MAIA
Mapping and Assessment for Integrated ecosystem Accounting

Co-design pilots ecosystem core accounts in participating countries

Deliverable 3.2

Lead Authors: Adrián García Bruzón (URJC), Fernando Santos-Martín (URJC), C. Sylvie Campagne (LUH) and Benjamin Burkhard (LUH)

Contributing authors: Dimopoulos Panayotis, Ioannis P. Kokkoris, Konstantinos Kotsiras (UPAT), Adrien Comte (CIRED; AgroParisTech), Oinonen Soile (SYKE), Pohjola Johanna (SYKE), Salminen Jani (SYKE), Karsten Grunewald (IOER), Hristina Prodanova (NIGGG-BAS; LUH), Boian Koulov (NIGGG-BAS), Lieven De Smet (INBO), Raïsa Carmen (INBO), Radoslav Stanchev (ExEA), Genoveva Popova (ExEA), Ivailo Rangelov (NSI), Ioanna Grammatikopoulou (Czech academy of sciences), Linda de Jongh (Statistics Netherlands), David N. Barton (NINA), Alejandro Caparrós (CSIC), Ana Luisa Solera Carnicero (INE).

Project Acronym	MAIA
Project Title	Mapping and Assessment for Integrated ecosystem Accounting
Starting Date	01st November 2018
Duration	48 months
Website	http://maiaportal.eu/

Deliverable	3.2
Deliverable Title	Report on Co-design natural capital and ecosystem accounts in participating countries
Work Package/Task	WP3
Task Leader	LUH. URJC
Dissemination level	Public
Status	Draft

Version	Status	Date	Authors/Contributors
1.0	Draft	09/07/2020	Adrian Garcia Bruzón (URJC), Fernando Santos-Martín (URJC), Sylvie Campagne (LUH) and Benjamin Burkhard (LUH)
1.1	Draft	24/07/2020	Contributing authors review: Dimopoulos Panayotis, Ioannis P. Kokkoris, Konstantinos Kotsiras (UPAT), Adrien Comte (CIRED; AgroParisTech), Hristina Prodanova (NIGGG-BAS; LUH), Boian Koulov (NIGGG-BAS), Lieven De Smet (INBO), Raïsa Carmen (INBO), VITO, Ioanna Grammatikopoulou (Czech academy of sciences), David N. Barton (NINA), Alejandro Caparrós (CSIC).
1.2	Draft	10/09/2020	Minor changes. Contributing authors review: Radoslav Stanchev (ExEA), Genoveva Popova (ExEA), Ivailo Rangelov (NSI)

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The responses have been treated in the strictest of confidence in line with current data sharing practices. The data is stored on the servers of Leibniz University of Hannover and Universidad Rey Juan Carlos and used for research purposes only. The information contained in this document is based on the responses of the in-depth interviews and so presents the pilot accounts of the 10 European countries participating in MAIA in February 2020.

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PREFACE

The Horizon 2020 MAIA (Mapping and Assessment for Integrated ecosystem Accounting) Coordination and Support Action aims to mainstream natural capital and ecosystem accounting (NCA) in EU Member States (MS). MAIA uses the System of Environmental Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA) as the conceptual and methodological basis for NCA. The SEEA EEA is a system for NCA developed under auspices of the UN Statistical Commission, and provides a consistent framework for analysing and storing information on ecosystem assets and flows of ecosystem services. The SEEA is part of the System of National Accounts, used by statistical agencies world-wide to produce economic and other statistics. In MAIA, a flexible approach will be followed, allowing for adaptation of the SEEA EEA framework to the conditions of the individual EU MS. The work is based on the detailed, recent technical recommendations in support of Experimental Ecosystem Accounting, published by UN et al. (2017), recognising the experimental status of the SEEA EEA approach.

The MAIA project will ensure mainstreaming of NCA (based on the SEEA-EEA) and alignment with the identified policy needs (from MAIA Work Package (WP) 2) within the 10 participating countries (nine in the EU and Norway). The main objectives of MAIA WP 3 are testing, piloting and mainstreaming NCA in European countries. The basic rationale behind WP 3 is that testing and mainstreaming of NCA approaches is most effectively done on the basis of concrete pilot studies, where available methods (principally, but not limited to the SEEA) will be tested, applied and evaluated jointly by a range of relevant partners in each participating EU MS. WP 3 will be conducted in very close collaboration with statistical agencies and other government offices in charge of or working on natural capital and ecosystem accounts (ministries, state agencies, research organisations with access to data, etc.). Accounts will be developed based on existing large-scale reference data as well as new, additional datasets to be created through data inter- and extrapolation, combining existing datasets and applying spatial and other models available in the consortium.

The aim of the preceding MAIA Deliverable 3.1 report was to present the state-of-the-art of Natural Capital and Experimental Ecosystem Accounting (NCA-EEA) in the 10 European countries participating in the MAIA project. The aim of this Deliverable 3.2 is to provide the foundation for the next step, the co-design of natural capital and ecosystem core accounts. This information will be essential in achieving the aims of the EU Biodiversity Strategy's Target 2 Action 5, which is "*Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020*".

SUMMARY

This report shows that ecosystem core accounts have been implemented in all 10 countries that are participating in MAIA. The created knowledge base can be harnessed for co-designing accounts in order to fulfil the requirements of Action 5 of Target 2 of the EU Biodiversity Strategy 2020. The analysis was based on the outcomes of the state-of-the-art of NCA implementation assessment done for MAIA Deliverable D3.1 and subsequent interviews with individual countries' representatives. Most countries follow the framework provided by SEEA-EEA. However, a diverse level of implementation of the five SEEA-EEA core accounts could be observed, with much work done related to ecosystem extend and services and less on ecosystem condition and asset accounts.

For each country, a selection of two to three pilot core accounts were made based on the results of Deliverable 3.1 and the policy workshops (WP2) that were conducted in each participating country in the beginning of the project. A tentative list of core accounts in each country was identified and can be seen in Table 1. This list of potential core accounts were discussed in each country with relevant stakeholders with the aim to co-design the final list and the methodological approach based on existing models and datasets in the participating countries. There is ample experience for all accounts listed in Table 1 within the consortium to ensure smooth testing and implementation in each country. For example in all countries, work on extent accounting is foreseen, as a basis for compiling the full suite of accounts. In extent accounting, consistency with existing data such as CORINE land cover data and MAES ecosystem types have been pursued. Condition accounts have been piloted in only a few countries (i.e. Netherlands, Norway, Spain) and are being developed at European scale, and experiences will be exchanged between participants. Ecosystem services accounts have also been piloted already in several countries, and the current project will build upon these experiences and refine methodologies and share methodologies and test ES supply and use accounting with all member states. Finally, it was also tested on the compilation of asset accounts but only in very few examples as this is seen by most stakeholders as the final step in the development of the accounting system. The results and the provided set of identified gaps and needs in the countries will help the MAIA consortium in subsequent tasks as well other stakeholders to mainstream NCA-implementation and to co-design accounts.

1. INTRODUCTION

The implementation of natural capital and ecosystem core accounts in the ten European countries that are participating in the MAIA project is dependent on the current state of NCA implementation (see MAIA Deliverable D3.1 report) and on various pre-conditions in order to fulfil the tasks of the EU's Biodiversity Strategy's Action 5 of the Strategy's 2nd Target aiming at Mapping and Assessment of Ecosystems and their Services (MAES). The current MAES phase is dedicated to the promotion of the integration of the values of ecosystem services into accounting and reporting systems at EU and national level by 2020. In order to mainstream natural capital and ecosystem accounts in EU member states and to harness existing knowledge and experiences from within the EU member states and from other SEEA-EEA applications, these accounts should - in an optimum case - be co-designed jointly in the participating countries. The main aim of this Deliverable D3.2 report is to provide guidance on how such a co-design could be implemented in each country.

2. METHODS AND DATA

Following MAIA Deliverable D3.1 that was presenting the results of the MAIA Online Survey in EU member states, individual interviews with stakeholders were held to validate the ongoing and planned NCA studies and to record needs, limitations and gaps to achieve NCA in the individual countries. Therefore, this report is based on the data collected and integration of the Online Survey and the individual interviews.

2.1 Online survey

The survey was conducted with the Limesurvey software between June and September 2019 and included questions on published, ongoing or planned NCA activities in the ten participating countries of MAIA. Under NCA (or NCA-like initiatives), any initiative on accounting and/or monitoring the state, trend and use of natural resources and the environment, including the use and provisioning of soil, water, environment, biodiversity, food or material production, or natural resources, were included. A specific focus was placed on those aspects of natural capital that are not included in national economic statistics. The survey was distributed amongst MAIA consortium members and stakeholders of each country.

In Deliverable D3.1, the data recorded were not changed and remain as they were recorded online. The results show heterogeneities between the ten countries involved in MAIA, especially in the number of submitted records of survey participants and studies reported. The number of records ranged between 1 completed record for Belgium, Finland and Germany and the maximum of 20 completed/reported records for Bulgaria. For the number of respondents, 1 respondent participated in the surveys for Finland and Germany and 53 for Bulgaria. Without the distinction of published, ongoing or planned studies, a total of 54 studies have been recorded. Except with the highest number of studies recorded for Bulgaria (21), all other countries (Belgium, Czech Republic, France, Finland, Germany, Greece, Netherlands, Norway and Spain) presented a mean of 3,7 recorded studies per country. The recorded studies were mainly at the national scale (48 %), regional (29 %), local (18 %) and multinational scale (5 %). In the different types of accounts (based on the SEEA EEA approach), ecosystem services supply and use were the most assessed in all recorded studies. Biophysical accounts were indicated in 38 studies and monetary accounts in 19 studies. This heterogeneity of results can be explained by a difference of the number of studies in the ten countries, a lack of involvement of relevant people, the need of better dissemination of the survey or a different understanding of the survey. Indeed, a general confusion regarding the term “studies” used in the survey was noted, because some records about projects containing several studies and some records about one specific study only were collected.

As a summary of NCA applications in the ten MAIA countries, at least one finished study has been recorded in Bulgaria, Czech Republic, France, Finland, Greece, Spain and the Netherlands and at least one ongoing study was recorded in Belgium, Germany, Norway and Spain. This online survey allowed to list, besides scientific publications, also project reports, grey literature and case studies that are usually not published in scientific journals. This concerned 76 % of the studies reported, which were documented in 48 % of project reports. The online survey did not have information on criteria for repeatability and compliance with accounting standards or whether a statistical office distributed the data.

2.2 Individual stakeholder Interviews

Following the online survey results and to achieve MAIA Task 3.2 “Co-design of natural capital and ecosystem accounts in participating countries”, interviews were proceeded to individual countries’ stakeholders to validate the ongoing and planned NCA studies and to record needs, limitations and gaps to achieve NCA. When the results of the online Survey and wrote D3.1 were analysed, some misunderstanding were highlighted on wording as “NCA studies” and so to differentiate an accounting and an assessment. The Online survey

results needed to be further validated and discussed to differentiate between accounts and assessments in the results.

The process

First, information recorded from the survey for each MAIA country (Task 3.1, data in the D3.1 report) were sent as Excel files to the researchers and stakeholders involved in MAIA from the respective country.

After that, it was inquired during a dedicated interview whether the online survey results relate to the situation of the respective country and further questions on the problems faced in their finished studies, the needs and the gaps related to the on-going NCA studies were asked. The interviews went on between February and March 2020, mainly online.

The structure

The interviews' structure was mainly composed with open questions as follows:

- Which framework of accounting are you using?
- What type of ecosystem core accounts are you doing?
- Which method(s) are used for each core accounts?
- What key datasets are used or developed?
- With whom do you carry out the core accounts? What gaps do you see? What do you need or miss? What can the MAIA team do to support?

The country representatives were asked these questions on the different studies validated on the Excel files sent and which were confirmed as accounts.

Conducting the individual interviews

Altogether ten interviews and several exchanges were done between January and April 2020. The number of participants involved in the validation of the data was higher than the number of persons that were interviewed because additional internal discussions were held inside each country to validate the NCA data. The interviews have two outcomes: the Excel files updated and a Word document detailing the exchange of interviews.

The final data presented here are the results of the interviews (the Excel files' updates and the Word document) with in addition the consideration of the information presented by each country during the Online meetings between 26th to the 28th of May 2020.

3. RESULTS

3.1 General characteristics of NCA implementation in MAIA countries

First, the general characteristics of NCA activities in each MAIA country will be described. The results presented in this section are a combination of the information collected in the online survey and the data reported in the individual interviews checked also with the presentations of each country during the online MAIA meeting in May 2020 (Figure 1). In general, it was observed that the total number of projects and the number of finished projects are higher in the online survey than in the individual interviews. In the online survey, we recorded the total of the projects performed were recorded in each country, but without testing whether those projects really belonged to NCA research activities. The principal idea of this survey was collecting general information on on-going or finished NCA- related projects in each MAIA country. Both sources of information are useful to understand the state- of-the- art of NCA activities in each country. For more information about the online survey results, see the Deliverable D3.1 report.

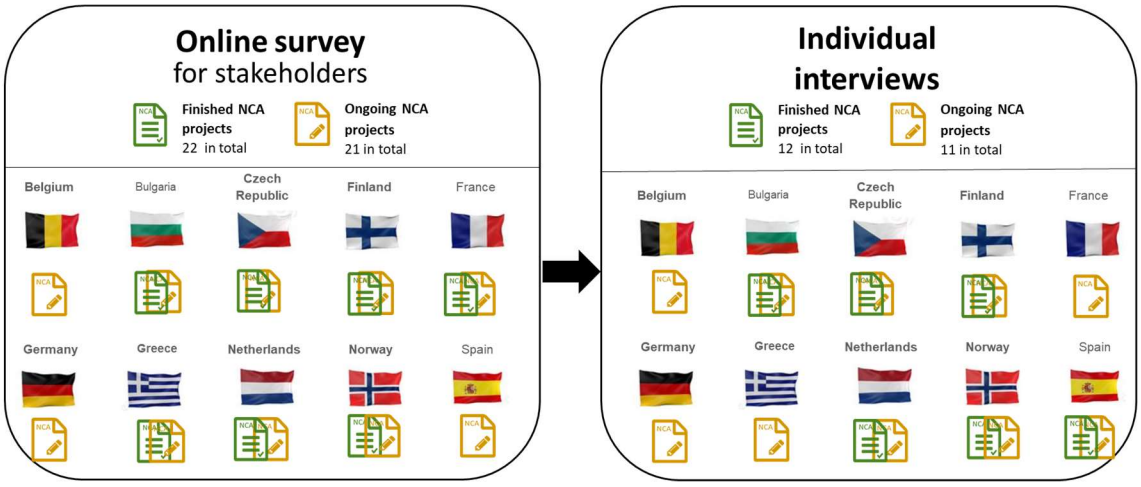


Figure 1: Sources of information (online survey and individual interviews) for each country used to elaborate this report.

