and literature data and its evaluation in ArcGIS. These assessments encompass urban, cropland, grassland, woodland, and forest, shrubland, sparsely vegetated land, wetlands, rivers and lakes, and marine ecosystems.

Data for these assessments are derived from national and international sources. The spatial coverage and resolution vary depending on the specific dataset, and data is updated at different intervals.

Several mismatches were discovered in both the MAES methodological framework and EUNIS classification, as well as geospatial errors in all the datasets. The eight terrestrial ecosystem types, spatial datasets cannot be used altogether as the topology analyses show an extremely large number of gaps and overlaps (Petkova et al., 2022).

Croatia

In Croatia, the primary ecosystem typology employed is the National Habitat Classification (NHC), which is used at the national level and is compatible with various international classifications including CORINE. The NHC is officially published with crosslinks to Annex I and the Bern Convention, ensuring alignment with EU Ecosystem typology, IUCN GET, CLC, and MAES. It is compatible with EUNIS and is currently under revision to enhance compatibility with the latest version of the EUNIS habitat classification (Croatian Ministry of Economy and Sustainable Development, 2021). The spatial resolution of the typology units is fine, and digital maps of the typology are available.

Regarding ecosystem condition assessment, beyond the mandatory EU directives, there have been no additional assessments conducted in Croatia. The responsibility for assessing ecosystem condition lies with the Bureau of Statistics at the national level, but the official agreement for data collection from various institutions, such as the Ministry of Economy and Sustainable Development and the Department of Agriculture, is yet to be established.

As for data sources, key datasets used for ecosystem mapping and assessment include the Habitat and Protected Areas dataset provided by the Ministry of Economy and Sustainable Development, the Corine Land Cover dataset from Copernicus, and forest data from Croatian Forests Ltd. The NHC and Habitat map of Croatia serve as the base dataset for ecosystem mapping, although they are not frequently revised due to resource constraints, especially concerning forest data. Therefore, ecosystem properties, particularly for reporting according to the Regulation (EU) 691/2011, are likely to be assessed using freely available datasets such as CLC.

Cyprus

In Cyprus, the MAES typology is the primary framework used for categorising ecosystems at the national level which is compatible with CORINE. Ecosystem units within this typology are characterised by a relatively coarse spatial resolution, and digital maps representing these typologies are readily available for reference.

The most recent assessment for the identification of ecosystem services indicators at the national level in Cyprus can be found in the study conducted by Vogiatzakis et al. (2020). No ecosystem condition has been assessed, except as required for the EU Water

Framework Directive. The assessment of ecosystem condition is an ongoing collaborative effort involving various organisations, including government departments such as the Department of Environment, Water Development Department, Department of Fisheries and Marine Research, and the Forestry Department. Research institutions, such as the Open University Cyprus, Frederick University, University of Cyprus, and The Cyprus Institute, also play a significant role in this evaluation.

Czechia

In Czechia, the primary ecosystem typology used is known as the "Consolidated Layer of Ecosystems of the Czech Republic," with a national scope and compatibility with international classifications, including CORINE and EUNIS after some processing (Nature Conservation Agency of the Czech Republic, 2023). This typology operates at a fine spatial resolution and is available in digital format.

Regarding the assessment of ecosystem condition, aside from mandatory EU directive assessments, multiple organisations in Czechia participate in ecosystem condition assessments. These assessments cover various ecosystems, including natural habitats, forests, water bodies, and soil. Habitat quality is assessed with defined thresholds, while the quality of forests, water bodies, and soil has also been evaluated, though thresholds for the latter are not specified. The methods employed for assessing ecosystem condition are based on complete survey or statistically robust estimates, and uses the Czech habitat map for Natura 2000, Czech forest inventory and monitoring, and Czech water monitoring, among others.

In terms of data sources, the Czech Nature Conservation Agency provides habitat quality spatially explicit data represented in vector format. It covers a period of 12 years from 2000 to 2012.

Denmark

In Denmark, the ecosystem typologies utilised include the Habitats Directive Annex 1 and the National Classification of Nature Types (The Danish Environmental Protection Agency, 2023). These typologies have an international and national scope, and they are compatible with international classifications such as CORINE. The spatial resolution of the typology units is fine, and digital maps of the typology are available.

Ecosystem condition assessments in Denmark go beyond the mandatory EU directives and are conducted by various organisations, including the National Environment Agency under the Ministry of Environment and the Danish Centre for Environment under Aarhus University. These assessments cover terrestrial ecosystems, marine ecosystems, and lakes and water courses. Indicators, thresholds, and reference levels have been defined for these assessments. The methods used for assessing ecosystem condition include species structural conditions and chemical loads, with reference information available online on the website of the Danish Environmental Protection Agency.

The data sources used for these assessments are provided by NOVANA - Danish environment data, with a spatially explicit coverage. The spatial resolution varies depending on the ecosystem type, and the temporal resolution ranges from 1 to 12 years. The data has been available since 2004 and is regularly updated.

Estonia

Estonian ecosystem assessments are based on a custom-developed ecosystem typology (Helm et al., 2021), which aligns with the broader MAES framework. This typology has a national scope. The typology is partially compatible with the Annex I Habitats Directive classification. The country operates with a fine spatial resolution for its typology units and the typology maps are readily available in digital format, facilitating accessibility and utilisation.

In terms of ecosystem condition assessment beyond mandatory EU directives, Estonia has made some progress, with several organisations actively involved in these activities. The Estonian Environment Agency, Estonian University of Life Sciences, and Tartu University lead these assessments.

Across various ecosystems such as forests, agricultural lands, wetlands, grasslands, inland water and sea, the country employs composite indicators that encompass a wide array of parameters, each assessed with a high level of detail. These assessments are supported by robust methodologies and tools, including the use of R, ArcGIS, and QGIS.

For data sources, Estonia has a comprehensive set of spatial data, including the Estonian Base Map, Estonian Agricultural registry map, Annex I habitats map, semi-natural grasslands map, Estonian soil map, Estonian wetlands map, Estonian Forest Registry map, Estonian LiDAR survey data, Landsat thermal data from NASA, and information about protected areas. These datasets cover various spatial resolutions and temporal resolutions.

Finland

Finland uses an array of ecosystem typologies to assess ecosystem condition and other aspects of the country's biodiversity. These encompass international, national, and subnational scopes, with a notable inclination toward international typologies such as Natura 2000, HELCOM HUB (Boedeker et al., 2013), and the Status Assessment of Habitat Types in Finland (Kontula and Raunio, 2019), which are all EUNIS-compatible. This diversity in typologies is coupled with fine-resolution spatial units, facilitating detailed assessments. Moreover, Finland has ensured the availability of digital maps for many of its typologies, enhancing accessibility.

In Finland, environmental condition is currently estimated regularly by Natural Resources Institute Finland (Luke), the Finnish Forest Centre (Metsäkeskus), Geological Survey of Finland (GTK), Finnish Environment Institute (SYKE) and Parks & Wildlife Finland (Metsähallitus). Luke, the Finnish Forest Centre and GTK inventories are mostly concerned with natural resources and estimate environmental condition as part of a

larger effort. Parks & Wildlife Finland concentrates on the condition of protected areas. SYKE has developed maps and ecosystem condition indicators with reference levels based on environmental data collected by other organisations. Additionally, municipalities, cities and companies collect data on environmental condition on a smaller scale. Future efforts will include compiling these data and making them available as well as a more comprehensive estimate of the condition of Finnish ecosystems at the luonnontila.fi website.

These estimates include various ecosystems, mainly marine and freshwater environments, farmlands, forest biotopes, wetlands, and bogs. The assessments have mainly been based on comprehensive datasets, field inventories, remote sensing, and modelling. These assessments have contributed to the development of valuable tools and resources, such as the VELMU Map Service, sea ice charts, and habitat distribution models, facilitating ongoing ecosystem evaluation and management.

Finland has also participated in international assessments, notably the Baltic Sea assessment by HELCOM, which encompasses various indicators related to species abundance, population structure, zooplankton size/mass, nutrient levels, harmful substances, and seabed oxygen levels. Finland is also a member of the Circumpolar Biodiversity Monitoring Programme (CBMP) which monitors the biodiversity of marine, freshwater, terrestrial and coastal environments of the Arctic based on key elements, called Focal Ecosystem Components (FECs).

France

In France, several ecosystem typologies are utilised for ecological assessment and conservation, including CLC, Corine Biotope, EUNIS, and Phytosociology (Muséum national d'histoire naturelle (MNHN) and Inventaire National du Patrimoine Naturel (INPN), 2023), with applications at both the national and subnational levels. These typologies are compatible with international classifications, particularly CLC and EUNIS. The spatial resolution of these typology units can vary, encompassing both fine and coarse resolutions. Additionally, digital maps are available for some of these typologies.

Ecosystem condition assessment in France extends beyond the mandatory EU directives' assessments. Numerous organisations are involved in these assessments. These organisations include ONB (Office National de la Biodiversité), INPN (Inventaire National du Patrimoine Naturel), INRAE (for soil assessments), IGN-IFN (Institut Geographique National - Inventaire Forestier National) for forest assessments, MNHN (Museum National d'Histoire Naturelle), RMQS (Réseau National de Mesure de la Qualité des Sols), UICN France, Water Office and Agencies, and the Ministry in charge of ecology (MTCT / CGDD), which oversees urban ecosystem assessments.

Several distinct ecosystems have been assessed, each with a specific set of indicators, although the presence of defined thresholds or reference levels for these indicators is not always clear. The assessment methods employed vary across ecosystems, with GIS being a common tool used for spatial analysis and data visualisation.

Germany

In Germany, the official ecosystem typology employed for ecosystem accounting is the National Ecosystem Classification for Germany (Statistisches Bundesamt (Destatis), 2021a). This typology is hierarchically structured into ecosystem sections (e.g., “A Terrestrial areas”), ecosystem divisions (e.g. “A03 Forest and woodland”), ecosystem groups (e.g. “A03.1 Broadleaf forests”), and ecosystem classes (“A03.13 Riparian forests”). On the most detailed level, the typology consists of 74 ecosystem classes. It operates at the national scale and has demonstrated compatibility with several international classifications, including CORINE, EUNIS, MAES, and IUCN (Statistisches Bundesamt (Destatis), 2021b). For the compilation of the ecosystem type map and account high-quality data with suitable spatial and temporal resolutions was selected, prioritizing official and Copernicus program data for their reliability. Through a triennial update interval, it tracks changes in the ecosystem extent over time (Bellingen et al., 2022).

In terms of ecosystem condition, beyond the mandatory EU directives, the German Federal Statistical Office compiles ecosystem condition accounts (Statistisches Bundesamt, 2023). The ecosystems considered include settlement areas and transport infrastructure, agricultural land, forests and woodland, semi-natural open areas, freshwater systems, and marine waters. The ecosystem condition accounting builds upon various data sources such as remote sensing, modelling, and existing monitoring systems. These sources vary in terms of spatial coverage, spatial resolution, temporal resolution, and the years for which data is available. They include land cover models, data on the extent of ecosystems, digital terrain models, and further information compiled by various governmental agencies and institutions. The accounts focus on describing the key components of an ecosystem, encompassing chemical, physical, functional, compositional, and structural attributes. The accounts do not aim to fully document the ecosystem condition but rather aim to represent essential characteristics crucial for ecosystem functionality and relevant ecosystem services over time (Statistisches Bundesamt, 2023). They are structured according to the ecosystem division of the National Ecosystem Classification described in the previous section. All considered aspects of the ecosystem condition are aggregated spatially for all ecosystem types and summarised into accounts at different administrative levels (municipal, district, state, national) across Germany. Through a triennial update interval, it tracks changes in ecosystem condition over time.

The digital maps representing the ecosystem typology and condition, as well as the corresponding ecosystem extent and condition accounts, are readily accessible through official sources such as Destatis reports (available through their webpage, https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economic-Accounting/ecosystem-account/_node.html#584336) and the “Ökosystematlas”, an online geoportal (Statistisches Bundesamt (Destatis), 2023); https://oekosystematlas-ugr.destatis.de/).

Greece

In Greece, ecosystem assessment relies on the MAES typology, which is primarily of national scope but also includes subnational aspects. This typology aligns with international classifications, specifically referencing the Directive 92/42 Habitat types. The spatial resolution of the typology units is fine, and digital maps are readily available. Key references for this typology include publications by Maes J et al., (2013) and (Verde et al., 2020).

Beyond mandatory EU directives, Greece has conducted ecosystem condition assessments that fall under the responsibility of the Department of Biology at the University of Patras in collaboration with the JRC. Woodland and forest ecosystems are among the assessed categories, where indicators, including the Forest Condition Index, are used. Thresholds have been defined for these indicators, and the assessment employs methodological approaches relying on statistical tools such as ArcGIS and QGIS using the SEEA EA as reference framework. Additionally, software and models, including those proposed by Vallecillo et al. (2022), play an important role in this assessment.

Data for habitat type mapping, specifically under Directive 92/43, are provided by the Ministry of Environment and Energy. These data have broad spatial coverage, with a spatial resolution of 1:5,000. While the temporal resolution is not specified, the data are from the year 2016 and have not been updated.

Hungary

Hungary utilises several ecosystem typologies, including Natura 2000 (Annex I), Á-NÉR (Bölöni et al., 2007), CORINE, and national ecosystem type map categories (Tanács et al., 2022). Á-NÉR and the National Ecosystem Type map serve mostly national purposes while Natura 2000 and CORINE are suitable for international purposes. However, the first two are not perfectly compatible with international classifications, although some crosslinks can be established (e.g., with EUNIS, MAES, IUCN, CORINE). The typology units have fine spatial resolution (20 m for the National Ecosystem Type map and small–scale habitat patch maps in the case of Á-NÉR), and digital maps of these typologies are readily available.

Hungary has assessed ecosystem condition beyond the mandatory EU directives. Both types of assessments (mandatory and extra) were (and still are) coordinated by the Nature Conservation department of the Ministry of Agriculture. Besides some relevant older initiatives, the last comprehensive condition assessment was carried out within the frames of the MAES-HU project, designed to fulfil requirements by the EU Biodiversity Strategy to 2020. Several ecosystems have been assessed using various indicators and assessment methods. For forests, indicators cover canopy composition (e.g., proportion of non-native and invasive tree species) and structure (e.g., age cohorts). Wetland assessments include proxy indicators related to the frequency of water cover, surface water, and landscape features. Grasslands are also assessed based on proxy indicators such as semi natural areas and proximity to roads. Croplands are evaluated using more detailed data, considering parameters like parcel size and the

number of cultivated plants. Water ecosystems align with the WFD's biological components. Urban areas are assessed simply in terms of urban green areas. Soil fertility assessment is also performed, although specific indicators are not detailed. Additionally, farmlands (including grasslands and croplands), forests and wetlands are also assessed using the ratio of the present bird species to the expected number of species. The departure of current vegetation from potential natural vegetation is also assessed as a different way to approach condition. Various software, models, and tools, including ArcGIS and R, are employed for these assessments.

In terms of data sources, several are used for ecosystem assessments which include the Ecosystem Map of Hungary, the Hungarian Land Parcel Identification Scheme (LPIS), Beneficiaries' Declarations, the National Forestry Database (NFD), the Multiple Potential Natural Vegetation database of Hungary (MPNV) (Somodi et al., 2017), Copernicus High Resolution Layer (HRL), Water and Wetness Probability Index (WWPI), Open Street Map (OSM) roads, CORINE Land Cover improved state layers, soil productivity data from the Hungarian Soil Research Institute, and boundary information of Natura 2000 areas and Protected Areas provided by the Ministry of Agriculture. These data sources encompass a wide range of spatial coverages and resolutions, supporting ecosystem assessments across the country.

Ireland

In Ireland, ecosystem assessment practices revolve around a primarily national habitat classification system(Fossitt and Heritage Council (Ireland), 2000), which serves as the primary typology used in policy and formal national reports. However, the landscape of ecosystem typologies is evolving, with increasing utilisation of international frameworks such as MAES, IUCN, and EUNIS, primarily within the research sphere.

According to the respondent, the spatial resolution of these typology units is categorised as "Not mapped" and digital maps of the typology are currently unavailable. Regarding ecosystem condition assessments, Ireland primarily engages in the mandatory EU directives' assessments. Beyond these obligatory assessments, Ireland reports no extensive ecosystem condition assessments. The responsibility for assessing ecosystem condition is competence of the National Parks and Wildlife Service, a government agency dedicated to the conservation and management of Ireland's natural heritage.

Israel

In Israel, the ecosystem assessment comprises three distinct typologies, each tailored to specific organisational needs and purposes. These typologies, though unique to Israel, do not align with EU or international common typologies. They include:

- Israel Nature and Parks Authority (NPA) (Rotem and Weil, 2014): This typology encompasses 23 terrestrial ecosystem units, representing the natural potential ecosystems across the entire country.

- Israel National Terrestrial Biodiversity Monitoring Program (IBM) (Ron Drori et al., 2017): IBM focuses on nine terrestrial monitoring ecosystem units, covering a substantial portion of the country's land. While it aligns with national objectives, it does not necessarily conform to international classifications.
- Israel National Ecosystem (Services) Assessment Project (I-NEA) (Lotan et al., 2019, 2018): I-NEA classifies six main ecosystem types with subdivisions, encompassing both marine and terrestrial territories. Like the others, it does not mirror international typologies.

The spatial resolution of these typology units varies from national to subnational, with maps available in digital format only for NPA.

Multiple organisations and entities, including the Hamaarag-Israel National Nature Assessment Program, NPA, Jewish National Fund (JNF-KKL, the Israeli forest department), Israel Oceanographic and Limnological Research (IOLR), Israel Centre for Aquatic Ecology, and The Society for the Protection of Nature in Israel (ASPNI), along with universities, research centres, and NGOs, conduct localised assessments.

Ecosystems assessed span diverse categories, from Mediterranean maquis and planted forests to grasslands, coastal sand dunes, desert fringe, arid loess plains, arid mountains, extreme arid regions, inland water bodies, marine environments, and urban areas. These assessments encompass a wide range of indicators and monitoring methods, relying on long-term field monitoring, GIS analysis, remote sensing, and specialised surveys.

Data sources primarily stem from the Israel National Terrestrial Biodiversity Monitoring Program (IBM), the National Monitoring Program of Israel's Mediterranean Waters (conducted by Israel Oceanographic and Limnological Research and Israel Centre for Aquatic Ecology), and forest health surveys conducted by the JNF-KKL. These sources cover representative selected sites and exhibit varying spatial and temporal resolutions, with data available from as early as the 1980s to recent years.

Italy

In Italy, several ecosystem typologies are utilised, including MAES, CORINE, and the Ecosystem Map of Italy (Angelini et al., 2009; Lapresa et al., 2004). These typologies serve both international and national purposes. The national typologies align with international classifications such as EUNIS, MAES, and CORINE. The spatial resolution of these typology units is categorised as fine, and digital maps of the typologies are readily available.

The Italian Institute for Environmental Protection and Research (ISPRA) takes the lead in the assessment of ecosystem condition. Various ecosystems undergo assessment, including terrestrial ecosystems, with indicators such as conservation status, risk status, habitat quality, land take, fragmentation, and more being measured. These assessments rely on tools such as GIS, earth observation, and specific models such as IUCN and

Environmental Sensitive Area (ESA) index. Italy's comprehensive Nature Map project at a 1:50,000 scale aims to map ecosystems and assess their status continually.

The data sources for ecosystem condition assessments are primarily provided by ISPRA and cover a broad spatial and temporal spectrum. These sources encompass risk status of ecosystems, conservation status of terrestrial habitats, fragmentation, land take, and burnt areas. The spatial coverage of these datasets varies, with some being spatially explicit, while others are aggregated at administrative or ecological scales. Spatial resolutions also differ, but many datasets are updated annually or periodically to ensure relevance and accuracy.

Latvia

In Latvia, a diverse range of ecosystem typologies are used in national and international assessments. The most widely used typology for national-level ecosystem and habitat mapping and assessment is Annex I of the Habitats Directive. Additionally, CORINE is employed for terrestrial ecosystems, HELCOM HUB (Boedeker et al., 2013)for marine ecosystems, and a national forest ecosystem typology by the National Forest Register and various studies (Imants Liepa et al., 2014; Kabucis, 2001). While the National terrestrial habitat typology is not commonly used for national-scale mapping, it serves specific cases to assess non-protected habitats and ecosystems. Moreover, the WFD typology of water bodies is integral to river basin management plans and freshwater ecosystem assessments. These typologies operate at fine and coarse resolutions and are available in digital format, facilitating their accessibility and utilisation.

In terms of ecosystem condition assessment beyond mandatory EU directives' assessments, Latvia's approach has primarily been driven by the Nature Conservation Agency for terrestrial ecosystems, the Latvian Institute of Aquatic Ecology for marine ecosystems, and the Latvian Environment, Geology, and Meteorology Centre for freshwater ecosystems. While the assessment methodologies vary, the approach consistently leans toward complete surveys or statistically robust estimates.

The ecosystem condition assessment encompasses a range of ecosystems, including forests, grasslands, wetlands, heathlands, shrubs, freshwaters, and marine environments. Indicators are employed to estimate the conservation status and ecological status of these ecosystems, with thresholds or reference levels defined in some cases.

Data for these assessments are sourced from in-situ data providers such as the Nature Conservation Agency for terrestrial ecosystems, the Latvian Institute of Aquatic Ecology for marine ecosystems, and the Latvian Environment, Geology, and Meteorology Centre for freshwater ecosystems.

Lithuania

In Lithuania, ecosystem management and assessment are underpinned by the utilisation of the MAES typology (Maes J et al., 2013). The spatial resolution of the

typology units varies, with some operating at fine resolution and others at a coarser scale. However, the availability of digital maps of these typology units remains uncertain at this point.

Ecosystem condition assessments in Lithuania extend beyond the mandatory EU directives and are carried out by the Environmental Protection Agency Lithuania and various research institutions, predominantly universities. These assessments cover a wide array of ecosystems, including agricultural areas, forests, grasslands, urban areas, and freshwater bodies.

Various indicators, such as land use classes, soil characteristics, air and soil temperatures, precipitation, and chemical properties of surface and groundwater, are employed in these assessments. Nevertheless, as of now, defined thresholds or reference levels for these indicators are yet to be established. The assessment methodologies employed in Lithuania are based on the extrapolation from a limited amount of data. The software tools used for conducting these assessments include MS Excel and Hysplit, depending on the specific ecosystem and its associated indicators.

Moreover, the data sources for these assessments primarily rely on field sampling carried out by Lithuanian authorities. The spatial coverage and resolution of these datasets vary, with some being spatially explicit. The temporal resolution of data collection is generally annual, with a few exceptions in certain datasets. The available data spans from as early as 1990 to the most recent data available for 2021.

Luxembourg

Luxembourg, as a part of its ecosystem assessment practices, employs multiple ecosystem typologies, including the Biotope Cadastre of Open Landscapes (Naumann, 2009) and the Forest Biotope Cadastre (Ministère de Développement durable et des Infrastructures Administration de la nature et des forêts Service des forêts, 2017). The former represents a fusion of "open landscape" Habitat Directive classes, mapped exclusively in national protected areas, and a dedicated national classification focusing on natural springs and their immediate surroundings. The latter pertains specifically to Habitat Directive classes related to forests. Additionally, the Forest Inventory indicates forest classes per dominant species-assemblage. These typologies serve both international and national scopes, although they are not compatible with international classifications. Fine resolution units are used within these typologies, and they are available in digital format.

In terms of ecosystem condition assessment, the country has extended its evaluations beyond the mandatory EU directives' assessments. However, the assessment process is characterised by its current absence of dedicated monitoring for ecosystem condition across all ecosystems. Instead, condition assessment primarily occurs within isolated project work, not tied to a specific reporting framework. Recent efforts have been directed more toward ecosystem services rather than direct condition assessment. Luxembourg is also implementing the River Ecosystem Service Index (RESI) project.

In terms of ecosystems assessed, the country has focused on grasslands and forests. For grasslands, bird species richness is assessed using data-derived indicators, with thresholds and reference levels defined. The assessment methods are based on complete survey or statistically robust estimates or extrapolation from a limited amount of data, relying on bird species richness and the Cadastre. Python and GIS tools are employed in the assessment process.

Regarding data sources, Luxembourg relies on datasets provided by MECDD (Ministère de l'Environnement, du Climat et du Développement durable). These datasets cover a wide spatial range, with a spatial resolution of a 25m² minimum mappable unit. The temporal resolution varies, with yearly updates in subsets rather than a fixed update cycle. These datasets have been available since 2011 and continue to be updated.

Malta

Malta adopts the EUNIS and MAES ecosystem typologies, which are applied at both international and subnational levels. While a national assessment is yet to be undertaken, Malta has conducted numerous subnational assessments as integral components of national strategies and European projects, such as LIFE IP(Project Green - Valley Management, 2023) and during recent Horizon 2020/Europe and other EU-funded projects which have involved national authorities in Malta (e.g., ESMERALDA, EnRoute, ReNature). These typologies have been adapted and designed to align with international classifications, including EUNIS and CORINE and the MAES initiative of the European Commission. The scope of these typologies encompasses a range of geographical levels, including international, national, and subnational. However, it should be noted that not all ecosystem typology units have been digitally mapped, leading to varying spatial resolutions. The availability of digital maps may differ based on the specific ecosystem.

Beyond the obligatory assessments mandated by EU directives, Malta has extended its ecosystem condition evaluations. Key organisations involved in these assessments include the Environment & Resources Authority and the Energy and Water Agency. A variety of ecosystems have been assessed, with a focus on valleys and their associated water catchments, as well as urban areas. These assessments employ a diverse set of ecosystem condition indicators, including land cover, population distribution, invasive and alien species, riparian habitat area, hydromorphological changes, number of artificial barriers (water flow), number of artificial reservoirs, soil cover and tree cover. Expert assessments have been carried out for urban and valleys and water catchment ecosystems using expert estimations per land use or land cover class (e.g., Balzan et al., 2021).

These assessments utilise a range of methods, primarily relying on Geographic Information System (GIS) tools and geospatial analysis. Field surveys were conducted for valleys and water catchments in 2018 which was subsequently followed with a spatial analysis and modelling, and subsequently leading to the publication of ecosystem service maps for the considered valleys and water catchments. In urban

areas, data sources include land use and land cover (LULC) maps, expert assessment, and spatial proxies.

Norway

Norway's ecosystem assessment landscape is characterised by a harmonised typology known as "Nature in Norway (NiN)," with concerted efforts made to align it with the EU Ecosystem Typology for accounting, specifically at Levels 1 and 2 (Framstad et al., 2022). This typology has not been mapped; therefore, digital maps are not readily accessible.

The Norwegian Institute for Nature Research (NINA) has conducted ecosystem condition assessments beyond the EU directives. The assessments encompass various ecosystems, including forests and mountains. For both ecosystems, an index-based approach relying on multiple variables is employed. These assessments are underpinned by extensive research, with reference levels and limits defined for the indicators used. NINA utilises its own models and tools.

In terms of data sources, the country uses diverse datasets to support its ecosystem assessments. National land cover maps, provided by the National Land Resource Map, offering spatially explicit data at a fine resolution of 0.2 hectares and updating every 7-8 years since 2006 are used. Additionally, data on habitat types are sourced from The Norwegian Biodiversity Information Centre, providing detailed information at a 1:500 spatial resolution, with ongoing updates.

Poland

In Poland, the ecosystem typology is primarily based on the MAES typology (Maes J et al., 2013), which has an international scope. The typology units are characterised by a coarse spatial resolution, and digital maps of this typology are readily available.

Ecosystem condition assessments in Poland go beyond the mandatory EU directives, and these assessments are carried out by several organisations. These organisations include the Chief Inspectorate for Environmental Protection, which carries out State Environmental Monitoring (PMŚ), The General Directorate for Environmental Protection (GDOŚ), the Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG), Polish Geological Institute - National Research Institute (PIG) and the State Forests (LP). These assessments encompass a range of ecosystems and involve specific indicators, each with its own unique assessment methods. For some of these indicators, clear thresholds or reference levels have been defined.

Agroecosystems are monitored using data from Statistics Poland, the Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG), and the EC Joint Research Centre (JRC). These sources provide valuable insights into aspects such as crop productivity, biomass production, and soil health, with digital information accessible through shapefiles.

Forest ecosystem assessments are overseen by the State Forests and draw data from sources such as the Forest Inventory Results, Forest Monitoring Data, and Forest Stand Data. These assessments, which include forest health indicators, are conducted at the natural forest land level and across various voivodeships and regional directorates. The data is available at regular intervals, offering continuous insights into forest condition.

For urban ecosystems, data is primarily sourced from the European Environment Agency (EEA) under the framework of the Copernicus program, which includes the CORINE Land Cover (CLC), Copernicus layer Total productivity, Tree cover density, and Urban Atlas. Additionally, the General Directorate for Environmental Protection in Poland provides data related to protected areas. These sources provide comprehensive information on urban greenery, productivity, and land cover every few years, enabling the monitoring of changes and trends in urban environments.

Freshwater ecosystem assessments are conducted using data from State Environmental Monitoring (SEM), focusing on surface water bodies. The data is collected annually and has been available from 2016 to 2020. For marine water ecosystems, assessments are overseen by State Environmental Monitoring (SEM) in Polish Coastal Waters. Data sources for these assessments are varied, and indicators are calculated at various intervals. The data include information on biological diversity, non-indigenous species, fish and shellfish populations, eutrophication, sea-floor integrity, contaminant concentrations, marine litter, underwater noise, and energy.

Portugal

In Portugal, the primary ecosystem typologies used are the Carta de Ocupação e Uso do Solo (COS) (RDEA - Regional Directorate of the Environment of the Government of the Azores, 2018) and Carta de Ocupação do Solo Conjuntural (COSc) (Caetano and Marcelino, 2022), both with a national scope (Costa et al., 2022). These typologies are compatible with various international classifications, including MAES, CORINE, EUNIS, and IUCN. They offer fine-resolution mapping, and digital maps of these typologies are readily available.

Regarding ecosystem condition assessment, Portugal has done assessments beyond the EU directives. The assessment is conducted by various organisations, including Direção-Geral do Território, which has developed technical specifications for the COS. Several ecosystems are assessed, including forest ecosystems, heathland, sparsely vegetated land, agroecosystems, and more. Various indicators are used, such as soil organic carbon, diversity of tree species, forest biomass, invasive species, and fire recurrence. The assessment methods involve a combination of GIS, field inventory, scientific literature review, and public official statistics.

Data sources for ecosystem condition assessment in Portugal include agencies such as the Agência Portuguesa do Ambiente (APA), Instituto da Conservação da Natureza e Florestas (ICNF), and Instituto Nacional de Estatística (INE). These datasets cover various aspects, such as soil organic carbon, forest inventory, invasive species, burned areas,

environmental statistics, and agro-environmental indicators. They exhibit varying spatial and temporal resolutions, with some data being updated annually.

Romania

In Romania, the primary ecosystem typology employed is EUNIS (Davies et al., 2004), which has an international scope. The spatial resolution of this typology is fine. However, digital maps of the typology units are not available. The ecosystem condition assessment in the country extends beyond mandatory EU directives, and various organisations are involved in this process, such as the National Institute for Research and Development in Forestry "Marin Drăcea," the National Research and Development Institute for Environmental Protection in Bucharest, and several academic institutions.

These assessments cover a range of ecosystems, including urban areas, croplands, grasslands, forests, heathlands, shrublands, sparsely vegetated land, wetlands, rivers and lakes, marine inlets, transitional waters, and coastal ecosystems. Each assessment employs a variety of indicators with defined thresholds or reference levels, using different assessment methods.

The primary data sources for these assessments include CORINE Land Cover data, LPIS data from the National Agency of Cadastre and Land Registration, orthophoto maps, DTM LIDAR data from the Ministry of Environment, Water and Forests, SPOT satellite imagery from CNES, geological maps from the Geological Institute of Romania, soil maps from the National Research and Development Institute for Pedology, Agrochemistry, and Environmental Protection, DEM data from the European Environment Agency, climatic data from WorldClim – Global Climate Data, and forest type maps from the JRC. These data sources vary in spatial and temporal coverage.

Slovak Republic

In the Slovak Republic, the ecosystem typology employed is EUNIS, complemented by a national typology primarily based on the national catalogue of habitats (Valachovič and Stanová, 2002). This typology exhibits an international scope and is compatible with the EUNIS classification. The spatial resolution of the typology units is characterised as coarse, and digital maps of the typology are readily available (Černecký et al., 2020). The ecosystem map has been compiled from various sources: (1) the non-forest areas were delineated on the basis of data from the land parcel identification system (LPIS, 2018); (2) Data on spatial distribution of forest ecosystems were subsequently obtained from the National Forest Centre and added to the collected data (NFC, 2017); (3) Watercourses, road and railway infrastructure, buildings and urban vegetation elements were incorporated into the map on the basis of Open Street map data (Geofabrik, 2015); (4) Corine Land Cover (CLC, 2012) data was used as the basis for filling in areas where more accurate spatial data was lacking.; (5) Selected attributes of habitats were then taken from Comprehensive Nature Conservation Information System – CNCIS (SNC SR, 2018) databases as a basis for ecosystem identification.

Beyond the obligatory EU directive assessments, ecosystem condition assessment is actively conducted by the State Nature Conservancy of the Slovak Republic, collaborating with research institutions such as universities and the Slovak Academy of Sciences.