In relation to the scale of the NCA activities in each MAIA country, it can be seen that the national level is the most common scale (Figure 2). Regional level is also well represented (i.e. Flanders (Belgium), Peloponnese (Greece), Andalusia (Spain)). Local scale NCA activities seem less done as only Norway and Finland reported to work on a local scale. Some of the countries are working only at one scale, for example Belgium at a regional level. l. In other cases, countries are working at various scales (e.g. Finland, France, Greece, the

Netherlands, Norway or Spain). Based on this analysis it is clear that a clear gap to work at local level exists. This could be taken under consideration for future NCA projects and activities.

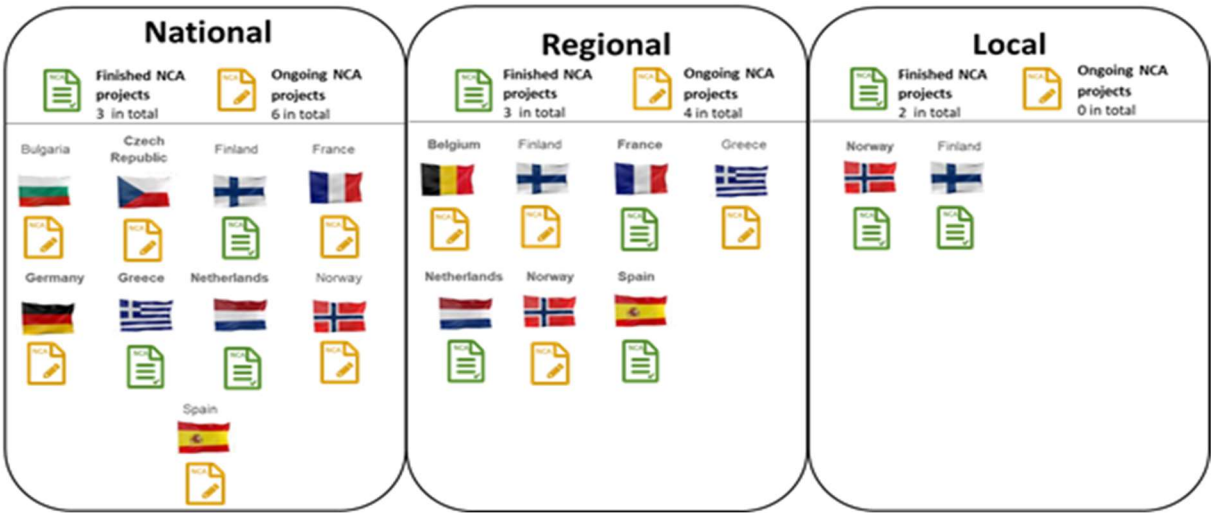


Figure 2: Scale of NCA activities implemented in MAIA countries.

It is also very important to understand what type of NCA framework has been followed in each country. As MAIA uses the System of Environmental Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA) as the methodological basis for NCA, in this report whether each country followed the SEEA-EEA framework or not (Figure 3) were reported. In this case, most of the countries followed the SEEA-EEA framework, but there are a few cases in which they did not. In these cases, although the methods are different, often relationships between the no-SEEA-EEA projects and activities with the SEEA-EEA case studies exist. However, in the interviews, the countries who are not following the SEEA-EEA, are developing new initiatives to translate their accounts to the SEEA-EEA framework or started initiatives to develop NCA in SEEA-EEA terms.

Figure 3: Classification of NCA projects according to whether they follow or not the SEEA-EEA framework.

In terms of the ecosystem type classification that each project followed, countries are mainly divided between those that use European ecosystem type classifications (such as ecosystem types suggested by MAES, the EUNIS classification or alike and those that focus on national classifications (Figure 4). During the interviews it was also mentioned that a trend exists to use international ecosystem classifications (i.e. IUCN) in new projects and then to try to crosswalks between national ecosystem type classifications with European or international ecosystem type classifications.

At the moment, only one country reported that it follows an international ecosystem type classification (Finland). Some countries have conducted projects using different types of classifications. In this point, there is a discrepancy between the number of countries that use the SEEA-EEA framework and the ecosystem type classifications they are using. This discrepancy can be a good point to analyse whether the source of this difference is due to the lack of a clear international classification or whether it is due to the difficulty of the countries to adopt these international classifications at national, regional or local levels.

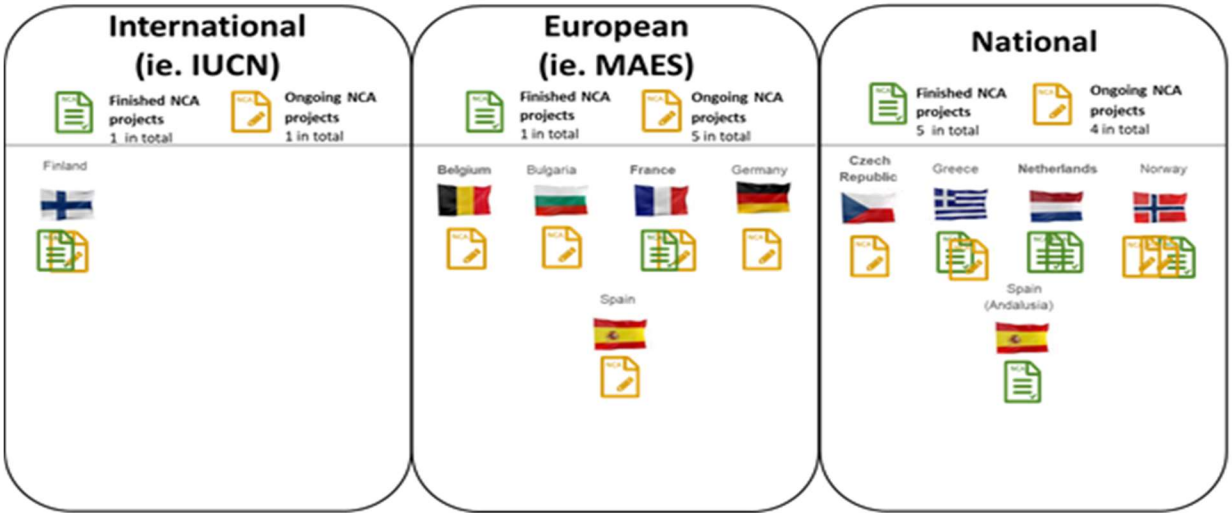


Figure 4: Ecosystem type classification used in the MAIA country projects.

The number of ecosystems types used in each NCA project by country were also assessed (Figure 5). We divided the number of ecosystem types in the natural capital accounting systems in three groups: (1) countries with a high number of ecosystem types (more than 15); (2) countries with medium number of ecosystem types (between 2. and 15); and (3) countries that focus especially on one type of ecosystem. In this last group, countries that focused their efforts on only one ecosystem type were: marine (Finland and France), urban (Norway) and forest (Spain and Greece).

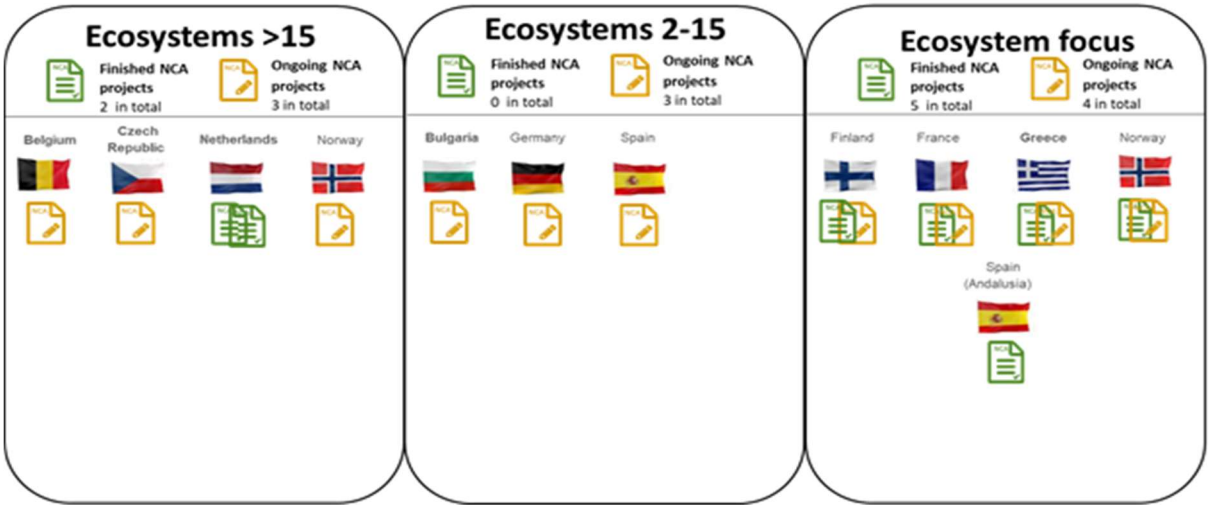


Figure 5: Number of ecosystem types studied in country projects.

Finally, the level of implementation of each country in terms of the five SEEA-EEA core accounts was assessed (Table 1). The numbers in the cells and colours refer to the scale of the initiatives and the text explains the type of results (report, publication, etc.).

Table 1: Level of implementation of SEEA-EEA core accounts per country involved in the MAIA project by core account.

		Core accounts				
MAIA countries	**Status of the studies**	**Extent account**	**Condition account**	**Biophysical ecosystem services account**	**Monetary ecosystem services account**	**Ecosystem asset account**
Belgium	Finished			Report - 2	Report - 2	
	On-going /planned	2	2	2	2	
Bulgaria	Finished	NSI Report - 1	NSI Report - 1			
	On-going /planned	1 - Forest-Water bodies	1 - Forest-Water bodies	3 - Forest-Water bodies	3 - Forest-Water bodies	1 - Forest-Water bodies
Czech Republic	Finished	Report - Method	Report - Method.		Published--Method	1- Publication
	On-going /planned	1- Habitats Directive	1- Habitats Directive	1 - Forest, Habitats Directive	1 - Forest, Habitats Directive	
Finland	Finished	Publication - 1 - Forest/water bodies	Publication - 1 - Forest/water bodies	Publication - 1 - Forest/water bodies	Publication - 1 - Forest/water bodies	
	On-going /planned	2 - 3 - Forest and water bodies	2 - 3 - Forest and water bodies	2 - 3 - Forest and water bodies		
France	Finished					
	On-going /planned	1 - Marine	1 - Marine			1 - Marine
Germany	Finished	Publication - 1				
	On-going /planned		1	1	1	1
Greece	Finished					
	On-going /planned	2. Forest and Water bodies		2. Biodiversity		
Netherlands	Finished	Report - 2 & - 1	Report - 2 & - 1	Report - 2 & - 1	Report - 2 & - 1	Report - 2 & - 1
	On-going /planned	1 & 2 - Marine	1 & 2 - Marine	1 & 2 - Marine	1 & 2 - Marine	1 & 2 - Marine
Norway	Finished		Publication - 1			
	On-going /planned	2 - 3 - Urban	2 - 3 - Urban	2 - 3 - Urban	2 - 3 - Urban	2 - 3 - Urban
Spain	Finished		2 - Forest	2 - Forest	2 - Forest	2 - Forest
	On-going /planned	1	1	1	1	1
Legend	1. National	2. Regional	3. Local			

In the case of projects that focus on a unique ecosystem type, the text means the kind of this ecosystem. To resume the information of Table 1 in the following sections, explanation country by country are provided with their ecosystem accounting initiatives for each core account following the SEEA-EEA classification: extent, condition, ecosystem services (biophysical and monetary) and ecosystem asset account.

3.2 Extent accounts

Following the SEEA-EEA framework, extent accounts is the first required step to do an ecosystem accounting at national level. Based on the results from the individual interviews, we can see that all MAIA countries have done (or is ongoing) ecosystem extent accounts at multiple scales (Table 2). For example, we highlight the work done in the Netherlands at national and regional levels and in Norway at the local level.

About the methods and data that each country used to carry out the extent accounts, a wide range of methodologies and datasets were used. Some of the standard procedures use long-term land cover information (CORINE land cover (CLC) data, LULUCF, Cadastral data) as the base to do extent account change assessments using a crosswalk to convert land cover data into an ecosystem type classification.

Table 2: Extent accounts methods and data used in each MAIA country.

	SPATIAL SCALE			METHODS	DATA
	National	Regional	Local		
Belgium		Flanders		Time series study. For Flanders regional land cover 2013-2016. For CLC 1990-2018	Flanders regional land cover and CLC
Bulgaria				Time series study. 1990-2018	CLC layers 1990-2018, Crosswalk table between MAES Ecosystem type classification and CLC classes, National Ecological Network Database - NATURA2000 sites, Protected Areas, Biogeographical regions and Cadastral data.

Czech Republic				Two approaches. Experimental using the national layer and general using CLC. Time series study 2014-2018	National multisource layer of Ecosystems, CLC, Urban Atlas, ZABAGED geographic data, and other specific data for water bodies
Finland		Northern Finland	Simojoki and other cities	National, local: time series based on multiple sources of data.	National and regional: Remote sensing, statistical information, national inventories.
France		Metropolitan France		Both: Ground-truthing point data and results from habitat suitability models. One-time study.	Both: Data from CarpeDiem project and EMODNET EUSeaMap using the EUNIS classification of ecosystems
Germany				Only measure changes of areas. Time series study. 2012-2018. LULUC assessment	CLC. National information support.
Greece		Peloponnisos		Time series study. 1945-2019 (area change)	National and regional datasets and imagery (Forest map, Natura 2000 habitat types mapping, Forest management studies datasets).
Netherlands	Working in 2015 and 2018 update	Limburg		National: Nationwide maps were overlapped in a staged approach. 2006-2018 time series study	National: Topographical maps, cadastre maps, geographical registries, geographical land use data.
Norway		Greater Oslo Trøndelag	Oslo	National: LULUCF time series 1990-2018. Local: 2015-2018	National: LULUCF. Regional: Sentinel-2 landcover classification. Local: Sentinel-2 landcover & Blue-Green Factor (BGF) classification mapping data
Spain				Validated with LUCAS survey. Time series study 1970-2015	Lulucf multi-source dataset (1970-2015)

As a result, every MAIA country was able to present maps and accounting tables for different time periods and to show present and past trends. A few countries are working in a specific ecosystem such as France and Finland in marine ecosystems and Norway in urban ecosystems.