Ecosystems such as grasslands and forest have been assessed using factors such as human interventions in the forest and the age of the forest, with corresponding thresholds. Arable land assessments focus on soil fertility, again with established thresholds. Terrestrial ecosystem assessments encompass habitat distribution and conservation status, utilising various methods ranging from expert opinion to comprehensive surveys or statistically robust estimates.

Data sources for these assessments are extensive and diverse, covering various spatial and temporal scales. The State Nature Conservancy provides a comprehensive map of ecosystems. Monitoring of habitats of European interest, also provided by the State Nature Conservancy, similarly offers extensive spatial coverage. The National Forest Centre contributes forestry data sets with detailed spatial and temporal information, spanning from 2007 to the present day.

Slovenia

In Slovenia the ecosystem typologies used include PHYSIS (Jogan et al., 2004), EUNIS, and MAES (Šmid Hribar et al., 2021). The typologies have a fine spatial resolution, and digital maps are available.

Regarding ecosystem condition assessment, the respondent is not aware of assessments beyond the mandatory EU directives. The Institute of the Republic of Slovenia for Nature Conservation, with subcontractors, is involved in ecosystem condition assessment. The specific ecosystems assessed, indicators used, and methods are not detailed.

Several datasets are used, including a land use database from the Ministry of Agriculture, Forestry and Food, habitat types, the Register of Natura 2000 areas, the Register of valuable natural features, ecological important areas, protected areas, and the Water cadastre.

Spain

In Spain, a diverse array of ecosystem typologies is employed for classifying and assessing various ecosystems. This approach integrates both international and national perspectives and is designed to align with global classifications:

- Millennium Ecosystem Assessment: Adapted for Spain by (Santos-Martin, 2014), this framework offers a comprehensive perspective on ecosystem services.
- MAES (Mapping and Assessment of Ecosystems and their Services): Aligns with broader European initiatives for ecosystem mapping and assessment.

- LULUCF (Land Use, Land-Use Change, and Forestry): As explored by (Lerner Cuzzi et al., 2021), this typology provides insights into the impact of land use on ecosystems.
- SIOSE (Information System for Land Occupation in Spain): This national system offers detailed land use and land cover data, crucial for understanding and mapping Spanish ecosystems.

These typologies, covering international and national scopes, are compatible with global standards like IUCN-GET. They provide fine spatial resolution, and digital maps are readily available.

Ecosystem condition assessments in Spain have largely been centred around mandatory EU directives, with limited official conduct of assessments extending beyond these directives. However, a pilot study focusing on ecosystem conditions at the national level for forest ecosystems was conducted and published by Bruzón et al. (2023). This study specifically targeted 18 types of forest ecosystems, including a range of broadleaved and coniferous ecosystems across various Mediterranean, Atlantic, Alpine, and Macaronesian regions, as well as mixed ecosystems within these categories.

These assessments incorporated a suite of 11 indicators. These indicators included the Normalised Difference Water Index (NDWI), Soil Organic Carbon (SOC), AOT40f (Ozone), Nitrogen Depositions (critical loads), Species Richness of Forest Birds and Vascular Flora, Tree Cover, Normalised Difference Vegetation Index (NDVI), Gross Primary Productivity (GPP), Forest Area Density, and the Naturalness Index. For each of these indicators, specific reference levels and thresholds were established. The assessment methodologies were based on comprehensive surveys or statistically robust estimations, utilising analytical tools like ArcGIS Pro, Google Earth Engine, and Python for data analysis and visualisation.

The data sources leveraged for these condition assessments included satellite data from Landsat and MODIS sensors, Topsoil Organic Carbon Content datasets (OCTOP) for analysing topsoil organic carbon content, interpolated air quality data sourced from the European Environment Agency (EEA), and information regarding critical loads of eutrophication deposition. Reports on the application of the Habitats and Birds Directives in Spain also contributed to these assessments. In addition, tools, and databases such as the Guidos toolbox, the LULUCF database, and the Spanish National Ecosystem Assessment provided valuable data sources for evaluating the country's ecosystems.

Sweden

Sweden relies on several ecosystem typologies for assessments, including the National Land Cover Data (NMD) (Naturvårdsverket, 2020), National Forest Inventory (NFI) (Fridman et al., 2014), and National Inventering av Landskapet i Sverige (NILS) (Esseen et al., 2007). These typologies primarily have a national scope and are compatible with international classifications, but not completely. For example, NMD is partly compatible with CORINE as well as EUNIS, while other national typologies may not align with international standards. Spatial resolutions for these typologies vary from fine to coarse, with both digital and non-digital map formats available.

The country assesses ecosystem condition beyond mandatory EU directives, with key organisations involved including the Swedish Environmental Protection Agency, Swedish University of Agricultural Sciences, Swedish Board of Agriculture, and Swedish Forest Agency. Ecosystem assessments span various categories, such as forests, deciduous forests, natural grasslands, wetlands, and mountains. For these ecosystems, indicators are used to evaluate condition, but not all have defined thresholds or reference levels. The assessment methods vary, with a predominant reliance on remote sensing and field inventories.

The ecosystem assessment efforts draw data from multiple sources. The NMD has a spatial resolution of 10 metres and is available across the country. NFI and NILS both provide spatially explicit information, with data from samples across the country.

Switzerland

Switzerland utilises the TypoCH ecosystem typology (Delarze et al., 2008), which has a national scope and is compatible with international classifications, including EUNIS, MAES, and IUCN. This typology is characterised by fine spatial resolution and digital maps are available.

Ecosystem condition assessments beyond mandatory EU directives are conducted primarily by InfoSpecies and the Swiss Federal Institute for Forest, Snow and Landscape Research (WSL). The assessments cover various ecosystems, including dry meadows and forests with nitrogen load as an indicator. For dry meadows, forests, and bogs and fens information related to excessive nitrogen inputs and ammonia emissions is used. For forest assessments indicators such as deadwood volume, forest biomass, growing stock, stand density, and structural diversity are used.

In addition, assessments for all ecosystems except marine involve the presence of indicator species. However, thresholds or reference levels for these indicators are not defined. The assessments are conducted using a method involving sample plots extrapolated to larger regions. There is also an assessment for naturalness, human impact, remoteness, and ruggedness.

Switzerland has access to various data sources, including air pollutant concentration data provided by the Swiss Federal Office for the Environment, with spatially explicit data and an annual temporal resolution. The National Forest Inventory data is provided by the Swiss Federal Institute for Forest, Snow, and Landscape Research (WSL) and covers production regions or bioregions with multi-year surveys conducted from 1983 to 1985 and 2009 to 2017. The data sources for NDVI and NDWI come from the Swiss Data Cube, with spatially explicit data at a resolution of 30 metres, and an annual temporal resolution.

The Netherlands

In the Netherlands, the primary ecosystem typology utilised for assessing ecosystems is the new European ecosystem typology for ecosystem accounting (EUROSTAT, 2023). This typology has an international scope and is designed to align with the latest standards in ecosystem accounting. While it is international in scope, it is also compatible with other international classifications, particularly the updated and enhanced MAES typology.

Regarding ecosystem condition assessments, the Netherlands has gone beyond the mandatory EU directives, covering a wide range of ecosystems across the country. Ecosystem condition assessments are conducted by the Central Bureau of Statistics (CBS) and Wageningen University and Research (WUR). These assessments encompass multiple indicators and employ various methods and tools to evaluate the condition of ecosystems.

Some of the ecosystems assessed include all types found in the Netherlands, and the indicators used for assessment vary depending on the ecosystem type. For instance, for all ecosystems, indicators such as vegetation cover, hedgerow density, and the percentage of area managed for nature protection (including Natura 2000 areas) are considered.

Furthermore, forest ecosystems, open nature areas, wetlands, water bodies, coastal areas, cropland, grassland, horticultural areas, other agricultural lands, urban and infrastructure regions, and public green spaces have been assessed using indicators such as the Living Planet Index and Mean Species Abundance. These indicators help assess the biodiversity and health of these ecosystems. In addition, specific indicators related to air quality, eutrophication, acidification, and urbanisation pressure are evaluated for different ecosystem types.

The methods used for assessing ecosystem condition include remote sensing, GIS, and trend analysis with Kalman filtering. These techniques are applied to analyse spatial and temporal data.

As for data sources, the Netherlands has a comprehensive set of resources for these assessments. These sources include ecosystem extent accounts, vegetation cover data, hedgerows and tree rows datasets, areas managed for nature protection records, and information on various environmental indicators. These data sources are typically maintained by different organisations, such as CBS, WUR, the Dutch Cadastre (Kadaster), and more. They offer fine spatial coverage with varying spatial resolutions, temporal resolutions, and data availability years, enabling ongoing monitoring and analysis of ecosystem condition.

United Kingdom

In the United Kingdom, a variety of ecosystem typologies are used, which depend on the specific policy or private sector application. These typologies are primarily based on

adaptations of EUNIS or MAES (Edwards J et al., 2020), with more recent utilisation of UN SEEA -EA typology based on the GET. They have a national scope and are compatible with international classifications, such as EUNIS or MAES. The spatial resolution of these typology units is fine, and digital maps of the typologies are readily available.

Ecosystem condition assessments in the UK go beyond mandatory EU directives and are conducted by organisations such as Defra and Natural England. These assessments cover a wide range of terrestrial ecosystems and utilise various indicators. In some cases, thresholds and reference levels have been defined. The assessment methods used vary in complexity, with references available for each specific indicator. For instance, soil pH data are sourced from the UK Centre for Ecology and Hydrology, while the Bat index for woodlands is provided by the Office for National Statistics and the Bat Conservation Trust.

Data sources for these assessments are diverse and often collected by governmental and environmental agencies. They cover different spatial and temporal resolutions, with records dating back to the late 1970s. For example, soil pH data is sourced from the UK Centre for Ecology and Hydrology, while the National Forest Inventory is conducted by Forest Research.

5.3. Linking national and international ecosystem typologies

The ecosystem typologies used at national level by SELINA partners, as well as the scale at which they are used (scope of utilised typologies), and compatibility of these with international typologies is outlined in Section 5.2.

As the amendment to Regulation 691/2011 (Proposal 2022/0210) (European Commission, 2022a) on reporting on European environmental economic accounts extends 'the scope of the European environmental economic accounts to provide better information for the European Green Deal, a growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy' (European Commission, 2022a). The addition of a reporting module on ecosystem accounts is underpinned by the framework of SEEA Ecosystem Accounts and is hence links to ecosystem accounting at national level. To facilitate this, a proposed ecosystem typology (EUROSTAT, 2023) referred to as the European Typology for Accounting, was developed to enable the compilation of ecosystem extent accounts in a harmonized manner at EU level. It is therefore of interest know how information on ecosystems at national level can be reported under this new typology.

In an exercise to explore the extent to which a national ecosystem typology can be used to report ecosystem extent accounts under the European Typology for Accounting, and how this can be enhanced using openly available Earth Observation information, the Ecosystem Map of Hungary (noted in Section 5.2.2 Country Specific Typologies + Condition Assessments), is used. This is based on the 'National Ecosystem Type Map Categories' (Tanács et al., 2022). It follows the MAES ecosystem typology (Maes J et al., 2013) and is a spatially and thematically detailed, hierarchical map developed for the Hungarian Mapping and Assessment of Ecosystem Services (MAES-HU).

The advantage of using the Ecosystem Map of Hungary as a basis for this work is the detailed information on ecosystem types available at national level and that the basis of the map is partly similar in terms of typologies and classes to the proposed European Ecosystem Typology for Accounting. It therefore allows the drawing of valuable conclusions for the typology crosslinking process.

The structure of the Ecosystem Map of Hungary at Level 1 corresponds to MAES Level 2 types, with 6 categories represented in Hungary: urban, croplands, grasslands and other herbaceous vegetation, forests and woodlands, wetlands, rivers, and lakes, with 56 Level 3 types. This finer level was designed to approximate the Hungarian Á-NÉR General National Habitat Classification System (Bölöni et al., 2007). However, as Á-NÉR uses differential herbaceous species in its definitions, the final topology of the ecosystem map is unique, with its own rules and definitions. The approach to mapping was based on the identification and use of regularly updated sectoral databases. Image-based predictive mapping was used to fill data gaps, based on Earth Observation and environmental datasets. The mapping process was followed by validation with local experts.

The European Ecosystem Typology for Accounting is described in Section 6.1.5., and the crosslinks and mapping exercise is described in detail in Section 6.3.

6 International ecosystem typologies

International ecosystem typologies and classification systems first emerged in the third quarter of the 20th century (Figure 9) as means to set common habitat definitions for global intergovernmental environmental agreements. Subsequently, the increasing awareness of environmental issues and more widespread availability of digital data and processing capabilities supported the development of various habitat based as well as hybrid land cover ecosystem typologies.

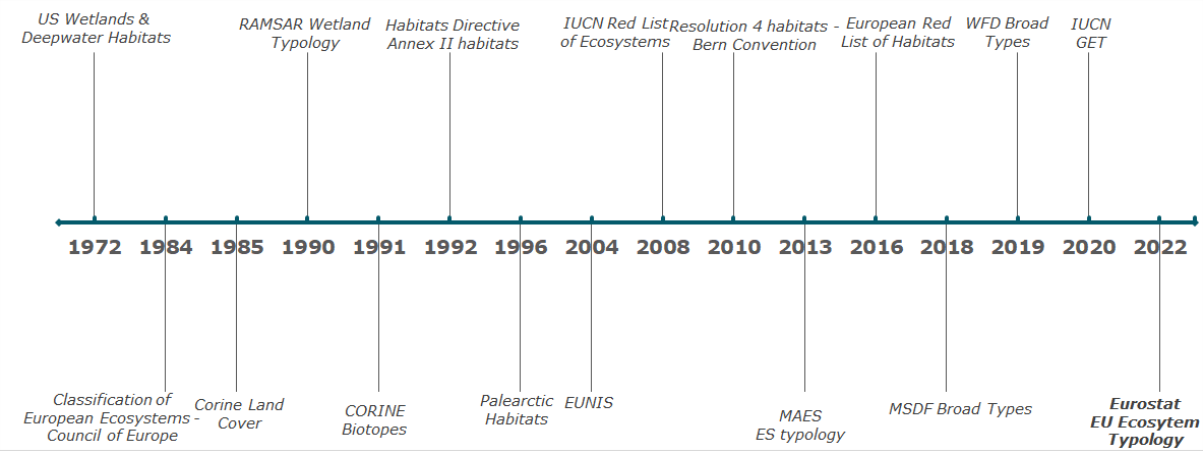


Figure 9. Simplified timeline of the main ecosystem typologies, habitat classifications and land cover classification systems (Source: Own diagram).

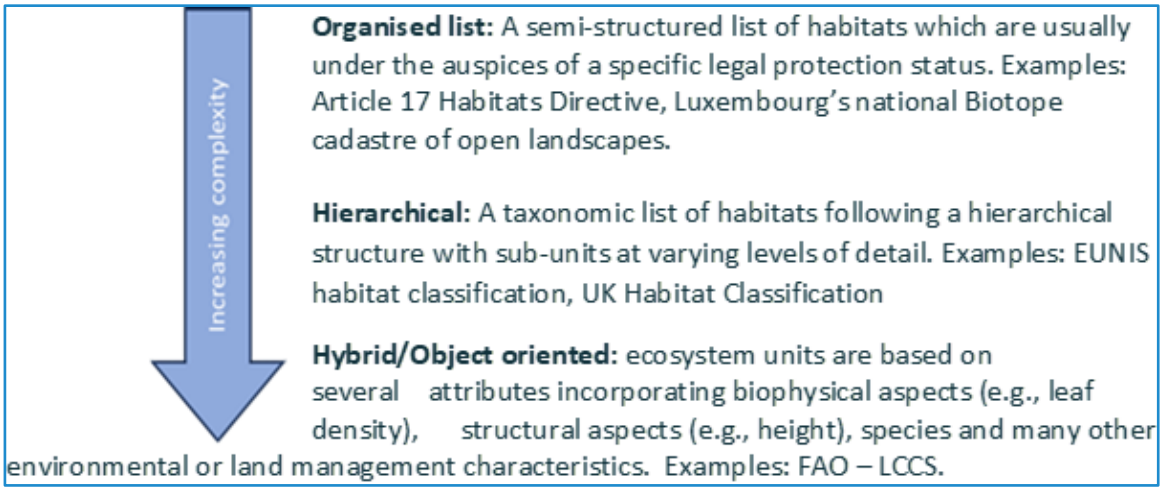
Systems of grouping, defining the environment in which we live, were developed to address specific questions at varying scales, or to address specific policy needs, both nationally and internationally. Therefore, it is important to distinguish between the related concepts of ecosystem typology, habitat classification and land cover classification. There is no universal definition for any of these concepts, but the similarities and differences in these are described in Bogaart et al. (2019) in the context of SEEA ecosystem accounting and specifically the development of a reference classification of ecosystem types.

Habitats are described as: (i) 'provided by ecosystems for individual species' (Bogaart et al., 2019; (ii), 'the place or type of site where an organism or population naturally occurs' (Secretariat of the Convention on Biological Diversity, 2011); and (iii) 'a place where plants or animals normally live, characterised primarily by its physical features (topography, plant or animal physiognomy, soil characteristics, climate, water quality etc.) and secondarily by the species of plants and animals that live there' (Davies et al., 2004). Habitat classifications based on species descriptors are not conceived specifically to describe ecological processes, however, the concept of describing a 'habitat' is widely used and can be used as a proxy for ecosystems.

Land cover classifications are based on the physical aspects of landscapes rather than biodiversity or the biological aspects of land cover. Land cover is described as (i) "physical and biological cover of earth's surface including artificial surfaces, agricultural areas, forests, (semi-) natural areas, wetlands and water bodies" in the EU INSPIRE

Directive (European Commission, 2007); and (ii) is described as the combination of landscape elements, like buildings, trees, roads, water bodies etc, along with biophysical characteristics to portray a continuous surface (Arnold et al., 2023). As land cover classifications are widely used, and information is more readily available and more easily interpreted, they can be used as a starting point to provide a more spatially detailed ecosystem classification. It is acknowledged that land cover classifications, while used as proxies of ecosystem types, are limited in thematic accuracy (Vallecillo et al., 2022), however as a spatial component is important for condition assessment (i.e., under the EU-wide methodology), land cover classification i.e., CLC, is the best available data source to disaggregate broad ecosystem types into land cover types.

Ecosystem typologies differ by their order of organisation as well as level of detail. They may feature a specific focus, such as monitoring specific habitats or environmental processes, or may be developed to address a specific policy need. In addition, they may have also developed around the constraints of a specific sensor or data source.
The three general forms of organisation within typologies observed are:



In terms of their thematic and physical class content, a typology may be derived from plant community based taxonomic definitions and based on a 'classification' system for defining habitats within ecosystems (e.g., EUNIS), to more land cover and land use focused systems that characterises landscape elements, allowing individual classes to be described (e.g., Corine Land Cover). The term "ecosystem typology" in this report incorporates all of these.

Crosslinks between typologies enable the translation between the class descriptions or 'nomenclatures' used in each. Linking two nomenclatures shows the degree of similarity and requires a translation of terminology used. The degree of similarity tells if classes between typologies are equal or are better described as overlapping, broader than or narrower than each other. This is important both in terms of the definition but also for practical purposes e.g., mapping where classes need to be aggregated etc. Crosslinks also identifies inconsistencies in the use of synonyms which may cause misinterpretation of the underlying matter. Likewise, in ecosystem typologies, similar class naming may not always carry the same meaning. This circumstance becomes

increasingly evident with the level and detail of classification that is compared. For example, urban areas may be defined by many different parameters, including the degree of soil sealing, building height and configuration, land use and management, and presence of ruderal species. The same applies for grasslands which may vary drastically in terms of species composition based on abiotic environmental properties.

In the context of this work a database has been compiled with a group of the more frequently used international typologies as identified from a literature review. The aim of this is to gather basic information on these typologies in one repository including published crosslinks. (see international typology & dataflow database draft). Further to this, the European Ecosystem Typology for Accounting is highlighted for an exercise integrating data streams that define and allow the crosslinking and mapping of ecosystem types.

6.1 Description of international ecosystem typologies

In the context of this report, 'International Ecosystem Typologies' is a grouping term used to refer to the ecosystem typologies, habitat classifications and land use classifications. Typologies are diverse in terms of their content, purpose, development, and structure, as highlighted above. An overview and summary of the key ecosystem typologies is given for those considered in the 'International typology & dataflow database_draft', a data repository accompanying this report, which gathers information on the typology structure and crosslinks between them.

6.1.1 Annex I Habitats Directive

Annex I habitats of the Habitats Directive (European Commission, 1992) are natural and semi-natural habitat types of community interest whose conservation requires the designation of special areas of conservation. The overall aim of the Directive is to ensure that all habitats (and species listed in Annex II) are maintained or restored to a favourable conservation status within their natural range in the EU. There are 233 habitat types in the Annex that are reported under Article 17 (the habitats within are often referred to as Article 17 habitats), of which more than one-third are designated as priority due to being in danger of disappearance, and therefore require a higher degree of protection than the non-priority habitats. While the European Commission publishes an interpretation manual for the list of habitats (European Commission, 2013), several countries publish their own guidelines, based on these. Annex I was initially based on the hierarchical classification of European habitats developed by the CORINE Biotopes (Devillers et al., 1991), the only existing classification at European level at that time. A draft list of habitat types for Annex I was then compiled from this and submitted to national experts preparing the Directive as a working document in August 1989. The Annex I list was published in the Official Journal in May 1992 (European Commission, 2013) upon completion. Article 17 reporting requires reporting on the Conservation Status of Annex I habitats every 6 years. This is further described in Section 6.2.

6.1.2 Broad Types - Water Framework Directive derived

The 'Broad Types' (Lyche Solheim et al., 2019) is a surface water typology derived from the intercalibration process of national classification systems under the Water Framework Directive (European Commission 2000), aimed at linking national water body types to a few European types which could be used to aggregate and compare information one ecological status and pressures across countries (Lyche Solheim et al., 2019). The typology is based on a set of descriptors representing the permanent characteristics of the water body intercalibration types (European Topic Centre on Biological Diversity, 2015)and the broad types are further grouped based on a limited number of abiotic discriminating factors (e.g. altitude, geology). The Broad Type system correlates well with both the national WFD types (60-70%) and European rivers and lakes in general (80%) (Lyche Solheim et al., 2019). Reporting under the WFD requires the assessment of good ecological status (GES) as well as good chemical status. This is further described in Section 6.2.

6.1.3 Broad Types - Marine Strategy Framework Directive

The MSFD typology is the list of habitats, also referred to as MSFD Benthic Broad Habitat Types (Palialexis, 2018), compiled for assessing the Good Environmental Status (GES) in marine waters. They are derived from the EUNIS 2012 marine habitat classification and can correspond to one EUNIS type or an aggregation of several EUNIS types. The MSFD Broad type list (European Commission, 2017) is The European list of marine habitats reported on, however the marine habitats assessed and reported on at national level may go beyond this list. Reporting under the MSFD requires the reporting on good environmental status (GES), further described in Section 6.2.

6.1.4 Corine Land Cover

The Corine Land Cover (Coordination of information on the environment) typology is based on an information system of recording land cover and land use data under the Copernicus Land Monitoring Service (CLMS). It was originally established as a tool to inform environmental policy in relation to land cover and extracts information from high resolution satellite images as a basis for land cover mapping. The reference year of the first CLC inventory was 1990, and the first update was in 2000. Further inventories followed with an update cycle of 6 years (European Environment Agency (EEA), 2021). The typology is divided into 5 broad level land-cover classes: artificial surfaces, agricultural areas, forest and semi-natural areas, wetlands, and water bodies, beneath which are 2 further levels, including detailed definitions for 44 level 3 land cover classes.

6.1.5 EU Ecosystem Typology for Accounting

The EU Ecosystem Typology for Accounting is under development for the purpose of obligatory reporting on Ecosystem accounts (extent, condition, and ecosystem services) by European Member States from 2026 onwards under Proposal 2022/0210 (European Commission, 2022). The typology (EUROSTAT, 2023) defines the ecosystem Level 1

classes for obligatory reporting, with a finer division at Level 2 (voluntary reporting) and Level 3. It is based on MAES classes at Level 1 while aligning with CLC at Level 2 and both EUNIS and Corine Land Cover classes at Level 3. The Level 2 classes support the mapping and modelling of ecosystem conditions and ecosystem services. The typology is still under development at the time of writing this report, however it is near finalisation. The classification at Level 1 can be considered an update of MAES, with the main difference being the insertion of a new Level 1 class 'Coastal ecosystems', which, among others - prevents coastal beaches being placed in the same ecosystem type as mountain peaks (which would both be in the 'sparsely vegetated' ecosystem class under the MAES typology). In addition, the new ecosystem typology also includes the new Level 2 and Level 3 classes.

6.1.6 EUNIS European Nature Information System - Habitats

The EUNIS habitat classification is a comprehensive cascading typology covering the whole of the European land and sea area, i.e., the European mainland as far east as the Ural Mountains, including offshore islands (Cyprus; Iceland but not Greenland), and the archipelagos of the European Union Member States (Canary Islands, Madeira, and the Azores), Anatolian Turkey, and the Caucasus. It is in line with other European-scale typologies, such as the Palearctic habitat classification (Devillers and Devillers-Terschuren, 1996) and comparable to the scale applied to the classification of vegetation in traditional phytosociology. All but the smallest EUNIS habitats occupy at least 100 m^2; there is no upper limit to the scale of the largest. At the smaller scale, microhabitats (features generally occupying less than 1 m^2 that are important for some smaller invertebrates and lower plants) can be described. At the larger scale, habitats can be grouped as habitat complexes, which are frequently occurring combinations or mosaics of individual habitat types, usually occupying at least 10 ha, which may be interdependent. At present, the EUNIS classification is divided into three main groups; terrestrial, inland surface water, and marine habitats, which each have their own set of criteria and approaches to defining and distinguishing between habitats.

The EUNIS classification system has been undergoing a revision since 2012 and is due for completion for all habitat groups in 2023/2024. The revised EUNIS groups have been published and therefore 2 versions of the EUNIS typology are in use today: EUNIS 2012 and EUNIS 2021. The revised EUNIS groups published to date are marine benthic habitats, marine pelagic habitats, ice-associated marine habitats, coastal habitats, grasslands, and lands dominated by forbs, mosses or lichens, heathland, scrub and tundra, forest and other wooded land, inland habitats with little or no soil and mostly sparse vegetation, and vegetated human-made habitats. The remaining groups for publication are wetland habitats, inland water habitats, and habitat complexes.
It should be noted that EUNIS 2012 is an important typology due to it being used as the underlying data source for other typologies, e.g., Resolution 4 habitats of the Bern Convention.
The EUNIS habitat classification is also the basis for the Ecosystem Map of Europe v3.1 (Weiss and Banko, 2018), developed to improve the biological description of land cover-based ecosystem types and used as input to process for the mapping and assessment

of ecosystems and their services in Europe. The map, with a 100m resolution, uses EUNIS 2012 in combination with other spatial (CLC 2012, OSM, CLMS) data sources.

6.1.7 IUCN Global Ecosystem typology

The IUCN Global Ecosystem Typology is a hierarchical classification system that, in its upper levels, defines ecosystems by their convergent ecological functions and, in its lower levels, distinguishes ecosystems with contracting assemblages of species engaged in those functions (Keith et al., 2020). There are 108 ecosystem functional groups at Level 3, which cascade further down into biogeographic ecotypes, global ecosystem types, and local ecosystem types. The typology, which was adopted in 2020, covers natural, semi-natural and artificial ecosystems. However, artificial and farmed ecosystems are grouped in few classes, which limits their application for ecosystem accounting.

6.1.8 IUCN Red List of habitats

The *European Red List of Habitats* project was carried out during the period 2014-2016 on behalf of the European Commission DG Environment (Gubbay et al., 2016; Janssen et al., 2016) with the aim of providing a Red List assessment of all natural and semi-natural terrestrial, freshwater, and marine habitats in the EU28 and beyond. For the Red List, the EUNIS typology was applied, with some adaptations. These adaptations followed the proposed EUNIS, which were published in the same period for habitat groups: forest, scrub, and grassland habitats (Schaminée et al., 2016, 2014), as well as proposals for other habitat groups. The resulting Red List formed the basis for the new EUNIS proposals in the following years. For terrestrial habitats, the *Red List of European Habitats* was organised into seven expert groups according to EUNIS main types from the 2012 classification: coastal habitats, freshwater types, mires and bogs, grasslands, heathland and scrub, forests, and sparsely vegetated habitats. The Red List applied the criteria and categories according to the IUCN guidelines (with some slight adaptations) and was based on data sources and expert knowledge of about 300 experts from 33 countries. In total, a red list assessment was carried out for 235 terrestrial and freshwater habitats and 257 marine habitats. Detailed information on these habitats is publicly available through online factsheets containing information on, e.g., crosslinks to other classifications, lists of characteristic species, photos, distribution maps, pressures and threats, conservation measures, and data on occurrences in individual countries for this list of habitats (accessible here: https://forum.eionet.europa.eu/european-red-list-habitats/library/).

6.1.9 Mapping and Assessment of Ecosystems and their Services (MAES)

MAES typology (Mapping and Assessment of Ecosystems and their Services) (Maes J et al., 2013) was developed in response to underpinning the delivery of the EU Biodiversity Strategy 2020 for mapping and assessing ecosystems and their services on national territory (Target 2, Action 5 of BDS 2020). An EU-wide ecosystem assessment process

was undertaken to harmonise information on ecosystem condition, biodiversity, and the capacity of these ecosystems to provide ecosystem services. The mapping of MAES ecosystem types is based on EUNIS (2012) level 2 habitat types along with data from Corine Land Cover as the main spatial reference. Further information from e.g., Copernicus high resolution layers, imperviousness information, data from Article 17 and Natura 2000, complete the ecosystem map.

6.1.10 Natura 2000

The Natura 2000 typology is a listing of general habitat classes that was developed to provide an overall picture of the broader characteristics of the protected site. Natura 2000 sites are protected for specific Annex I habitats and Annex II species listed in the EU Habitats Directive. The sites also list other habitats and species from that Annexes that are present but for which the site was not designated. Providing information on the general site character (European Commission, 2011a) gives an indication of the presence of other habitat groups, each provided as a proportion of the total site area.
The 27 classes (N01 to N27) cover the main ecosystem groups with several classes representing on group e.g., N17 Coniferous forest, N18 Evergreen woodland, N19 mixed woodland, and individual classes covering several individual habitats e.g. N02 Tidal rivers, estuaries, mud flats, sand flats, lagoons.

6.1.11 Resolution 4 habitats of the Bern Convention

Annex I of Resolution 4 of the Bern Convention lists 215 habitats protected under the Emerald Network of Nature Protection Sites. The list, adopted in 1996, was a selection of habitats from the Palaearctic classification (Devillers and Devillers-Terschuren, 1996), but in 2010 was revised to be a selection from the EUNIS 2012 habitat classification. As the Palaearctic classification is no longer in use, this transition ensured that the list could be easily updated with new habitats, if relevant. A comprehensive overview of the evolution of the Resolution 4 list can be found in Evans and Roekaerts, 2019). It should be noted that the EUNIS habitat classification on which the list of habitats is based has been undergoing revision since 2012.

6.1.12 Additional international typologies

Further international typologies identified during this work are listed for interest below.

USGS / ESRI World Terrestrial Ecosystem Map

The map of terrestrial World Ecosystems is based on a set of three authoritative data sources, including the World Climate Regions, World Landforms, as well as World Vegetation and Land Cover.
The classification legend is derived from a combination of four factors: temperature and moisture regimes establishing the macroclimate, landforms that modify microclimates

into micro and mesoclimates and world vegetation/land cover that identify the major plant formations.