In these cases, the spatial resolution of extent account results were higher than in countries that are working with multiple ecosystem types (Spain, Germany). In the following paragraphs, we include a summary information about extent accounts in each MAIA country.

3.2.1. Belgium

Ecosystem extent accounts have been developed by the Nature Reporting Unit of the Flemish Government, describing state and trends for the MAES EU ecosystem types. This has been done for two sets of data, using (1) the best available spatially explicit data (see below) for Flanders combined in the Landgebruiksbestand 2013 and 2016 and (2) Corine Land Cover data for 1990 and 2018. Strengths and weaknesses of the two sources of land use and cover data have been assessed. The resolution of Corine Land Cover data is insufficient for a region like Flanders with a wide variety of land uses on a small surface area.

The Landgebruiksbestand combines the best available set of spatially explicit information (GIS-layers and other (spatial) data sources). This includes data from administrative databases, satellite imagery, aerial orthophotos and field recordings. Some key layers are the Biological Valuation Map (BWK), the Green Map (differentiating between 'agriculture', 'low green', 'high green' and 'not green' areas on a 1 m x 1 m grid), Agriculture use parcels (indicating what crops have been grown on a specific plot of land in a given year) and Cadastral map (CADMAP).

Extent accounts were developed for 2013 and 2016, building on the best available data in land use maps at 10x10m for Flanders. The limitations of these extent accounts are assessed per pilot theme. Possibilities and limitations of extent account data to assess the evolution between 2013 and 2016 for different supply and use accounts are examined.

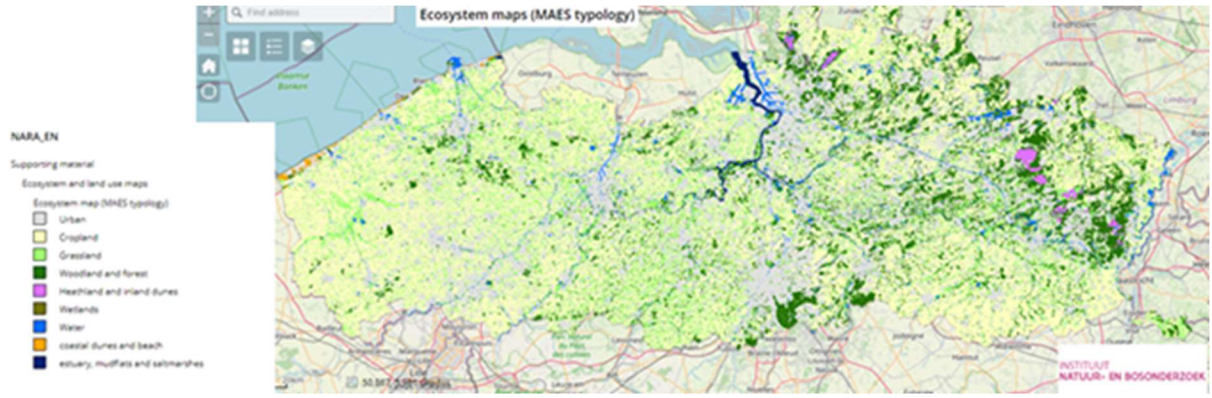


Figure 6: Example of ecosystem extent account in Flanders (Belgium). Source: Flanders Regional Ecosystem Assessment . Visor web:https://geo.inbo.be/ecosysteemdiensten/.

3.2.2 Bulgaria

In Bulgaria, the main work has been on the extent accounts. The stock and changes in the area for 10 ecosystem types at national level, based on Corine Land Cover (CLC) for the period 1990 – 2012 in square kilometres (km²) are calculated. The changes are presented according to the accepted reporting tables and include additions, reductions, net additions, total turnover, and stable stock of ecosystem types.

The Bulgarian extent account approach is based on Corine Land Cover (CLC) data and includes aggregation and splitting of the Corine Land Cover polygons into the 1 km² x 1 km2 population grid. The sum of the distributed area equals 1 km2. Then they show the opening and closing stock of land in km² using the MAES ecosystem types. Additionally, results focused on Natura 2000 areas, based on CLC classes and MAES ecosystem types were studied (Petrov, et al. 2019). Based on CLC 2018 the Ecosystem extent on national scale was updated (Figure 7). On the figure below are shown opening and closing stock of land in a spatial unit of 1 km² for a period 1990 – 2018.

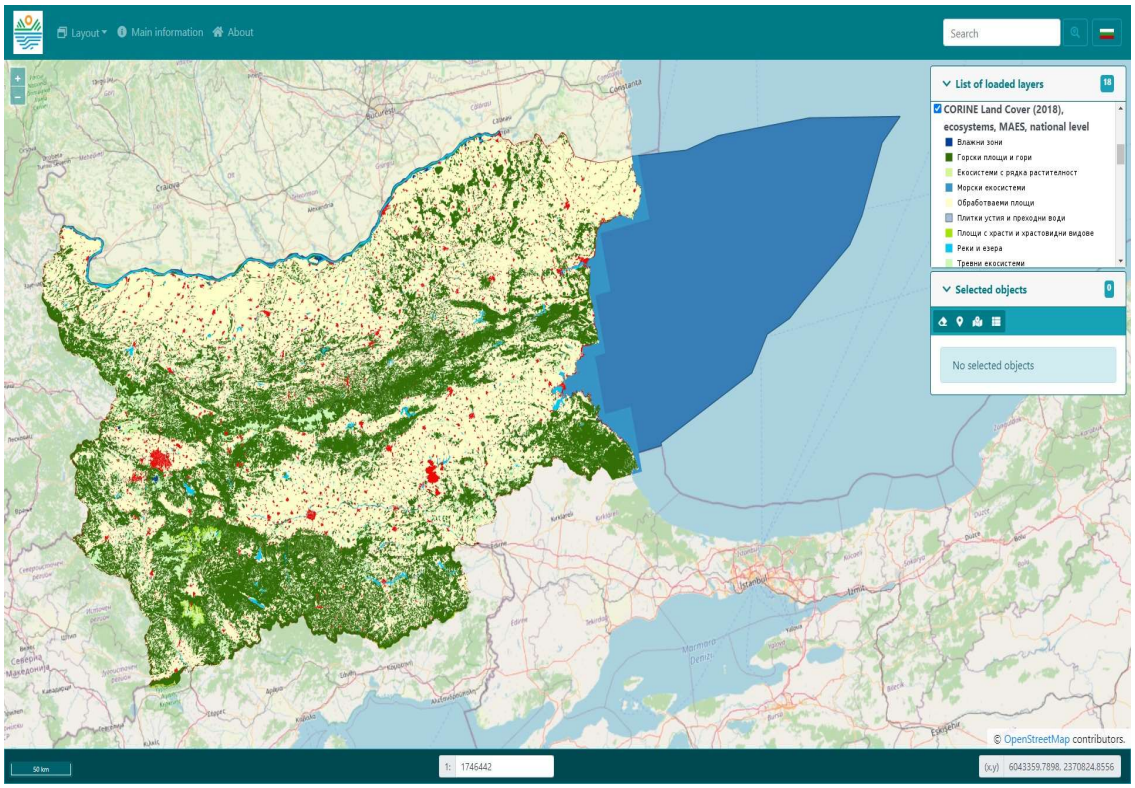


Figure 7: Map of Ecosystem types in Bulgaria based on the CLC 2018 dataset. Source: ExEA.

3.2.3 Czech Republic

The extent account at the national level is based on the Consolidated Layer of Ecosystems of the Czech Republic (CLES) together with Corine Land Cover data. Extent account tables have been made by CzechGlobe together with the Nature Conservation Agency of the Czech Republic in 2012. They tested the methodology of the European Environment Agency on Land and Ecosystem Accounting and applied this approach using Corine Land Cover data, in cooperation with the Czech Statistical Office. This approach enables to classify extent changes and detect major trends of ecosystem change. Based on this input, the Czech Statistical Office (CZSO) compared the extent of agricultural land from different data sources (e.g. cadastre data, CZSO, CLC etc.).

They have updated the extent account based on the CORINE Land Cover (CLC) inventory. To illustrate the change in the extent of ecosystem we report two consecutives periods of data i.e. 2012, 2018. They aim to compose alternative account based on the the Consolidated Layer of Ecosystems (KVES) .This inventory is more detailed and focused on natural ecosystems combined with land cover / land use. Currently the database provides data for only period (2012) but it will be updated by end of this year and next by the end of 2025. We may encounter some comparability issues of ecosystems descriptions across layers 3 between the updated versions of inventory.

Considering the scale of the analysis ecosystem accounting units are represented at aggregated level of ecosystem types. They also provide the extent of ecosystem at aggregated level for protected (Natura 2000) areas which are of specific policy interest in CZ.

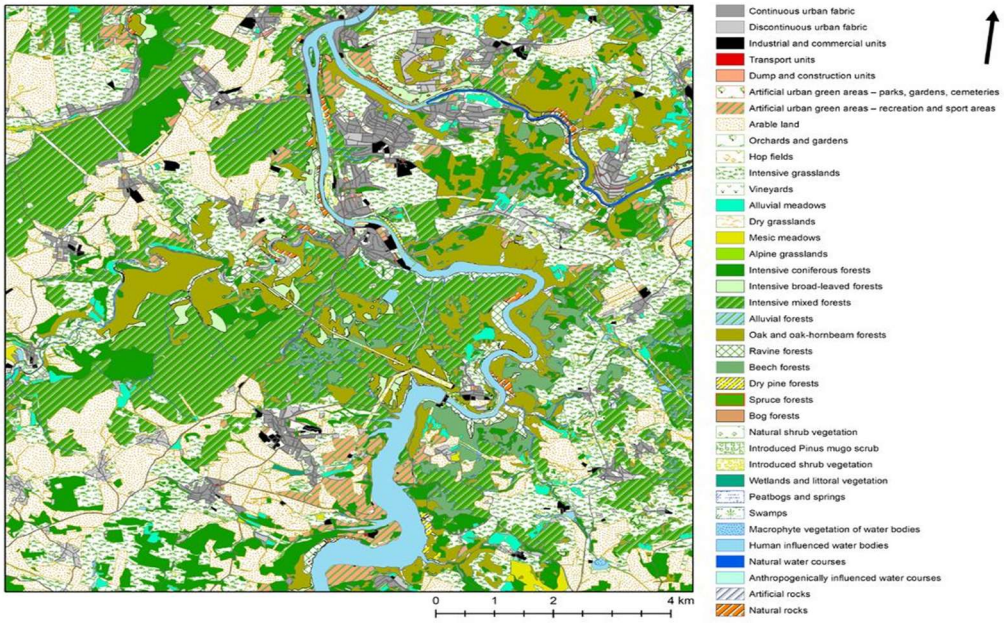


Figure 8: Map of the Consolidated Layer of Ecosystems of the Czech Republic. Source: Vačkář, et al. (2018).

3.2.4 Finland

Several organizations are responsible for operational environmental monitoring programs and are producing most of the data used in ecosystem accounting. Most datasets are nationwide. In environmental data gathering, manual in-situ measurements are still forming the backbone of the monitoring programs. However, a large part of the environmental (GIS) datasets is nowadays composed of automated in-situ measurements and remote sensing datasets. The extent, location, soil and vegetation type of forest soils are obtained from the national forest inventory (MS-NFI 2018). Statistics on growing stock volume and biomass by tree species and land type, tree species dominance, total roundwood removals and total drain are obtained from forestry statistics.

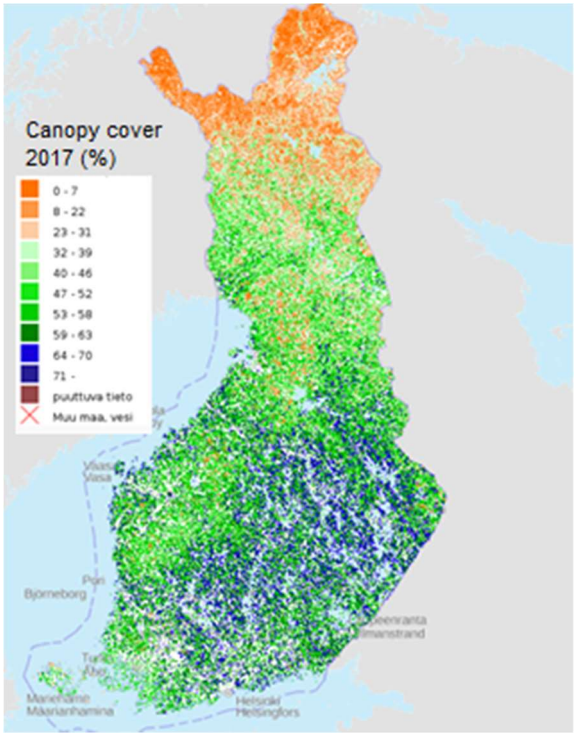


Figure 9: Canopy cover in Finland in 2017 Source: Finland national forest inventory (2017).

3.2.5 France

Our ecosystem types (ET) will be the habitats defined in the EUNIS database for the benthic areas. In the process of marine accounts, a composite map of marine habitats (EUNIS level 2, EUNIS level 4) of benthic areas were developed. Maps of benthic habitats have been produced in the project CarpeDiem (Vanhoutte-Brunier et al., 2019), and will be used here as a main source of ecosystem extent input data. These maps have the advantage of using the EUNIS classification of habitats and of covering the entire marine ecosystem accounting

areas at the national scale, as they are a composite of different datasets. This is the main strength of this database since most of the marine maps are focused on specific areas and specific ecosystem components.

However, they have the disadvantage of being composites of datasets from different time periods using different methodologies, therefore the accounting period here will be from 2001-2018, and no changes in extent of different habitats can be recorded within this period.

The water column is a marine habitat with plankton and pelagic species inhabiting it, which has to be monitored using specific ecosystem types in the marine ecosystem accounts.

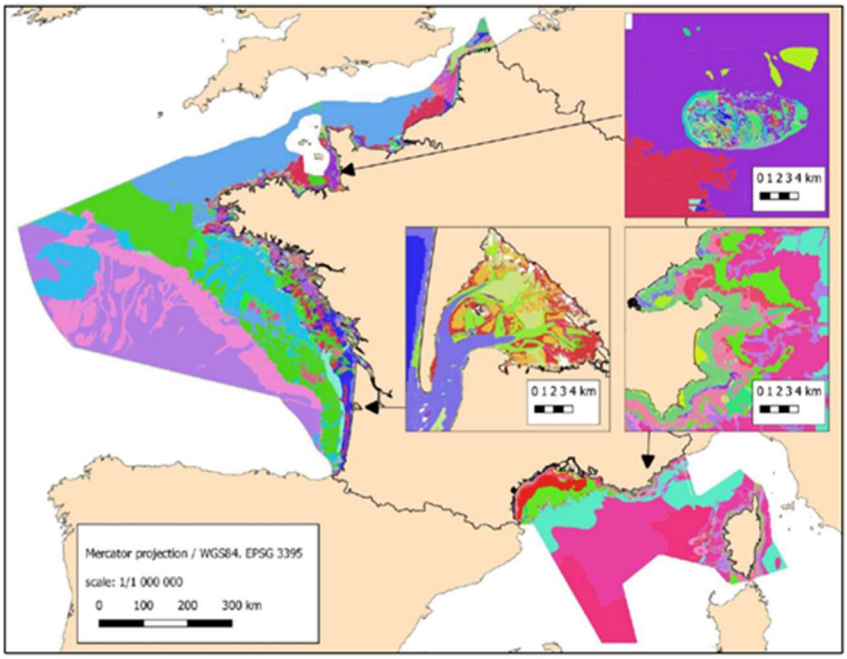


Figure 10: Example of marine extent account map of France. Source: CarpeDiem project (Vanhoutte-Brunier et al., 2019).

3.2.6 Germany

Germany created a nationwide uniform system of ecosystem type classifications that can consistently deal with diverse data sources on the extent and condition of ecosystems. GIS land-use and ecosystem data that is compatible with EU-wide approaches or with other regularly collected data sources were combined and blender blended , for example, from sample-based surveys, to generate a complete, updatable picture of the state of Germany's ecosystems (Grunewald, et al. 2020). Allocation tables with different classes or levels (layers) enable an ecosystem extent accounting, which are used to help draw up balances (area balances, status balances, ecosystem service balances) and can be further detailed, depending on the respective task.

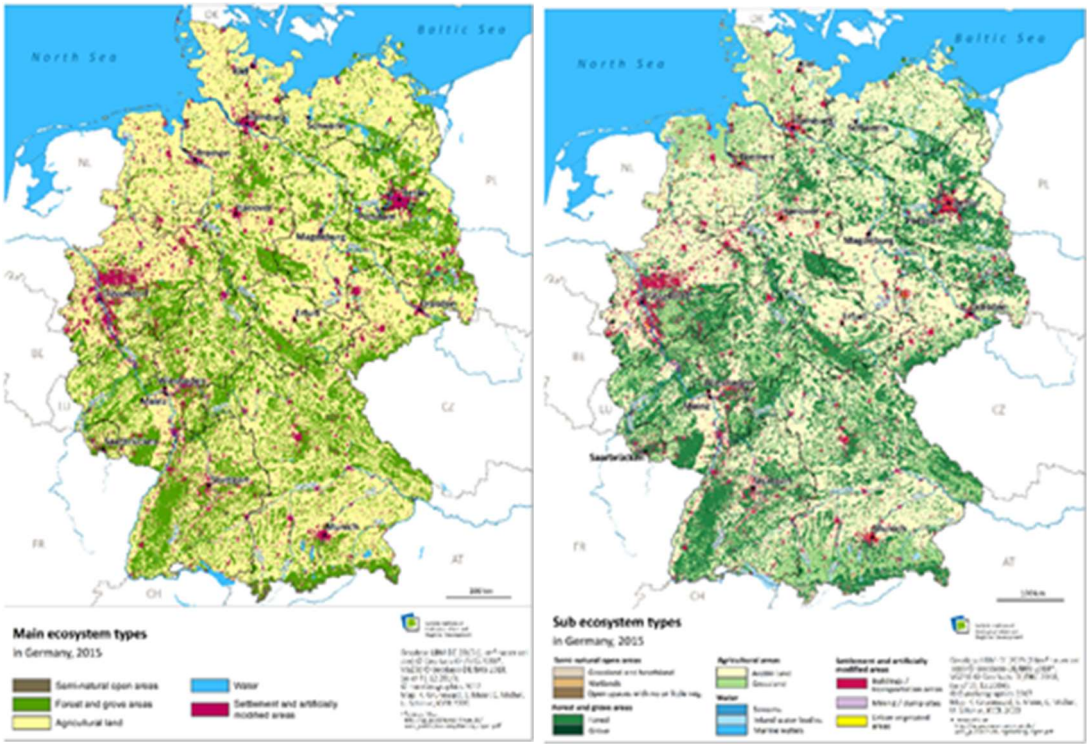
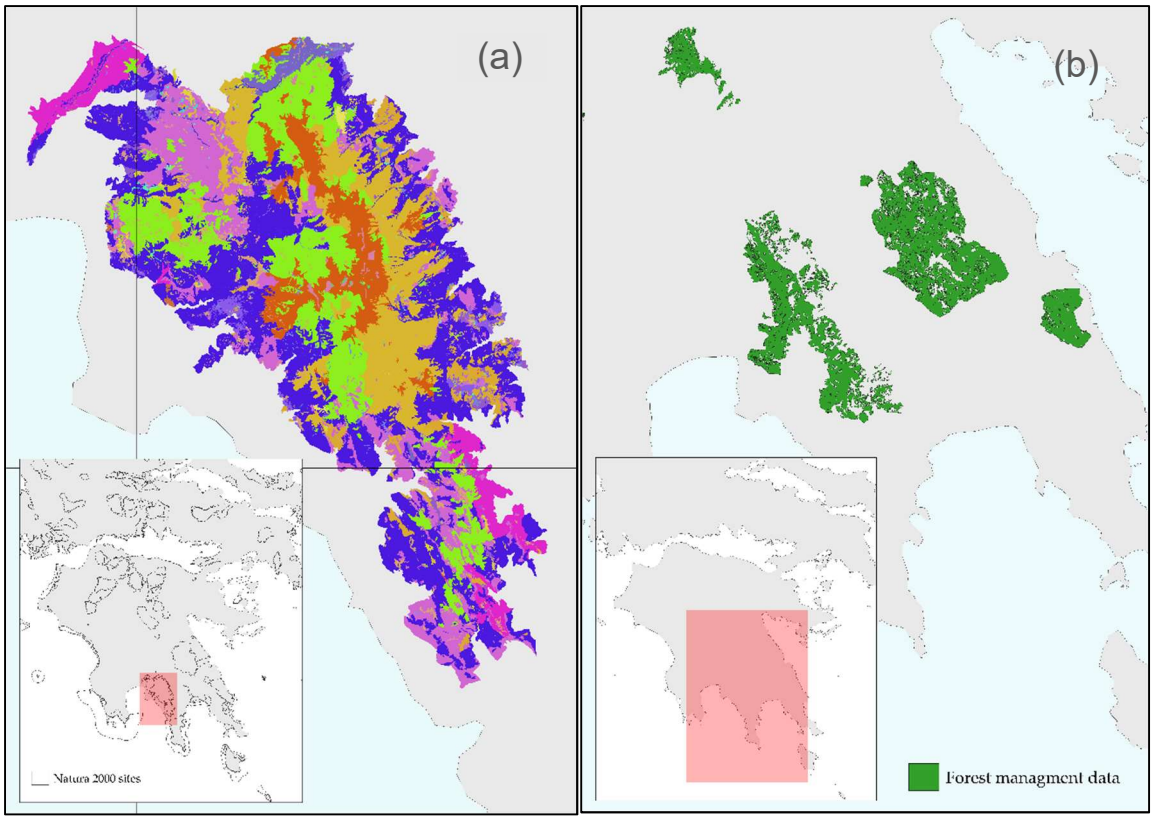


Figure 11: Main ecosystem types in (left) and ecosystem subtypes (right) used in Germany to assess extent accounts. Source: Grunewald, et al. (2020).

3.2.7 Greece

At national level, the Hellenic Cadastre / Ministry of Environment and Energy developed a forest map (http://gis.ktimanet.gr/wms/forestsuspension/default.aspx). Additionally, they developed a geoportal for the determination of river basin districts, river basins, and underground and surface water bodies (http://wfdver.ypeka.gr/en/geoportal-en/). All these datasets are used to calculate general ecosystem extent accounts at national and regional level.

Within the MAIA project, Greece is focusing on thematic biodiversity accounts (e.g. extent of plant diversity hotspots, endemism hotspots, Annex I habitat types) to assess biodiversity values in the Peloponnisos region. To do this, Greece is developing a classification and modelling approach to map and assess ecosystem services that can be the basis for the creation of natural capital accounts. Currently, they are identifying and selecting data sources to create these biodiversity values.



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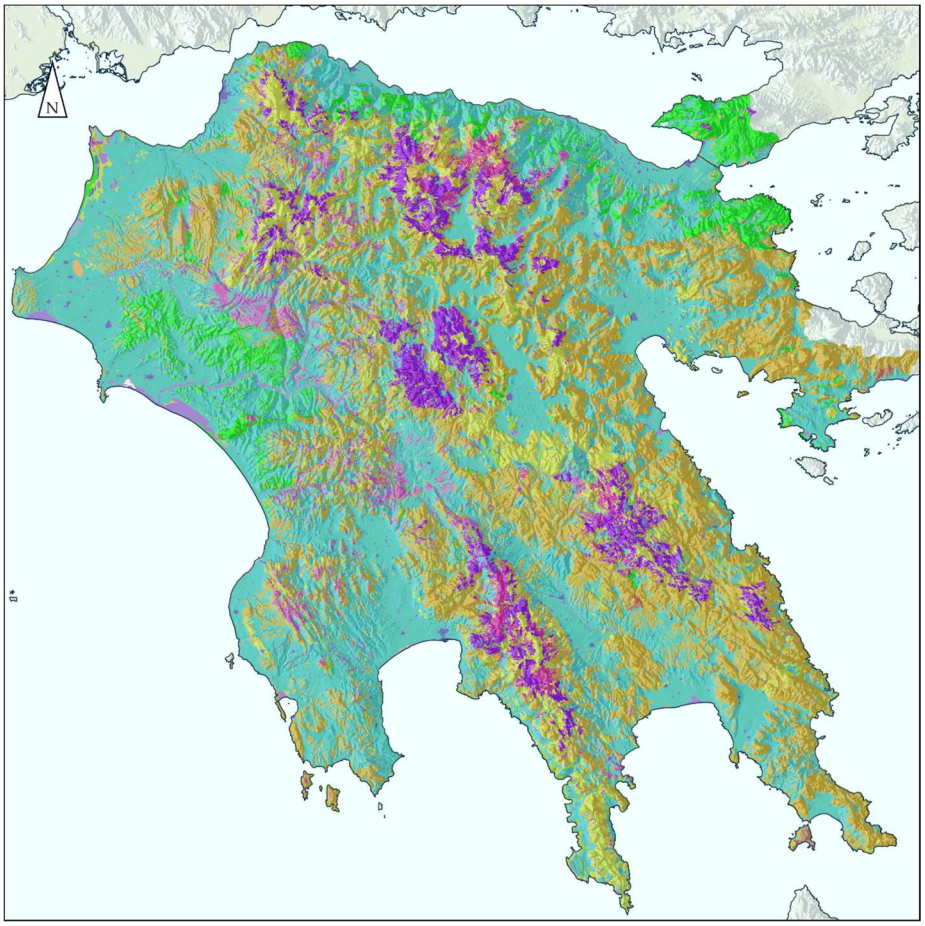

Figure 12: Data source examples used for developing an extent account in Peloponnisos.

Source:(a) Detail from the Natura 2000 habitat type mapping dataset 1:5000 (Ministry of the Environment and Energy), (b) Detail from Forest Management areas (Forest Service), (c) Vegetation map of Peloponnisos (Ministry of Environment and Energy).

3.2.8 Netherlands

The Netherlands are using multiple data sources (topographical maps, cadastre maps, geographical registries, geographical land use data) to calculate extent accounts at the national level. They are using a national ecosystem type classification that could be linked with international classifications (e.g. IUCN), which is one of the topics currently taken up in the SEEA EEA revision process.

The Netherlands developed an ecosystem types map through a systematic combination of several maps and datasets covering the national territory. Maps were combined following a strict hierarchical approach. Once a unit is assigned, it can no longer be changed. The resolution of this map is 10 m x 10 m and covers the entire country with thirty-one thematic categories. They have a thematic crosswalk with the United Nations System of Environmental-Economic Accounting (SEEA) and Mapping and Assessment of Ecosystems and their Services (MAES) initiative.