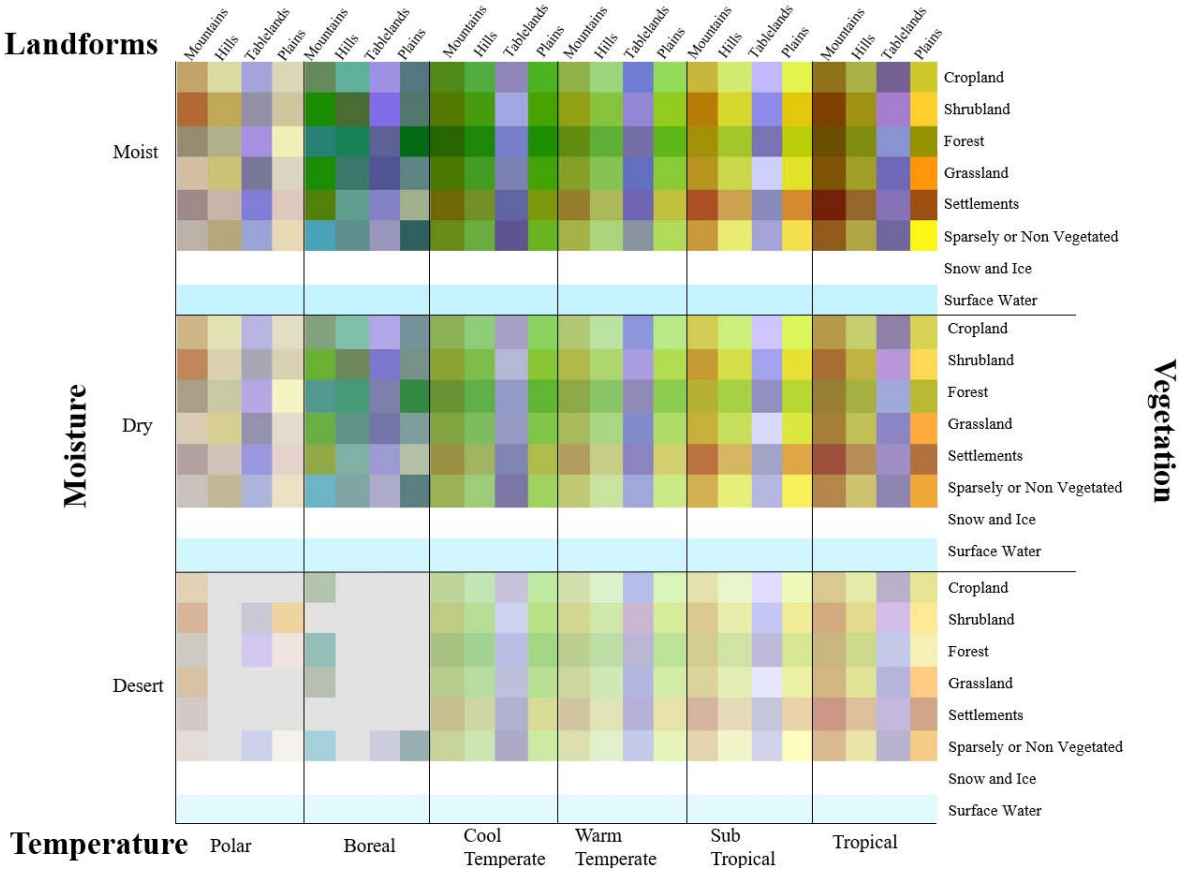


Figure 10. Combination of variables within the terrestrial ecosystems map (Source: https://storymaps.arcgis.com/stories/a4a6b1f779be4b64816d1876cfe669b9 - accessed 07/08)

FAO Land Cover Classification System (FAO LCCS)

The Land Cover Classification System (LCCS) was developed in the late 1990s and first published in 2000 by the FAO (Di Gregorio and Jansen, 2000). It was developed to provide a standardised mapping framework for the classification of land cover by means of field surveys and/or earth observation.

Its main goal was to integrate a large range of classification attributes to overcome problems that pre-assigned land cover classifications pose to mapping heterogeneous and mosaic landscapes in real world settings.

The mapping approach consists of two distinct phases which can optionally build on each other. The first phase is 'Dichotomous' which distinguishes between 8 classes and primarily uses the presence of vegetation and secondarily the edaphic conditions to distinguish classes. The subsequent "Modular-Hierarchical Phase" allows for a deeper description of these main classes by specific a-priori defined classifiers. These are specific to the respective land cover class.

The LCCS was updated in a second (2005) and third version (2016).

Dynamic World Land Use Land Cover Classification Taxonomy

The Dynamic World Land Use Land Cover Classification Taxonomy (Brown et al., 2022) is a global scale ecosystem classification typology based on near real time (NRT) mapping of land use land cover (LULC) using Sentinnel-2 10m imagery. The 'taxonomy' consists of 9 land cover types: water, trees, grass, flooded vegetation, crops, shrub & scrub, built area, bare ground and snow & ice, which are broadly consistent with land use classes in the IPCC Good Practice Guidance and which were developed through a review of existing LULC maps (e.g. USGS Anderson classification system, the ESA LUCAS survey, the Map Biomass Classification and the GlobeLand 30 land cover types).
The dataset behind is regularly updated and the operates as a freely available resource on the cloud system, a clear benefit considering how long it takes to develop conventional land cover maps. This system also has the capability to produce historic land cover information, which in turn allows the capture of land use change.
Dynamic World was developed as a partnership between Google and World Resources Institute.

ELC10 – European 10m resolution Land Cover Map

The Sentinel-based pan-European land cover map (ELC10) (Venter and Sydenham, 2021) is produced using with LUCAS (Land Use/Cover Area Frame Survey) as land cover reference data and CLC to establish baseline land cover proportions. The upper level of the LUCAS land cover typology is used i.e. artificial land, cropland, woodland, shrubland, grassland, bare land, wetland, and water. The spatial coverage is for most of Europe, excluding Malta, Turkey, Iceland, and Turkey. and is roughly comparable to the range covered by CLC. Google Earth engine cloud computing platform was used for remote sensing analyses.
Venter and Sydenham (2021) show the applicability of the ELC10 in being able to distinguish small landscape features such as hedgerows and urban green spaces. Some drawbacks highlighted are issues with distinguishing between shrubland and bare land classes in southern Europe.

6.2 Typologies and ecosystem condition

Ecosystem condition is defined as the quality of an ecosystem measured in terms of its abiotic and biotic characteristics (United Nations, 2021).'Good condition' in relation to an ecosystem is defined in the EU Regulation 2020/852(European Commission, 2020) as being when 'the ecosystem is in good physical, chemical, and biological condition or of a good physical, chemical and biological quality with self-reproduction or self-restoration capability, in which species composition, ecosystem structure, and ecological functions are not impaired'.

In terms of the international typologies outlined in Section 6.1, condition is currently reported under EU obligations as 'status' at regular intervals (6-yearly reporting cycle) e.g. the EU Habitats Directive (HD) assessing the 'structure & function' parameter for reporting 'Conservation Status', the Water Framework Directive (WFD) reporting on

‘Good Ecological Status (GES)’ and the Marine Strategy Framework Directive (MSFD) reporting on ‘Good Environmental Status (GES)’.

Reporting on condition under the WFD and MSFD are largely harmonised at EU level and therefore allow comparability among countries, unlike for the HD where different methodologies are used for assessing the structure and functions of habitats at national level, which is considered in terms of habitat condition. The SEEA EA (United Nations, 2021) and the approach to operationalising the SEEA EA at the EU level in the ‘EU-wide methodology to map and assess ecosystem condition’ (Vallecillo et al., 2022) outline the need for a streamlined assessment of ecosystem condition. In the context of SELINA, Milestone 7 on Reference ecosystem condition definition, Task 3.3 “Derive a minimum set of key ecosystem condition indicators per ecosystem type”, aims to develop a framework for identifying ecosystem condition and reference levels for the wider use in various contexts (Czucz et al., 2023).

In addition to the above, the proposal for an amendment (Council Procedure 2022/0210) (European Commission, 2022a) to Regulation No 691/2011 (European Commission, 2011b) the European Environmental Economic Accounts includes the reporting on extent, condition, and ecosystem services for ecosystem accounts. The ecosystems are those referred to in Section 6.1.5 and the amendment to the regulation includes mandatory indicators to assess condition, with voluntary ones for further consideration (EUROSTAT, 2023). Defining the ecosystem extent is an important first step to assessing ecosystem condition. Extent accounts present policy relevant information on changes in ecosystem extent, and they are the basis for the compilation of ecosystem condition and ecosystem services accounts (EUROSTAT, 2023).

As the extent and condition accounts are supposed to be separate processes, it is important to note that in typologies aiming to provide a comprehensive system, condition and type are often entangled. Much degraded and artificial ecosystems cannot be easily fit into the same system as natural habitats. This leads to the creation of categories such as e.g. ‘T4 - Lines of trees, small anthropogenic forests, recently felled forest, early-stage forest and coppice’ in EUNIS or the ‘uncharacteristic’ categories in Hungarian general national habitat classification system’ (Á-NÉR ((- Általános Nemzeti Élőhelyosztályozási Rendszer) (Bölöni et al., 2007), where, unlike for the other types, the category definition is more related to the condition of the vegetation than its composition. When examining temporal changes, this means that changes in condition can lead to a change in category and thus, extent.

To prepare for reporting under the above-mentioned Regulation, it should be considered how ecosystems are currently defined at national level, which ecosystem typology forms the basis for classification, characterisation, or assessment at national level, and how this can be crosslinked to the European Ecosystem Typology for Accounting. Section 6.3 below outlines a methodology explored to spatially delineate the ecosystem extents for Ecosystem Accounting under Regulation (EU) 2020/852 (European Commission, 2020) with the use of openly available data, mainly earth observation. It is accepted that information on habitat types and ecosystems collected at national level through dedicated surveys, monitoring programmes or expert opinion

is the most accurate source of information available and that freely available, open data (e.g., Copernicus products) are complementary to fill gaps in data.

Ecosystem condition is further developed in the SELINA project under Task 3.2 “Derive a minimum set of key ecosystem condition indicators per ecosystem type”, which looks at the development of a spatially explicitly set of ecosystem condition indicators, Task 3.3 “Define the reference levels and conditions that describe the good condition of an ecosystem” and Task 3.4 “Propose a scientifically robust decision framework to support the designation of ecosystem condition levels (from favourable (good) to unfavourable (not good) state)”. The latter will explore the assessment of accuracy-scale trade-offs with a view to addressing the complex relationship between pressures, drivers, and ecosystem condition interaction.

6.3 Crosslinking national and international typologies

6.3.1 Introduction

Several countries based their national ecosystem typologies, described in Section 5.2.2, on one or a combination of ecosystem typologies as described in Section 6.1. Fifty-two percent of respondents to the survey described in Section 5 to gain insights into Ecosystem Typologies and data sources used by SELINA partner countries (Figure 3), report the use of international typologies (such as CLC, MAES, EUNIS), while a further 17% use other typologies (such as the European Typology for Accounting, the Water Framework Directive etc.).

This demonstrated the need for comprehensive crosslinking of national and international typologies, whether to serve as a basis for a national typology, for specific reporting obligations or for accounting purposes.

A crosslinking exercise can take place in multiple ways and largely depend on the end-use of the typology. The main challenge to crosslinking is resolving the non-distinct relationships between classes of two typologies. The EUNIS habitat classification system has comprehensive links to several international typologies at different levels in the hierarchical structure, depending on the information available, and uses an expert evaluation of typical vegetation of the habitat, along with a system of qualifiers to show the degree of relationship between the typologies e.g., if it is equal to, broader than, narrower than, partly overlap (Figure 11).

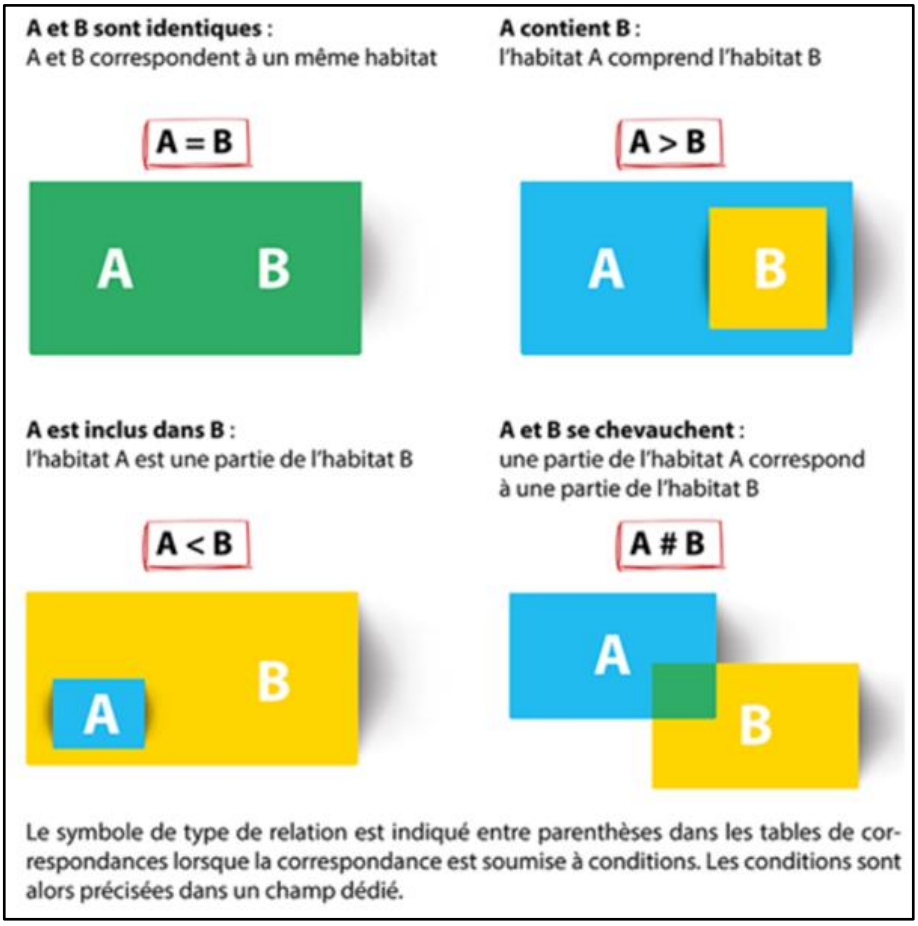


Figure 11. Possible crosslink types designated for EUNIS crosslinks (Source: La Riviere et al., 2023)

This system of describing relationships with qualifiers can be resolved well at tabular level, does not make for suitable mapping as a complete disaggregation of habitat types between typologies is needed.

For land cover classifications, the EIONET Action Group on Land monitoring in Europe (EAGLE) data model uses an extensive range of land cover components, land use attributes and land characteristics rather than purely physiognomic aspects, which allows the integration of various land cover and land use information from different datasets by means of a standardised and very extensive definition of possible attributes. Especially in Europe, historic cultural practices have often formed the landscape, and information on land use can be important, especially for agricultural ecosystems. Describing these attributes in classes of two different typologies, whether an ecosystem typology, habitat classification or land cover classification, allows for the comparison of classes and, further, the identification of data sources to map extents.

This method of characterisation allows the description of land cover attributes (land cover components LCC, land use attributes LUA and land characteristics LCH, Figure 14) of the translated classes in a structured way. The land cover components are the physical characteristics of the landscape e.g., trees, soil. The land use attributes capture the functional aspect of the landscape e.g., if it is used for agriculture, mining, forestry.

The land characteristics are additional information that does not fall under either land cover or land use but can further describe certain aspects of a land cover or land use e.g., building type, degree.

This structure of describing attributes can then be linked to third-party data which can improve the key problem of crosslinks for non-distinct classes by identifying overlapping class definitions within different mappings of typology classes (Figure 12).

Figure 12 illustrates that by integrating third-party information at a spatial level these connections between habitat classes can be made at a spatial level.

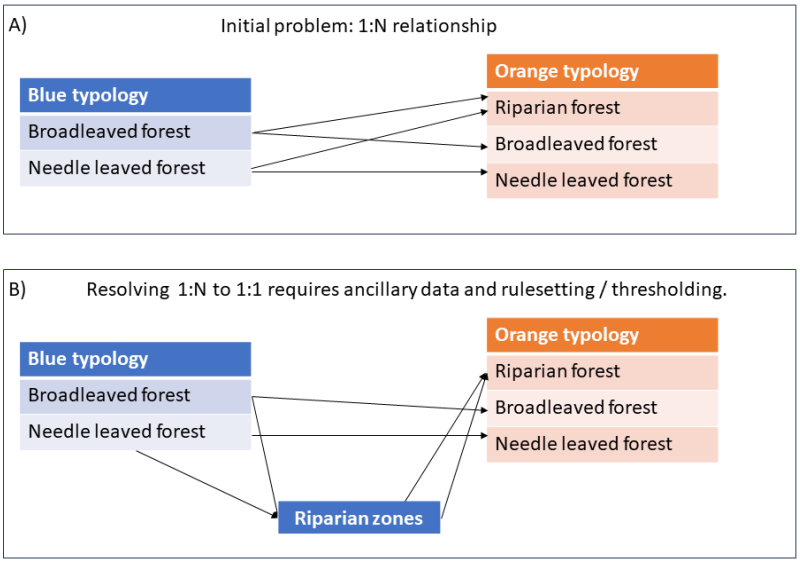


Figure 12. Illustration of basic approach to resolving non-distinct relationships (Source: Own illustration)

While it is acknowledged that information on ecosystems at national level is the best available information to start a mapping process and accounting process, the issues associated with an incompatibility in nomenclatures, a lack of data and gaps in information can be resolved by incorporating additional data sources to complement mapping.

6.3.2 Exercise for mapping an ecosystem typology using CLMS

To operationalise the mapping of ecosystem types using spatial information and satellite-based Earth Observation data provided by the Copernicus Land Monitoring Service (CLMS), a draft methodology is described that crosslinks a national typology, the Ecosystem Map of Hungary (hu_es) described in Section 5.2, to an international typology, the European Ecosystem Typology for Accounting (eu_es) described in Section 6.1.5. The European Ecosystem Typology for Accounting was chosen as the target typology for this exercise as it will become a reporting obligation for which ecosystem extents, condition and ecosystem services will be reported.

The aim of this exercise was to:

- investigate the extent to which CLMS (and other freely and openly available data) could be used to map to an ecosystem typology,

and this was undertaken by:

- using the Ecosystem Map of Hungary (hu_es) as a source dataset, and the European Typology for Accounting (eu_es) as the target dataset
- establish how far Level 3 classes in the hu_es could be crosslinked to Level 3 classes in eu_es using CLMS etc.

It should be noted that the process described below is specific to the Hungarian context as a detailed ecosystem typology was already in place, many Level 3 classes were 1:1 relationships and therefore no identification of CLMS-derived or other openly available data was necessary to complete the mapping process.

The use of the Ecosystem Map of Hungary also allowed a thorough quality analysis and back-checking of mapped classes which would not be available under different circumstances.

It is assumed that the end user of this process described would use data available at national level as the basis for mapping to the European Typology, and then use data derived from CLMS sources to fill gaps in information. These data sources are available for Level 2 of the European Typology, in the SELINA repository (International typology & dataflow database_draft).

6.3.3 Methods and data

A brief outline of the crosslinking and mapping process is as follows:

- translating the crosslinks: a tabular exercise (MS Access, Excel) to crosslink the hu_es and eu_es, plus use of the EAGLE data model,
- identification/compilation of CLMS derived data required for the mapping exercise (literature, Excel, QGIS),
- scripting and mapping to the new typology (R, QGIS)

These elements are described further below.

Translating the crosslinks

Class definitions within ecosystem typologies represent a collection of distinguishable attributes fused together to form a single distinct class within the nomenclature.
Aligning and translating potentially dissimilar definitions therefore requires dismantling and organising these attributes into a common and unambiguously defined attribution framework.
For this work, the EAGLE (Arnold et al., 2023) data model was used to standardise information between the 2 typologies.

Figure 13 summarises the dataflow of linking typologies and when the EAGLE data model is used to resolve relationships between classes.

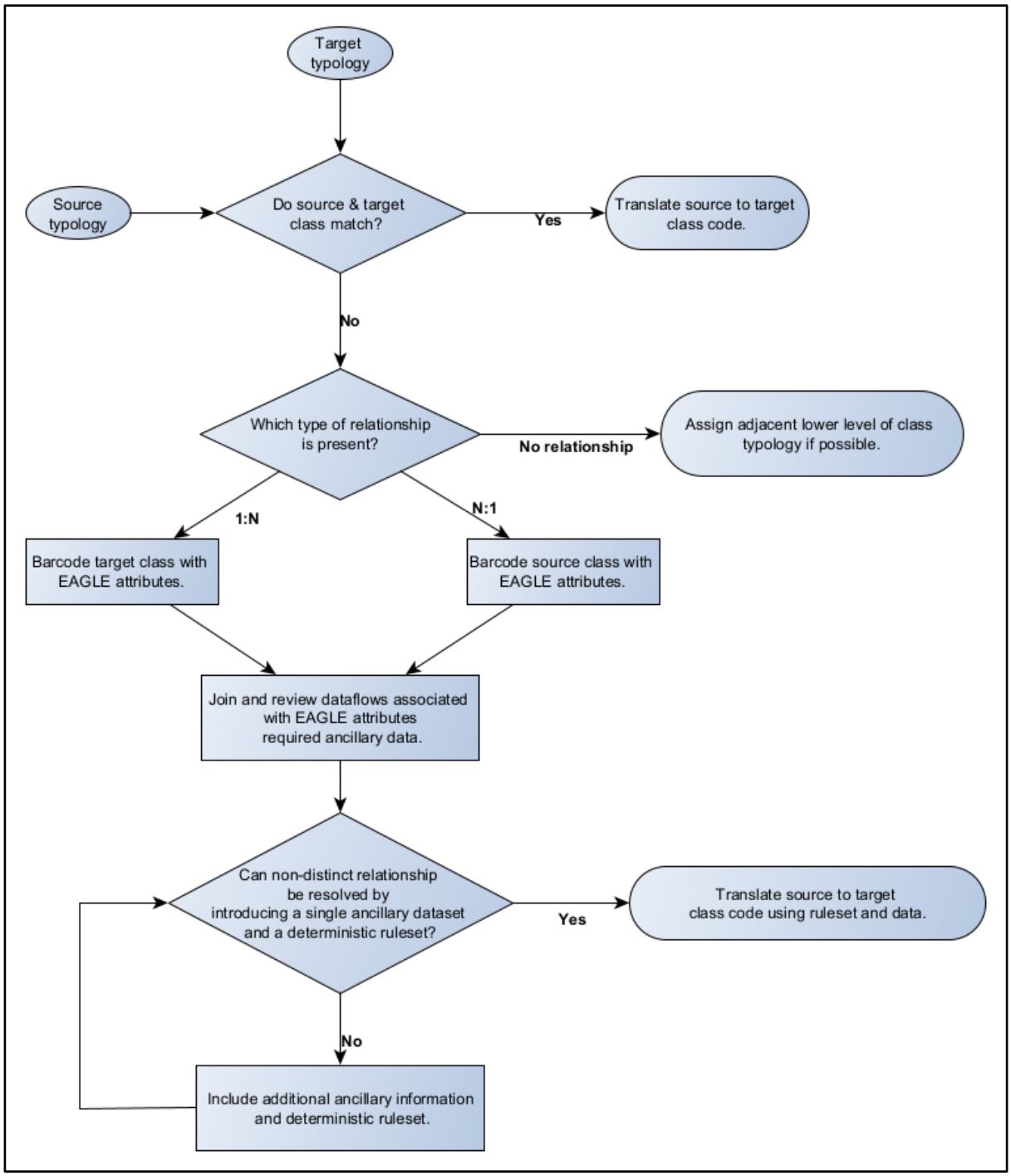


Figure 13. Suggested approach for resolving non-distinct class relationships in crosslinks using EAGLE (Source: Own illustration)

EAGLE MATRIX					
LCC_Code	LCC_name	LUA_Code	LUA_Name	LCH_Code	LCH_Name
2	BIOTIC / VEGETATION	1	Primary Production Sector	1	Built-up Characteristics
2_1	Woody Vegetation	1_1	Agriculture	1_1	Soil Sealing Degree % <integer percentage value>
2_1_1	trees	1_1_1	commercial crop production	1_2	Built-up Pattern
2_1_2	Bushes, Shrubs	1_1_2	Farming Infrastructure	1_2_1	scattered single houses, discontinous
2_1_2_1	regular bushes	1_1_2_1	animal husbandry	1_2_2	single blocks, discontinous
2_1_2_2	dwarf shrubs	1_1_2_2	farming storage	1_2_3	suburban row houses/terraced/semi detached houses
2_2	Herbaceous Vegetation(grass-like, forbs, fems)	1_1_2_3	other farming infrastructure	1_2_4	city street blocks, closed front
2_2_1	Graminoids (grass-like)	1_1_3	production for own consumption	1_2_5	large complexe buildings, big halls
2_2_1_1	grasses, sedges, rushes, cereals (low growing)	1_2	Forestry	1_3	BuildingNatureType (from INSPIRE data specs BU)
2_2_1_2	reeds, bamboos, canes (high growing)	1_2_1	short rotation	1_3_1	BuildingNatureType value
2_2_2	non-graminoids (forbs, ferns)	1_2_2	intermediate / long rotation	1_4	OtherConstructionNatureType (from INSPIRE data specs BU)

Figure 14. Examples of EAGLE attributes to standardise land use information: land cover characteristics (LCC), land use attributes (LUA) and land characteristics (LCH) (randomly chosen examples from the lists).

i) Initial visual comparison

Through an initial semantic comparison of the 2 typologies, a broad overview of the nature of the relationship between them was established. This allowed the identification of distinct and non-distinct class assignments, which gave an indication of specific classes where CLMS or other open data sources were needed.

A general approach was developed for eventual mapping:

- where 1:1 links existed, the polygons in the hu_es would simply be recoded to the eu_es
- where N:1 links existed, the polygons from hu_es would be merged and coded under the eu_es class
- where 1:N crosslinks existed, these classes needed further intervention to be completely resolved, such as using the EAGLE data model (ii) below with the aim of disaggregating the source classification into distinct classes of the target classification.
- where classes could not be crosslinked at Level 3 (non-distinct classes), these were mapped at lower in eu_es (Level 1 or 2)

ii) Disaggregation of 1:N classes

The complexity of crosslinking and associated workload increases with the level of detail within class descriptions and occasionally requires the input of additional data and expertise on class content. The EAGLE data model was used to disassemble the source and target classes into their composing elements. This allowed the reduction of incongruencies between the typologies by allowing to assign portions of the source class(es) to matching portions within target class(es). Elements within EAGLE (Figure 14)

can then be linked with specific dataflows. That can be utilised to convert non-distinct to distinct class relationships:

- Class types (labels and definitions) were compared for terminology/descriptors on land cover/land use attributes.
- LCC, LUA, LCH attributes were assigned to each class type.
- Classes were compared based on attributes assigned, which showed links between classes where 1 hu_es was linked to multiple eu_es (and vice versa).

Disaggregating classes in this way facilitates the identification of data flows and allows mapping of classes to be undertaken (described below).

To note: for consistency, the process described above (i.e., establishing the common LCC, LUA, LCH) was also applied to classes where there was no ambiguity between typologies or where data sources did not need to be identified for mapping purposes e.g., where there were 1:1 classes.

Identification of dataflows

Dataflows and CLMS sources were identified based on EAGLE attributes assigned to each of the classes:

- While scanning the class descriptions for common attributes during the crosslinking exercise (terminology, descriptors used), data-sources were assigned based on correspondence with the EAGLE element (LCC, LUA, LCH).
- This preliminary scanning exercise was followed by the addition or the identification of more appropriate data sources as the mapping exercise took place (further described below), and the list updated.
- Several data sources were identified as appropriate for individual classes. These were all listed and investigated for appropriateness at the mapping stage.
- A list of CLMS and other open data sources dataflows as part of this exercise was compiled and will be made available in the SELINA repository (International typology & dataflow database_draft). This comprises:
    - *Linked data flow 1*: look-up table for EAGLE land attributes which can be used to specify certain class attributes which are in turn linkable to specific dataflows. This has been provided for the land cover classes, and where available, for some land use attributes and land characteristics.
    - *Linked data flow 2*: look-up table for the European Typology for Accounting Level 2 and linked dataflows.

A simplified image of the crosslinking exercise and the identification of dataflows for mapping is shown in Figure 15 below.

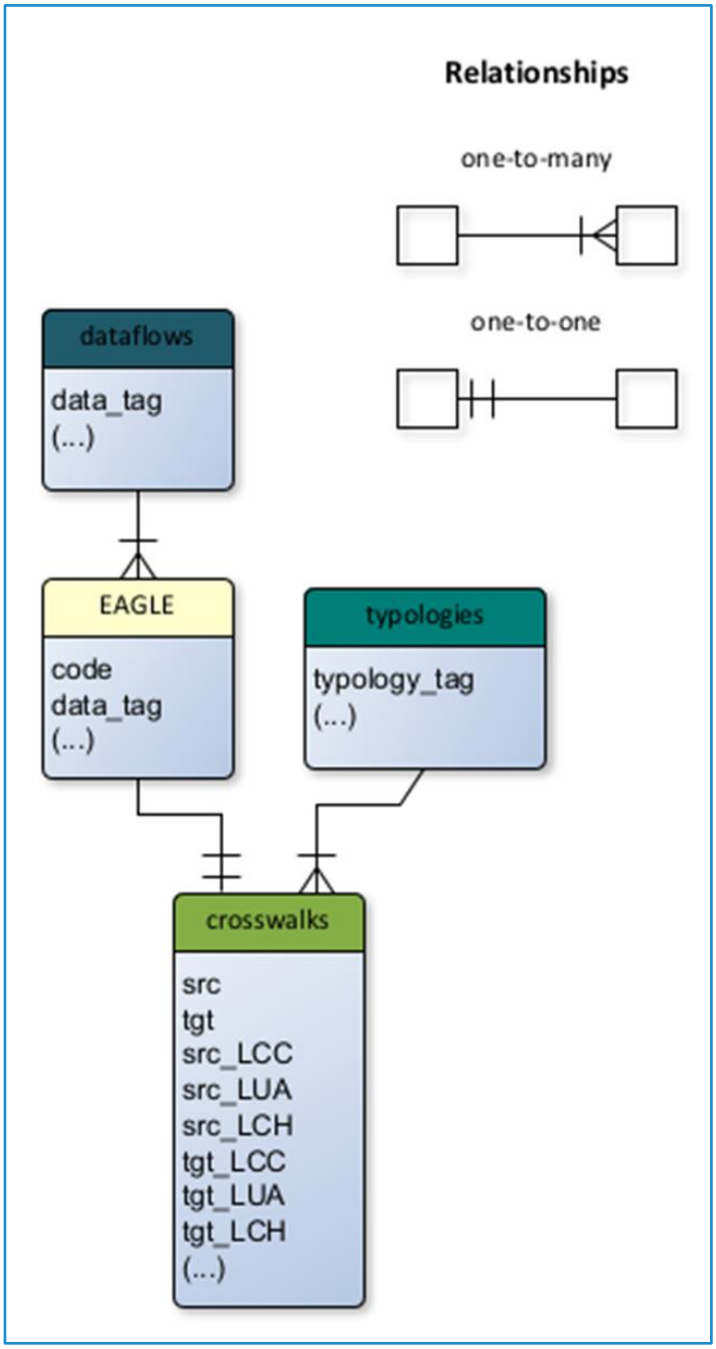


Figure 15. Workflow employed for the identification of data sources.

To note: the linked data flows and data sources are provided in the context of this exercise on mapping to the European Ecosystem Typology for Accounting. This does not infer that it is a definitive list of dataflows that can be used for extent mapping purposes. Where more than one dataflow is linked to an attribute or a Level 2 class, it is for the user to determine which dataflow best serves their needs.

Mapping process

The data management and mapping process was undertaken using a combination of R (version 4.3.1) and QGIS (version 3.30.2). Packages used in R included *tidyverse, terra,*

tidyterra, here, sf and readxl. After the nature of crosslinks was identified, the following broad rules were applied (Table 1).

Table 1. Summary of the approach to mapping from hu_es to eu_es using CLMS and related products.

1:1 classes
No additional data sources were required. The hu_es classes were re-coded (with R script)
N:1 classes
No additional data sources were required for mapping. The hu_es classes were aggregated under the eu_es class (with R script)
1:N classes
Additional data sources were required to map to the eu_es. These were identified and where multiple data sources were identified, the definitions and nomenclature were screened to see which best met the definition of the eu_es. The data layers were analysed visually in QGIS for coherence with the hu_es mapped classes i.e. identification of class codes to be used for mapping Occasionally, not all Level 3 eu_es classes that were crosslinked could be mapped. In these situations, these classes were left displayed at Level 1 or 2 hu_es and the map recoded to the crosslinked Level 1 or 2 eu_es Based on the class codes identified, the data management (i.e., extracting, merging, clipping, reprojecting and rasterisation) was undertaken in R and QGIS to further examine, undertake quality analysis and map the results A raster approach was used and part of the preprocessing of data was to ensure that all data layers used were rasterised to the same resolution (10m)
Other cases
Some class definitions at Level 3 were simply not crosslinked based on definitions. These were mapped at Level 1 eu_es Classes where there were no thematically suitable equivalent data available to eu_es were labelled as 'unclassified' in the final European Ecosystem Typology Map for Hungary.

The resulting map of this exercise is seen in Annex C (Figure 17). The mapped classes described in Table 1 are shown in Figure 18.

6.3.4 Results

The aim of the exercise employing the methodology summarised in Section 6.3.3 was to establish how far the national typology (Ecosystem Map of Hungary, hu_es) could be mapped to the international typology (European Typology for Accounting, eu_es) using Copernicus data at Level 3. It should be noted that mapping to this class level is a detailed exercise and was undertaken to determine the availability of data sources.

In practical terms, where a Level 3 class could not be mapped, this was mainly due to the following reasons:

- lack of data at this level (even though classes between typologies could be crosslinked)
- lack of coherence / incompatibilities in definitions and description of classes (it could not be definitively decided which classes could/should be crosslinked)

The solutions to these issues were:

- map to the higher level (i.e., Level 2 or Level 1) where crosslinking occurred but no data were available at Level 3
- leave the class as 'unmapped'

In both cases, data sources were suggested to further investigate (International typologies database_draft) as the cases described below are unique to the Hungarian exercise and may not apply to others.

The results of this exercise are summarised in Table 2 listing the proportion of Level 3 hu_es classes that could be mapped to the eu_es. The resulting map developed for Hungary from this process is shown in Annex C.