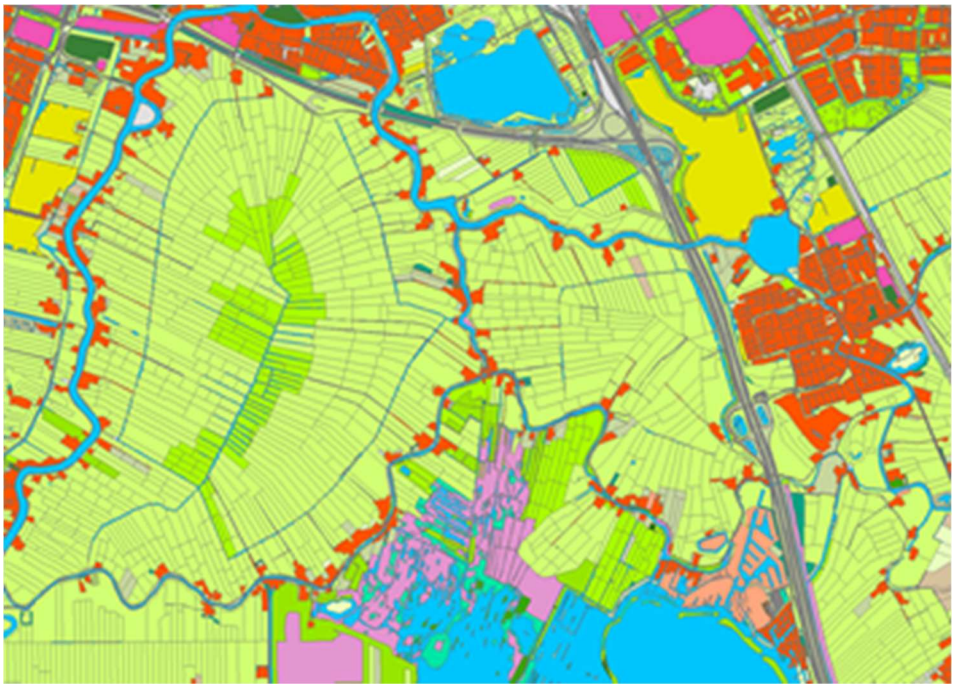

Figure 13: Detail of the Netherlands' ecosystem type map used to calculate extent accounts. Source: Van Leeuwen et al. (2017).

3.2.9 Norway

The Statistical Office is conducting a project to develop a land use and land use changes dataset at national level. These datasets appear in statistical form the website of the Statistical office (https://www.ssb.no/en/statbank/list/arealstat). The statistical information has an annual temporal resolution since 2011, and a thematic resolution of 19 general land cover and land use types with 64 subcategories.

At national level 9 major ecosystems of Norway (except urban areas) have been identified at a regional and municipal level with data series since 1990, as a basis for the Norwegian Nature Index (a biodiversity account): https://www.naturindeks.no/Ecosystems. However, the exact boundaries of the ecosystems are not identified in the Nature Index - the biodiversity index for those ecosystems is compiled for municipal and regional statistical units. While LULC maps using Copernicus products have been compiled for some time and applied to i.a carbon accounting, Norway's major terrestrial ecosystem types used in the Nature Index were mapped for the first time in 2019 (Venter and Stabbetorp 2019) (Figure 14.1).

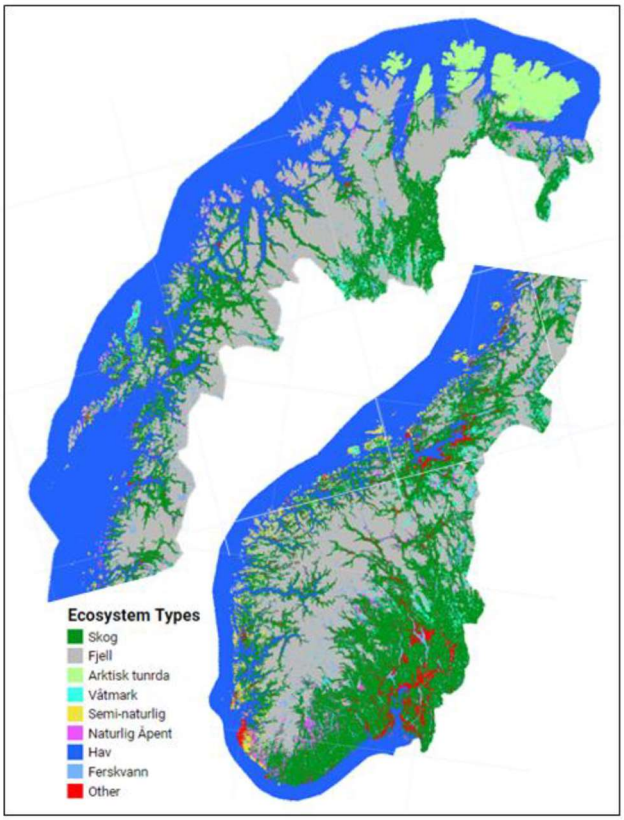

Figure 14.1 Map of Norway's main ecosystem types (Venter and Stabbetorp 2019). Link to interactive map.

At regional level, the URBAN EEA project mapped canopy and vegetation cover for urban areas in the Greater Oslo region, combining Sentinel-2 remote sensing with cadastre data from Statistics Norway. The project was carried out in close cooperation with municipal authorities in order to obtain updated knowledge on land use. Current urban land cover was also compared to municipal development plans (Ellefsen and Garnåsjordet, forthcoming). Current agricultural production statistics registration is only at farm corporate level, making it difficult to distribute spatially to plot level for further ecosystem service modelling. Statistics Norway is currently evaluating the capability of satellite remote sensing data to detect crop types with enough detail to identify pollinated versus non-pollinated crops and allocate them at parcel level (Steinnes et al. forthcoming).

In the national main ecosystem map, built urban areas are classified as “other” ecosystem with tree canopy in parks identified as “forest” and open vegetation in parks identified as “open lowland” (Figure 14.2).

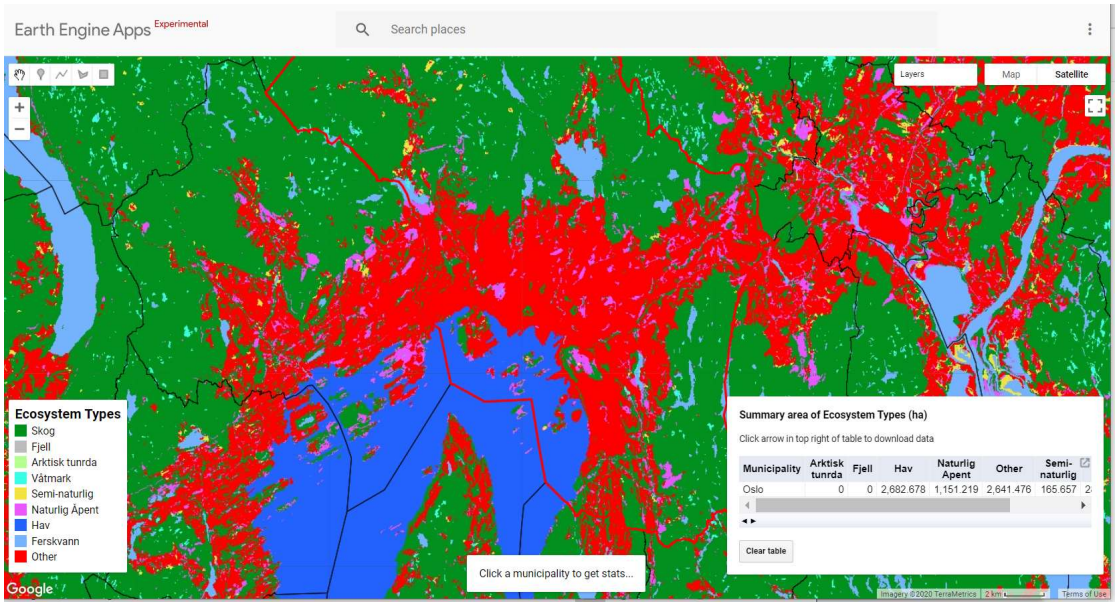

Figure 14.2 National ecosystem mapping of Oslo’s urban ecosystems as “other” ecosystems. Link to interactive map.

For the purpose of municipal accounts extent and condition must be identified jointly as the extent and configuration of vegetation cover on the ground and on buildings become indicators of urban ecosystem condition (Figure 14.3).

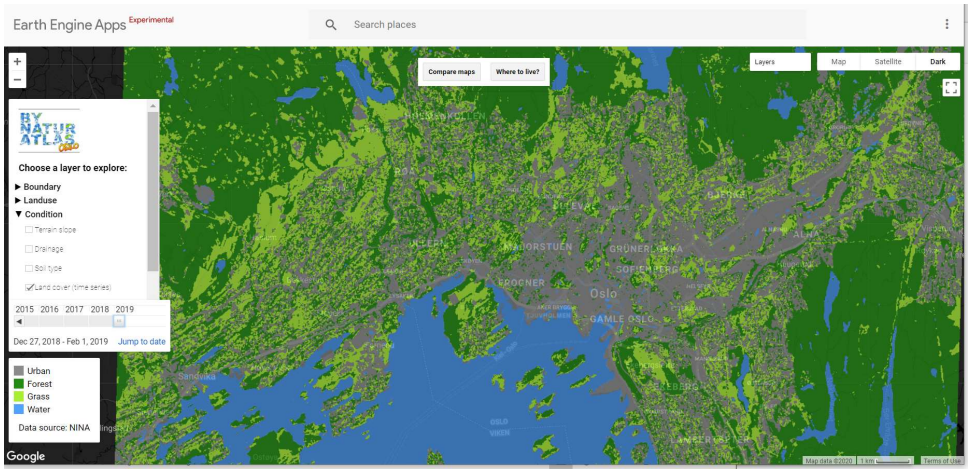

Figure 14.3 Local level mapping of Oslo built area land cover for combined extent-condition accounting.

3.2.10 Spain

In the context of the MAIA project, the University of Madrid (URJC) is currently developing a national level extent account following the SEEA-EEA framework. The spatial representation of Spanish ecosystems is based on the MAES (2013) EU ecosystem type classification.

To calculate the extent accounts for each ecosystem type, Spain used the official LULUCF dataset, developed by the Ministry of Ecological Transition and Demography Challenge of Spain. This multi-source dataset with digital information from 1970 to 2015 is the most complete and accurate (with a pixel resolution of 25 m x 25 m) that covers the whole national territory.

Related to the extent accounts and flows, it was created tables from a time-series dataset, we calculated the total change for the period and the annual rate. For these land accounts, we measured the gross and net changes, swaps between ecosystems, the stable stocks and a gains and losses statistical representative flows approach to distinguish between a systematic landscape transition and a seemingly random landscape (García-Bruzón and Santos-Martín, forthcoming).

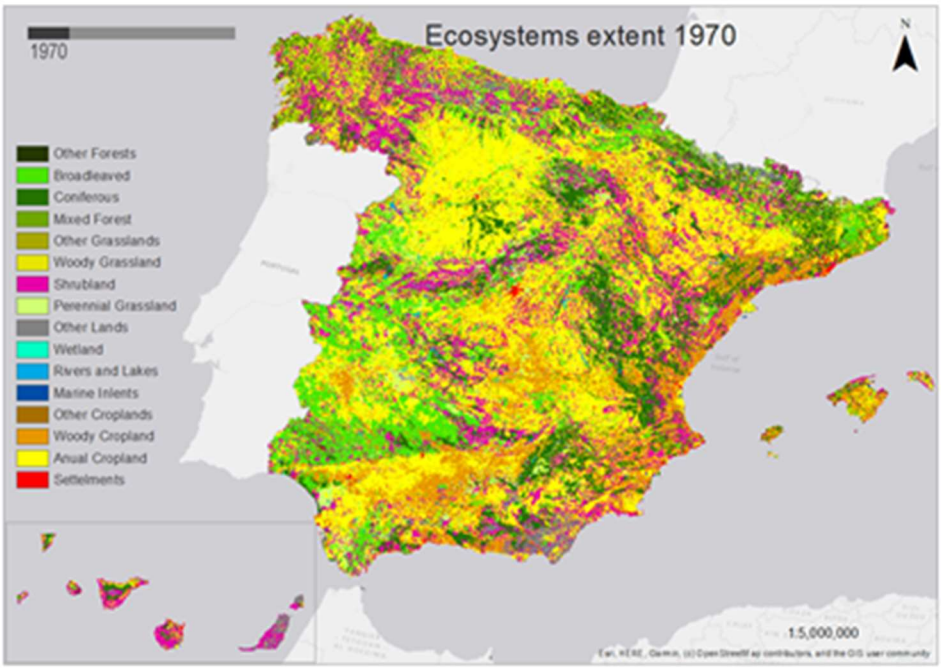

Figure 15: Example of Spanish ecosystem extent account based on LULUCF dataset. Source: García-Bruzón and Santos-Martín (forthcoming).

3.3 Condition accounts

Following SEEA-EEA recommendations, condition accounts can be assessed following a four step approach. In this report, we investigated the individual characteristics for each MAIA country following this four steps approach (Table 3). The first step is the basic approach, which is based on the identification of a condition set of indicators (i.e. species richness, area fragmentation, NDVI, etc). Based on these set of indicators, we can measure the change in the condition for a certain ecosystem type. The second step consists of the development of an index that integrates all the indicators to achieve a unique value of the condition, comparable in time and space. For example, we can use a linear proportion of the indicators to measure a one value index per ecosystem type unit.

The third step consists of including a reference indicator level to measure an aggregation index weighted according to the reference values. These reference values can be measured in multiple ways. For example, we can use the indicator values of ecosystem areas with minimum human disturbance or theoretical values of pristine ecosystems.

Finally, the fourth step refers to the type of validation that is carried out on the indicators, indices and reference values to achieve a consistent system. This validation can include an analogous study using truth growth data or use quality flags of the data or be based on collected expert opinions.

Based on the individual interview, we can see that many MAIA countries use a multi-indicators approach to measure the condition accounts (Table 3). This type of indicator is the recommended way by SEEA-EEA. In this framework, a hierarchical classification of condition typology (SECT) is used. The structure of the classes reflects a combination of long-standing ecological tradition (composition, structure and function). On the other hand, some countries based their condition account on the compositional state of biological species. For the other steps, we can see a significant disparity between countries. Some of them only include only one of the steps in their condition accounts, whereas others are going to measure the four levels for their condition accounts.

Table 3: Condition accounts in each MAIA country.

	INDICATORS	AGGREGATIONS	REFERENCE	VALIDATION	DATA
Belgium	Regional: Multi-indicator based ecosystem specific condition accounts to be developed.	Regional: Categorical index			Regional: Water framework directive, Marine strategy framework directive, Habitats Directive, Forest Inventory and various biotic and abiotic monitoring networks and data.
Bulgaria	National: Multi-indicator based		National: Literature, National reports	National: Expert assessment, Scale	National: National data.
Czech Republic	National: Species abundance	National: Mean Species Abundance (MSA)	National: Original natural state	National: Four thousand monitored sites	National: Four hundred monitors delivering data.
Finland	Regional: Multi-indicator based		Literature	Estimations	Literature and Finnish ES indicators and Biodiversity.
France	National & Regional: Multi-indicator based		National & Regional: Different reference levels to three families of indicators based on the notion of good ecological status		National & Regional: Water framework directive, Marine strategy framework directive and Habitats Directive.
Germany	National: In development				
Greece					
Netherlands	National: Multi-indicator based				National: Among other the Living Planet Index, Atlas Natural Capital, National Institute for Public Health and the Environment (RIVM) and EU Water Framework Directive.

Norway	National: species indicators Trøndelag test: Multi-indicator based Local: species indicators	National, local: Norwegian Nature Index Trøndelag: integrate index	National, Local: Point in time. The indicators are normalised for facilitate comparison	National: Expert assessments and scientific data	National: Indicators were selected from the main species groups.
Spain	National: Multi-indicators based Regional (Andalusia): relative preservation value of threatened biodiversity	National: Statistical index	National: Minimum disturbance	National: Field survey	National: Lulucf, remote sensing, European data, national data. Regional (Andalusia): Field data and international information.

3.3.1. Belgium

Belgium will develop multi-indicator based ecosystem specific condition accounts for Flanders based on the work done by the Nature Reporting Unit of the Flemish Government in the framework of the Regional Ecosystem Assessment (REA) for Flanders published in 2014 (Stevens et al. 2015) and the evaluation of the EU Biodiversity Strategy to 2020. For this data from the Water framework directive, Marine strategy framework directive, Habitats Directive, Forest Inventory and various biotic and abiotic monitoring networks will be used. Next to indicators covering ecological quality we will also include condition indicators that cover ecosystems' capacity to supply ecosystem services.

For example, in Figure 15 we include a detail of the Belgium map developed by the Research Institute Nature and Forest (INBO), which assesses ecosystem values based on the biological valuation and habitat maps.

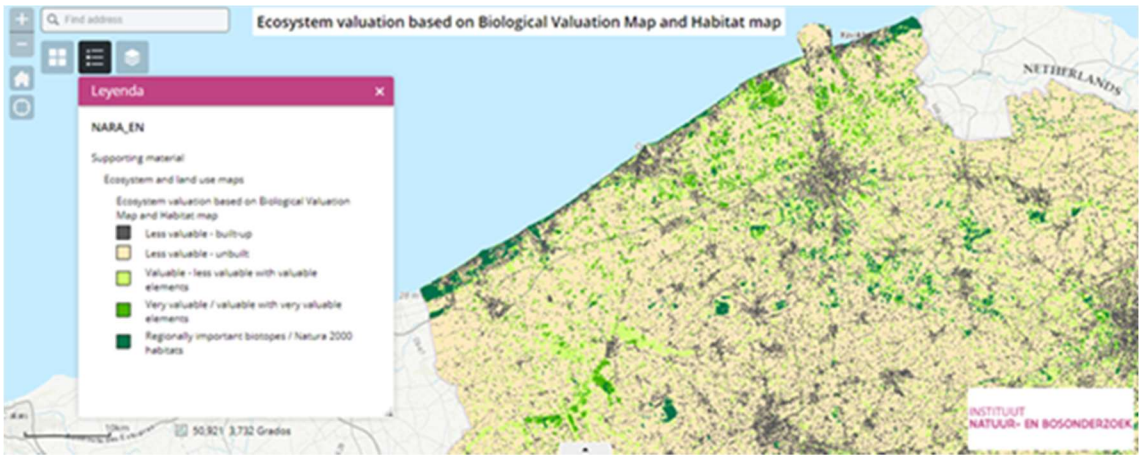

Figure 16: Detail of ecosystem valuation map developed in Belgium. Source: Research Institute Nature and Forest

3.3.2. Bulgaria

The main data sources for the condition accounts are expected to be the results from related Natura 2000 and MAES activities. The application of the minimum requirements about usability of the data for statistical purposes (Petrov, et al. 2019).

3.3.3. Czech Republic

Condition accounts were constructed based on the Mean Species Abundance (MSA), which was used as an indicator that reflects the divergence from the original natural state. Concerning biodiversity and protected areas, a biodiversity monitoring system to assess the status of species of European importance (EVD) and habitat types (TPS) into the Habitat Directive was reported trying to join this monitory with SEEA-EEA framework.

The monitored phenomena of European importance include a total of 60 habitat types (Annex I of the Habitats Directive) and 174 species (Annexes II, IV of the Habitats Directive). Every year, monitoring is carried out at nearly 4000 monitoring sites by approximately 400 monitors delivering data, the number of which is tens of thousands per year.

3.3.4 Finland

Finland has developed a condition modelling based on national survey data from recreation activities, which provide some evidence of the effect of environmental quality. In the available studies, the variation in environmental conditions across the recreation destinations that individuals visit has been found to be associated with different participation patterns.

Another approach used for ecosystem condition accounting is the combined travel cost and contingent behavior modelling for predicting the number of visits of ecosystems in different conditions. Respective indicator data from recreation ecosystem services and their link with the condition of the ecosystems is available for forests, agricultural land, freshwater and marine areas and unbuilt coastal areas ecosystems (Vihervaara, 2018).

To assess the conditions of freshwater and marine ecosystems, they have specific information about the quality and ecological state of these ecosystems (see Figure 16).

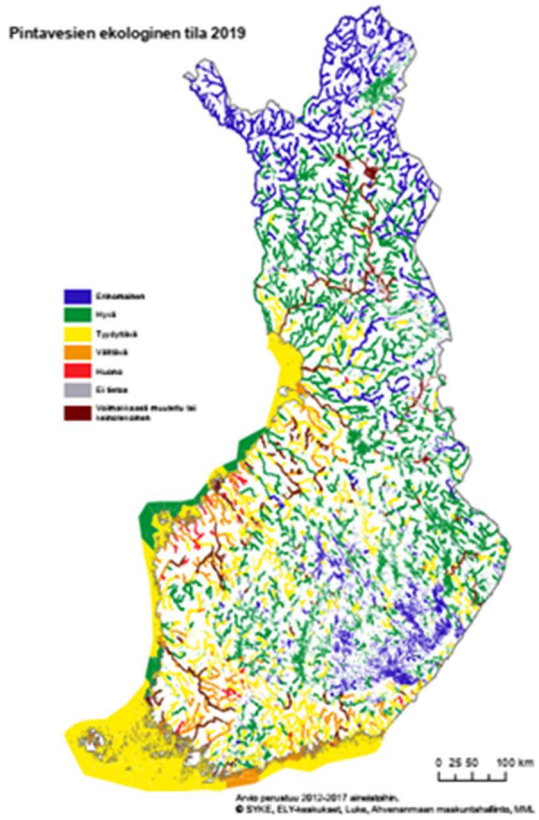

Figure 17: Ecological status of surface waters in Finland 2019. Source: SYKE (2019).

3.3.5 France

In connection with ongoing developments of the SEEA-EEA and current academic discussions, a conceptual framework and a methodology have been developed for the condition account (Comte et al. 2020). It makes the case for a measurement of ecosystem condition structured into a parsimonious and inclusive set of indicators focused on categories of management issues (i.e. managing conservation, uses and risks) and on the motivation of reference levels for the assessment of ecosystem degradation.

The condition of pelagic and benthic habitats is organized in three sets of indicators: the conservation status of species and habitats (heritage dimension), the capacity to sustainably provide goods and services (capacity dimension), the ability of ecosystems to maintain their overall functionality under disturbance (function dimension) (Comte et al., 2020). The condition account to be developed will have two sets of values for each column of conditions: one which must help to monitor the changes of conditions of the marine environment both for benthic and pelagic areas during the accounting period; one which monitors the reference conditions reflecting environmental standards to reach, mostly the good ecological status found in the MSFD.

3.3.6 Netherlands

In line with the SEEA-EEA, the condition account was compiled by ecosystem types. Each ecosystem type has distinct characteristics that should be considered in assessing its condition. In accounting tables, the data are presented for different themes (e.g. soil, vegetation) and for different ecosystem types (urban areas, agricultural land, surface water, heath lands, etc.). For each ecosystem type, multiple indicators were used. These indicators may be relevant across different ecosystem types, or only for one or two specific ecosystem types (Lof et al. 2019).

Data availability and consistency with the chosen ecosystem types is difficult. Data sources used are among others the Living Planet Index, Atlas Natural Capital, National Institute for Public Health and the Environment (RIVM) and the EU Water Framework Directive. They propose three sets of condition indicators based on Technical Recommendations for SEEA EEA.

At regional level, they work with physical state indicators concerning the recording of relatively fixed characteristics of ecosystem assets such as measures of soil type, slope, altitude, climate or rainfall and environmental state indicators, which reflect measures of impacts or pressures on the environmental state, for example, measures of pollution, emissions or waste (De Jong, et al. 2016).

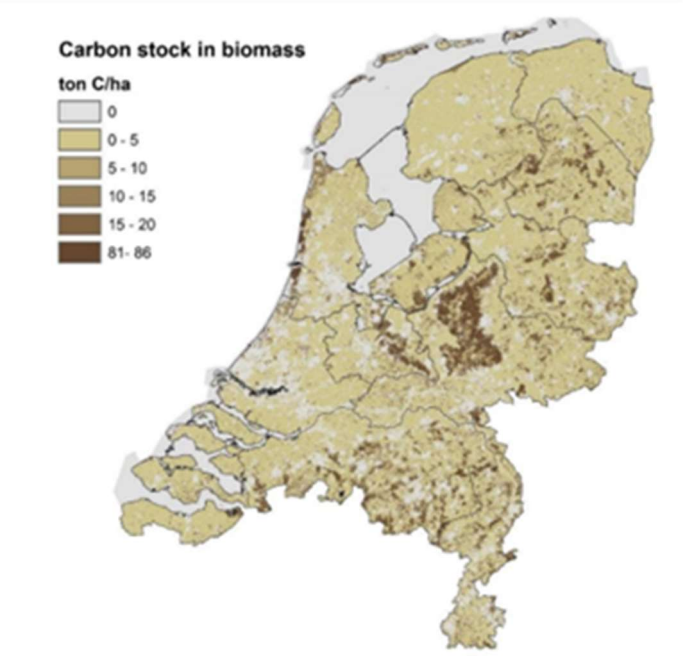

Figure 18: Carbon stock in the above ground biomass in the Netherlands in 2013. Source: Lof et al. (2019).

3.3.7 Norway

Norway has compiled the Norwegian Nature Index(NNI), which is a biodiversity index,) in repeated accounts - 1990-2000-2010-2014 - the NNI is a national coverage biodiversity account compiled with data collating national data on species and ecosystem monitoring programmes. Data has municipal level resolution with statistical units at regional and national level. The NNI has been the basis for development of methodology and national objectives for ecosystem condition (Nybø et al. 2017). There have been regional level tests of ecosystem condition assessment in Trøndelag county (Nybø et al. 2019) and in arctic tundra and arctic Barents Sea (Jepsen et al. 2019). National assessment of selected ecosystems will be undertaken in 2020 and 2021.

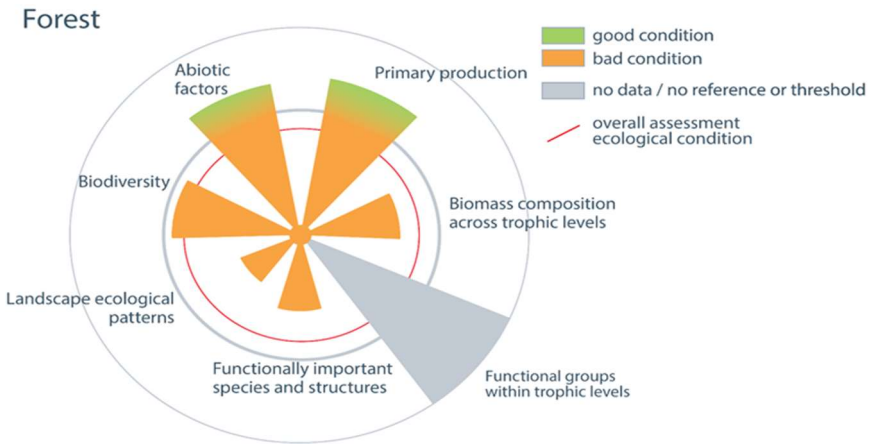

Figure 19: Forest condition by indicator categories. Source: Nybø et al. (2019).

The methodology for ecological condition uses Index-Based Ecological Condition Assessment (IBECA) (Jakobsson et al. 2020), which is derived from the index methodology for the NNI.

Urban ecosystems are not covered by the NNI nor IBECA. As part of developing experimental accounts the MAIA project in Norway will test IBECA for Oslo municipality. At local municipal level we will identify ecosystem condition indicators specifically linked to piloted ecosystem services.

3.3.8 Spain

Spain is developing a methodology based on the recommendation of the SEEA-EEA framework and European initiatives for different ecosystem types of (urban, forest, shrubland, sparsely vegetation, grassland, cropland and water categories). This

development aims to create a reference level for condition accounts at the national level. In line with the SEEA-EEA, they are going to compile the indicators by ecosystem type. Each ecosystem type has distinct characteristics that should be considered in assessing its condition. For each ecosystem type, multiple indicators will be used. They are going to reference these indicators with minimum disturbance areas to create an aggregation index of the condition by type of ecosystem.