Table 2. Summary of the proportion of Level 3 (L3) classes that could be mapped using Copernicus data and associated products and broad observations within each Level 1 class (acronyms are used: hu_es and eu_es).

Level 1 Class hu_es & proportion of Level 3 classes mapped to eu_es	**Specific observations**
Urban L3: 38%	The urban Level 3 hu_es classes were mostly one-to-many relationships with the eu_es. Due to a lack of coherence in class definitions between the two typologies this resulted in only 38% of classes which could be mapped to Level 3. The broad issue is illustrated in Figure 16 below. It was found that several classes in the hu_es could be found in one class in the eu_es. For example, grassland, forest, water classes could form part of the Level 3 urban class, but there was no means to disentangle these individual Level 3 hu_es classes. This issue arises from hu_es urban classes being mapped as land cover whereas the eu_es is based on land use. The urban ecosystem group proved to be the most challenging of all ecosystem groups in terms of crosslinking and mapping. It was found that while classes could generally be linked at Level 3 between the typologies, the difference between using ecosystem types and land use between the typologies caused an incompatibility of the nomenclatures. As 'urban' or 'artificial' areas are not an ecosystem in the true sense of the term, it is difficult to crosslink classes between these 2 typologies. In order to be able to accurately map the eu_es class settlements and other artificial areas, a land use approach is needed. A good example of this is the Level 3 eu_es class 'airports'.

Croplands L3: 97%	The Level 3 cropland class in hu_es was mapped to the Level 3 of the eu_es croplands using the JRC EUCropmap layer (2018, although this has been updated for 2022). In the Hungarian example, this allowed the Level 3 arable land class to be disaggregated into 17 individual Level 3 classes under eu_es. The main issue observed when mapping the cropland class was the Level 3 eu_es class 'hedgerows in cropland' and 'tree rows in cropland'. In hu_es, most hedgerows and tree rows were mapped mainly under 'herbaceous vegetation' (Level 1 grasslands) or 'other ligneous vegetation' (Level 1 forests and woodlands). However, these could not be distinguished for the purpose of mapping to the eu_es. Further analysis will be needed to delineate between hedgerows and tree rows present in cropland or grasslands. A specific observation for Hungary was: - The Level 3 eu_es classes that were mapped as Level 1 croplands are: Perennial bioenergy crops, nurseries, hedgerows in cropland, tree rows in cropland, field margins and other agricultural landscape features. This was due to a lack of data to accurately identify the location of these.
Grassland and other herbaceous vegetation L3: 51%	Half of the grassland Level 3 classes in hu_es could be crosslinked and mapped to the eu_es as these were one-to-one relationships. The Level 3 class hu_es 'closed grasslands in hills and mountains or on cohesive soil' was crosslinked to two eu_es classes: 'Dry grasslands' and 'Alpine and subalpine grasslands'. As there was no available data to delineate these two types, these were left unmapped. As with cropland, the Level 3 eu_es class 'hedgerows in grasslands' and 'tree rows in grasslands' could not be distinguished as mentioned above. In hu_es, these are incorporated into the class 'other herbaceous vegetation'.

Forest and woodlands L3: 100%	The forest habitats at Level 3 were one-to-one matches with the European Typology. No additional data sources were needed to map this class. However, potential data sources have been identified (International typology & dataflow database_draft) for wider use to map forest classes at Level 2 in eu_es. It should be noted that 'tree rows' are included in eu_es as a separate Level 3 under cropland and grassland.
Wetlands L3: 8.2%	The Level 3 classes identified in hu_es (two classes) were aggregated and mapped as Level 1 Inland wetlands in eu_es. These are: 'Tall-herb vegetation of marshes and fens standing in water' and 'fens and mesotrophic wet meadows, grasslands with periodic water effect'. There is a lack of coherence in the definition of wetlands between the typologies. Throughout the course of this work, the following studies were noted in terms of providing coarse wetland and peatland mapping products: e.g., (Kovács et al., 2023; Tanneberger et al., 2017)
Rivers and lakes L3: 94%	Most Level 3 classes in rivers and lakes could be mapped to the eu_es using CLMS and the EUHydro layer. Some specific observations for Hungary are: - Many of the hu_es oxbow lakes have been mapped under water courses. However, they also occur under water bodies. As most instances occurred under water courses it was decided to map them as 'rivers' under eu_es.

The results shown in Table 2 are the proportion of Level 3 classes from Ecosystem typology of Hungary (hu_es) that were mapped to the European Typology for Accounting (eu_es). The percentages were calculated as the sum of classified pixels at Level 3 eu_es, per Level 1 hu_es class, divided by the sum of all hu_es pixels per Level 1 hu_es class.

The outstanding percentage (i.e., not mapped) include classes:

- that were not coherent with the eu_es definition.
- where no data were available to map.

The analysis above includes the one-to-one crosslinks for which no additional data sources were needed for mapping purposes (i.e., the information in hu_es was simply re-coded to the eu_es).

The Level 3 classes where no data were available for mapping were coded as 'unclassified' in the map (see Annex C) and coloured black.

The main challenge with mapping the Level 3 ecosystem classes was the differences in the class definitions between the two typologies. An example of this is faced with mapping the Level 3 classes under the 'urban' or 'settlements and other artificial area' ecosystem groups and is described below.

Level 1 Urban class (hu_es)

The image in Figure 15a is an extract of the hu_es set showing a collection of national Level 3 classes from within multiple Level 1 ecosystem categories (woodlands, urban, wetlands, etc.). When compiling data for the shown extent, the issue of crosslinking the different thematic concepts of the two nomenclatures (hu_es and eu_es) becomes obvious. On closer inspection of Figure 15b, the area is found to be a water treatment facility, including paved areas, location of trees and shrubs, and grassland areas that could be identified from the image (red box, 6.7 ha).

While the hu_es is mapped based on land cover, the eu_es would see the unit in its entirety based on its function/land use and mapping it as 'Other infrastructure'. Therefore, when attempting to mimic the Hungarian classification, as shown in Figure 15c, several possible land cover elements could occur within the area that should be mapped using the land use approach.

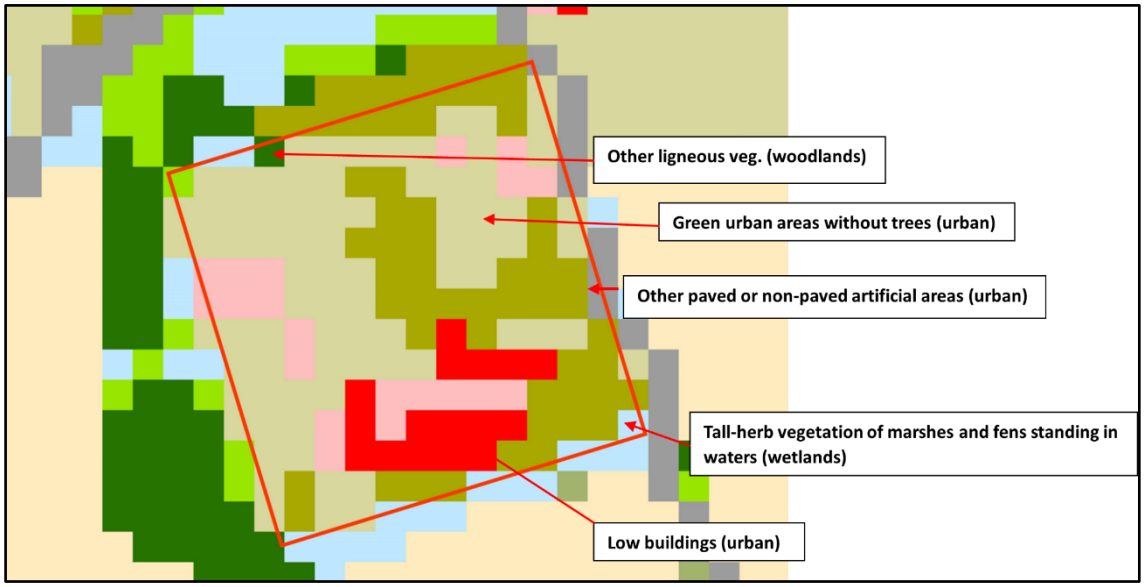


Figure 15a). hu_es Level 3 classes (area of red box extent is 6.4 ha).

Figure 15b). satellite image (google maps).

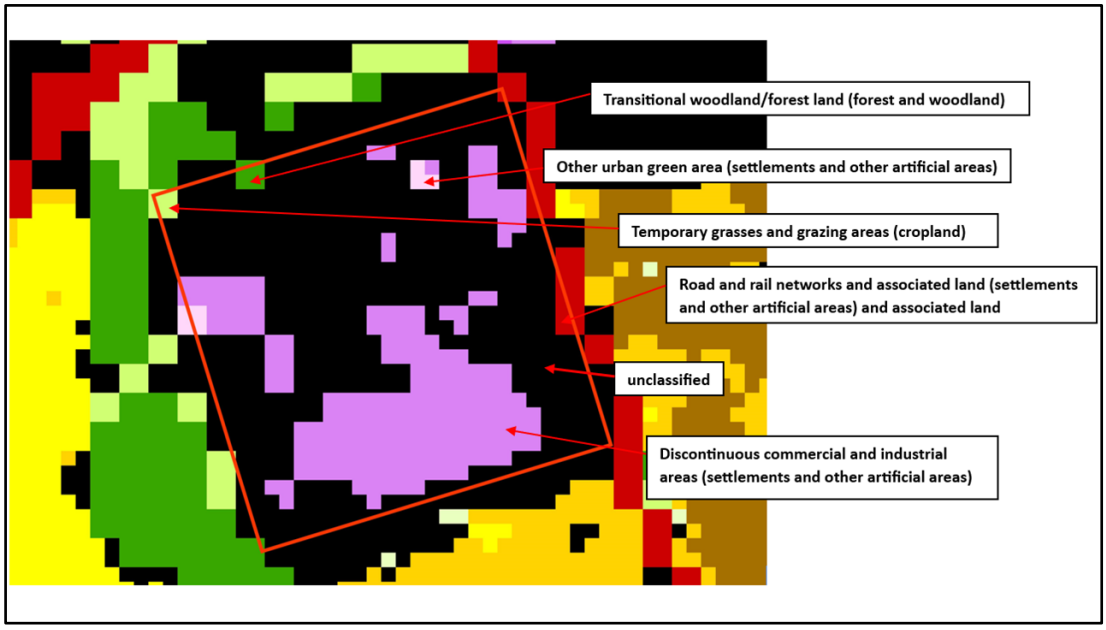


Figure 15c). mapping to eu_es with CLMS (and other data) using a land use approach.

This discrepancy is an example of where ecosystem and land use-based approaches conflict.

General observations about results and methodology

The broad observations captured in Table 2 are not exhaustive and provide a snapshot of findings for the Hungarian example. As described in Section 6.3.3, the starting point in this exercise was a detailed base ecosystem map at national level which is not always available in other countries when undertaking a similar exercise. This allowed a thorough system of quality analysis of the process at each step, for example, by being able to ensure 'boundaries' between the hu_es and data sources used for mapping were coherent, by being able to distinguish which data source was best for mapping a class as they could be compared with the existing hu_es base map.

Additionally, because of the several one-to-one matches between hu_es and eu_es classes, there was no need to search for data sources for mapping purposes.

An output of this exercise was the compilation of a list of data sources that can be used as a starting point for other users to produce ecosystem extents according to the European Ecosystem Typology class definitions, including those with little or no data available at national level. When applying this methodology, it is best practice to consider the information available at national level first, being the most detailed, and the data sources referred to in this exercise would be used to complement this i.e., to fill in gaps for missing data. The purpose is not to replace information available at national level with freely available data.

For the wider application of this method, a list of open EO data sources (mainly Copernicus and related products but additional sources) has been compiled to

facilitate a future user who may not have as detailed a starting point as described above. These data sources are listed for:

- Level 2 of eu_es
- All land cover components (LCC) as part of the EAGLE data model described in Section 6.3.3.

The data sources are those compiled through observations from this work on the Hungarian example and should be thoroughly assessed for the needs at national level. These lists have not undergone any form of exhaustive analysis for the presence of classes, other than what is described in the nomenclature. As typologies and classes described within that are developed at a national level are unique and specific, the onus is on the user to establish the degree of usefulness of these data sources.

Under the updated Regulation 2020/852, ecosystem extents under the European Ecosystem Typology for Accounting are to be reported at Level 1. The exercise with the Ecosystem Map of Hungary above has demonstrated how far this is possible in the context of Level 3 of the European Ecosystem Typology for Accounting and the ability to crosslink classes with the Ecosystem Map of Hungary. It has highlighted issues with capturing thematic detail at this level (as shown in Figure 15). Replicability and outcome of the method will differ when applied elsewhere.

Throughout the course of this exercise, a database was developed (International typology & dataflow database_draft) with the aim of providing a one-stop-shop for international ecosystem typology classifications, their associated published crosslinks, the main workflows behind the typologies and a list of open EO data sources that can be used to assist with defining ecosystem extents according to the European Ecosystem Typology classes. This will be hosted on the platform developed under SELINA Task 6.6 Operational databases development. Within this task, information about applied ES methods, model and data diagnostics as well as assessed Ecosystem Condition indicators will be synthesised into an operational open access online database, which will upgrade existing efforts such as the MAES Methods Explorer (https://database.esmeralda-project.eu/home) and link to the ES Valuation Database (ESVD, https://www.esvd.net/). Through the planned open-access publication of this information, the SELINA consortium aims to significantly contribute to addressing the common obstacle of interoperability between ecosystem typologies. This effort will facilitate overcoming the challenge and promote synergies in terms of data availability, resolution, and thematic depth.

7 Conclusions

- The definition of ‘ecosystem typology’ was broadened to include various approaches such as ecosystem-based methods, land cover/land use approaches, and specific habitat lists for reporting obligations.
- This inclusive definition ensures that a wide range of ecological characteristics and requirements are considered in ecosystem condition assessments.
- The comprehensive survey conducted within the SELINA consortium has been a cornerstone in providing crucial insights into ecosystem typologies, condition assessment methods, and data sources at the national level.
- The survey unveiled a rich diversity of ecosystem typologies used by partner countries. It illuminated the extent to which these typologies align with international classifications.
- The responses demonstrated the varied methods employed by the 30 SELINA partner countries, the Azores and the EU to assess ecosystem condition.
- This variety of typologies indicates a robust and adaptable approach to understanding and managing diverse ecological systems.
- Respondents from across the consortium assessed a broad spectrum of ecosystems.
- The assessment of various ecosystems, from terrestrial to marine, highlights the consortium's commitment to a comprehensive understanding of ecological systems.
- The survey highlighted the reliance on both national and international data sources, reflecting a comprehensive approach to data collection and analysis.
- The integration of different data sources strengthens the assessment process, allowing for more nuanced and accurate evaluations.
- The findings indicate that the responding countries used various methods to assess ecosystem condition. This methodological diversity is crucial for addressing the unique challenges and characteristics of different ecosystems.
- The use of multiple methods ensures a more robust and nuanced understanding of ecosystem conditions and dynamics.
- The collected and synthesised data from the survey responses lay the groundwork for a more holistic approach to ecosystem condition assessments within the SELINA project. This includes: (i) Integration of Data Flows: Offering insights for the mapping and assessment of ecosystems condition, ecosystem services, and ecosystem accounting; and (ii) Applications in decision-making contexts: The findings are instrumental for both public and private decision-making contexts, as highlighted in WPs 8 and 9.
- The survey underscored the significance of integrating national and international ecosystem typologies.

- From the list of international typologies, the EUNIS habitat classification system was noted for its role in facilitating these connections, as it includes crosslinks to major international typologies, enhancing the coherence and comparability of ecosystem data.
- The process of aligning national typologies with international standards can be challenging, as exemplified by the Ecosystem Map of Hungary and the European Ecosystem Typology for Accounting.
- A key challenge identified was the differences in class definitions between national and international typologies.
- To address these challenges, the report led to the creation of two lists of open and freely available data sources, such as CLMS (Copernicus Land Monitoring Service): One list correlates data sources with Level 2 classes of the European Ecosystem Typology, and the other links them to the EAGLE Land Cover Components (LCC).
- These lists are instrumental in filling data gaps at the national level and facilitating the construction of maps for the European Ecosystem Typology.

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7 Annexes

Annex A – Survey

SELINA WP3 Survey - Ecosystem typologies and ecosystem condition

Disclaimer

The European Commission is not responsible for the content of questionnaires created using the EUSurvey service - it remains the sole responsibility of the form creator and manager. The use of EUSurvey service does not imply a recommendation or endorsement, by the European Commission, of the views expressed within them.

SELINA
Ecosystems and their services for an evidence-based policy and decision-making

WP3 of the SELINA project aims to test and develop a methodology to map and assess the condition of terrestrial and aquatic ecosystems to support the EU implementation of the SEEA-EA (System of Environmental Economic Accounting - Ecosystem Accounting), the legally binding restoration targets in the Biodiversity Strategy, and thus a better integration of ecosystem condition in public and private decision-making on different levels.

The objective of this survey is to get an overview of the ecosystem typologies and data sources that describe ecosystem properties used by the countries involved in SELINA. Additionally, this survey aims to have a general outlook on ecosystem condition assessment among the SELINA partners.

This survey has seventeen questions and should take about 20 minutes to complete.

We appreciate that you take the time to fill out this survey to the best of your knowledge. If you have questions, please email Paula Rendón (URJC) at paula.rendon@urjc.com.

Your personal information will be collected only for the purpose of this survey. All data is stored in a password protected electronic format.

SELINA receives funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101060415.

1. General information

1.1. Name of the respondent

1.2. E-mail

1.3. Country

1.4. Organization

1.5. Type of organization

- ☐ Research and development
- ☐ Administrative
- ☐ Private business
- ☐ Other

If other, please specify:

2. Ecosystem typologies

This section aims to identify and describe the ecosystem typologies used in your country.

2.1. Name of the ecosystem typology or typologies used in your country (e.g., EUNIS, MAES, IUCN, etc.)

2.2. What is the scope of the typology or typologies?

- ☐ International
- ☐ National
- ☐ Subnational

If a national or subnational typology is used, is it compatible with international classifications?

- ○ No
- ○ Yes

If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)

2.3. What is the spatial resolution of the typology units?

- ☐ Fine resolution
- ☐ Coarse resolution
- ☐ Not mapped

2.4. Are maps of the typology available in digital format?

- ☐ No
- ☐ Yes
- ☐ I do not know

2.5. Could you please provide some references of the typology or typologies used?

(e.g., MAES Typology (Maes J, et al. (2013) Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg).

3. Ecosystem condition

This section aims to get a general outlook on the ecosystem condition assessment in your country. Understanding ecosystem condition as the overall quality of an ecosystem asset in terms of its characteristics (United Nations, 2012).

3.1. Has ecosystem condition been assessed in your country beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD)).

- ○ No
- ○ Yes
- ○ I do not know

3.2. Which organization(s) assess(es) ecosystem condition in your country?

3.3. Which ecosystems have been assessed?

	Ecosystem	Which indicators have been used?	Have thresholds or reference levels been defined for the indicators? (Yes/No/I do not know)	What types of methods have been used to assess ecosystem condition? (0,1,2,3)*	What software, models or tools have been used to assess ecosystem condition? (e.g. Python, R, ARIES, CENTURY, etc.)	Reference (e.g., publications, websites)
1						
2						

3						
4						
5						
6						
7						
8						
9						
10						

* 3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

4. Data sources

The objective of this section is to have an overview of the data used to describe the main properties of ecosystems.

4.1. Which data sets are used to describe the properties of ecosystems?

	Data set	Data provider (e.g., EUROSTAT)	Spatial coverage (0,1,2,3,4)*	Spatial resolution (e.g., 1 km, 30 m, etc.)	Temporal resolution (e.g., monthly, annual, bi-annual, etc.)	Year of first available data (e.g., 1990)	Year of latest available data (e.g., 2018)	Reference (e.g., website)
1								
2								
3								
4								
5								

6								
7								
8								
9								
10								

* 4 = Spatially explicit; 3 = Aggregated at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

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Thank you for taking the time to complete this survey. We truly value the information you have provided. Your responses will contribute to our analysis of the typologies, ecosystem condition assessments and data sources. If you have any comments on the survey or the work package, please send an email to Paula Rendón (URJC) at paula.rendon@urjc.es

Many thanks,
SELINA WP3

Submit

EUSurvey

Annex B - Factsheets per country

Europe

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	MAES, CORINE
Scope of the typology or typologies?	International
If a national or subnational typology is used, is it compatible with international classifications?	
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	An updated terminology of MAES ecosystems is presented in Vallecillo, S; Maes, J; Teller, A; Babí Almenar J; et al. EU-wide methodology to map and assess ecosystem condition: Towards a common approach consistent with a global statistical standard. Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/13048, JRC130782

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	European Commission (at EU level)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
All ecosystem types	Very exhaustive list (indicators available in the publication)	No	3-2 (some modelled)	python, R, ArcGIS, google earth engine, ...	Maes, J., Teller, A., Erhard, M., Condé, et al. (2020) Mapping and Assessment of Ecosystems and their Services: An EU ecosystem assessment, EUR 30161 EN, Publications Office of the European Union, Luxembourg, 2020, ISBN 978-92-76-17833-0, doi:10.2760/757183, JRC120383.

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

Austria

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	EUNIS, MAES, Rote Liste gefährdeter Biotoptypen Österreichs
Scope of the typology or typologies?	National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Habitats Directive Annex I
Spatial resolution of the typology units	Fine resolution; Coarse resolution
Maps of the typology available in digital format	Yes
References	Essl F., et al. (2002) Rote Liste gefährdeter Biotoptypen Österreichs - Konzept. Umweltbundesamt, Monographien M-155. https://www.umweltbundesamt.at/fileadmin/site/publikationen/m155.pdf

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	I do not know
Organisation(s) assessing ecosystem condition	Federal states of Austria, Umweltbundesamt (Environment agency Austria)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Agricultural soils		I do not know	2		https://bodenkarte.at/

Forest ecosystems	Forest structure, volume, carbon stock, forest damage	I do not know	3		https://www.bfw.gv.at/publications/?lang=en
Lakes	Water quality	I do not know	2		https://www.ages.at/umwelt/wasser/badegewaesser-monitoring

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
IACS agricultural parcels	AMA - Agrarmarkt Austria	4	Digital vector data based on Orthophoto delineation	Yearly	2015	2022	https://www.data.gv.at/suche/?searchterm=INVEKOS
Forest inventory data	BFW - Austrian Research Centre for Forests	3	unknown	irregular intervals	1992-1996	2016-2021	https://waldinventur.at/#/map/0
Agricultural soils	BFW - Austrian Research Centre for Forests	4	unknown	unknown updates	before 1979	2000-now	https://bodenkarte.at/
Water quality (lakes)	AGES - Austrian Agency for Health and Food Safety GmbH	2	unknown	in periodical intervals	unknown	2022	https://www.ages.at/umwelt/wasser/badegewaesser-monitoring?bundesland=s&cHash=b90657871d7115f2adca3610d53539c7

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

The Azores

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Classification of habitats derived from the regional Land Cover Survey.
Scope of the typology or typologies?	Regional (adapted from Portuguese national guidelines).
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	CORINE
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	COS.A / 2018 (Regional Directorate of the Environment (2018) Land Cover Survey of the Autonomous Region of the Azores).

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	I do not know
Organisation(s) assessing ecosystem condition	Regional Directorate of the Environment of the Azores (RDEA). University of the Azores

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest	Tree Cover; Tree Height; Tree Age;Canopy stratification; Biotic/Abiotic condition; Cultivation state; Forest connectivity; Species composition.	I do not know.	2	Dendrometric field measurements; Aerial photos; Cartographic maps; GIS software; Orthophotographs;	https://drrf.azores.gov.pt/inventario-florestal/
Freshwater lakes and watercourses	Indicators of abiotic (physico-chemical) and biotic (compositional) characteristics.	Yes	2	Analytical measurements; Microscopic identification.	Multiple publications from different departments and research groups of the University of the Azores as well as the Regional Directorate of the Environment.
Croplands and Grasslands	Indicators of abiotic (physico-chemical) and biotic (compositional) characteristics.	I do not know.	2	Analytical measurements. Microscopic identification.	Multiple publications from different departments and research groups of the University of the Azores as well as the Regional Directorate of the Environment.

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Land Cover Survey	SPOT6/SPOT7; WorldView-III/WorldView-IV; Administrative maps by the Portuguese General Directorate of the Territory.	4	20 m	So far once every decade.	2007	2018	http://ot.azores.gov.pt/COSA-2018.aspx
Forest Inventory	GPS field observation; Aerial photos; Portuguese cartographic military map.	4	500 m^2 (polygon)	So far once every decade.	2007	2018	https://drrf.azores.gov.pt/inventario-florestal/

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Bulgaria

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	MAES
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	MAES, CORINE, EUNIS
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	Nedkov S, Doncheva S, Markov B (2017) Mapping of ecosystems in Bulgaria based on MAES typology. – In: Chankova, S., et al. (Eds.) Seminar of Ecology - 2016 with international participation, Proceedings. 21-22 April 2016, Sofia. ISBN: 979-853-476-132-4. https://www.researchgate.net/publication/319136620 Nedkov S, Borisova B, Nikolova M, Zhiyanski M, Dimitrov S, Mitova R, Koulov B, Hristova D, Prodanova H, Semerdzhieva L, Dodev Y, Ihtimanski I, Stoyanova V (2021) A methodological framework for mapping and assessment of ecosystem services provided by the natural heritage in Bulgaria. Journal of the Bulgarian Geographical Society 45: 7-18. https://doi.org/10.3897/jbgs.e78680 Hristova D, Stoycheva V (2021) Mapping of ecosystems in Bulgaria for the needs of natural heritage assessment. Journal of the Bulgarian Geographical Society 45: 89-98. https://doi.org/10.3897/jbgs.e76457 Petkova G, Prodanova H, Stoycheva V (2022) Analysis of the national ecosystem database of Bulgaria: (Mis)matches with the MAES framework. Journal of the Bulgarian Geographical Society 47: 73-82. https://doi.org/10.3897/jbgs.e99268

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Bulgarian Ministry of Environment and Water (MOEW), Institute of Biodiversity and Ecosystem Research - Bulgarian Academy of Sciences (IBER-BAS), Forest Research Institute - Bulgarian Academy of Sciences (FRI-BAS) and the National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Sciences (NIGGG-BAS)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Urban	set of indicators (see Methodology)	No	2	ArcGIS	Zhiyanski M, Nedkov S, Mondeshka M, Yarlovska N, Vassilev V, Borisova B, Bratanova-Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of urban ecosystems condition and their services in Bulgaria. Cloprint, Sofia pp 82. ISBN 978-619-7379-03-7 https://eea.government.bg/en/projects/Ecosystems/urbanes/URBAN_ENG.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Cropland	set of indicators (see Methodology)	No	1	ArcGIS	Yordanov Y, Mihalev D, Vassilev V, Bratanova-Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of cropland ecosystems condition their services in Bulgaria. Clorind, Sofia, 74 pp. ISBN 978-619-7379-05-1 https:// eea.government.bg/en/projects/Ecosystems/croplandes / CROPLAND_ENG.pdf
Grassland	set of indicators (see Methodology)	No	1	ArcGIS	Apostolova I, Sopotlieva D, Velev N, Vassilev V, Bratanova-Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of grassland ecosystems condition and their services in Bulgaria. Clorind, Sofia, 60 pp. ISBN 978- 619-7379-09-9 https://eea.government.bg/en/projects/ Ecosystems/grasslandes/GRASSLAND_ENG.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Woodland and forest	set of indicators (see Methodology)	No	1	ArcGIS	Kostov G, Rafailova E, Bratanova- Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of woodland and forests ecosystems condition and their services in Bulgaria. Clorind, Sofia, 84 pp. ISBN 978- 619-7379-08-2 https://eea.government.bg/en/projects/Ecosystems/woodlandforestes/FOREST_ENG.pdf
Shrubland	set of indicators (see Methodology)	No	1	ArcGIS	Velev N, Apostolova I, Sopotlieva D, Vassilev V, Bratanova-Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of heathland and shrub ecosystems condition and their services in Bulgaria. Clorind, Sofia, 56 pp. ISBN 978-619-7379-10-5 https://eea.government.bg/en/projects/Ecosystems/heathlandshribses/SHRUB_ENG.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Sparsely vegetated	set of indicators (see Methodology)	No	1	ArcGIS	Sopotlieva D, Apostolova I, Velev N, Vassilev V, Bratanova-Doncheva S, Gocheva K, Chipev N (2017) Methodology for assessment and mapping of sparsely vegetated land ecosystems condition and their services in Bulgaria. Clorind, Sofia, 60 pp. ISBN 978-619-7379-13-6 https://eea.government.bg/en/projects/Ecosystems/sparselyvegetatedlandes/SPARSLEY_ENG.pdf
Wetlands	set of indicators (see Methodology)	No	1	ArcGIS	Apostolova I, Sopotlieva D, Velev N, Vassilev V, Bratanova-Doncheva S, Gocheva K (2017) Methodology for assessment and mapping of wetland ecosystems condition and their services in Bulgaria. Clorind, Sofia, 56 pp. ISBN 978-619-7379- 14-3 https://eea.government.bg/en/projects/Ecosystems/wetlandses/WETLAND_ENG.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Rivers and lakes	set of indicators (see Methodology)	No	1	ArcGIS	Uzunov Y, Pehlivanov L, Chipev N, Vassilev V, Nedkov S, BratanovaDoncheva S (2017) Methodology for assessment and mapping of freshwater ecosystems condition and their services in Bulgaria. Clorind, Sofia, 64 pp. ISBN 978- 619-7379-17-4 https://eea.government.bg/en/projects/Ecosystems/riverlakeses/FRESHWATER_ENG.pdf
Marine	set of indicators (see Methodology)	No	1	ArcGIS	Karamfilov V, Berov D, Pehlivanov L, Nedkov S, Vassilev V, BratanovaDoncheva S, Chipev N, Gocheva K (2017) Methodology for assessment and mapping of marine ecosystems condition and their services in Bulgaria. Clorind, Sofia, 66 pp. ISBN 978-619-7379-18-1 https://eea.government.bg/en/projects/Ecosystems/marinees/MARINE_ENG.pdf

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
EUNIS	EEA, MOEW	4	10 m	every 6 years	2006	2018	https://land.copernicus.eu/local/urban-atlas
National Statistical Institute	INFOSTAT	3	Unknown	Annually	2004	Unknown	https://www.nsi.bg/en
"National Concept for Spatial Development 2013-2025"	MRD						
CORINE	EEA, MOEW	4	100 m	every 6 years	1986	2018	https://land.copernicus.eu/pan-european/corine-land-cover
Dept. “Green Systems”	Municipalities	4	Not applicable	Not applicable	Not applicable	Not applicable	Not applicable
Industrial Reporting	EEA	3	10 m	Annually	2007	2023	https://www.eea.europa.eu/data-and-maps/data/industrial-reporting-under-the-industrial-7/eu-registry-e-prtr-lcp
Road Infrastructure Agency	CEDR	3	Unknown	Annually	2000	2023	https://www.cedr.eu
National Railway Infrastructure Company	National Railway Infrastructure Company	3	Unknown	Unknown	2011	2022	https://www.rail-infra.bg/en
Bulgarian Ports Infrastructure Company	Bulgarian Ports Infrastructure Company	3	Unknown	Annually	2013	2020	http://www.bgports.bg/en

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Civil Aviation Administration	MTITC	3	Unknown	Annually	2015	2021	https://www.mtc.government.bg/en
Cadastre maps	Registry Agency	3	Unknown	Unknown	1953	2022	https://portal.registryagency.bg
Municipal Development plans	ME, MOEW	3	Not applicable	Not applicable	Unknown	Unknown	Not applicable
State Policy on Waste Management	MOEW	3	Unknown	Unknown	2009	2023	https://www.moew.government.bg/bg/otpaduci/tretirane-na-otpaduci/deponirane-na-otpaduci/zakonodatelstvo/
National database for Biodiversity	MOEW	4	Unknown	monthly	2003	2022	https://www.moew.government.bg/bg/vodi/povurhnostni-vodi/kompleksni-i-znachimi-yazoviri/
NEK EAD “Dams and cascades”	ME	4	Unknown	Unknown	Unknown	Unknown	https://nek.bg/dams/index.php/bg/
Rivers Basins Management Plans	MOEW	2	Unknown	Unknown	2010	2018	https://www.moew.government.bg/bg/vodi/planove-za-upravlenie/planove-za-upravlenie-na-rechnite-basejni-purb/planove-za-upravlenie-na-rechnite-basejni-2022-2027-g/

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Natura 2000 mapping and database	MOEW	2	Unknown	Annually	2002	2021	https://natura2000.egov.bg/EsriBg.Natura.Public.Web.App
Soil maps and their properties	JRC	3	1 km x 1 km; 10 km x 10 km		Unknown	Unknown	https://esdac.jrc.ec.europa.eu/resource-type/european-soil-database-soil-properties
ESTIMAP	JRC	4	Unknown	Unknown	Unknown	Unknown	Unknown
Global Monitoring for Environment and Security	ESA and EEA	4	0.3 km	Unknown	1992	2020	https://www.esa.int/About_Us/Ministerial_Council_2012/Global_Monitoring_for_Environment_and_Security_GMES
EUROSTAT	European Commission	4	unknown	twice a day,	1958	2023	https://ec.europa.eu/eurostat
JICA project	MOEW	3	Unknown	Unknown	2004	2005	Not aplicable
National Soil Monitoring Network	MOEW	3	16x16 km	annual	2004	2022	Not aplicable
State Digital Orthophoto map	State Fund "Agriculture"	3	Unknown	Unknown	Unknown	Unknown	https://dfz.bg/en/
Land and Parcel Information System (LPIS)	State Fund "Agriculture"	3	Unknown	Unknown	Unknown	Unknown	https://dfz.bg/en/

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Integrated Administration and Control System (IACS)	State Fund "Agriculture"	3	Unknown	Unknown	Unknown	Unknown	https://dfz.bg/en/

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Croatia

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	National habitat classification of Croatia
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS, CORINE
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	European Commission, DG Enviroment, 2013: Interpretation Manual of European Union Habitats, EUR 28.

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	I do not know
Organisation(s) assessing ecosystem condition	

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Habitats and protected areas in Croatia	Ministry of Economy and Sustainable Development of Republic of Croatia	4	N/A (polygons)	N/A	2004	N/A	https://www.bioportal.hr/gis/?lang=en
Corine Land Cover	Copernicus	4	100 m	several years	2000	2018	https://land.copernicus.eu/pan-european/corine-land-cover
Forests	Croatian Forests Ltd.	3	N/A (polygons)	every 10 years	2000	2021	https://webgis.hrsume.hr/arcgis/apps/dashboards/index.html#/2991321d6022406e9d4eb402501dcea0

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Cyprus

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Mapping and Assessment of Ecosystems and their Services (MAES)
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Mapping and Assessment of Ecosystems and their Services (MAES); Common International Classification of Ecosystem Services (CICES); Coordination of information on the environment (CORINE)
Spatial resolution of the typology units	Coarse resolution
Maps of the typology available in digital format	Yes

References	Maes J, Teller A, Erhard M, et al. (2013) An analytical framework for ecosystem assessments under action 5 of the EU Biodiversity Strategy to 2020 discussion paper, final, April 2013. European Union. Maes J, Teller A, Erhard M, et al. (2014) Indicators for ecosystem assessments under action 5 of the EU Biodiversity Strategy to 2020. European Commission. Potschin M, Haines-Young R (2012) Landscapes, sustainability and the place-based analysis of ecosystem services. Landscape Ecology 28 (6): 1053- 1065. European Commission (2011) Our life insurance, our natural capital: an EU biodiversity strategy to 2020. European Union. Maes J, Teller A, Erhard M, et al. (2018) An analytical framework for mapping and assessment of ecosystem condition in EU. European Union. Manolaki P, Vogiatzakis I (2017) Ecosystem services in a peri-urban protected area in Cyprus: a rapid appraisal. Nature Conservation 22: 129- 146. https://doi.org/10.3897/natureconservation.22.13840. The latest (to our knowledge) assessment of suitable and ecosystem indicators used for Cyprus (at a national level) are in the study below: Vogiatzakis, I. N., Zotos, S., Litskas, V. D., Manolaki, P., Sarris, D., & Stavrinides, M. (2020). Towards implementing Mapping and Assessment of Ecosystems and their Services in Cyprus: A first set of indicators for ecosystem management. One Ecosystem 5: e47715. There are also a few more studies for specific ES studies in Cyprus at a different (narrower) spatial level which are not included in the list above and tables below. This include work done in LIFE projects (LIFE Rizoelia, LIFE for Birds, iLifeTroodos)

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	Government Departments (Department of Environment (HD), Water Development Department (WFD) Department of Fisheries and Marine Research (MSFD), Forestry Department); Research Institutions (Open University Cyprus, Frederick University, University of Cyprus, The Cyprus Institute)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Czechia

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Consolidated Layer of Ecosystems of the Czech Republic
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	CORINE, EUNIS (compatible after some processing)
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	https://metadata.nature.cz/en/record/basic/63c80cbb-5824-4895-8651-755a10a020812

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	Multiple organisations

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Natural habitats	Habitat quality	Yes	3		Czech habitat mapping for Natura 2000
Forest	Forest quality	Don´t know	3		Czech forest inventory and monitoring
Water	Water bodies quality	Don´t know	3		Czech water monitoring
Soil	Soil erosion	Don´t know	3		Czech soil erosion monitoring

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Habitat quality mapping	Czech Nature Conservation Agency	4	Habitat units (vector)	12 years	2000-2005	2022	https://geoportal.gov.cz/php/micka/record/basic/4b31eb64-6e50-4222-91d4-500b0a02080a?dlang=eng

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Denmark

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Habitats Directive Annex 1. + National Classification of Nature Types
Scope of the typology or typologies?	International;National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Habitats Directive Annex 1 CORINE
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	https://inspire.ec.europa.eu/document/HabDir https://mst.dk/erhverv/rig-natur/naturbeskyttelse/3-beskyttede-naturtyper/beskyttelse-af-3-naturtyper

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	National Environment Agency under the Ministry of Environment Danish Centre For Environment under Aarhus University

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Terrestrial types except forests	species structural conditions	Yes	3		https://mst.dk/erhverv/tilskud-miljoeviden-og-data/data-og-databaser/miljoegis-data-om-natur-og-miljoe-paa-webkort
Forest types	species structural conditions	Yes	3		https://mst.dk/erhverv/tilskud-miljoeviden-og-data/data-og-databaser/miljoegis-data-om-natur-og-miljoe-paa-webkort
Marine	species Structural conditions Chemical loads	Yes	2		https://mst.dk/erhverv/tilskud-miljoeviden-og-data/data-og-databaser/miljoegis-data-om-natur-og-miljoe-paa-webkort
Lakes and water courses	species Structural conditions Chemical loads	Yes	3		https://mst.dk/erhverv/tilskud-miljoeviden-og-data/data-og-databaser/miljoegis-data-om-natur-og-miljoe-paa-webkort

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Terrestrial nature types except forests	NOVANA - Danish environment data	4	polygons	6 years	2004		https://mst.dk/erhverv/rig-natur/naturen-i-danmark/novana-overvaagning-af-natur-og-vandmiljoe
Forests	NOVANA - Danish environment data	4	polygons	12 years	2004		https://mst.dk/erhverv/rig-natur/naturen-i-danmark/novana-overvaagning-af-natur-og-vandmiljoe
Marine	NOVANA - Danish environment data	4	polygons	1 year	2004		https://mst.dk/erhverv/rig-natur/naturen-i-danmark/novana-overvaagning-af-natur-og-vandmiljoe
Lakes and water courses	NOVANA - Danish environment data	4	polygons	6 years	2004		https://mst.dk/erhverv/rig-natur/naturen-i-danmark/novana-overvaagning-af-natur-og-vandmiljoe

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Estonia

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	Estonia developed its own ecosystem typology within the MAES process
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Partially
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Annex I habitats classification
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	https://loodusveeb.ee/sites/default/files/inline-files/elme-ost-baastasemed_l6pparuanne_14-06-21.pdf

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Estonian Environment Agency, Estonian University of Life Sciences, Tartu University

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forests	Composite indicator, including: Forest age, forest structure, forest composition, soil properties, presence of drainage channels, protection status	Yes	3	R, ArcGIS, QGIS	https://loodusveeb.ee/sites/default/files/inline-files/elme-ost-baastasemed_l6pparuanne_14-06-21.pdf
Agricultural land	Composite indicator, including: Soil properties and structure, biodiversity practices, presence of organic farming, presence of heritage meadows, small woody elements	Yes	3	R, ArcGIS, QGIS	https://loodusveeb.ee/sites/default/files/inline-files/elme-ost-baastasemed_l6pparuanne_14-06-21.pdf
Wetland	Distance to drainage ditches	Yes	3	R, ArcGIS, QGIS	https://loodusveeb.ee/sites/default/files/inline-files/elme-ost-baastasemed_l6pparuanne_14-06-21.pdf
Grasslands	Composite indicator, including: Grassland management practice, historical continuity, shrub coverage, drainage ditches, presence of protected species.	Yes	3	R, ArcGIS, QGIS	https://loodusveeb.ee/sites/default/files/inline-files/elme-ost-baastasemed_l6pparuanne_14-06-21.pdf
Inland waters	Not much information available. Mostly WFD and expert based assessments	No	?	?	?
Sea	Composite indicator, based on multiple human inputs	Yes	2	?	https://gis.sea.ee/adrienne/map/IL_map

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Estonian Base Map	Estonian Land Board	4	1:10000	annual		2022	https://geoportaal.maaamet.ee/eng/Spatial-Data/Topographic-Maps/Estonian-Basic-Map-1-10-000-p306.html
Estonian Agricultural registry map	Estonian Agricultural Register and Information Board	4	1:10000	annual		2022	https://kls.pria.ee/kaart/
Annex I habitats map	Estonian Nature Information System	4	parcel level			2022	https://infoleht.keskkonnainfo.ee/
Semi-natural grasslands map of Estonia	Estonian Agricultural Register and Information Board	4	parcel level	annual		2022	https://kls.pria.ee/kaart/
Estonian soil map	Estonian Land Board	4	1:10000	single timestep	2000	2015 (major update)	https://geoportaal.maaamet.ee/eng/Spatial-Data/Estonian-Soil-Map-p316.html
Estonian wetlands map	Estonian Nature Information System	4	1:10000			2022	https://infoleht.keskkonnainfo.ee/
Estonian Forest Registry map	Environmental Agency	4	parcel level	annual		2022	register.metsad.ee

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Estonian LiDAR survey	Estonian Land Board	4	1m/pixel	4 years for each survey block	2008	2015	https://geoportaal.maaamet.ee/eng/Spatial-Data/Elevation-data-p308.html
Landsat thermal data	NASA	4	30 m/pixel	8 days revisit time			
Protected areas	Estonian Nature Information System	4	1:10000	annual		2022	https://infoleht.keskkonnainfo.ee/

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Finland

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	VMI (NFI, National Forest Inventory); The Red List of Species in Finland; Vegetationstyper i Norden; Biotope classification (used by Metsähallitus); The Status Assessment of Habitat Types in Finland; HELCOM underwater biotopes, habitats and biotope complexes; Classification of lake types in the ecological monitoring of freshwater bodies; Protected areas biotope inventory (applied only within protected areas, subnational); EUNIS, CORINE, MAES
Scope of the typology or typologies?	International; National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Natura 2000, Helcom HUB (+ Status Assessment of Habitat Types in Finland) – EUNIS
Spatial resolution of the typology units	Fine resolution; Coarse resolution; Not mapped
Maps of the typology available in digital format	Yes

References	
	Red list of species: Hyvärinen, E., Juslén, A., Kemppainen, E., Uddström, A. & Liukko, U.-M. (eds.) 2019. The 2019 Red List of Finnish Species. Ympäristöministeriö & Suomen ympäristökeskus. Helsinki. 704 p. https://punainenkirja.laji.fi/about/r-49 The status assessment of habitat types in Finland: Kontula, T. & Raunio, A. (eds). 2019. Threatened Habitat Types in Finland 2018. Red List of Habitats – Results and Basis for Assessment. Finnish Environment Institute and Ministry of the Environment, Helsinki. The Finnish Environment 2/2019. 254 p. https://luontotyyppienuhanalaisuus.ymparisto.fi/lutu/#/ Påhlsson, L. (eds.) 1995. Vegetationstyper i Norden. - Nordiska Ministerrådet, Tema Nord 1994: 665. Rask, M., Vuori, KM., Hämäläinen, H. et al. Ecological classification of large lakes in Finland: comparison of classification approaches using multiple quality elements. Hydrobiologia 660, 37–47 (2011). https://doi.org/10.1007/s10750-010-0384-7 Helcom HUB: HELCOM 2013 Red List of Baltic Sea underwater biotopes, habitats and biotope complexes. Baltic Sea Environmental Proceedings No. 138. VELMU models: Virtanen et al 2018: Evaluation, Gap Analysis, and Potential Expansion of the Finnish Marine Protected Area Network (https://www.frontiersin.org/articles/10.3389/fmars.2018.00402/full) VMI / NFI: https://jukuri.luke.fi/handle/10024/532024; https://www.luke.fi/fi/seurannat/valtakunnan-metsien-inventointi-vmi Protected areas inventory typology: https://www.metsa.fi/wp-content/uploads/2020/09/Valtion_suojelualueiden_biotooppikuviot.pdf Biotope classification: Seppo, T., Heikki, E. ja Heikki, T. (toim.). 2001. Yleispiirteinen biotooppiluokitus, Metsähallituksen luonnonsuojelujulkaisuja. Sarja B 57. Metsähallitus , Vantaa.

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Finnish Environment Institute; Parks & Wildlife Finland; Natural Resources Institute Finland; Finnish Forest Centre, Geological Survey of Finland (GTK)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Wetlands	Bird population trends	No	2	TRIM	https://www.wetlands.org/knowledge-base/waterbird-populations-portal/
Farmland	Bird population trends	No	2		https://www.luke.fi/en/farmland-birds
Forests	Change in natural properties, microclimate, locations of nests or rare vegetation, volume of dead wood, buffer zones around streams, etc.	Yes	3		https://www.metsakeskus.fi/fi/avoin-metsa-ja-luontotieto/luontotietoaineistot/
Forests	Volume of dead wood, forest age structure, presence of human activity	yes	3	Laser scanning, aerial photography, zonation, DPSIR	https://silvafennica.fi/article/10662#h1_2

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
					https://geoportal.ymparisto.fi/meta/julkinen/dokumentit/Zonation_metsa_forest_skog_Biodiversity_2018.pdf
Boreal forests	Indicator bird species	Yes	2	ALS and other RS data, the MaxEnt model	https://esajournals.onlinelibrary.wiley.com/doi/10.1002/eap.2505
Streams	Change in species community	Yes	3	Various statistical models (PienvesiGIS, Random Forests, RIVPACS)	Aroviita, J., & Ilmonen, J., et al. (2021). Pienten virtavesien tilan arvioinnin kehittäminen. 2021. Maps available (under Hydrography): https://kartta.paikkatietoikkuna.fi/?lang=en
Biotopes of protected areas	State of growth and succession, disturbance to natural state	Yes	3	Aerial photography, field inventories	https://www.paikkatietohakemisto.fi/geonetwork/srv/eng/catalog.search#/metadata/e3aa7b2a-e6e2-45dc-a29a-b64bcf2aba9f
Marine, freshwater, terrestrial and coastal (international, arctic)	Species and migratory birds, land cover change	Yes	0	MODIS satellite products	https://caff.is/indices-and-indicators https://abds.is/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forests, bogs, marine and freshwater, agricultural and city environments, fjells, coast, cliffs	Birds, protection status of directive species, WFD, MSFD (under development, will be updated)	Yes	2, 3		https://luonnontila.fi/indikaattorit-elinymparistoittain/
Baltic sea (international assessment by HELCOM)	Species abundance, population structure, zooplankton size/mass, nutrients, harmful substances, oxygen situation on the sea floor etc.	Yes	3	Various	https://helcom.fi/baltic-sea-trends/indicators/ http://stateofthebalticsea.helcom.fi/

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
River estuaries (1130), Lagoons (1150), Wide and shallow bays (1160) and Boreal Baltic narrow inlets (1650) (coast of Finland)	Parks and Wildlife Finland, Finnish Environment institute	2	polygon	N/A		2018	https://www.ymparisto.fi/en-US/VELMU/VELMU_Map_Service
Baltic Sea - Ice concentration and thickness charts	Copernicus Marine Service	4	km2	daily	2019	2023	https://data.marine.copernicus.eu/product/SEAICE_BAL_SEAICE_L4_NRT_OBSERVATIONS_011_004/description?view=-&task=results&product_id=-&option=-
Finnish sea ice charts	Finnish Meteorological Institute	4	km2	daily/seasonal	1995	2023	https://en.ilmatieteenlaitos.fi/ice-conditions
Lagoon data from Finnish coast 2021	Parks and Wildlife Finland	2	polygon	N/A	2021	2021	https://www.ymparisto.fi/en-US/VELMU/VELMU_Map_Service
MARINE BIOTOPE DISTRIBUTION MODELS	Finnish Environment institute	4	20x20m	N/A	2018	2018	https://www.frontiersin.org/articles/10.3389/fmars.2018.00402/full Also available in VELMU Map service.

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
The Status Assessment of Habitat Types in Finland 2018 (Baltic habitat types)	Finnish Environment institute	1		N/A	2018	2018	https://helda.helsinki.fi/handle/10138/308426
EU Habitat Directive marine habitat types 2016-2021	HELCOM	4	1x1km	N/A		2021	https://metadata.helcom.fi/geonetwork/srv/eng/catalog.search#/metadata/cc77dbd9-b4bc-43bf-accf-39fe603c1fda
High biodiversity value forests 2018	Finnish Environment institute	4	96x96m	N/A	2018	2018	https://ckan.ymparisto.fi/dataset/monimuotoisuudelle-tarkeat-metsaalueet-high-biodiversity-value-forests-2018-zonation-fin-eng-sw

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

France

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	CLC, Corinne Biotope, EUNIS, Phytosociology (mainly in conservation)
Scope of the typology or typologies?	National, Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	CLC, EUNIS
Spatial resolution of the typology units	Fine and Coarse
Maps of the typology available in digital format	Some
References	https://inpn.mnhn.fr/telechargement/referentiels/habitats/typologies

3. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Difficult to assess if it for or beyond…
Organisation(s) assessing ecosystem condition	ONB (Office National de la Biodiversité), INPN (Inventaire National du Patrimoine Naturel), INRAE (for soil), IGN-IFN (Institut Geographique National - Inventaire Forestier National (Forests), MNHN (Museum National d'Histoire Naturelle, RMQS (Réseau National de Mesure de la Qualité des Sols), UICN France, Water Office and Agencies, Ministry in charge of ecology (MTCT / CGDD) for Urban, CEREMA.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Mountains and Rocky	Habitat and species of EU community interest	I do not know	1	None	https://inpn.mnhn.fr/espace/espace-synthese?lgaen
N2000 areas	Habitat Area, Structure, Capacity, Functions	I do not know	1	None	https://inpn.mnhn.fr/espace/espace-synthese?lgaen Maciejewski, L., Lepareur, F., Viry, D., Bensettiti, F., Puissauve, R., & Touroult, J. (2016). État de conservation des habitats: propositions de définitions et de concepts pour l'évaluation à l'échelle d'un site Natura 2000. Revue d'Ecologie, Terre et Vie, 71(1), 3-20.
Freshwater	Community Interest Species occurrence, Indicator species	Conceptual consideration about the notion of reference.	2	None	Bensettiti, F., & Puissauve, R. (2015). Résultats de l'évaluation de l'état de conservation des habitats et des espèces dans le cadre de la directive Habitats-Faune-Flore en France. Rapportage «article, 17, 2007-2012.
Marine	Community Interest Species occurrence, Indicator species	Conceptual consideration about the notion of reference.	2	None	Juliette delavenne, Thibaut de Bettignies. Evaluation de l'état de conservation des habitats naturels marins à l'échelle d'un site Natura 2000 : Guide méthodologique. PatriNat (OFB-MNHN-CNRS-IRD); UMR 5245. 2023, pp.41. mnhn-04089730

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Soils	Macrofauna, Earthworms, Nematodes, Microbial biomass, Humic indices, pollutants	Not that I know	3	GIS	http://www.gissol.fr/le-gis/programmes/rmqs-34 Daniel Cluzeau, Muriel Guernion, R. Chaussod, Fabrice Martin-Laurent, Cecile Villenave, et al.. Integration of biodiversity in soil quality monitoring: Baselines for microbial and soil fauna parameters for different land-use types. European Journal of Soil Biology, 2012, 49 (SI), pp.63-72. ⟨10.1016/j.ejsobi.2011.11.003⟩. ⟨hal-00704897⟩
Forests	Several indicators related to pests, frost, drought	Not that I know	2	GIS	https://agriculture.gouv.fr/telecharger/136245
Forests	Dead trees	Not that I know	3		https://www.ign.fr/reperes/bilan-de-sante-des-forets-francaises

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

Germany

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	National Ecosystem Classification for Germany
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	CORINE, EUNIS, MAES, IUCN
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	DESTATIS (2021) Ecosystem Accounts - National Ecosystem Classification for Germany. Link: https://www.destatis.de/EN/Themes/Society-Environment/Environment/Environmental-Economic-Accounting/ecosystem-account/Methods/national-ecosystem-classification-5852206219004.pdf?__blob=publicationFile; Bellingen et al. (2022) Ecosystem accounts - ecosystem extent account. WISTA. Link: https://www.destatis.de/EN/Methods/WISTAScientificJournal/Downloads/ecosystem-accounts-062021.pdf? __blob=publicationFile; DESTATIS (2021) Methode der Flächenbilanzierung der Ökosysteme. Link: https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/methode-flaechenbilanzierung-oekosysteme-5852201189004.pdf?__blob=publicationFile; Ökosystematlas: https://oekosystematlas-ugr.destatis.de/

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	DESTATIS (German Federal Statistical Office)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Settlement areas and transport infrastructure	Chemical state characteristics: Particulate matter, Near surface ozone, Nitrogen oxides; Physical state characteristics: Heat days, Light emission, Soil sealing; Functional state characteristics: NDVI (Apr-Sep); Compositional state characteristics: Characteristic bird species; Structural state characteristics: Urban green space; Ancillary data: Air temperature, Precipitation	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Agricultural land	Chemical state characteristics: Near surface ozone, Groundwater nitrate concentration; Soil organic carbon, Soil pH; Physical state characteristics: Plant available water; Functional state characteristics: NDVI (Apr-Sep); Compositional state characteristics: Characteristic bird species; Structural state characteristics: High Nature Value farmland; Landscape and seascape characteristics: Diversity of arable land; Management: Protected area, Grassland use intensity; Pressure: Nitrogen surplus; Ancillary data: Evapotranspiration, Air temperature, Precipitation	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forests and woodland	Chemical state characteristics: Near surface ozone, Particulate matter; Soil organic carbon, Soil pH; Physical state characteristics: Soil moisture (abnormal dryness and drought); Functional state characteristics: NDVI (Apr-Sep), Length vegetation period; Compositional state characteristics: Characteristic bird species, Diversity of main tree species; Structural state characteristics: Stock of dead wood, Canopy density; Management: Protected area; Pressure: Fire-damaged area; Ancillary data: Air temperature, Precipitation, Snow cover	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Semi-natural open areas	Physical state characteristics: Soil moisture (abnormal dryness and drought), Glacial extent; Functional state characteristics: NDVI (Apr-Sep), Length vegetation period; Compositional state characteristics: Characteristic alpine species (flora and fauna); Management: Protected area, Grassland use intensity; Pressure: Coastal sealing; Ancillary data: Air temperature, Precipitation, Snow cover	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/
Freshwater	Chemical state characteristics: Nitrate-nitrogen (water courses), Total phosphorus (water courses); Functional state characteristics: Bathing water quality (water courses and standing lakes); Management: Protected area	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Freshwater according to the Water Framework Directive	Chemical state characteristics: Acidification (water courses and lakes); Physical state characteristics: Salinity (water courses and lakes), Oxygen condition (water courses and lakes), Transparency (lakes), Temperature (water courses and lakes) ; Compositional state characteristics: Fish fauna (water courses and lakes), Macrophytes/Phytobenthos (water courses and lakes), Macrozoobenthos (water courses and lakes), Phytoplankton (lakes); Landscape and seascape characteristics: Morphology (water courses and lakes), Sediment permeability (water courses), Hydrological regime (water courses and lakes)	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Marine waters	Physical state characteristics: Surface temperature, Salinity, Sea state/Swell; Compositional state characteristics: Characteristic bird species; Structural state characteristics: Marine mammals; Management: Protected area; Pressure: Fishing intensity, Noise emission, Shipping density, Economic use	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/
Marine waters according to the Marine Strategy Framework Directive (MSFD)	Descriptors of the MSFD D1 Biodiversity; D3 Commercial fish and shellfish stocks; D4 Ecosystems and food web; D5 Eutrophication; D6 Benthic habitat; D7 Changes in the hydrographical conditions; D8 Hazardous substances in the environment; D9 Hazardous substances in food; D10 Litter; D11 Energy supply, including underwater noise	No	3	Python and ArcGis	https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Umwelt/UGR/oekosystemgesamtrechnungen/Publikationen/Downloads/statistischer-bericht-zustandsbilanz-oekosysteme-5853201239005.xlsx?__blob=publicationFile; https://oekosystematlas-ugr.destatis.de/

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Landbedeckungs modell für Deutschland (LBM-DE)	Federal Agency for Cartography and Geodesy (dt: Bundesamt für Kartographie und Geodäsie (BKG))	4	Position accuracy: 5 m; Minimum mapping width: 15 m	every 3 years	2009	2018	https://gdz.bkg.bund.de/index.php/default/digitales-landbedeckungsmodell-fur-deutschland-stand-2018-lbm-de2018.html	Ecosystem Extent
Basis-DLM	Federal Agency for Cartography and Geodesy (dt: Bundesamt für Kartographie und Geodäsie (BKG))	4	Position accuracy: 3 m; Minimum mapping width: 15 m	diverse			https://gdz.bkg.bund.de/index.php/default/digitales-basis-landschaftsmodell-ebenen-basis-dlm-ebenen.html	Ecosystem Extent
Digitale Geländemodell (DGM)	Federal Agency for Cartography and Geodesy (dt: Bundesamt für Kartographie und Geodäsie (BKG))	4	Cell Size: 1-10 m	annual	diverse	diverse	https://gdz.bkg.bund.de/index.php/default/digitale-geodaten/digitale-gelandemodelle.html?___store=default	Ecosystem Extent
Großlandschaften Deutschlands	Federal Agency for Nature Conservation (dt: Bundesamt für Naturschutz (BfN))	2	NA	NA	NA	NA	https://www.bfn.de/daten-und-fakten/biogeografische-regionen-und-naturraeumliche-haupteinheiten-deutschlands	Ecosystem Extent

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Bodenübersichtskarte (BÜK)	Federal Institute for Geosciences and Natural Resources (dt: Bundesanstalt für Geowissenschaften und Rohstoffe (BGR))	4			2010		https://www.bgr.bund.de/DE/Themen/Boden/Informationsgrundlagen/Bodenkundliche_Karten_Datenbanken/BUEK200/buek200_node	Ecosystem Extent
Water typology based on Waterfremwork directive (dt: Wasserrahmenrichtlinie (WRRL))	German Environment Agency (dt: Umweltbundesamt (UBA)) and "Bund/Länder-Arbeitsgemeinschaft Wasser"	2	NA				https://www.gewaesser-bewertung.de/index.php?article_id=425&clang=0	Ecosystem Extent
Copernicus Riparian Zones High Resolution Layer	European Environmental Agency	4	Minimum mapping unit: 0.5 ha; Mapping mapping: 10 m	multi-annual	2012	2018	https://land.copernicus.eu/local/riparian-zones	Ecosystem Extent
FFH/Natura2000 Protection areas	Diverse	2		every 6 years		2019-2020	https://geodienste.bfn.de/schutzgebiete?lang=de	Ecosystem Extent
Copernicus Small Woody Features High Resolution Layer	European Environmental Agency	4	5 m	multi-annual	2015	2018	https://land.copernicus.eu/pan-european/high-resolution-layers/small-woody-features	Ecosystem Extent
Biotope mapping and seagrass + musselbed mapping	(All/ coastal) German federal states individually	4	diverse	diverse				Ecosystem Extent

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Gletscherausmaß	Bayerische Akademie der Wissenschaften (BAdW)			irregular				Ecosystem Condition
Landwirtschaftliche Flächen mit Hohem Naturwert	Bundesamt für Naturschutz (BfN)			yearly			https://www.bfn.de/karten-und-daten/anteil-der-landwirtschaftsflaechen-mit-hohem-naturwert-high-nature-value-farmland	Ecosystem Condition
Charakteristische Vogelarten	Bundesamt für Naturschutz (BfN)			yearly			http://dns-indikatoren.de/15-1	Ecosystem Condition
Wirtschaftliche Nutzung	Bundesamt für Seeschifffahrt und Hydrographie (BSH)			yearly			https://www.bsh.de/DE/THEMEN/Offshore/Nutzungskarten/nutzungskarten.html	Ecosystem Condition
Lärm	International Council for the Exploration of the Sea (ICES)	4	200 m	diverse			https://underwaternoise.ices.dk/continuous/viewonmap	Ecosystem Condition
Lärm	Bundesamt für Seeschifffahrt und Hydrographie (BSH)			yearly			https://marinears.bsh.de/FIS_SCHALL_PORTAL/pages/index.jsf	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Oberflächentemperatur	Copernicus Programme	4	0.111 × 0.067 °	yearly			https://data.marine.copernicus.eu/product/NWSHELF_MULTIYEAR_PHY_004_009/description	Ecosystem Condition
Oberflächentemperatur	Copernicus Programme	4	4 km	yearly			https://data.marine.copernicus.eu/product/BALTICSEA_MULTIYEAR_PHY_003_011/description	Ecosystem Condition
Salzgehalt	Copernicus Programme	4	0.111 × 0.067 °	yearly			https://data.marine.copernicus.eu/product/NWSHELF_MULTIYEAR_PHY_004_009/description	Ecosystem Condition
Salzgehalt	Copernicus Programme	4	4 km	yearly			https://data.marine.copernicus.eu/product/BALTICSEA_MULTIYEAR_PHY_003_011/description	Ecosystem Condition
Versiegelung	Copernicus Programme	4	20 m (2015); 10 m (2018)	every 3 years		NA	https://land.copernicus.eu/pan-european/high-resolution-layers/imperviousness	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Küstenversiegelung	Copernicus Programme	4	20 m (2015); 10 m (2018)	every 3 years			https://land.copernicus.eu/pan-european/high-resolution-layers/imperviousness	Ecosystem Condition
Vegetationsindex	Copernicus Programme	4	300 m	monthly (April - September)			https://land.copernicus.eu/global/products/ndvi	Ecosystem Condition
Vegetationsperiode	Copernicus Programme	4	500 m (2015); 10 m (2018)	yearly			https://land.copernicus.eu/pan-european/biophysical-parameters/high-resolution-vegetation-phenology-and-productivity/vegetation-phenology-and-productivity	Ecosystem Condition
Kronendichte	Copernicus Programme	4	10 m (2015); 10 m (2018)	every 3 years			https://land.copernicus.eu/pan-european/high-resolution-layers/forests/tree-cover-density/status-maps	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Seegang	Copernicus Programme	4	0.2 × 0.2 °	yearly			https://data.marine.copernicus.eu/product/GLOBAL_MULTIYEAR_WAV_001_032/description	Ecosystem Condition
Hitze	Deutscher Wetterdienst (DWD)	4	1 km	yearly			https://opendata.dwd.de/climate_environment/CDC/grids_germany/annual/hot_days/	Ecosystem Condition
Niederschlag	Deutscher Wetterdienst (DWD)	4	1 km	monthly			https://opendata.dwd.de/climate_environment/CDC/grids_germany/seasonal/precipitation/	Ecosystem Condition
Schneebedeckung	Deutscher Wetterdienst (DWD)	4	1 km	yearly			https://opendata.dwd.de/climate_environment/CDC/grids_germany/annual/snowcover_days/	Ecosystem Condition
Lufttemperatur	Deutscher Wetterdienst (DWD)	4	1 km	monthly			https://opendata.dwd.de/climate_environment/CDC/grids_germany/seasonal/air_temperature_mean/	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Evapotranspiration	Deutscher Wetterdienst (DWD)	4	1 km	monthly			https://opendata.dwd.de/climate_environment/CDC/grids_germany/monthly/evapo_r/	Ecosystem Condition
Lichtemissionen	Earth Observation Grop (EOG)	4	500 m	yearly	2012	2020	https://eogdata.mines.edu/products/vnl/	Ecosystem Condition
Fischfangintensität	EMODnet Human Activities	4	0.05×0.05 degree	yearly			https://ows.emodnet-humanactivities.eu/geonetwork/srv/ger/catalog.search#/metadata/d57fbdea-489e-4e11-9ff1-f0f706cfe783	Ecosystem Condition
Waldbrandstatistik	Bundesinformationszentrum Landwirtschaft (BZL)	0		yearly			https://www.ble.de/DE/BZL/Daten-Berichte/Wald/wald_node.html;jsessionid=C48A17A887F6574173DFC8AD9FBC61B5.internet952	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Schifffahrtsdichte	EMODnet Human Activities	4	1 km	yearly	2017	2022	https://emodnet.ec.europa.eu/geonetwork/emodnet/eng/catalog.search#/metadata/0f2f3ff1-30ef-49e1-96e7-8ca78d58a07c; https://emodnet.ec.europa.eu/geoviewer/	Ecosystem Condition
Badewasserqualität	Europäische Umwltagentur (EEA)			yearly			https://www.eea.europa.eu/data-and-maps/data/bathing-water-directive-status-of-bathing-water-14	Ecosystem Condition
Nutzbare Feldkapazität	Helmholtz-Zentrum für Umweltforschung (UFZ)	4	4 km	daily			https://www.ufz.de/index.php?de=37937	Ecosystem Condition
Bodenfeuchteindex	Helmholtz-Zentrum für Umweltforschung (UFZ)	4	4 km	daily			https://www.ufz.de/index.php?de=37937	Ecosystem Condition
Lärm (Dauerschall)	International Council for the Exploration of the Sea (ICES)							Ecosystem Condition
Schutzgebietsflächen	Protected Planet							Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Charakteristische alpine Arten	Schirpke et al. 2018	4	100 m				https://link.springer.com/article/10.1007/s10980-018-0628-x	Ecosystem Condition
Kegelrobben	The Common Wadden Sea Secretariat (CWSS)			yearly			https://www.waddensea-worldheritage.org/resources/2021-2022-grey-seal-report	Ecosystem Condition
Seehunde	The Common Wadden Sea Secretariat (CWSS)			yearly			https://www.waddensea-worldheritage.org/resources/2022-harbour-seal-report	Ecosystem Condition
Monitoring von marinen Säugetieren	Bundesamt für Naturschutz (BfN)	4	10 km	every 3 years			https://www.bfn.de/wirbeltiere	Ecosystem Condition
Organischer Bodenkohlenstoff (Wälder und Gehölz)	Thünen-Institut	4	1 km	every 10 years			https://www.thuenen.de/de/fachinstitute/waldoekosysteme/projekte/bodenschutz-und-waldzustand/projekte-bodenzustandserhebung/kohlenstoffvorraete-und-vorratsaenderungen-in-waldboeden	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Organischer Bodenkohlenstoff (Agrarland)	Greifswald Moor Centrum	4	5 to 125 m				https://www.greifswaldmoor.de/files/dokumente/GMC%20Schriften/2020-01_Tegetmeyer%20et%20al.pdf	Ecosystem Condition
Organischer Bodenkohlenstoff (Agrarland)	Thünen-Institut	4	100 m	every 10 years			https://www.openagrar.de/receive/openagrar_mods_00054877	Ecosystem Condition
Diversität des Ackerlands	Thünen-Institut	4	10 m	yearly			https://atlas.thuenen.de/layers/CTM_GER_2018_rst_v201:geonode:CTM_GER_2018_rst_v201	Ecosystem Condition
Mahdfrequenz	Thünen-Institut	4	10 m	annual	2017	2021	https://atlas.thuenen.de/layers/GLU_GER_2018_SUM_DOY1_PGL_CGL_FAL_v201:geonode:GLU_GER_2018_SUM_DOY1_PGL_CGL_FAL_v201	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
pH-Wert	Thünen-Institut	4	1 km	every 10 years		NA	https://atlas.thuenen.de/layers/pH_map_30_100:geonode:pH_map_30_100; https://atlas.thuenen.de/layers/pH_map_0_30:geonode:pH_map_0_30	Ecosystem Condition
Diversität der Hauptbaumarten	Thünen-Institut	4	10 m	every 3 years	2017/2018	NA	https://atlas.thuenen.de/layers/Dominant_Species_Class:geonode:Dominant_Species_Class	Ecosystem Condition
Gesamtphosphor	Umweltbundesamt (UBA)			yearly			https://gis.uba.de/maps/resources/apps/nitratbericht_eu_richtlinie/index.html?lang=de	Ecosystem Condition
Nitrat im Grundwasser	Umweltbundesamt (UBA)			yearly			https://cdr.eionet.europa.eu/de/eu/nid	Ecosystem Condition
Nitrat-Stickstoff	Umweltbundesamt (UBA)			yearly			https://gis.uba.de/maps/resources/apps/nitratbericht/index.html?lang=de	Ecosystem Condition

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference	Account type
Stickstoffdioxid	Umweltbundesamt (UBA)	4	2 km	hourly			https://gis.uba.de/maps/resources/apps/lu_schadstoffbelastung/index.html?lang=de	Ecosystem Condition
Stickstoff-Flächenbilanz	Justus Liebig Universität Gießen			yearly			https://www.liki.nrw.de/natur-und-landschaft/b6-stickstoffueberschuss	Ecosystem Condition
Bodennahes Ozon	Umweltbundesamt (UBA)	4	2 km	hourly			https://gis.uba.de/maps/resources/apps/lu_schadstoffbelastung/index.html?lang=de	Ecosystem Condition
Feinstaub	Umweltbundesamt (UBA)	4	2 km	hourly			https://gis.uba.de/maps/resources/apps/lu_schadstoffbelastung/index.html?lang=de	Ecosystem Condition

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Greece

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	MAES, habitat types
Scope of the typology or typologies?	National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	MAES, Dir.92/42 Habitat types
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	MAES Typology: (Maes J, et al. (2013) Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg; (Verde et al. 2020). National scale land cover classification for ecosystem services mapping and assessment, using multitemporal copernicus EO data and google earth engine. Remote Sensing, 12(20), 3303.