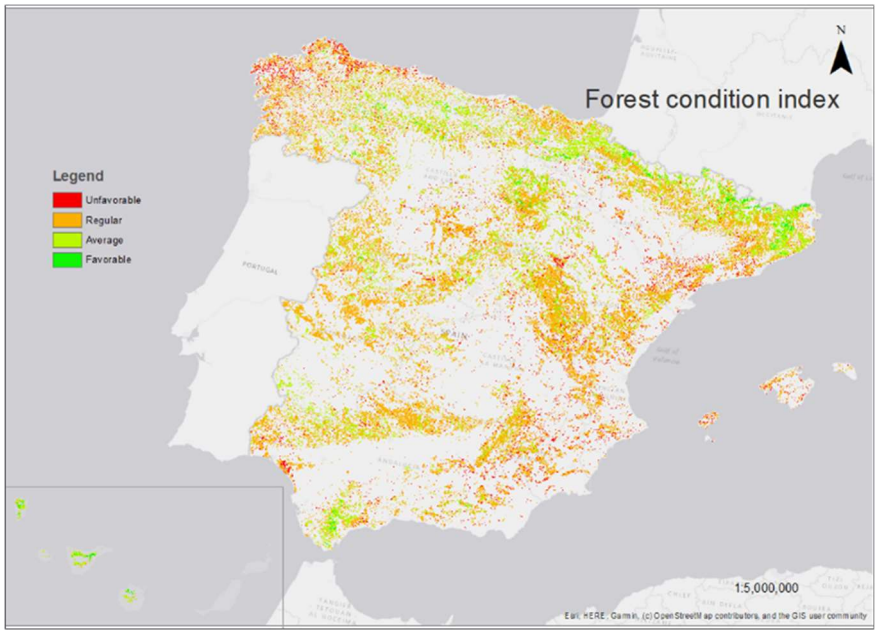

Figure 20: Forest aggregation condition index in Spain in 2000. Source: Garcia-Bruzón and, Santos-Martín (forthcoming).

In Andalusia, a new comprehensive indicator for mapping the relative preservation value of threatened biodiversity was developed and applied. The indicator was developed on the basis of explicit criteria to (1) select threatened species according to regional government responsibility for species' preservation; (2) combine species' presence by means of weighting factors based on differences in threat status, sensitivity to disturbance, functional role, and amount of knowledge; and (3) map species distributions at the scale of 1 km x 1 km UTM squares or lower from the information available. See Díaz et al. (2020) for details.

3.4 Ecosystem services accounts

This section provides an overview of biophysical and monetary accounting methods for ecosystem services (ES) that are part of NCA activities in the MAIA countries. In most cases, the process of mapping ecosystem service values (biophysical or monetary) falls within the broader process of ecosystem services assessments. Mapping and assessment of ecosystems services are essential in any NCA activity or projects. The EU Biodiversity Strategy, Action 5 of Target 2 in particular, sets the requirement for an EU-wide knowledge base designed to be: a primary data source for developing Europe's green infrastructure; resource to identify areas for ecosystem restoration; and, a baseline against which the goal of not net loss of biodiversity and ecosystem services' can be evaluated. Biophysical quantification and representation of the ES data in maps is fundamental for any further analysis in monetary terms. Biophysical data is required to develop strategies for sustainable use and management of ecosystems, ecosystem services and natural capital accounting at country and EU level. Biophysical data can be gathered either by direct observations and measurements, by indirect methods such as proxies or spatial extrapolation, or by modelling. In practice, multiple different methods are often used together, e.g. via integrated modelling platforms such as InVEST, ESTIMAP or ARIES, or through purpose-fitted selection of appropriate data and methods.

Based on the results on the individual interviews, we found that many projects exist on ecosystem services quantification (both in biophysical and monetary terms) due to the scientific, political and economic interests in this topic. Most countries appear to be working on a wide range of ecosystem services classes, and only some countries focus on a few specific services (Table 4). Most countries reported they are going to work in biophysical and monetary dimensions. Finally, we can see a great diversity of biophysical and monetary methods (Table 4).

The ES accounts were in most cases developed in previous research projects or initiatives, and now every country is trying to analyse how this data can be integrated into an ecosystem accounting system at the national/subnational scale.

Table 4: Ecosystem services accounts developed by each MAIA country.

	BIOPHYSICAL ES	MONETARY ES	METHODS	DATA
Belgium	Wood production, carbon storage in biomass, health effects of nearby green space and water availability	Wood production, carbon storage in biomass and health effects of nearby green space	ES wood production, carbon storage in biomass and health effects of nearby green space are mostly data based methods while the ES water availability also relies on (hydrological) modelling	Administrative data, census data, data from field recordings, market prices, stated preferences, avoided costs, dose effect relationships …
Bulgaria				
Czech Republic	Carbon regulation, water potential retention, water filtration and recreation service	Carbon regulation, water filtration and recreation service	Look-up tables. Social cost of carbon. Potential direct runoff volume. Curve numbers method. Replacement cost. Variant of Remme et al. (2015, 2018) potential testing of other approaches (Vallencillo et al. 2019)	National as well as globally available data. Data from Czech Statistical Office and Ministry of Agriculture. Secondary data. SNA data.
Finland	Fish stocks, forest carbon sequestration, recreation and nature-based tourism	Fish stocks, forest carbon sequestration, recreation and nature-based tourism	Social cost of carbon, Input-output.	Literature and Finnish ES indicators. National Forest Inventory (NFI).
France				
Germany				
Greece	Forest products, Water for irrigation and drinking, Biodiversity	Forest products, Water for irrigation and drinking	In development	Water framework directive, and Habitats Directive, Forest management studies
Netherlands	Crop, fodder, drink water and wood production, biomass from non-agricultural sources, erosion prevention, protection against heavy rainfall, pollination, pest control, carbon sequestration in biomass, air filtration, nature recreation (hiking) and nature tourism	Crop, fodder, drink water and wood production, biomass from non-agricultural sources, erosion prevention, protection against heavy rainfall, pollination, pest control, carbon sequestration in biomass and air filtration	Biophysical valuation approaches: Statistical models for each ES. Monetary valuation approaches: Market and cost based, revealed and stated preference.	Biophysical valuation: National spatial data. Monetary valuation:: statistical economic data, such as national accounts statistics, production statistics, price statistics, tourism statistics, etcetera

Norway	Local (NINA): Existing models: Stormwater regulation Air pollution filtration Carbon sequestration New models: Recreation time Ecosystem condition specific ES	Local (NINA): New valuation methods: stormwater regulation value urban trees ES value and asset value transfer. Recreation time value	New models: Index-Based Ecological Condition Assessment (IBECA) stormwater regulation demand using simulated exchange value urban trees asset value (BBN value transfer) Recreation opportunity cost of time	Physical data: Vascular plant species; tree inventory, vegetation cover REO urban stormwater modelhttps://nina.earthengine.app/view/new-waterways i-Tree Eco modelling of municipal tree ES ESTIMAP Oslo-BYM recreation mapping STRAVA recreation data Mobile GSM data
Spain	National: Carbon sequestration, crop production, timber production, freshwater supply, and nature recreation Regional (Andalusia): timber, cork, firewood, industrial nuts, grazing (grass, acorn, browse, wild fruit), conservation forestry services, hunting recreation services, commercial recreation services, landowner residential services, livestock, agricultural crops and amenity service auto-consumption, fire control services, public recreation services, mushrooms, carbon, landscape conservation services, threatened wild biodiversity preservation services and water supply stored in lowland watershed reservoirs	National: Carbon sequestration, crop production, timber production, freshwater supply, and nature recreation. Regional (Andalusia): timber, cork, firewood, industrial nuts, grazing (grass, acorn, browse, wild fruit), conservation forestry services, hunting recreation services, commercial recreation services, landowner residential services, livestock, agricultural crops and amenity service auto-consumption, fire control services, public recreation services, mushrooms, carbon, landscape conservation services, threatened wild biodiversity preservation services and water supply stored in lowland watershed reservoirs	National: Meta-analysis, market based, choice experiment, statistical model. Regional (Andalusia): Agroforestry Accounting System (AAS), market data, Simulated Exchange Value, choice experiments, contingent valuation, remote sensing, biophysical models, statistical models	National: Lulucf, remote sensing, European data, national data, field survey. Regional (Andalusia): Forest National Inventory data for forests and woodlands (age structure); remote sensing land cover and land use data; prices for observed transactions; in depth analysis of revenues and costs of estates; interviews to non-industrial landowners, free access visitors, households, hunters, hunting estate managers and mushroom gatherers; public expenditures; threatened biodiversity index and green water consumption models

3.4.1. Belgium

In the framework of the Regional Ecosystem Assessment for Flanders, INBO published in 2014 (Stevens, et al. 2015) ecosystem services supply and use maps for 16 ecosystem services: Game production, Production of energy crops, Wood, Food and Water production, Green space for outdoor activities, Coastal protection, Regulation of noise pollution, Maintenance of soil fertility, Regulation of water quality, Regulation of erosion risk, Regulation of flooding risk, Pollination, Pest control, Global climate regulation and Regulation of air quality.

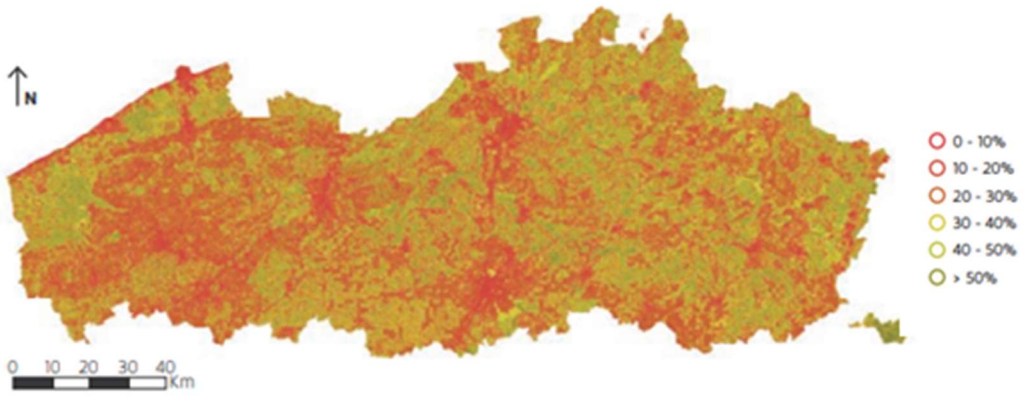

Figure 21: Total supply of ecosystem services in Flanders and Brussels-Capital region, based on those services with an above-average supply. Source: Stevens, et al. (2015).

When developing NCA for Flanders, those services will be included progressively, considering policy demand/relevance and data availability. The first pilot accounts deal with wood production, carbon storage in biomass, health effects of nearby green space and water availability. Especially the latter two are innovative in the sense that they broaden the scope of ES accounts and follow new approaches, combining various data sets with modelling.

In the scoping phase, for each pilot, the expectations and priorities of stakeholders were assessed against the available understanding, methods, and data for Flanders.

For two pilots (water supply and public health impacts of green areas) methods were further developed, and data were collected to ensure that NCA data meet the request of stakeholders.

For water supply, models and data were collected to develop physical supply accounts that – by means of detailed water balance sheets - identify the contribution of water infiltration in ecosystems to groundwater supply which in turns feeds surface water supply.

For groundwater, supply accounts were made for Flanders, and for surface water, supply accounts were demonstrated for one basin. Data to develop physical accounts for all water uses were collected and examined. Interim results were discussed with stakeholders and shows the relevance of the concepts for drought indicators and policies. (also contributed to task 3.1.)

For cultural services, the focus is on health impacts from green environments. Supply and use accounts were developed, both in physical and monetary terms. To that purpose,

literature review was organized to select dose-response functions, and these were discussed with public health agencies. To develop monetary accounts, data were collected for avoided health costs, productivity gains and welfare costs of suffering, in line with requirements for national accounting. (also contributed to task 3.3)

For wood supply and use, supply and use accounts are developed, based on existing methods and data. Gaps in understanding, methods and data were identified and discussed.

3.4.2. Bulgaria

No ecosystem services accounts have been prepared in Bulgarian up to now. Studies focus on the following biophysical ecosystem services: forest carbon sequestration, carbon storage in biomass, timber production. Data sources: Forest Fund (Forest Executive Agency - ExFA), Forest management plans, LULUCF, statistical data.

Finished Studies:
Project PDP02 - Methodological Support for Ecosystem Services Mapping and Biophysical Valuation (MetEcoSMap) – National scale outside Natura 2000
Results and visualization:

- http://eea.government.bg/bg/ecosystems
- http://www.metecosmap-sofia.org/
- http://tunesinurb.org.

3.4.3. Czech Republic

The ecosystem services accounts focus on carbon regulation, water potential retention and recreation services. Biophysical and monetary valuation of ecosystem services were carried out by applying the value transfer methods to estimate the value of future flows of ecosystem services from ecosystem assets (Vačkář, et al. 2018).

They have developed the EKOSERV database for unit value transfer at the national level. The EKOSERV database has been updated using the systematic review protocol tested to collect relevant data for ecosystem service valuation at the national level. The EKOSERV database consists of 197 records on either biophysical or economic values (Frélichová, et al. 2014).

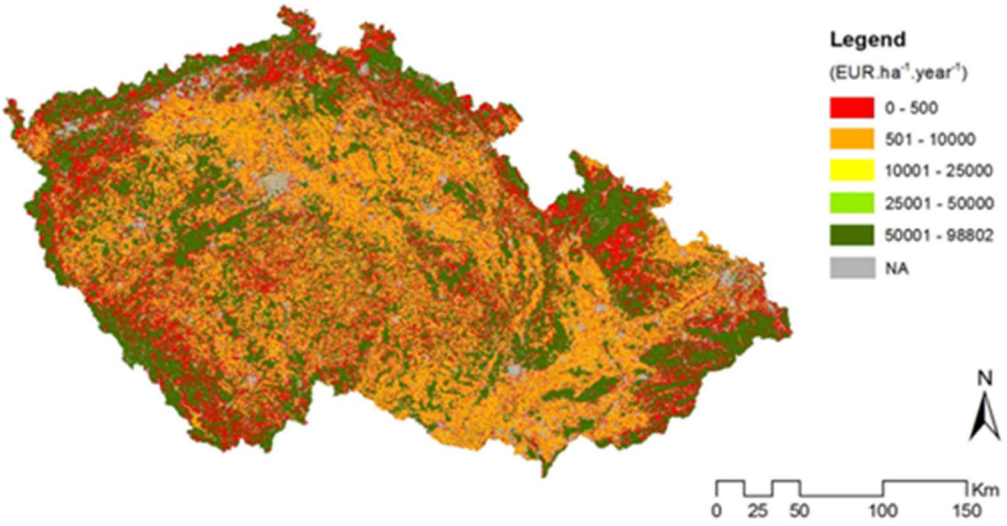

Figure 22: Valuation map of ecosystems in the Czech Republic. Source: Frélichová, et al. (2014).