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Department of Biology, University of Patras / JRC

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Woodland and forest	Forest condition index (Using variables extracted from the Greek HD monitoring database)	Yes	2	ArcGIS, QGIS	Vallecillo, S; Maes, J; Teller, A; Babí Almenar J; Barredo, J.I; Trombetti, M; Abdul Malak, D.; Paracchini ML; Carré A; Addamo AM; Czúcz, B; et al. EU wide methodology to map and assess ecosystem condition: Towards a common approach consistent with a global statistical standard. Publications Office of the European Union, Luxembourg, 2022, doi:10.2760/13048, JRC130782

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Dir. 92/43 habitat type mapping	Ministry of Environment and Energy	4	Scale 1:5,000	N/A	2016	2016	https://mapsportal.ypen.gr/layers/geonode:habitats_egsa87

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Hungary

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	Natura2000 (Annex I), Á-NÉR, CORINE, national Ecosystem type map categories
Scope of the typology or typologies?	International; National
If a national or subnational typology is used, is it compatible with international classifications?	No
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	it is possible to create some crosswalks but there is no perfect correspondence
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	Á-NÉR: Bölöni, J., Molnár, Z., Illyés, E., Kun, A., 2007. A NEW HABITAT CLASSIFICATION AND MANUAL FOR STANDARDIZED HABITAT MAPPING. Annali di Botanica 7, 55–76. https://doi.org/10.4462/annbotrm-9085 Ecosystem type map of Hungary: Tanács, E., Belényesi, M., Lehoczki, R., Pataki, R., Petrik, O., Standovár, T., Pásztor, L., Laborczi, A., Szatmári, G., Molnár, Z., Bede-Fazekas, Á., Somodi, I., Kristóf, D., Kovács-Hostyánszki, A., Török, K., Kisné Fodor, L., Zsembery, Z., Friedl, Z., Maucha, G., 2021. Compiling a high-resolution country-level ecosystem map to support environmental policy: methodological challenges and solutions from Hungary. Geocarto International 0, 1–24. https://doi.org/10.1080/10106049.2021.2005158 (I can provide this paper on request)

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	A national evaluation was carried out in the frames of MAES-HU; that (and other similar activities) are coordinated by the Nature Conservation department of the Ministry of Agriculture

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference

Forests	Number of native tree species The proportion of native tree species in the upper and lower canopy layers (%) Number of native admixing tree species Presence of the main tree species characteristic of the specific habitat type in the expected proportion The proportion of the native mixing tree species compared to that expected in the specific habitat type The proportion of non-native tree species in the upper and lower canopy layers (%) The proportion of invasive tree species in the upper and lower canopy layers (%) Number of age cohorts Difference between the lowest and highest cohort age (years) Presence of old (>=100 years or 60 in the case of native softwood forests) trees Number of (10-cm) dbh-classes (Shannon) diversity of (10-cm) dbh-classes – considered only if number of (10-cm) dbh classes >2 Presence of large (dbh>50) trees Presence and type of the shrub layer	yes	3	ArcGIS, R	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Wetlands	Proportion of wetlands (220 m radius) Frequency of water cover (Water and Wetness Probability Index) Presence of surface water and temporary surface water (220 m radius) Proportion of semi natural areas (220 m radius) Presence of roads (within the 20 m cell) Heterogeneity of wetland types	yes	2	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543
Grasslands	Proportion of semi natural areas (300, 500, 1000 m radius) Proportion of semi natural grasslands (300, 500, 1000 m radius) Distance to (any) roads Distance to major roads Distance to surface water Distance to canals Proportion of protected areas (AES or HVNA) Frequency of water cover (Water and Wetness Probability Index)	no	1	ArcGIS, eCognition	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Croplands	Proportion of semi natural areas (300 m radius) Average parcel size Number of cultivated plants (no or no/ha) Areal proportion of alfalfa and green fallow Proportion of fallow land Proportion of maize Proportion of protected areas (AES or HVNA)	yes	2/3 (not all variables considered relevant could be included, due to a lack of national-level data)	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543
Water	WFD biological components	yes	2/3	ArcGIS; we used the WFD methodology with minimum changes	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Urban areas	- Proportion of urban green areas (trees) within the settlement - Proportion of urban green areas (non-tree) within the settlement - Proportion of urban green areas within the settlement	no	2	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543
Soil	Soil fertility	no	2	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
All, except urban	Ratio of present bird species compared to the expected (%)	no	2	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543
Grasslands and wetlands	Departure of the current vegetation from the Potential Natural Vegetation	no	2	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Misc	Number of ecosystem types (1 km radius) (Shannon) diversity of ecosystem types (1 km radius) Land take (based on Corine Land Cover time series) 2000-2018 Loss of grasslands Forest area changes Proportion of Natura 2000 areas in the different ecosystem types	no	2/3	ArcGIS	Tanács, E., Bede-Fazekas, Á., Csecserits, A., Kisné Fodor, L., Pásztor, L., Somodi, I., Standovár, T., Zlinszky, A., Zsembery, Z., Vári, Á., 2022. Assessing ecosystem condition at the national level in Hungary - indicators, approaches, challenges. OE 7, e81543. https://doi.org/10.3897/oneeco.7.e81543

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
The Ecosystem Map of Hungary	Made in MAES-HU (Ministry of Agriculture)	4	20 m	one-time (so far)	2015	2015	Tanács, E., Belényesi, M., Lehoczki, R., Pataki, R., Petrik, O., Standovár, T., Pásztor, L., Laborczi, A., Szatmári, G., Molnár, Z., Bede-Fazekas, Á., Somodi, I., Kristóf, D., Kovács-Hostyánszki, A., Török, K., Kisné Fodor, L., Zsembery, Z., Friedl, Z., Maucha, G., 2021. Compiling a high-resolution country-level ecosystem map to support environmental policy: methodological challenges and solutions from Hungary. Geocarto International 0, 1–24. https://doi.org/10.1080/10106049.2021.2005158 (see also: termeszetem.hu)
Hungarian Land Parcel Identification Scheme (LPIS)	Hungarian State Treasury	1	specific units (blocks)	annual	do not know	2022	https://mepar.mvh.allamkincstar.gov.hu/#/

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Beneficiaries' Declarations (BD)	National Centre of Land Management	1	specific units (blocks)	annual	do not know	2022	data on request
National Forestry Database (NFD)	Ministry of Agriculture	1	3,5 ha on average, ranging from 0,5 ha to over 30 ha	annual	1935	2022	Tobisch, T., Kottek, P., 2013. Forestry-related databases of the Hungarian forestry directorate [WWW Document]. National Food Chain Safety Office (NFCSO), Hungary. URL https://portal.nebih.gov.hu/documents/10182/862096/Forestry_related_databases.pdf/3ff92716-2301-4894-a724-72fafca9d4fc (accessed 6.23.20).

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Multiple Potential Natural Vegetation database of Hungary (MPNV)	Centre for Ecological Research	1	35-ha hexagons	one-time	2010's?	2010's?	Somodi, I., Molnár, Z., Czúcz, B., Bede-Fazekas, Á., Bölöni, J., Pásztor, L., Laborczi, A., Zimmermann, N.E., 2017. Implementation and application of multiple potential natural vegetation models – a case study of Hungary. Journal of Vegetation Science 28, 1260–1269. https://doi.org/10.1111/jvs.12564
Copernicus High Resolution Layer (HRL), Water and Wetness Probability Index (WWPI)	Copernicus	4	20 m	one-time (?)	2015	2015	Langanke, T., Moran, A., Dulleck, B., Schleicher, C., 2016. Copernicus Land Monitoring Service– High Resolution Layer Water and Wetness Product Specifications Document. Copernicus team at EEA.
Open Street Map (OSM) roads	OSM	4					www.osm.com

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
CORINE Land Cover improved state layers 2000, 2006, 2012, 2018	Copernicus	4	5 ha/25 ha	6-years	2000	2018	
Soil productivity	Hungarian Soil Research Institute	4	100 m	one-time	from a long period	from a long period	https://dosoremi.hu/en/
Boundary of Natura2000 areas and Protected Areas	Ministry of Agriculture	4	polygon map	2018			available on request

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Ireland

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Primary typology used in policy and formal national reports is a national habitat classification system. Corine Land Cover data sets are used routinely by state agencies. MAES, IUCN and EUNIS increasingly used, but mainly in the research sphere.
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	No
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Not mapped
Maps of the typology available in digital format	No
References	Fossit, J. (2000) A Guide to Habitats in Ireland

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	National Parks and Wildlife Service (government agency)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Israel

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	"In Israel 3 slightly different typologies are used in the national scale, depending on the organisation/project and its purpose, none of them is similar to the EU/international common typologies:
Scope of the typology or typologies?	Israel nature and parks authority (NPA) – 23 terrestrial ecosystem-units presenting the natural potential ecosystems (covering the whole country).
If a national or subnational typology is used, is it compatible with international classifications?	Israel national terrestrial biodiversity monitoring program (IBM) – 9 terrestrial monitoring ecosystem-units (covering most, but not all, of the country's land).
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Israel national ecosystem (services) assessment project (I-NEA) – 6 main ecosystem types with subdivisions within them (covering the whole marine and terrestrial territory)"
Spatial resolution of the typology units	National; Subnational
Maps of the typology available in digital format	No
References	NPA - Rotem, D., & Weil, G. (2014). Natural ecosystem-units in Israel and the Palestinian authority-representativeness in protected areas and suggested solutions for biodiversity conservation. Journal of Landscape Ecology, 7(1), 91-109. IBM – Drori, R., Berg, N., & Perevolotsky, A. (2017). Monitoring the State of Nature in Israel. Stepping in the Same River Twice: Replication in Biological Research, 94. I-NEA - 1) Lotan, A., Kost, R., Mandelik, Y., Peled, Y., Chakuki, D., Shamir, S. Z., & Ram, Y. (2018). National scale mapping of ecosystem services in Israel–genetic resources, pollination and cultural services. One Ecosystem, 3, e25494. 2) Lotan A, Grossbard, S, Safriel U, Feitelson E (editors). 2019. Ecosystems and human well-being - National Assessment. Key Findings Report. Tel-Aviv, Hamaarag - Israel's National Ecosystem Assessment Program, Steinhardt Museum of Nature, Tel Aviv University (in Hebrew).

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	I do not know
Organisation(s) assessing ecosystem condition	Hamaarag-Israel national nature assessment program; Nature and Parks Authority (NPA); Jewish National Fund (JNF-KKL, the Israeli forest department); Israel Oceanographic and Limnological Research (IOLR); Israel Center for Aquatic Ecology; The Society for the Protection of Nature in Israel (ASPNI); Others (universities, research centres, NGO's) do local assessments.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Mediterranean maquis	Biodiversity (woody plants, birds, mammals), woody plant cover, changes in ecosystem area (land use changes	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Planted forests (by HaMaarag)	Biodiversity (woody plants, birds, mammals, reptiles), woody plant cover, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Planted forests (by KKL)	woody plant diversity and cover, tree density, tree health, invasive species	I do not know	3	Long-term field monitoring (new scheme)	
Grassland and dwarf shrubland	Biodiversity (woody plants, birds, mammals), woody plant cover, grass biomass, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Coastal sand dunes	Biodiversity (woody plants, mammals, reptiles, invertebrates), woody plant cover, invasive species, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Desert fringe	Biodiversity (woody plants, mammals, reptiles, invertebrates), woody plant cover, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Arid Loess plane	Biodiversity (woody plants, birds, reptiles), woody plant cover, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Arid mountains	Biodiversity (woody plants, birds, mammals), woody plant cover, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Extreme arid	Biodiversity (woody plants, birds, mammals), woody plant cover, changes in ecosystem area (land use changes)	No	3	Long-term field monitoring GIS analysis Remote sensing	https://hamaarag.org.il/report/
Inland water	Water quality (BOD, pH, O2 ammonium, coliforms, turbidity), biodiversity (invertebrates)	I do not know	3 (in specific water streams/bodies)	Field survey	https://smnh.tau.ac.il/en/research-at-smnh-2/centers/aquatic-ecology/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Marine	Climate change & Hydrology (sea level, acidity, dissolve nutrients and oxygen), pollution and litter (heavy metal, organic pollutants, microplastic), biodiversity (phytoplankton, zooplankton, bacteria, epifauna, rocky shore & hard substrate communities)	I do not know	3	Long-term field monitoring	https://library.oapen.org/handle/20.500.12657/62832 https://www.gov.il/en/departments/guides/marine_environment_monitoring?chapterIndex=2
Urban	Biodiversity (plants, birds, mammals, reptiles, butterflies), invasive and endangered plant species, planning	No	3 (in specific urban areas)	Field surveys (in 60 urban areas between 2009-2023)	https://mapateva.org.il/Apps/StoryTelling/PlayList_UrbanNatureIndex/index.html

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Israel national terrestrial biodiversity monitoring program (IBM)	Hamaarag-Israel national nature assessment program	4	Representative selected sites	2-4 year of cycle	2012	2021	https://hamaarag.org.il/report/
National Monitoring Program of Israel's Mediterranean Waters	Israel Oceanographic and Limnological Research	4	Representative selected sites		Some data are available since 1980's, most data were taken since 2018	2021	https://www.ocean.org.il/en/
	Israel Center for Aquatic Ecology	4	Representative selected sites		The centre was established in 2015		https://smnh.tau.ac.il/en/research-at-smnh-2/centers/aquatic-ecology/
Forest health survey	JNF-KKL (the Israeli forest department)	4	Representative selected sites				

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Italy

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	MAES, CORINE, Ecosystem Map of Italy
Scope of the typology or typologies?	International; National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS, MAES, CORINE
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	Davies C, et al. (2004) EUNIS habitat classification revised 2004.Report to: European environment agency-European topic centre on nature protection and biodiversity, 127-143. Devillers P, et al. (1991) CORINE biotopes manual: a method to identify and describe consistently sites of major importance for nature conservation. Data specifications–part, 2. Lapresa A, et al. (2004) Gli habitat secondo la nomenclatura EUNIS: manuale di classificazione per la realtà italiana. APAT, Roma. Angelini P, et al. (2009) Il progetto Carta della Natura. Linee guida per la cartografia e la valutazione degli habitat alla scala 1: 50.000.Manuali e Linee Guida 48/2009. https://doi.org/10.1016/j.envsci.2017.09.002

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	ISPRA - Italian Institute for Environmental Protection and Research

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
All	share of area protected within the N2000 network	No	3	na	Quarto rapporto sullo stato del Capitale Naturale in Italia, 2021
all terrestrial ecosystems	conservation status	Yes	3	simple GIS algorithm based on: i) actual versus potential cover of ecosystems considering the potential natural vegetation (VNP), and ii) quality of adjacencies among ecosystems or land cover types	Primo rapporto sullo stato del Capitale Naturale in Italia, 2017
all terrestrial ecosystems	risk status / risk of collapse	Yes	3	criteria according to: Rodríguez, J.P., Keith, D.A., Rodríguez-Clark, K.M., Murray, N.J., Nicholson, E., Regan, T.J., Miller, R.M., Barrow, E.G., Bland, L.M., Boe, K., et al. (2015). A practical guide to the application of the IUCN Red List of Ecosystems criteria. Philos Trans R Soc B 370, 20140003	Capotorti, G. L., et al. (2020). Implementation of IUCN criteria for the definition of the Red List of Ecosystems in Italy, Plant Biosystems, 154:6, 1007-1011, DOI: 10.1080/11263504.2020.1839806. // https://sinacloud.isprambiente.it/portal/home/item.html?id=cc9681ce700f42b1be2d09d65bdd604c
all terrestrial ecosystems	habitat quality	Yes	3	InVest	Secondo rapporto sullo stato del Capitale Naturale in Italia, 2018

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
all terrestrial ecosystems	land take (consumo di suolo)	No	3	GIS	https://www.snpambiente.it/category/temi/suolo/consumo-di-suolo/ // https://groupware.sinanet.isprambiente.it/uso-copertura-e-consumo-di-suolo/library/consumo-di-suolo
all terrestrial ecosystems	fragmentation	Yes	3	landscape metrics (effective mesh density) calculated in a GIS	https://groupware.sinanet.isprambiente.it/uso-copertura-e-consumo-di-suolo/library/consumo-di-suolo/frammentazione
all terrestrial ecosystems	burnt areas	No	3	na	Secondo rapporto sullo stato del Capitale Naturale in Italia, 2018
all terrestrial ecosystems	desertification risk	Yes	3	ESA index	Secondo rapporto sullo stato del Capitale Naturale in Italia, 2018
all terrestrial ecosystems	Inclusion in a SIC (Dir. 92/43/EEC), ZPS (Dir. 79/409/EEC), "Ramsar area" list (Ramsar Convention on Wetlands of 02/02/1971)	No	2	na	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
all terrestrial ecosystems	existing vertebrate types	No	2	earth observation - GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	existing vertebrate types	No	2	earth observation - GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	type of existing floristic species	No	2	earth observation - GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	biotype extension	Yes	2	earth observation - GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
all terrestrial ecosystems	biotype rarity (surface extension per each type of habitat)	Yes	2	earth observation - GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	vulnerable animal and flora species	No	2	IUCN method + GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	biotope fragmentation	No	2	GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
all terrestrial ecosystems	Pressure on the biotype from human activities	No	2	GIS	https://www.isprambiente.gov.it/it/pubblicazioni/manuali-e-linee-guida/progetto-carta-della-natura-alla-scala-1-50.000-linee-guida-per-la-cartografia-e-la-valutazione-degli-habitat
autoctonous forests and mediterranean scrubs	fire risk	Yes	3	IUCN model	Quinto rapporto sullo stato del Capitale Naturale in Italia, 2022

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
coastal	coastal dynamics / coastal erosion	No	3	earth observation - GIS	https://annuario.isprambiente.it/pon/basic/49
marine protected areas	stock and flow of natural capital	No	3	emergy analysis	Vassallo P., Paoli C., Buonocore E., Franzese P.P., Russo G.F., Povero P. (2017). Assessing the Value of Natural Capital in Marine Protected Areas: a Biophysical and Trophodynamic Environmental Accounting Model. Ecological Modelling, 355: 12-17
				ISPRA is developing the Nature Map (scale 1:50000) for Italy, which aims to map the ecosystems present and assess their status by highlighting areas of greatest naturalistic value and those at greatest risk of degradation. The work is in continuous development.	Angelini P, et al. (2009) Il progetto Carta della Natura. Linee guida per la cartografia e la valutazione degli habitat alla scala 1: 50.000.Manuali e Linee Guida 48/2009. https://www.isprambiente.gov.it/it/servizi/sistema-carta-della-natura http://cartanatura.isprambiente.it/Database/Home.php

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
risk status of ecosystems	ISPRA	4	na	na		2022	https://sinacloud.isprambiente.it/portal/home/webmap/viewer.html?layers=cc9681ce700f42b1be2d09d65bdd604c
conservation status of terrestrial habitats	ISPRA, MATTM	3		every 6 years		2018	https://annuario.isprambiente.it/sys_ind/350
fragmentation	ISPRA	4	1 km	annual	2012	2021	https://groupware.sinanet.isprambiente.it/uso-copertura-e-consumo-di-suolo/library/consumo-di-suolo/frammentazione
land take	ISPRA	4	10 m	annual (since 2015)	2006	2021	http://groupware.sinanet.isprambiente.it/uso-copertura-e-consumo-di-suolo/library/consumo-di-suolo
burnt area	ISPRA, CUFA	0		annual	1970	2019	https://annuario.isprambiente.it/sys_ind/674

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Latvia

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	Annex 1 of the Habitats Directive - most widely used in Latvia for national level ecosystem/habitat mapping and assessment; CORINE (for terrestrial ecosystems) - used in various international, national or local projects; HELCOM HUB (for marine ecosystems) - used in marine spatial planning and marine ES assessment; National forest ecosystem typology - used in the National Forest Register and in various studies; National terrestrial habitat typology - not used for national scale mapping, but in specific cases to assess non-protected habitats/ecosystems; WFD typology of water bodies - used in river basin management plans and freshwater ES assessments
Scope of the typology or typologies?	International; National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Habitat Directive Annex 1 list of habitats and HELCOM HUB compatible with EUNIS
Spatial resolution of the typology units	Fine resolution; Coarse resolution
Maps of the typology available in digital format	Yes

References	HELCOM marine habitat classification: HELCOM (2013). HELCOM HUB – technical report on the HELCOM underwater biotope and habitat classification. Balt. Sea Environ. Proc. No. 139. Helsinki: Helsinki Commission, 2013, https://helcom.fi/baltic-sea-trends/biodiversity/helcom-hub/ Latvian forest typology: I. Liepa et al., (2014). Latvijas meža tipoloģija, LLU, Jelgava, https://www.mf.llu.lv/sites/mf/files/files/lapas/Meza_tipologija.pdf Latvian national biotope typology: I. Kabucis (ed.), 2001.Latvijas biotopi. Latvijas Dabas fonds, Rīga

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	Nature Conservation Agency - terrestrial ecosystems (based on conservation status assessment of HD Annex I habitat types) Latvian Institute of Aquatic Ecology - marine ecosystems (based on MSFD descriptors) Latvian Environment, Geology and Meteorology Centre - freshwater ecosystems (based on WFD indicators)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest	Conservation status of protected habitat types: structure and functions	No	3;1		https://www.daba.gov.lv/lv/media/5696/download
Grasslands	Conservation status of protected habitat types: structure and functions	No	3;1		https://www.daba.gov.lv/lv/media/5696/download
Wetlands	Conservation status of protected habitat types: structure and functions	No	3;1		https://www.daba.gov.lv/lv/media/5696/download

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Heathlands and Shrubs	Conservation status of protected habitat types: structure and functions	No	3;1		https://www.daba.gov.lv/lv/media/5696/download
Freshwaters	Conservation status of protected habitat types: structure and functions	I do not know (maybe)	3;1		https://www.daba.gov.lv/lv/media/5696/download
Freshwaters	Ecological status of water bodies	Yes	3		https://videscentrs.lvgmc.lv/lapas/udens-apsaimniekosana-un-pludu-parvaldiba
Marine	Conservation status of protected habitat types: structure and functions	No	3;2;1		https://www.daba.gov.lv/lv/media/5696/download
Marine	Environmental status: D1-Benthic Quality Index BQI;	Yes	3;2;1		https://drive.google.com/file/d/17Rkcrg5qEnVuNxFEzLiR88VQqkKUnKyx/view

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
In situ data - terrestrial ecosystems	Nature Conservation Agency;	4; 2		according to reporting periods	2007-2012	2018	

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
In situ data - marine ecosystems	Latvian Institute of Aquatic Ecology;	4; 2		according to reporting periods	2008-2012	2018	
In situ data - freshwater ecosystems	Latvian Environment, Geology and Meteorology Centre	4; 2		according to reporting periods	2004-2009	2022	

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Lithuania

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	MAES
Scope of the typology or typologies?	International
If a national or subnational typology is used, is it compatible with international classifications?	
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Fine resolution; Coarse resolution
Maps of the typology available in digital format	I do not know
References	MAES Typology (Maes J, et al. (2013) Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	Environmental Protection agency Lithuania

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Agriculture	Land use classes, Soil chemical characteristics, agrochemicals use, surface and groundwater quality, tillage practices, crop residues, drainage infrastructure, water runoff	No	2	MS Excel	https://aaa.lrv.lt/lt/veiklos-sritys/aplinkos-monitoringas/ekosistemu-monitoringas
Forest	Average air temperature, average soil temperature, temperature of surface water, oxygen concentration in surface water, precipitation, soil moisture, ground water, forest density, Leaf area index, forest condition, leaf and litter chemistry, precipitation, humidity, snow coverage	No	2	MS Excel	https://aaa.lrv.lt/uploads/aaa/documents/files/VDU_(34)-A4E_8246.pdf
Grassland, forest	Tree condition, Tree damage, green algae, lichen diversity, leaf and litter chemistry, grass cover, grass diversity, vegetation spread capacity, surface and groundwater temperature and chemistry	No	2	Ms Excel	https://failai.gamta.lt/files/KMS_18_ASU_VDU.pdf
Forest, urban	Air, water, and soil chemistry. Ozone concentration.	No	2	Ms Excel	https://aaa.lrv.lt/uploads/aaa/documents/files/Tolimuju_pernasu_poveikis_LT_oro_baseino_uzterstumui_2020.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest, grassland	Species abundance, domination, diversity, soil moisture and temperature.	No	2		https://failai.gamta.lt/files/2006m_dirvozemio_faunos_tyrimai.pdf
Forest	Tree canopy defoliation, Dynamics of tree fall, damage to trees	No	2	Ms Excel	https://failai.gamta.lt/files/Pernasu_ekosistemoms_poveikis_2019.pdf
Forest , urban	Abundance of green aerial algae, Species diversity and abundance of epiphytic lichens	No	2	Hysplit, MS Excel	https://failai.gamta.lt/files/Pernasu_ekosistemoms_poveikis_2019.pdf
Grassland. forest	Tree condition, Tree damage, green algae, lichen diversity, leaf and litter chemistry, grass cover, grass diversity, vegetation spread capacity, surface and groundwater temperature and chemistry	No	2		https://failai.gamta.lt/files/Pernasu_ekosistemoms_poveikis_2019.pdf
Freshwater	Biomass, number of identified taxa, Shannon-Wiener biodiversity index, Simpson biodiversity index, EPT taxa number, BMWP, ASPT and the Danish Stream Fauna Index	N o	2	Ms Excel	https://failai.gamta.lt/files/Upeliu_monitoringas_2012_santraukos.pdf
Forest urban	Concentration values of heavy metals and benz(a)pyrene in precipitation	No	2	Ms Excel	https://aaa.lrv.lt/uploads/aaa/documents/files/Tolimuju_pernasu_poveikis_LT_oro_baseino_uzterstumui_2020.pdf

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Field sampling	Lithuanian	0,1	Not defined	Annual	2000	2015	
Field sampling	Lithuanian	0	Not spatially explicit	Annual	1998	2021	
Field sampling	Lithuanian	0	Not spatially explicit	Annual	2012	2018	
Field sampling	Lithuanian	0	Not spatially explicit	Annual	2006	2020	
Field sampling	Lithuanian	0	Not spatially explicit	One issue	2006	2006	
Field sampling	Lithuanian	0	Not spatially explicit	Bi-annual	2000	2019	
Field sampling	Lithuanian	0	Not spatially explicit	Bi-annual	2000	2019	
Field sampling	Lithuanian	0	Not spatially explicit	Annual	1998	2020	
Field sampling	Lithuanian	0	Not spatially explicit	Random	1998	2012	
Field sampling	Lithuanian	0	Not spatially explicit	Random	1998	2012	

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Field sampling	Lithuanian	0	Not spatially explicit	Annual	2000	2020	
Field sampling	Lithuanian	0	Not spatially explicit	Annual	2000	2021	

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Luxembourg

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	Biotope cadastre of open landscapes (Represents a fusion of "open landscape" Habitat Directive 92/43/EEC classes mapped only in national protected areas and dedicated national classification focusing on exclusively on natural springs and their immediate surroundings); Forest biotope cadastre (Habitat Directive 92/43/EEC classes pertaining to forests only); Forest Inventory indicating forest classes per dominant species-assemblage.
Scope of the typology or typologies?	International; National
If a national or subnational typology is used, is it compatible with international classifications?	No
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	https://data.public.lu/fr/datasets/biotope-cadaster-of-the-open-landscapes-2/ - dataset https://environnement.public.lu/content/dam/environnement/documents/natur/biodiversite/cadastre-des-biotopes/kartieranleitungbiotopkatasterluxmai09.pdf - mapping guideline (German) https://data.public.lu/fr/datasets/cadastre-des-biotopes-du-milieu-forestier/ - dataset https://environnement.public.lu/content/dam/environnement/documents/natur/biodiversite/cadastre-des-biotopes/erfassung%20der%20geschuetzten%20biotope%20im%20Wald.pdf - mapping guideline forest (German)

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes

Organisation(s) assessing ecosystem condition	"Currently no dedicated monitoring of ecosystem condition in all ecosystems. Condition is assessed in rather isolated project work that is not tied into a specific reporting framework. Thereby condition might not be the explicit focus. In 2014 Ecosystem condition was assessed for ecosystem types recorded in the aforementioned datasets (Biotop cadestre of open landscapes / forests). More current work focuses on Ecosystem services rather than condition directly. There is currently an implementation of the River Ecosystem Service Index (RESI) ongoing in Luxembourg https://www.resi-project.info/en/category/publication/ (We do not have explicit information on this.)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Grasslands	Bird species richness	Yes, data derived.	2 (Bird species richness), 3 (Cadestre)	Python / GIS	Internal Report (2014)
Forests	Bird species richness	Yes, data derived.	2(Bird species richness), 3 (Cadestre)	Python / GIS	Internal Report (2014)

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Species richness	LIST	1	Point dataset	Unknown, presumably yearly	Unknown	Unknown	Internal

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Biotope-cadastre-of-the-open-landscapes	MECDD	4	25m2 Minimum mappable unit	6-7 years; No fixed update cycle yearly update in subsets.	2011	2021	https://data.public.lu/fr/datasets/biotope-cadaster-of-the-open-landscapes-2/
Forest biotope cadastre	MECDD	4	25m2 Minimum mappable unit	6-7 years; No fixed update cycle yearly update in subsets.	2011	2021	https://data.public.lu/fr/datasets/cadastre-des-biotopes-du-milieu-forestier/

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Malta

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	EUNIS, MAES - A national assessment has not yet been carried out but several subnational assessments have been carried out as part of national strategies and/or European projects (e.g. LIFE IP, Horizon 2020)
Scope of the typology or typologies?	International; National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS, CORINE - A national assessment has not yet been carried out but several subnational assessments have been carried out as part of national strategies and/or European projects (e.g. LIFE IP, Horizon 2020)
Spatial resolution of the typology units	Fine resolution; Coarse resolution; Not mapped
Maps of the typology available in digital format	I do not know
References	The Ecosystem Condition/Services maps created for valleys and water catchments are available from: https://lifeip-rbmp-geoportal-valleymanagement.hub.arcgis.com/pages/ecosystem-services

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Environment & Resources Authority; Energy and Water Agency

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Valleys and their water catchments	Land Cover and Population	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Invasive and Alien Species	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Riparian Habitat area	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Protected Area Designation	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Valleys and their water catchments	Hydromorphological changes	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Number of artificial barriers (water flow)	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Number of artificial reservoirs	No	3	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency
Valleys and their water catchments	Land cover	No	2	R; ARCGIS	Balzan M & Tanti M (2020) Development of an ecosystem services-based categorisation methodology for water catchments in the Maltese Islands. Report produced for the Energy and Water Agency

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Urban	Soil cover	Yes	2	R	Balzan, M.V., Zulian, G., Maes, J., Borg, M., 2021. Nature-Based Solutions Assessing urban ecosystem services to prioritise nature-based solutions in a high-density urban area. Nature-Based Solut. 100007. https://doi.org/10.1016/j.nbsj.2021.100007
Urban	Tree cover	Yes	3	R	Balzan, M.V., Zulian, G., Maes, J., Borg, M., 2021. Nature-Based Solutions Assessing urban ecosystem services to prioritise nature-based solutions in a high-density urban area. Nature-Based Solut. 100007. https://doi.org/10.1016/j.nbsj.2021.100007

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Valleys and their water catchments	WorldPop	4	30m				Tatem, A.J., 2017. WorldPop, open data for spatial demography. Sci. Data 4, 2–5. https://doi.org/10.1038/sdata.2017.4 https://www.worldpop.org/
Valleys and their water catchments	Field surveys	4	1m		2018	2018	https://lifeip-rbmp-geoportal-valleymanagement.hub.arcgis.com/
Urban	Based on LULC map; satellite imagery (Sentinel 2)	4	10m		2018	2018	Balzan, M.V., Zulian, G., Maes, J., Borg, M., 2021. Nature-Based Solutions Assessing urban ecosystem services to prioritise nature-based solutions in a high- density urban area. Nature-Based Solut. 100007. https://doi.org/10.1016/j.nbsj.2021.100007

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Norway

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	(i) Nature in Norway (NiN), there has been an effort to harmonise the typology with Eurostat's typology for ecosystem accounting.
Scope of the typology or typologies?	International; National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Eurostat's typology for ecosystem accounting Levels 1 and 2.
Spatial resolution of the typology units	Not mapped
Maps of the typology available in digital format	No
References	Framstad, E., Austrheim, G., Evju, M., Johansen, L., Kolstad, A., Lyngstad, A., Olsen, S.L., Prestø, T., Vandvik, V., Vange, V. & Velle, L.G. (2022) Avgrensing og inndeling av terrestriske hovedøkosystemer i arbeidet med økologisk tilstand NINA Rapport 2169, pp. 80. Norsk institutt for naturforskning, Trondheim, Norge. https://brage.nina.no/nina-xmlui/handle/11250/3037362

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	The Norwegian Institute for Nature Research (NINA)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest	An index based on several variables	Yes	3	Own models, R.	(i) Framstad, E., Kolstad, A.L., Nybø, S., Töpper, J. & Vandvik (2022) The condition of forest and mountain ecosystems in Norway. Assessment by the IBECA method. NINA Report 2100. Norwegian Institute for Nature Research, Trondheim, Norway. (ii) Jakobsson, S., Evju, M., Framstad, E., Imbert, A., Lyngstad, A., Sickel, H., Sverdrup-Thygeson, A., Töpper, J.P., Vandvik, V., Velle, L.G., Aarrestad, P.A. & Nybø, S. (2021) Introducing the index-based ecological condition assessment framework (IBECA). Ecological Indicators, 124, 107252. (iii) Jakobsson, S., Töpper, J.P., Evju, M., Framstad, E., Lyngstad, A., Pedersen, B., Sickel, H., Sverdrup-Thygeson, A., Vandvik, V., Velle, L.G., Aarrestad, P.A. & Nybø, S. (2020) Setting reference levels and limits for good ecological condition in terrestrial ecosystems – Insights from a case study based on the IBECA approach. Ecological Indicators, 116, 106492. (iv) Töpper, J. & Jakobsson, S. (2021) The Index-Based Ecological Condition Assessment (IBECA) - Technical protocol, version 1.0. NINA rapport. Norwegian Institute for Nature Research, Trondheim.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Mountain	An index based on several variables	Yes	3	Own models, R.	(i) Framstad, E., Kolstad, A.L., Nybø, S., Töpper, J. & Vandvik (2022) The condition of forest and mountain ecosystems in Norway. Assessment by the IBECA method. NINA Report 2100. Norwegian Institute for Nature Research, Trondheim, Norway. (ii) Jakobsson, S., Evju, M., Framstad, E., Imbert, A., Lyngstad, A., Sickel, H., Sverdrup-Thygeson, A., Töpper, J.P., Vandvik, V., Velle, L.G., Aarrestad, P.A. & Nybø, S. (2021) Introducing the index-based ecological condition assessment framework (IBECA). Ecological Indicators, 124, 107252. (iii) Jakobsson, S., Töpper, J.P., Evju, M., Framstad, E., Lyngstad, A., Pedersen, B., Sickel, H., Sverdrup-Thygeson, A., Vandvik, V., Velle, L.G., Aarrestad, P.A. & Nybø, S. (2020) Setting reference levels and limits for good ecological condition in terrestrial ecosystems – Insights from a case study based on the IBECA approach. Ecological Indicators, 116, 106492. (iv) Töpper, J. & Jakobsson, S. (2021) The Index-Based Ecological Condition Assessment (IBECA) - Technical protocol, version 1.0. NINA rapport. Norwegian Institute for Nature Research, Trondheim.

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
(i)National land cover maps.	National Land Resource Map	4	0,2 ha	7-8 years	2006	Regularly updated	https://kilden.nibio.no/?topic=arealinformasjon&lang=nb&X=7195706.12&Y=284337.75&zoom=0.14319908400566345&bgLayer=graatone_cache
Habitat types of Norway (NiN)	The Norwegian Biodiversity Information Centre	4	1:500	Once	2011	Ongoing	(i) https://www.artsdatabanken.no/NiN (ii) https://geocortex02.miljodirektoratet.no/Html5Viewer/?viewer=naturbase

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Poland

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	MAES
Scope of the typology or typologies?	International
If a national or subnational typology is used, is it compatible with international classifications?	
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Coarse resolution
Maps of the typology available in digital format	Yes
References	Maes J, et al. (2013) Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg).

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Chief Inspectorate for Environmental Protection (GIOŚ)/State Environmental Monitoring (PMŚ); The General Directorate for Environmental Protection (GDOŚ); Institute of Soil Science and Plant Cultivation – National Research Institute (IUNG), State Forests (LP), Polish Geological Institute - National Research Institut (PIG)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Agroecosystems	1.Net crop productivity in agroecosystem (total yields of main crop)	No	3		https://ecoservpol.amu.edu.pl/en/results/
	2. Net production of biomass for non-food purposes in the agro-ecosystem (sum of crops - main or secondary)	No	3		
	3. Species richness of wild pollinators	No	3		
	4. Conservation status of species important for the EU community, related to Arable Land and Permanent Grassland	No	3		
	5.Conservation status of bird species important for the EU community, related to Arable Land and Permanent Grassland.	No	3		
	6. Soil biodiversity risk	No	3		
	7. Nutrients content in soil (e.g. NPK, soil organic matter)	No	3		
	8.Drought vulnerability of soil	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	9. Water field capacity of soil	No	3		
	10. The area of soil valuation class	Yes	3		
	11.The area of soil complex and soil type	Yes	3		
Forest ecosystems	1. Forest health: A. share of healthy trees (0-10% defoliation) in forests B. share of heavily defoliated trees (with defoliation above 25% and dead trees) in forests C. average defoliation	Yes	3	Manual on methods and criteria for harmonized sampling, assessment, monitoring and analysis of the effects of air pollution on forests. Revision 2016, ICP Forests, www.icp forests.org/Manual.htm State Forests Information System	https://ecoservpol.amu.edu.pl/en/results/https://www.bdl.lasy.gov.pl/
	2. Share of the area of unique natural value under legal protection in forests	No	3		
	3. Share of forest area endangered by infectious (fungous) diseases	No	3		
	4. Occurrence and control of major insect pests of forest trees	No	3		
	5. Drought and shortage of water in forest areas	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Urban ecosystems	1. Relative resistance of the shortest path Tree cover in residential areas [%]	No	2	GraphScape (Least cost path analysis); ArcGIS 10.2 (various spatial analysis)	https://ecoservpol.amu.edu.pl/en/results/
	2. Relative step number of the shortest path	No	2		
	3. Share of protected areas [%]	No	3		
	4. Number of trees per person.	No	2		
	5. Tree cover [%]	No	2		
	6. Average gross primary production in the vegetation season [Plant Phenology Index x day]	No	2		
	7. Proportion of residential areas beyond 300/1000m from spaces dedicated to recreation in nature to all residential areas [%]	No	2		
Freshwater ecosystems	1. The state of the population of fish species in rivers and lakes	No - size (number, or weight) according to the species structure of the fish	2	Methodology accoring to Water Framework Directive	https://ecoservpol.amu.edu.pl/en/results/
	2. Assessment of the protection status of plant species at the site	Yes - scale (valorization according to a three-point scale: FV - proper, U1 - unsatisfactory, U2 - bad)	2		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	3. Ecological condition of waters	Yes - 5 classes	2		
Marine water ecosystems	D1 - Biological diversity (e.g., fecundity rates)	Yes	3	Methodology according to Marine Strategy Framework Directive, including Commission Decision 2010/477/EU	https://ecoservpol.amu.edu.pl/en/results/http://www.gios.gov.pl/pl/stan-srodowiska/monitoring-wod/8-pms/102-baltyk/ https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/ocena_stanu_2020.zip http://data.europa.eu/eli/dec/2010/477(2)/oj
	D2 - Non-indigenous species (e.g., Trends in abundance, temporal occurrence, and spatial distribution in the wild of non-indigenous species)	Yes	3		
	D3 - Populations of all commercially exploited fish and shellfish (e.g., fishing mortality)	Yes	3		
	D4 - Marine food webs (e.g., Large fish by weight)	Yes	3		
	D5 - Human-induced eutrophication (e.g., nutrients concentration in the water column)	Yes	3		
	D6 - Sea-floor integrity (e.g., presence of particularly sensitive and/or tolerant species)	Yes	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	D7 - Permanent alteration of hydrographical conditions (e.g., extent of area affected by permanent alterations)	Yes	3		

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Agroecosystems	Statistics Poland	3	n/a	1. annual			Statistics Poland - https://stat.gov.pl/en/topics/agriculture-forestry/

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
	Protection (GDOŚ)	4	shapefile - not specified	unknown			Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG) - https://en.iung.pl/about-the-institute/ 10,11 - municipal and poviat offices, SIS for selected voivodeships Global Soil Biodiversity Index (Orgiazzi et al. 2016)
	EC Joint Research Centre (JRC)	4	500x500m	unknown			https://esdac.jrc.ec.europa.eu/content/global-soil-biodiversity-atlas#tabs-0-description=0 EC Joint Research Centre (JRC)
	Institute of Soil Science and Plant Cultivation – State Research Institute (IUNG)	4	Scale 1:5000	unknown			

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Forest ecosystems	State Forest	2 (natural -forest land), 3 (voivodships, regional directorates of Statate Forests)		annual	Forest Inventory Results 2005-2009	Inventory Results 2017-2021	https://www.bdl.lasy.gov.pl/ https://www.bdl.lasy.gov.pl/portal/gus-lesnictwo National Forest Inventory (only Polish language version) Statistical Yearbook of Forestry
	Forest Data Bank						
	Forest Monitoring Data						
	Forest Stand Data				2006	2022	
	National Forest Inventory Results						
Urban ecosystems	European Environment Agency (EEA) under the framework of the Copernicus programme (CORINE Land Cover; Copernicus layer Total productivity; Tree cover density; Urban Atlas)	4	CLC is 25 hectares for areal phenomena and 100 meter for linear phenomena; 10x10m; 10x10m; Minimum Mapping Unit: 0.25 ha	1. Every 6 years; Not stated; Every 3 years; Every 6 years	CLC-1990; TC-2012; UA -2006	2018; 2020; 2018; 2018	https://land.copernicus.eu

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
	General Directorate for Environmental Protection in Poland (protected areas)	4	Shapefile, not stated;	unknown	unknown	Not specified	
	The Local Data Bank of the Central Statistical Office	3	Not applicable (stat. data)	Every year	1995	December 31, 2020, currently also 2021	https://stat.gov.pl/
Freshwater ecosystems	The Chief Inspectorate of Environmental Protection (GIOŚ) carrying out the State Environmental Monitoring (PMŚ)	2 (surface water bodies)		annual	2016	2020	https://www.gios.gov.pl/pl/stan-srodowiska/monitoring-wod
Marine water ecosystems	The Chief Inspectorate of Environmental Protection (GIOŚ) carrying out the State Environmental Monitoring (PMŚ)	4 and 3 (Polish Coastal Waters)	various	annual (not all indicators are calculated each year)	2011	2020	http://www.gios.gov.pl/pl/stan-srodowiska/monitoring-wod/8-pms/102-baltyk/ https://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/ocena_stanu_2020.zip

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Portugal

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	Carta de Ocupação e Uso do Solo (COS), Carta de Ocupação do Solo Conjuntural (COSc)
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	MAES, CORINE, EUNIS, IUCN
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	"Costa, H.; Benevides, P.; Moreira, F.D.; Moraes, D.; Caetano, M. Spatially Stratified and Multi-Stage Approach for National Land Cover Mapping Based on Sentinel-2 Data and Expert Knowledge. Remote Sens. 2022, 14, 1865. https://doi.org/10.3390/rs14081865;

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Costa, H.; Benevides, P.; Moreira, F.D.; Moraes, D.; Caetano, M. Spatially Stratified and Multi-Stage Approach for National Land Cover Mapping Based on Sentinel-2 Data and Expert Knowledge. Remote Sens. 2022, 14, 1865. https://doi.org/10.3390/rs14081865; Direção-Geral do Território, 2022. Especificações técnicas da Carta de Uso e Ocupação do Solo (COS) de Portugal Continental para 1995, 2007, 2010, 2015 e 2018. Relatório Técnico. Direção-Geral do Território

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems; Heathland and sparsely vegetated land	Soil organic carbon; Diversity of tree species; Forest biomass; Invasive forest species; Fire recurrence;	I do not know	3	GIS; Field inventory	https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=70d785841c2d4c62b6e124bc6d20ed92; https://sig.icnf.pt/portal/apps/webappviewer/index.html?id=ee07ad5739fb462caafe9c2f2c4f47be; https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=983c4e6c4d5b4666b258a3ad5f3ea5af; Instituto da Conservação da Natureza e Florestas - ICNF (2015) - 6º Inventário Florestal Nacional; Instituto da Conservação da Natureza e Florestas - ICNF (2022) - 8.º relatório provisório de incêndios rurais
Agroecosystems	Nitrogen balance; Common farmland bird indicator	I do not know	2 and 3	Questionnaire survey; Field inventory	Instituto Nacional de Estatística - INE (2021) Estatísticas do Ambiente-2021; Instituto Nacional de Estatística - INE (2009) – Indicadores Agro-ambientais 1989 - 2007

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems; Agroecosystems; Heathland and sparsely vegetated land	Soil organic carbon; biomass productivity;	I do not know	2	Public official statistics; Scientific literature review; Biomass allometric equations	Agência Portuguesa do Ambiente - APA (2022) Portuguese National Inventory report on greenhouse gases, 1990 - 2020
Forest ecosystems; Agroecosystems; Heathland & sparsely vegetated land; River and lakes ecosystems; Marine ecosystems;	Multiple Environmental quality and Ecosystems attributes indicators	I do not know	1 and 2	Scientific literature review; Public official statistics	Henrique Miguel Pereira, Tiago Domingos, Luís Vicente, Vânia Proença (Ed.) Ecossistemas e Bem-Estar Humano Avaliação para Portugal do Millennium Ecosystem Assessment. Fundação da Faculdade de Ciências da U. L. e Escolar Editora, 2009
Forest ecosystems; Agroecosystem; Heathland and sparsely vegetated land	Invasive plant species	I do not know	1 and 2	Citizen-scientist sighting	https://www.invasoras.pt/pt

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems; Agroecosystem; Heathland and sparsely vegetated land	Wild pollinators indicator; Habitat quality	I do not know	3	InVEST software modelling	https://asebio.novaims.unl.pt/ Wentling, C.; Campos, F.S.; David, J.; Cabral, P. Pollination Potential in Portugal: Leveraging an Ecosystem Service for Sustainable Agricultural Productivity. Land 2021, 10, 431. https://doi.org/10.3390/land10040431 Felipe S. Campos, João David, Ricardo Lourenço-de-Moraes, Pedro Rodrigues, Bruno Silva, Carina Vieira da Silva, Pedro Cabral, The economic and ecological benefits of saving ecosystems to protect services, Journal of Cleaner Production, Volume 311, 2021, 127551, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2021.127551.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems; Agroecosystem; Heathland and sparsely vegetated land	Wild pollinators indicator; Habitat quality	I do not know	3	InVEST software modelling	https://asebio.novaims.unl.pt/ Wentling, C.; Campos, F.S.; David, J.; Cabral, P. Pollination Potential in Portugal: Leveraging an Ecosystem Service for Sustainable Agricultural Productivity. Land 2021, 10, 431. https://doi.org/10.3390/land10040431 Felipe S. Campos, João David, Ricardo Lourenço-de-Moraes, Pedro Rodrigues, Bruno Silva, Carina Vieira da Silva, Pedro Cabral, The economic and ecological benefits of saving ecosystems to protect services, Journal of Cleaner Production, Volume 311, 2021, 127551, ISSN 0959-6526, https://doi.org/10.1016/j.jclepro.2021.127551.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems; Agroecosystems	Arthropod diversity	I do not know	3	Field inventory; GIS; Scientific literature review	Borges, Paulo A.V., Picanço, A., Gil, A., Viinikka, A., Pitkanen, K., Adem Esmail, B., Geneletti, D.,(2018). Case Study Booklet: BALA - BIODIVERSITY OF ARTHROPODS FROM THE LAURISILVA OF AZORES, PORTUGAL prepared for "WS 5 - Testing the methods across biomes and regions" Madrid, Spain, 04-07 April 2017. ESMERALDA EC H2020 Grant Agreement no. 642007.
Forest ecosystems; Agroecosystem; Heathland and sparsely vegetated land	Soil Organic Matter; Ecological Value of Plant Communities; Plant Diversity; Bird Diversity	I do not know	2 and 3	GIS; Field inventory; Species distribution modelling; Scientific literature review; Public official statistics	Laporta, L.; Domingos, T.; Marta-Pedroso, C. Mapping and Assessment of Ecosystems Services under the Proposed MAES European Common Framework: Methodological Challenges and Opportunities. Land 2021, 10, 1040. https://doi.org/10.3390/land10101040

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest ecosystems	Normalized Difference Vegetation Index; Enhanced Vegetation Index; Normalized Difference Water Index	I do not know	3	Remote sensing; GIS	Mendes, S., Almeida, R., Duarte, L. & Teodoro, A.C. (2018) Remote sensing and GIS combination to evaluate the ecosystems' conditions in "Serras do Porto". Proc. SPIE 10783, Remote Sensing for Agriculture, Ecosystems, and Hydrology XX, 107832E. https://doi.org/10.1117/12.2325117
Forest ecosystems; Heathland and sparsely vegetated land	Soil organic carbon; Diversity of tree species; Forest biomass; Invasive forest species; Fire recurrence;	I do not know	3	GIS; Field inventory	https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=70d785841c2d4c62b6e124bc6d20ed92; https://sig.icnf.pt/portal/apps/webappviewer/index.html?id=ee07ad5739fb462caafe9c2f2c4f47be; https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=983c4e6c4d5b4666b258a3ad5f3ea5af; Instituto da Conservação da Natureza e Florestas - ICNF (2015) - 6º Inventário Florestal Nacional; Instituto da Conservação da Natureza e Florestas - ICNF (2022) - 8.º relatório provisório de incêndios rurais

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Soil organic carbon	Agência Portuguesa do Ambiente, IP (APA) & Instituto da Conservação da Natureza e Florestas, IP (ICNF)	4	Shapefile (Polygon)	Not applicable	1995	2005	https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=70d785841c2d4c62b6e124bc6d20ed92
National Forest Inventory	Instituto da Conservação da Natureza e Florestas, IP (ICNF)	4	Regular grid of points (500 meters apart)	10-years period	1995	2015	https://sig.icnf.pt/portal/apps/webappviewer/index.html?id=ee07ad5739fb462caafe9c2f2c4f47be
Forest invasive species	Instituto da Conservação da Natureza e Florestas, IP (ICNF)	4	Shapefile (Point)	Not applicable	2015	2015	https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=1d1bfef6ee55410e8942017985c74f19
Burned areas	Instituto da Conservação da Natureza e Florestas, IP (ICNF)	4	Shapefile (Polygon)	Anual	1975	2021	https://sig.icnf.pt/portal/home/webmap/viewer.html?useExisting=1&layers=983c4e6c4d5b4666b258a3ad5f3ea5af

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Environmental statistics	Instituto Nacional de Estatística, IP (INE)	3	Shapefile (Polygon)	Annual	1989	2022	https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_main
Agro-environmental indicators	Instituto Nacional de Estatística, IP (INE)	3	Shapefile (Polygon)	Annual	1989	2007	https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_main
Invasive plant species	InvasorasPT (Information and citizen-science platform on invasive plants in Portugal) & Centre for Functional Ecology - Science for People & the Planet (CFE)	4	Data points	Not applicable	I do not know	2023	https://www.invasoras.pt/pt
Pollination potential	ASEBIO project & NOVA School of Business and Economics	4	Raster (100 metres)	6-years period	1990	2018	https://asebio.novaims.unl.pt/
Habitat quality	ASEBIO project & NOVA School of Business and Economics	4	Raster (100 metres)	6-years period	1990	2018	https://asebio.novaims.unl.pt/

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Romania

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	EUNIS
Scope of the typology or typologies?	International
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	No
References	Davies, C.E., Moss, D. and Hill, M.O. (2004) EUNIS Habitat Classification. Copenhagen: European Environment Agency

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No

Organisation(s) assessing ecosystem condition	• National Institute for Research and Development in Forestry "Marin Drăcea" (former ICAS – Forest management and research institute) (INCDS/Acasa, 2011). • National Research and Development Institute for Environmental Protection, Bucharest • National Institute for Marine Research and Development "Grigore Antipa", Constanţa • "Danube Delta" National Institute for Research and Development, Tulcea • Research and Development Institute for Grasslands, Braşov • National Institute of Statistics (INS) • National Institute of Geography of the Romanian Academy • Biology Institute of the Romanian Academy • University of Suceava "Ştefan cel Mare", Faculty of Forestry • Transylvania University of Braşov, Faculty of Forestry and Forest Exploitations • University of Bucharest, Faculty of Geography, Centre for Environmental Research and Impact Studies (CCMESI) • University of Bucharest, Faculty of Geography, Centre for Integrated Analysis and Territorial Management • University of Agronomic Sciences and Veterinary Medicine (USAMV), Faculty of Land Improvements and Environmental Engineering • University of Bucharest, Research Center in Systems Ecology and Sustainability

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Urban	Groundwater for drinking; Surface water for drinking; Mediation of smell/noise/visual impacts; Average emissions of greenhouse gases; Area of Green Infrastructure Elements; Number of research units	No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017 ISBN: 978-606-8038-24-7

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Cropland	Surface of agricultural ecosystems; Cultivated areas;Average biomass; The amount of nutrients used; The amount of organic nutrients used;The market value for agricultural products;Biomass produced from energy crops	No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Grassland	Area of grassland ecosystems (E) used for grazing or grassland;The ratio of potential kinetic energy to accessibility	No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Forest and woodlands	Price per ton for products obtained from wild animals; Area of forest ecosystems;The surface of regenerated forest (renatured)	No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Heathland and shrub		No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Sparsely Vegetated land		No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Wetland		No	0,1,2	None	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Rivers and lakes		No	0,1,2	none	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Marine inlets and Transitional waters		No	0,1,2	none	MAES process in Romania Nature for Decision-Making (N4D) April 2017
Coastal		No	0,1,2	none	MAES process in Romania Nature for Decision-Making (N4D) April 2017

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
CORINE Land Cover	European Environment Agency (EEA)	4	1:100000	1990, 2000, 2006 and 2012	1990	2012	
LPIS (Agricultural plot identification system)	National Agency of Cadastre and Land Registration	4	1:5000	annual	2018	2023	https://lpis.apia.org.ro/
Orthophoto map	National Agency of Cadastre and Land Registration	4	1:5000				
DTM LIDAR	Ministry of Environment, Water and Forests	4	Resolution 5 m	once	Not known	Not known	not available
Satellite imagery SPOT	CNES (Centre national d'études spatiales)	4	Resolution MS: 5 m – 6 m		Not known	Not known	https://landinfo.com/spot-satellite-imagery/
Geological map	Geological Institute of Romania	4	1:200000	once	Not known	Not known	http://www.igr.ro/1GE/geoportaligr/viewgeol50kol.php
Soil map	National Research and Development Institute for Pedology, Agrochemistry and Environmental Protection	4	1:200000	once	Not known	Not known	https://esdac.jrc.ec.europa.eu/content/soil-map-romania-harta-pedologica

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
DEM -altitude -slope -exposition - landforms,	European Environment Agency (EEA)	4	100*100m	once	Not known	Not known	https://www.earthdata.nasa.gov/sensors/srtm
Climatic data	WorldClim – Global Climate Data	4	Resolution 1 km2	once	2000	Not known	https://worldclim.org/
Forest type map	Joint Research Centre, EC	4	25*25m	once	2006	Not known	https://forest.jrc.ec.europa.eu/en/past-activities/forest-mapping/

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Slovak Republic

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	EUNIS + national typology based mainly on habitats listed in national catalogue of habitats
Scope of the typology or typologies?	International; National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS
Spatial resolution of the typology units	Coarse resolution
Maps of the typology available in digital format	Yes
References	EUNIS + https://www.sopsr.sk/dokumenty/Katalog-biotopov-SK.pdf

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	State nature conservancy of the Slovak Republic + research institutions (Universities and Slovak academy of sciences)

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Grasslands	Secondary succession	Yes	2	Arc GIS 10.3	https://www.researchgate.net/publication/368544814_Value_of_ecosystems_and_ecosystem_services_in_Slovakia
Forest habitats	Human interventions in the forest, age of the forest	Yes	2	Arc GIS 10.3	https://www.researchgate.net/publication/368544814_Value_of_ecosystems_and_ecosystem_services_in_Slovakia
Arable land	Soil fertility	Yes	2	Arc GIS 10.3	https://www.researchgate.net/publication/368544814_Value_of_ecosystems_and_ecosystem_services_in_Slovakia
terrestrial ecosystem	habitat distribuion, conservation status	Yes	0,1,2,3		Mederly, P., Černecký, J. (Eds.), 2020. A Catalogue of Ecosystem Services in Slovakia: Benefits to Society. Springer International Publishing, Cham. https://doi.org/10.1007/978-3-030-46508-7

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Map of the ecosystems	State nature conservancy of the Slovak Republic	4	1:10 000	1:10 000	2018	2022	https://www.tandfonline.com/doi/full/10.1080/17445647.2019.1689858
Monitoring of habitats of european interest	State nature conservancy of the Slovak Republic	4	1:10 000	1:10 000	2013	2023	http://www.biomonitoring.sk/
Forestry data set	National forest centre	4	1:10 000	1:10 000	2007	2023	https://gis.nlcsk.org/islhp/

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Slovenia

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	PHYSIS, EUNIS and MAES
Scope of the typology or typologies?	National; Subnational
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS and MAES
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	"for Phyisis - Jogan, N., M. Kaligarič, M., I. Leskovar, A. Seliškar, J. Dobravec, 2004: Habitatni tipi Slovenije HTS 2004. Tipologija. Agencija republike Slovenije za okolje. Ljubljana.

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	I do not know
Organisation(s) assessing ecosystem condition	Institute of the Republic of Slovenia for Nature Conservation, with subcontractors. for 3.3 All compliant with the law (what Slovenia has to report to EU) but mostly just expert base and we do not have detailed data.

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Land use database	Ministry of Agriculture, Forestry and Food	4	The minimum area to be included under agricultural land is 1000 m2. However there are exceptions like: vineyard 500 m2, olive grove 500 m2, nut orchard 500 m2, other permanent crops 500 m2, greenhouse 25 m2.	annual	2002	2023	https://rkg.gov.si/vstop/
Habitat types	Institute of the Republic of Slovenia for Nature Conservation	4, but does not cover the whole country	1:3.000				https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US
Register of Natura 2000 areas	Institute of the Republic of Slovenia for Nature Conservation	4			2004	2021	https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US
Register of valuable natural features	Institute of the Republic of Slovenia for Nature Conservation	4	/				https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Ecological important areas	Institute of the Republic of Slovenia for Nature Conservation	4					https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US
Protected areas	Institute of the Republic of Slovenia for Nature Conservation	4			1992	2021	https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US
Register of ecologically important areas	Institute of the Republic of Slovenia for Nature Conservation	4					https://www.naravovarstveni-atlas.si/web/profile.aspx?id=NV@ZRSVNJ&culture=en-US
Water cadastre	Water Directorate of the Republic of Slovenia	4				2023	http://www.evode.gov.si/index.php?id=104

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Spain

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	Millennium ecosystem assessment, MAES, LULUCF
Scope of the typology or typologies?	International; National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	MAES, IUCN
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	(SNEA. (2014). Spanish national ecosystem assessment. Fundación Biodiversidad. Ministerio de Medio Ambiente, y Medio rural y Marino) (Alonso Moya, M. J., Roldán Martínez, Á., Lerner Cuzzi, M., and Fernández Ramiro, M. (2020). Cartografía del Sistema Español de Inventario de Emisiones (SEI). Serie Cartográfica LULUCF. XI Jornadas Ibéricas de Infraestructuras de Datos Espaciales (JIIDE2020))

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	No
Organisation(s) assessing ecosystem condition	

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
18 forest ecosystems (broadleaved sclerophyllous Mediterranean, broadleaved continental Mediterranean, broadleaved Mediterranean mountain, broadleaved Atlantic, broadleaved Alpine, broadleaved Macaronesia, coniferous sclerophyllous Mediterranean, coniferous continental Mediterranean, coniferous Mediterranean mountain, coniferous Atlantic, coniferous Alpine, coniferous Macaronesia, mixed sclerophyllous Mediterranean, mixed continental Mediterranean, mixed Mediterranean mountain, mixed Atlantic, mixed Alpine, and mixed Macaronesia)	11 indicators. Normalised difference water index (NDWI), Soil organic carbon (SOC), AOT40f (Ozone), Nitrogen depositions (critical loads), Species richness forest birds, Species richness forest vascular flora, Tree cover, Normalised Difference Vegetation Index (NDVI), Gross primary productivity (GPP), Forest Area Density, Naturalness index.	Yes	3	ArcGIS Pro, Google Earth Engine, Python	García Bruzón, A., Arrogante-Funes, P., & Santos Martín, F. Accounting the Condition of Forest Ecosystems in Spain. Available at SSRN 4215747.

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Landsat sensor	NASA	4	30 m	daily	1972-2023	2023	https://landsat.gsfc.nasa.gov/
OCTOP: Topsoil Organic Carbon Content for Europe	ESDAC	4	1 km	once	2004	2004	https://esdac.jrc.ec.europa.eu/content/octop-topsoil-organic-carbon-content-europe
Interpolated air quality data	EEA	4	2 km	annual	2006	2019	https://www.eea.europa.eu/data-and-maps/data/interpolated-air-quality-data-2
Exceedance of critical loads of eutrophication deposition of nutrient nitrogen	EEA	4	5 km	annual	2000	2020	https://www.eea.europa.eu/data-and-maps/figures/exceedance-of-critical-loads-of
Informe sobre la aplicación de la Directiva Hábitats en España (Artículo 17 de la Directiva)	MITERD	4	5 km	six-year	1994	2018	https://www.miteco.gob.es/es/biodiversidad/temas/espacios-protegidos/red-natura-2000/rn_cons_seguimiento_Art17.aspx
Informe sobre la aplicación de la Directiva Aves en España (Artículo 12 de la Directiva)	MITERD	4	5 km	six-year	1994	2018	https://www.miteco.gob.es/es/biodiversidad/temas/conservacion-de-especies/especies-proteccion-especial/2-3-ce-informes-sexenales.aspx

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Modis sensor	NASA	4	250 m - 1 km	daily	2001	2023	https://modis.gsfc.nasa.gov/
Guidos toolbox	European commission	4	38 / 5.000 Resultados de traducción Resultado de traducción Depending on the input data. In our case 50 m	every time you have the cartography			https://forest.jrc.ec.europa.eu/en/activities/lpa/gtb/
LULUCF database	MITERD	4	25 m	Years in a time series. 1970, 1990, 2000, 2006, 2009, 2012, 2015.	1970	2015	https://www.miteco.gob.es/ca/cambio-climatico/temas/el-proceso-internacional-de-lucha-contra-el-cambio-climatico/naciones-unidas/usossuelo.aspx
Spanish National Ecosystem Assessment	MITERD	4	100 m	once	2014	2014	http://www.ecomilenio.es/wp-content/uploads/2015/02/0a.-Introduction.-Part-1.pdf

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Sweden

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	National Land Cover Data (NMD), National Forest Inventory (NFI), National Inventory of the Landscape in Sweden (NILS)
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	National Land Cover Data (NMD) is partly compatible with CORINE as well as with EUNIS. Other national typologies are not compatible with international typologies.
Spatial resolution of the typology units	Fine resolution; Coarse resolution
Maps of the typology available in digital format	No; Yes
References	NMD: https://www.naturvardsverket.se/4a43ca/contentassets/37e8b38528774982b5840554f02a1f81/produktbeskrivning-nmd-2018-basskikt-v2-2.pdf; NFI: Fridman J., Holm S., Nilsson M., Nilsson P., Ringvall A. H., Ståhl G., 2014. Adapting National Forest Inventories to changing requirements – the case of the Swedish National Forest Inventory at the turn of the 20th century. Silva Fennica vol. 48 no. 3 article id 1095. http:// dx.doi.org/10.14214/sf.1095, link: https://www.slu.se/centrumbildningar-och-projekt/riksskogstaxeringen/; NILS: Esseen, P.-A., Glimskär, A., Ståhl, G., & Sundquist, S. (2007). Field instruction for the national inventory of the landscape in Sweden, NILS. Umeå, Sweden: Swedish University of Agricultural Sciences, Department of Forest Resource Management, Esseen, P.-A., Glimskär, A., Ståhl, G., & Sundquist, S. (2007). Field instruction for the national inventory of the landscape in Sweden, NILS. Umeå, Sweden: Swedish University of Agricultural Sciences, Department of Forest Resource Management, https://www.slu.se/centrumbildningar-och-projekt/nils/, https://www.naturvardsverket.se/om-miljoarbetet/miljoovervakning/programomraden/landskap/

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Swedish Environmental Protection Agency, Swedish University of Agricultural Sciences, Swedish Board of Agriculture, Swedish Forest Agency

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Forest	Forest land productivity	Yes	3		https://www.naturvardsverket.se/4a43ca/contentassets/37e8b38528774982b5840554f02a1f81/produktbeskrivning-nmd-2018-basskikt-v2-2.pdf
	Detailed height and coverage	No	3	Based on laser data	https://www.naturvardsverket.se/4a43ca/contentassets/37e8b38528774982b5840554f02a1f81/produktbeskrivning-nmd-2018-basskikt-v2-2.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	For all land, 14 different indicators, for example total wood volume, wood volume for large trees; for forest land: 15 different indicators, for example volume of dead wood per tree species, annual production of bilberry and lingonberry, coverage of species in the field layer; for productive forest land: 38 different indicators: area of old forest, wood volume per tree species, crown coverage per selected tree species.	Yes, thresholds for some indicators (productivity, mixed forest, etc) but for many not.	3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/globalassets/ew/org/centrb/rt/dokument/skogsdata/skogsdata_2023_webb.pdf
	Birds, coverage of selected species groups in field, bush and tree layers	Not in general, but for birds, a species-specific index is applied to be comparable.	1 and 3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/centrum bildningar-och-projekt/datavardskap-naturdata/
Deciduous forest	Birds, crown coverage, bush coverage, forest management measures, hydrological regime, forest age, volume dead wood, tree layer variability, large trees, natural disturbance (fire, storm, inundation)	Not in general, but for birds, a species-specific index is applied to be comparable.	1 and 3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/centrum bildningar-och-projekt/datavardskap-naturdata/

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Natural grasslands	Birds, butterflies, bumble bees, hydrological regime, traces of historical mowing or grazing, grazing intensity, occurrence of species favoured by grazing or mowing.	Not in general, but for birds, a species-specific index is applied to be comparable.	1 and 3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/centrum bildningar-och-projekt/datavardskap-naturdata/
Wetlands	Birds, coverage of selected species groups in field, bush and tree layers	Not in general, but for birds, a species-specific index is applied to be comparable.	1 and 3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/centrum bildningar-och-projekt/datavardskap-naturdata/
Mountains	Birds, coverage of selected species groups in field, bush and tree layers	Not in general, but for birds, a species-specific index is applied to be comparable.	1 and 3	Remote sensing and field inventories of sample squares across the country.	https://www.slu.se/centrum bildningar-och-projekt/datavardskap-naturdata/

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
NMD	SEPA	4	10 m	The plan is 5 years interval	2017-2019	2017-2019	https://www.naturvardsverket.se/verktyg-och-tjanster/kartor-och-karttjanster/nationella-marktackedata/

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
NFI	Swedish Forest Agency	1	Samples across Sweden	5 years for permanent samples	1923	2022	https://www.slu.se/centrumbildningar-och-projekt/riksskogstaxeringen/
NILS	Swedish Environmental Protection Agency, Swedish Board of Agriculture, and Swedish University of Agricultural Sciences	1	Samples across Sweden	5 years	2003	2022	https://www.slu.se/centrumbildningar-och-projekt/nils/; https://www.naturvardsverket.se/om-miljoarbetet/miljoovervakning/programomraden/landskap/

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Switzerland

1. Ecosystem typologies

Name of the ecosystem typology or typologies used in your country	TypoCH (Delarze)
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	Eunis, MAES, IUCN
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	Raymond Delarze, Yves Gonseth, Stefan Eggenberg, Mathias Vust; Lebensräume der Schweiz; ISBN 978-3-7225-0149-9 https://s.geo.admin.ch/9ca35716bc

2. Ecosystem condition

Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	InfoSpecies, WSL

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Dry meadows	Nitrogen load	yes			BAFU (Hrsg.) 2020: Übermässigkeit von Stickstoff-Einträgen und Ammoniak-Immissionen. Bewertung anhand von Critical Loads und Critical Levels insbesondere im Hinblick auf einen kantonalen Massnahmenplan Luftreinhaltung. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 2003: 23 S. https://s.geo.admin.ch/9d66d9e565
Forest	Nitrogen load	yes			BAFU (Hrsg.) 2020: Übermässigkeit von Stickstoff-Einträgen und Ammoniak-Immissionen. Bewertung anhand von Critical Loads und Critical Levels insbesondere im Hinblick auf einen kantonalen Massnahmenplan Luftreinhaltung. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 2003: 23 S. https://s.geo.admin.ch/9d66d9e565
Forest	Deadwood volume, Forest biomass, Growing stock, Stand density, Structural diversity	I do not know	2	Sample plots extrapolated to larger regions	https://www.lfi.ch/index-en.php
Bogs fens	Nitrogen load	yes			BAFU (Hrsg.) 2020: Übermässigkeit von Stickstoff-Einträgen und Ammoniak-Immissionen. Bewertung anhand von Critical Loads und Critical Levels insbesondere im Hinblick auf einen kantonalen Massnahmenplan Luftreinhaltung. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 2003: 23 S. https://s.geo.admin.ch/9d66d9e565
All (except Marine)	Presence of indicator species	Yes	2	R	https://www.infospecies.ch/fr/projets/infrastructure-ecologique.html Report only available in German or French
All (except Marine)	Naturalness, Human impact, Remoteness, Ruggedness	No	2	R	https://doi.org/10.1016/j.ecolind.2018.09.054

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Dry meadows	Nitrogen load	yes			BAFU (Hrsg.) 2020: Übermässigkeit von Stickstoff-Einträgen und Ammoniak-Immissionen. Bewertung anhand von Critical Loads und Critical Levels insbesondere im Hinblick auf einen kantonalen Massnahmenplan Luftreinhaltung. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 2003: 23 S. https://s.geo.admin.ch/9d66d9e565
Forest	Nitrogen load	yes			BAFU (Hrsg.) 2020: Übermässigkeit von Stickstoff-Einträgen und Ammoniak-Immissionen. Bewertung anhand von Critical Loads und Critical Levels insbesondere im Hinblick auf einen kantonalen Massnahmenplan Luftreinhaltung. Bundesamt für Umwelt, Bern. Umwelt-Vollzug Nr. 2003: 23 S. https://s.geo.admin.ch/9d66d9e565

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Air pollutants concentration	Swiss Federal Office for the Environment	4	200m to 2019, 100m from 2020	Annual	1990	2022	https://www.bafu.admin.ch/bafu/en/home/topics/air/state/data/historical-data/maps-of-annual-values.html

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
National Forest Inventory	Swiss Federal Institute for Forest, Snow and Landscape Research (WSL)	3	Production regions or bioregions	Multi-year surveys	1983-1985	2009-2017	https://www.lfi.ch/index-en.php
NDVI	Swiss Data Cube	4	30m	Annual	1984	2019	https://geonetwork.swissdatacube.org/geonetwork/srv/eng/catalog.search#/metadata/ddd5e734-1f1a-4e06-9402-7041ec625119
NDWI	Swiss Data Cube	4	30m	Annual	1984	2019	https://geonetwork.swissdatacube.org/geonetwork/srv/eng/catalog.search#/metadata/1008ba03-a57d-42d0-b7d7-3a861d91c4be

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The Netherlands

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	The new Eurostat - EEA - JRC ecosystem accounting methodology
Scope of the typology or typologies?	International
If a national or subnational typology is used, is it compatible with international classifications?	
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	I do not know
References	I strongly recommend using the new ecosystem typology in SELINA, it has been developed with inputs from JRC and EEA and is an updated and enhanced MAES typology, with three nested hierarchies.

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	CBS and WUR, all ecosystems

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
All	Vegetation cover (% trees, % shrubs, % low vegetation)	No	3	Remote sensing	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All	Hedgerows density (km/km²)	No	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All	% of area managed for nature protection (incl. Natura2000 areas)	No	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
Forest, Open nature, Wetlands, Water, Coastal, Cropland, Grassland, Horticulture, Other agriculture, Urban & infrastructure, Public green space	LIving Planet Index	No	3	Trend analysis with Kalman filtering	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
Forest, Open nature, Coastal, Wetlands, Water	Mean Species Abundance (characteristic and targets species)	Yes	3	Trend analysis with Kalman filtering	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
Forest, Open nature, Coastal, Wetlands, Water	% of area with good structure and function (Habitats Directive reporting)	Yes	3	Various (see Reference)	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All	% of area with Soil Organic Matter content higher than 3%	Yes	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
Water	% of area with good water quality (per WFD reporting) for 9 indicators (chemical quality, biological quality, ecological quality, acidity(pH), phosphorus, nitrogen, oxygen, temperature, turbidity)	Yes	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All	Concentration of air pollutants (PM10, PM2.5, NO2, SO2); % of area with concentration of air pollutants (PM10, PM2.5, NO2) below EU and WHO air quality limit values	Yes	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All except agricultural and urban	Eutrophication: % of area where N deposition (mol N/ha) exceeds N critical loads	Yes	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All except agricultural and urban	Acidification: % of area where acidifying deposition (mol H+/ha) exceeds critical loads	Yes	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All	Urbalization pressure : % of area with neighbouring urbanisation	No	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
All except agriculture	Cumulative heat sum in degrees Celsius	No	3	GIS	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf

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3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Ecosystem extent accounts	CBS	4	2.5 m	2-3 years	2013	2018	https://www.cbs.nl/-/media/_pdf/2022/20/nca-nl-technical-report-2022.pdf
Trees, shrubs and low vegetation cover in the Netherlands	Atlas Natuurlijk Kapitaal	4	10 m	1 map composite from several years	2009-2017	2009-2017	Atlas Natuurlijk Kapitaal (ANK), 2020. Trees, shrubs and low vegetation cover in the Netherlands, v2. Retrieved from http://www.atlasnatuurlijkkapitaal.nl
Hedgerows and tree rows	Kadaster	4	1:5.000 to 1:25.000	yearly	I do not know	2023	https://www.kadaster.nl/zakelijk/registraties/basisregistraties/brt
Areas managed for nature protection	LNV, IPO en Bij12	3	Na	yearly	2015	2022	https://www.bij12.nl/onderwerpen/natuur-en-landschap/voortgangsrapportages-natuur/
Living Planet Index	CBS, PBL, RIVM, WUR	2	Na	yearly	1990	2021	https://www.clo.nl/en/indicators/en1569-living-planet-index-for-the-netherlands
Mean Species Abundance (characteristic and targets species)	CBS, PBL, RIVM, WUR	2	Na	yearly	1994	2017	https://www.clo.nl/en/indicators/en2052-trends-in-quality-of-natural-habitats

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Soil Organic Matter content	WUR	3	Na	1 map	2015	2015	Conijn, J.G. and J.P. Lesschen (2015). PRI report 619 / Alterra report 2663.
Air pollutants concentrations (PM10, PM2.5, NO2, SO2)	RIVM	4	1 km	yearly	2011	2022	https://www.rivm.nl/gcn-gdn-kaarten/concentratiekaarten
N deposition	RIVM	4	1 km	yearly	2011	2021	https://www.rivm.nl/gcn-gdn-kaarten/depositiekaarten
Acidifying depositions	RIVM	4	1 km	yearly	2011	2021	https://www.rivm.nl/gcn-gdn-kaarten/depositiekaarten

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

United Kingdom

1. Ecosystem typologies	
Name of the ecosystem typology or typologies used in your country	It varies depending on the policy or private sector application. Most analyses are based on an adaptation of EUNIS or MAES, more recently UNSEEA
Scope of the typology or typologies?	National
If a national or subnational typology is used, is it compatible with international classifications?	Yes
If yes, which? (e.g., EUNIS, MAES, IUCN, CORINE, etc.)	EUNIS or MAES
Spatial resolution of the typology units	Fine resolution
Maps of the typology available in digital format	Yes
References	Edwards J, Knight M, Taylor S & Crosher I. E (May 2020) 'Habitat Networks Maps, User Guidance v.2', Natural England; Natural England natural capital maps https://www.ceh.ac.uk/our-science/projects/naturalengland-ncmaps; https://magic.defra.gov.uk/MagicMap.aspx

2. Ecosystem condition	
Ecosystem condition been assessed beyond the mandatory EU directives' assessments (Habitats Directive (HD), Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD))	Yes
Organisation(s) assessing ecosystem condition	Defra, Natural England

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
All terrestrial ecosystems	Soil pH	Yes	3		https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentanddconditionnaturalcapitaluk/2022#woodland
	Carbon concentrate in soil (g C kg-1)	No	3		
	Loss of ignition (%)	No	3		
	Soil bulk density	No	3		
Woodland	Bat index	No	3		
	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Butterfly index	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Moth index	No	3		
	Tree health – Pests and diseases	Yes	3		
	Invasive species	Yes	3		
	Regeneration at component group level	Yes	3		
	Number of native tree and/or shrub species	Yes	3		
	Deadwood volume (m3 per ha)	Yes	3		
	Vertical structure	Yes	3		
	Veteran trees	Yes	3		
	Age distribution of tree species	Yes	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Proportion of open space	Yes	3		
	Probability of connectivity	No	3		
Enclosed farmland	Bat index	No	3		
	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Moth index	No	3		
	% of woodland on farmland	No	3		
	Linear features on farmland - Hedges (thousand km)	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Linear features on farmland - Line of trees and fence (thousand km)	No	3		
	Linear features on farmland - Line of trees (thousand km)	No	3		
	Linear features on farmland - Bank/grass strip (thousand km)	No	3		
Semi-natural grassland	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Butterfly index	No	3		
	Probability of connectivity	No	3		
Mountain, moorland and heath	Water: Non-marine sulphate microequivalents per litre	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Water pH levels	No	3		
	Water Acid neutralising capacity microequivalents per litre	No	3		
	Dissolved organic carbon milligrams per litre	No	3		
	Nitrate levels microequivalents per litre	No	3		
	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Moth index	No	3		
	Probability of connectivity	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Average length of hedges	No	3		
Freshwater, wetlands and floodplain	Water quality according to the WFD	Yes	3		
	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Bat index	No	3		
	Number of salmon and trout caught by rod released, retained and fixed engine	No	3		
	Invasive species	No	3		
	Probability of Connectivity (values per catchment area for fen, marsh, and swamp)	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Hydromorphological impact ratio	No	3		
Coastal margins	Total average bees/km walk	No	3		
	Average queen bees/km walk	No	3		
	Bird index	No	3		
	Moth index	No	3		
	Average length of hedges in coastal habitats		3		
Marine	Water quality according to the WFD	Yes	3		
	Seabird index	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Percentage pressure of marine fish stocks of interest exploited with respect to FMSY (fishing maximum sustainable yield)	Yes	3		
	Invasive species	No	3		
Urban	Bird index	No	3		
	Moth index	No	3		
	Bat index	No	3		
All terrestrial ecosystems	Soil pH	Yes	3		https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentanddconditionnaturalcapitaluk/2022#woodland
	Carbon concentrate in soil (g C kg-1)	No	3		
	Loss of ignition (%)	No	3		

2.1. Ecosystems assessed.

Ecosystem	Indicators	Thresholds or reference levels been defined for the indicator (Yes/No/I do not know)	Types of methods used to assess ecosystem condition (0,1,2,3) *.	Software, models or tools used to assess ecosystem condition	Reference
	Soil bulk density	No	3		

3 = Complete survey or statistically robust estimate; 2 = Based mainly on extrapolation from a limited amount of data; 1 = Based mainly on expert opinion with very limited data; 0 = Insufficient or no data available

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Soil pH	UK Centre for Ecology and Hydrology	0			1978	2007	https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/habitatextentandconditionnaturalcapitaluk/2022#woodland
Carbon concentrate in soil (g C kg-1)	UK Centre for Ecology and Hydrology	0			1978	2007	
Loss of ignition (%)	UK Centre for Ecology and Hydrology	0			1978	2007	
Soil bulk density	UK Centre for Ecology and Hydrology	0			1978	2007	

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Woodland Bat index	Office for National Statistics, Bat Conservation Trust	0		Annual	1999	2020	
Total average bees/km walk	BeeWalk and Rothamsted Insect Survey	0		Annual	2010	2020	
Average queen bees/km walk	BeeWalk and Rothamsted Insect Survey	0		Annual	2010	2020	
Bird index	British Trust for Ornithology; Royal Society for the Protection of Birds	0		Annual	1970	2019	
Moth index	Wider Countryside Butterfly Survey (WCBS); Department for Environment, Food and Rural Affairs and UK Butterfly Monitoring Scheme (UKBMS), and Rothamsted Insect Survey	0		Annual	1991	2020	
National forest inventory	Forest Research	0		Every five years	2010	2015	
Scottish Equivalent Connected Area	NatureScot	0					

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
% of woodland on farmland	Department for Environment, Food and Rural, UK Centre for Ecology and Hydrology and Countryside Survey	0		Annual	1984	2020	
Linear features on farmland - Hedges (thousand km)	Department for Environment, Food and Rural, UK Centre for Ecology and Hydrology and Countryside Survey	0		Annual	1984	1987	
Linear features on farmland - Line of trees and fence (thousand km)	Department for Environment, Food and Rural, UK Centre for Ecology and Hydrology and Countryside Survey	0		Annual	1984	1987	
Linear features on farmland - Line of trees (thousand km)	Department for Environment, Food and Rural, UK Centre for Ecology and Hydrology and Countryside Survey	0		Annual	1984	1987	
Linear features on farmland - Bank/grass strip (thousand km)	Department for Environment, Food and Rural, UK Centre for Ecology and Hydrology and Countryside Survey	0		Annual	1984	1987	

3. Data sources

Data set	Data provider	Spatial coverage (0,1,2,3,4)*	Spatial resolution	Temporal resolution	Year of first available data	Year of latest available data	Reference
Water quality	Joint Nature Conservation Committee, Environment Agency, Natural Resources Wales, Scottish Environment Protection Agency, Department of Agriculture, Environment and Rural Affairs for Northern Ireland	0		Annual	2009	2020	
Freshwater salmonids	Environment Agency, Natural Resources Wales and Scottish Government	0		Annual	1994	2020	
Seabirds	Joint Nature Conservation Committee	0		Annual	1986	2019	

4 = Spatially explicit; 3 = Aggregates at administrative scale; 2 = Aggregated at ecological scale; 1 = Aggregated at other scale; 0 = Not spatially explicit

Annex C - Figures ecosystem typology Hungary

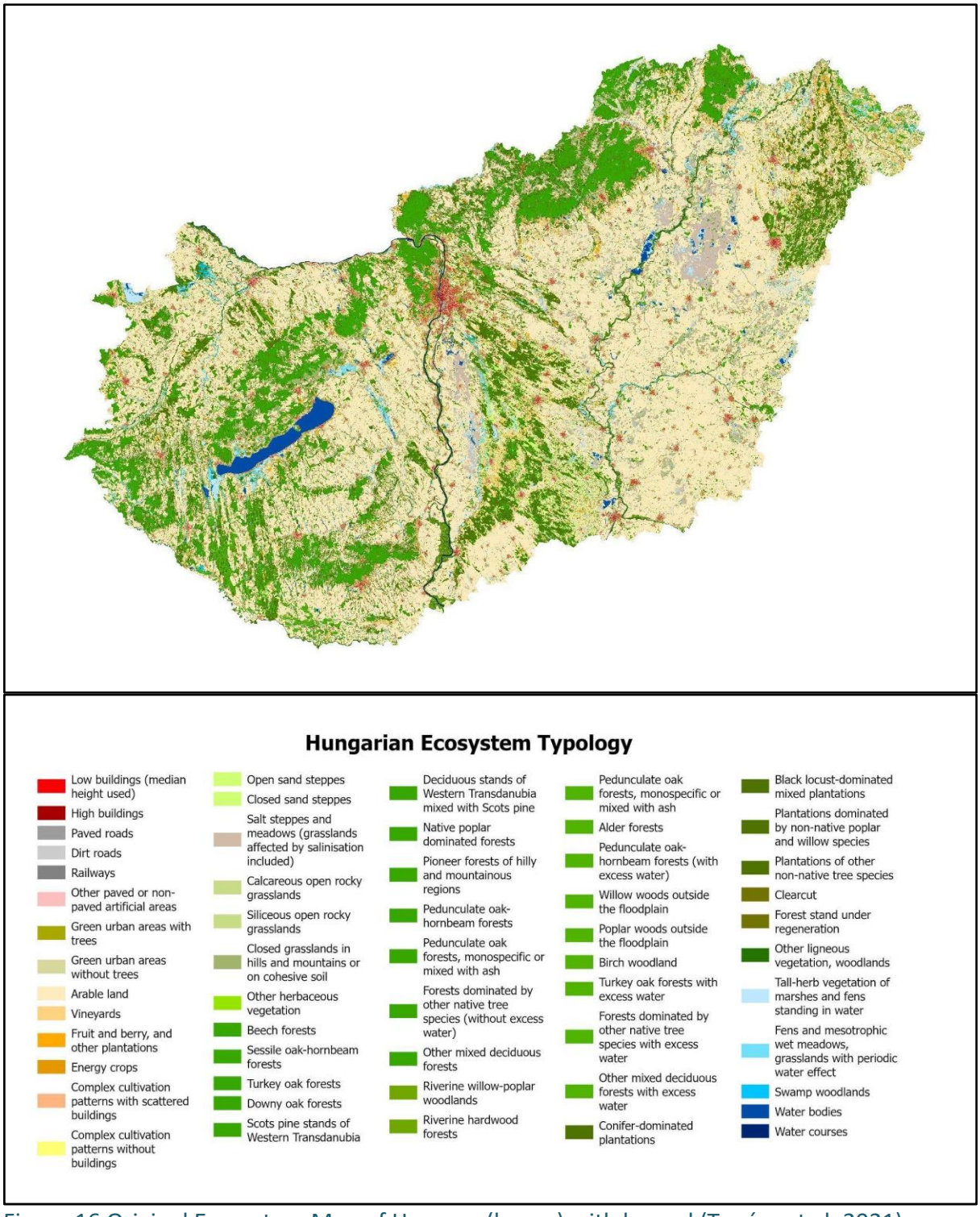

Figure 16 Original Ecosystem Map of Hungary (hu_es) with legend (Tanács et al. 2021)

The 56 Level 3 classes were the basis of crosslinking to the European Ecosystem Typology for Accounting, and the subsequent mapping.

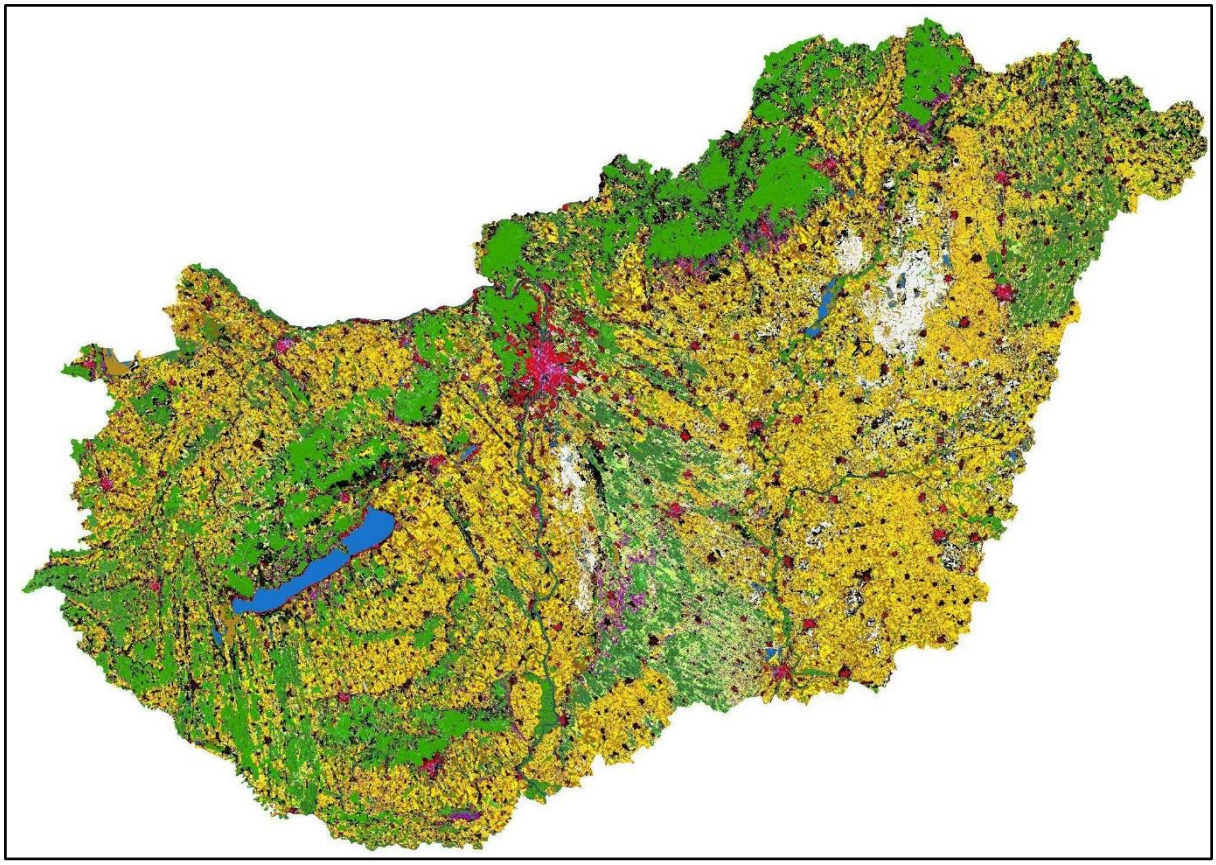

Figure 17: Final European Ecosystem Typology Map for Hungary (s4e, 2023)

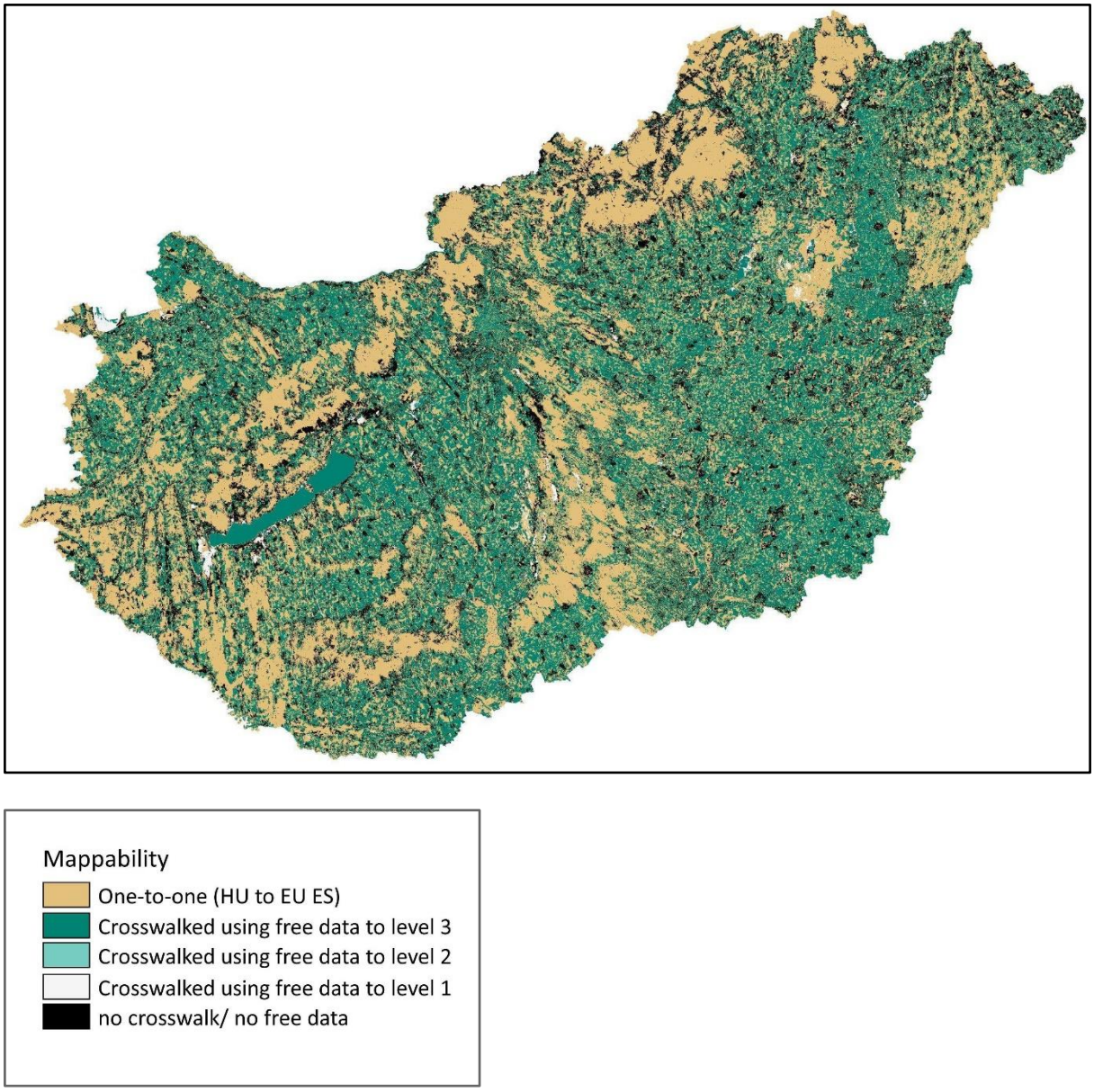

Figure 18: European Typology Map for Hungary showing nature of crosslinks from Ecosystem Map of Hungary (s4e).

Figure 18 shows the class level of the European Ecosystem Typology for Accounting that the Ecosystem Map of Hungary could be crosslinked to using CLMS and other open EO data, and therefore mapped. Where 1:1 relationships between the classes existed, no additional data were required. The aim of the task was to test a methodology to crosslink and map at Level 3 of the European Typology (dark green). Where this was not possible, the classes were mapped to Level 1 (white) or Level 2 (light-green). This process also highlighted that some classes could not be mapped, mainly due to a lack of coherence in the class definitions (black).