About recreation ecosystem services, they will use two complementary approaches to assess the different way that people interact with nature – nature recreation (short distance and quite regular visits to nature) and nature motivated tourism (tourism revenues related to tourism motivated by nature). It will be based on approaches developed in previously published studies, one implemented in the Netherlands (Remme et al. 2015, Horlings et al. 2020); and second developed by the Joint Research Centre for an EU wide application (Vallencillo et al. 2018, 2019).

3.4.4. Finland

Finland has developed National Ecosystem Services Indicators (Finnish ES indicators) to identify the ecosystem services and monitor their state. The Finnish ES indicators follow the CICES classification system and the so-called ES Cascade model. A total of 28 ecosystem services has been evaluated and four indicators have been identified for each ecosystem service (structure, functioning, benefit, value). They developed three pilot cases for ecosystem service accounting, one pilot for one provisioning ES (fish stocks), one for one regulating ES (carbon accounting) and one for one cultural ES (recreation and nature-based tourism). They use multiple methods for data acquisition, and they are evaluating different options to integrate the pilot cases into standard national accounts (Vihervaara, et al. 2018).

In general, the aim of their works were focused on improving the national capacity to proceed ecosystem accounting and to show gaps and possibilities in data and knowledge related to three pilot cases: marine, carbon and recreation ecosystem services. The most important data sources for accounting fish provisioning ecosystem services for Finland are fish stock

and landing data provided by the Natural Resources Institute Finland (LUKEuke) (physical and economic data) and the International Council for the Exploration of the Sea (ICES) (physical data and models), and economic and technical performance data maintained by Scientific, Technical and Economic Committee for Fisheries (STECF) (mainly economic data).

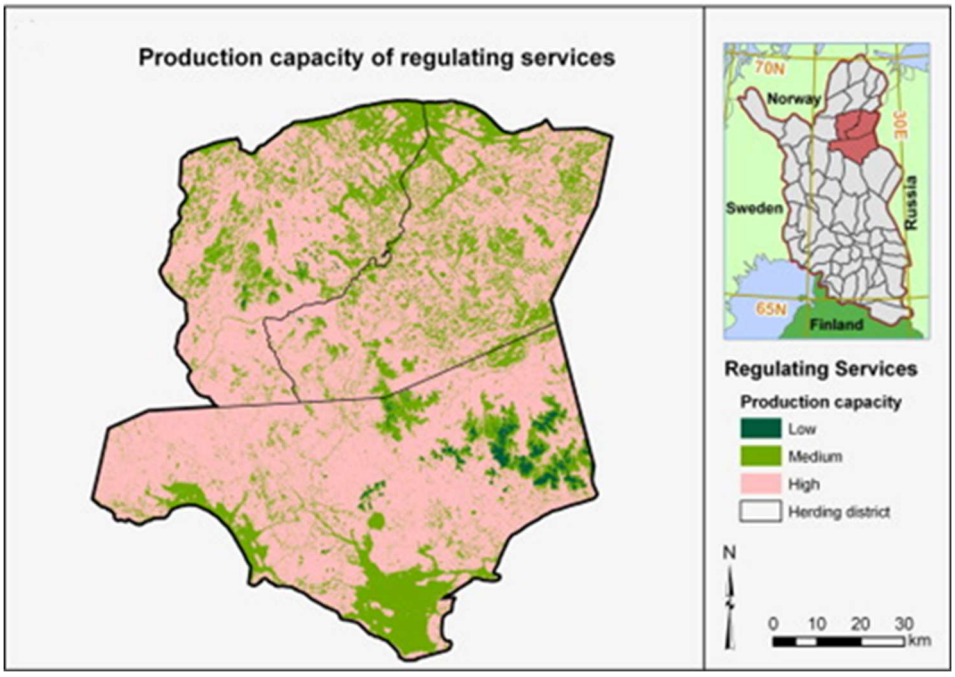

Figure 23: Distribution of regulating ecosystem services form Forest Lapland, in northern Finland. Source: Vihervaara, et al. (2010).

3.4.5. Greece

Regarding Ecosystem Services, academic efforts focused initially on identification of supply (Kokkoris et al., 2017), as a baseline for future quantitative assessments, followed by the the first local scale assessment of ES supply and monetary evaluation of water supply (Kokkoris et al., 2019) and the publication of a National Set of Indicators (Kokkoris et al., 2020). The theoretical background is provided by MAES and the classification of ES from CICES.

Main tools, so far, in assessing Ecosystem Services' actual and potential supply, are matrix-based approaches, incorporating expert judgement, questionnaires and modelling, according to data availability. The experience gained is crucial in creating ecosystem services' accounts at national level.

3.4.6. Netherlands

The ecosystem services accounts compiled are crop and fodder production, drinking water production, wood production, biomass from non-agricultural sources, erosion prevention, protection against heavy rainfall, pollination, pest control, carbon sequestration in biomass, air filtration, nature related tourism and recreation. Data sources are national and provincial statistics, geographical registries and look-up tables from scientific research. Data availability and reliability and the relevance for the Netherlands are factors used to decide on which services to focus on. The detail and resolution of the accounts differ a lot per ecosystem service.

Two basic approaches were used to produce the physical supply account. First, for some services such as crop production and drinking water extraction a ‘top-down’ approach was used. This involves a spatial disaggregation of information that is already in the SNA. Second, for other services such as carbon sequestration and erosion control, a ‘bottom-up’ approach was used. This approach was used for services that are not in the SNA, and for which national aggregates were obtained by aggregating local information based on various models (Statistics Netherlands and WUR, 2018).

They compile monetary accounts for ES on a national scale using several different statistical data sources and different valuation techniques by each ES, focus on market and cost based, revealed and stated preference approaches. They have selected methods that can be based on existing statistical economic data, such as national accounts statistics, production statistics, price statistics, tourism statistics, etc. (Statistics Netherlands and WUR, 2020).

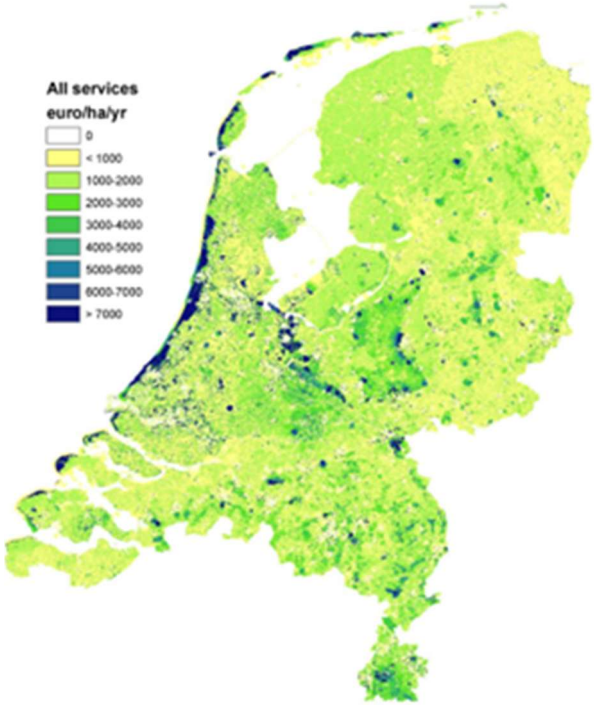

Figure 24: Monetary value of tourism and recreation ES in the Netherlands in 2015. Source: Statistics Netherlands and WUR, (2020).

3.4.7. Norway

Existing model and mapping results for different urban ecosystem assessment projects have been compiled in the Oslo Urban Atlas (Figure 25). We will mainly use existing models and maps of ecosystem services for Oslo to demonstrate physical and monetary supply-use tables for selected priority ES at municipal level (stormwater runoff regulation, air pollution filtration and carbon storage, recreation). Recreation time modelling will be a novel contribution of the MAIA project to existing models and maps. For selected ecosystem services at local level, significant ecosystem condition indicators will be identified (see previous section)

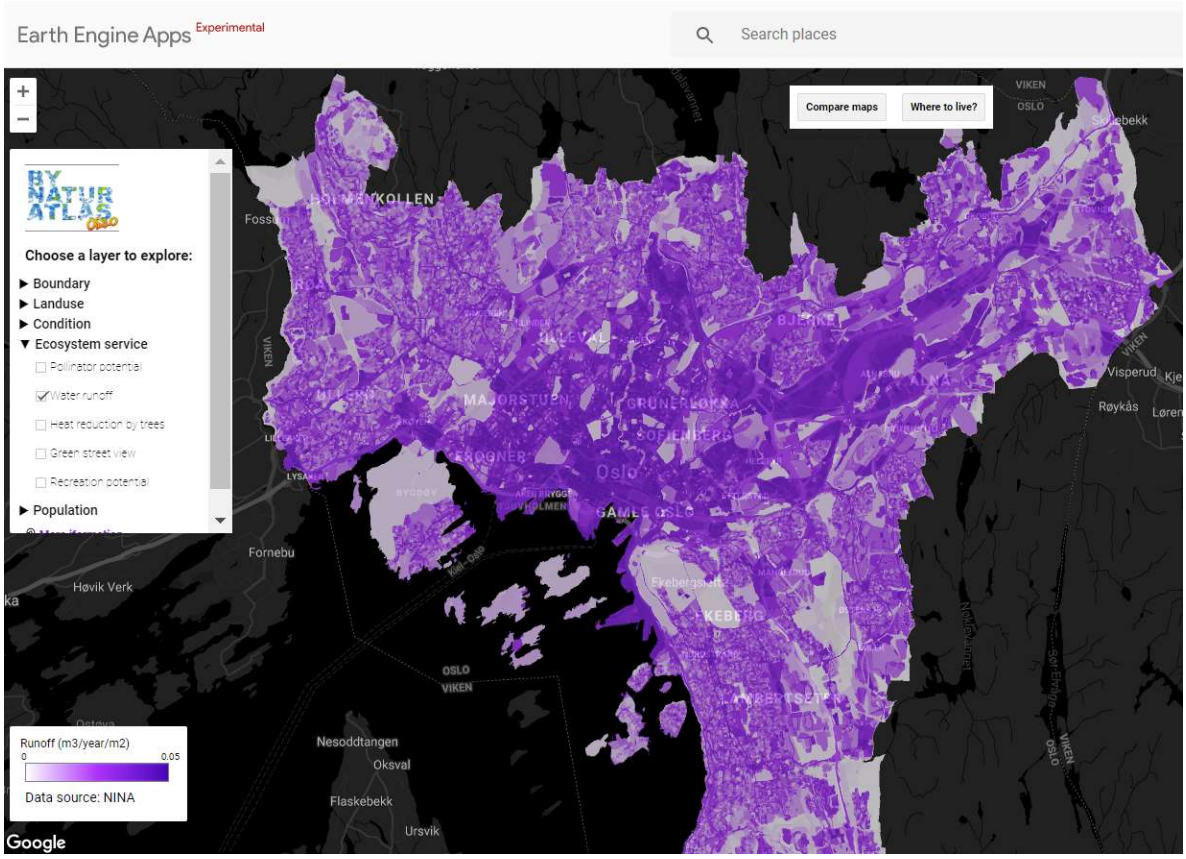

Figure 25: Property stormwater runoff in Oslo. Source: NINA Oslo Urban Atlas. https://nina.earthengine.app/view/urban-nature-atlas

MAIAs Norway case will make new contributions to the monetary valuation of ecosystem services for stormwater regulation, exploring an approach to simulated exchange value of stormwater fees; benefit transfer of regulating services of city trees using Bayesian belief networks (based on iTree Eco model estimates for municipally managed trees); time value of recreation based on STRAVA and mobile phone GSM data.

3.4.8. Spain

Spain has developed a National Ecosystem Assessment (http://www.ecomilenio.es/) to map and assess the state and trend of ecosystem services at the national scale. The Spanish National Ecosystem Assessment (SNEA) (Santos-Martín, et al. 2016), supported by the Biodiversity Foundation of the Ministry of Environment, provides the first analysis at national level that evaluates the ability of the Spanish ecosystems and biodiversity to supply ES and to maintain our human well-being. It follows the initiative of the Millennium Ecosystem Assessment promoted by the United Nations.

The SNEA began in 2010 and completed its first biophysical assessment in 2012 and started

a new phase in 2013 with the purpose of carrying out an economic valuation of ecosystem services supplied by priority ecosystems in Spain. The aim of the project was to visualize the contribution that ecosystems and biodiversity make to human well-being, not only in ecological terms but also in economic terms.

A total of 22 ecosystem services have been mapped and assessed in biophysical terms. In monetary units, 12 ecosystem services have been valued using three main techniques: (1) a meta-analysis of the studies previously conducted in Spain; (2) spatial representation of the varying values of ecosystem services using market-based methods; and (3) a choice experiment conducted in those services that are difficult to measure by other techniques of traditional economic valuation. For the MAIA project, ES accounts will be quantified using multiple methods for data acquisition (especially for carbon accounting) and evaluate options for integrating into standard national accounts. The ecosystem services they are going to measure are carbon sequestration, crop production, timber production and nature recreation.

At regional level, there is a long experience in Andalusian forests to account for ecosystem services (Campos et al. 2019a). The framework applied goes beyond the production boundary of standard national accounting by considering four private activities (forestry, hunting, residential and private amenity) and six public activities (mushroom picking, carbon sequestration, water, recreation, landscape and threatened biodiversity). Campos et al. (2019a) constitutes the first attempt to measure, at a regional scale, forest ecosystem services, products, total income and environmental assets using an ecosystem accounting methodology, the “Agroforestry Accounting System” (AAS), which is consistent with the valuation criteria of standard accounts (Caparrós et al. 2003). To keep the valuation consistent with standard accounts, the project simulates exchange values for non-market goods and services using the Simulated Exchange Value method (Caparrós et al. 2003; Caparrós et al., 2017). Although AAS precedes SEEA-EEA, recent contributions have shown that both systems are closely related and compatible, with minor adjustments regarding the institutional sectors (Campos et al., 2019b and 2020).

3.5 Ecosystem asset accounts

Ecosystem accounting goes beyond other approaches to ecosystem analysis and assessment through its explicit linking of ecosystems to economic and other human activity. The links are forged through the services provided by ecosystems and the impacts that economic and other human activity may have on ecosystems and their future capacity. While ecosystem accounting does consider ecosystems and the economy to be different systems, they are analysed jointly to reflect the fundamental connections between them. The use of an accounting framework enables the stock of ecosystems—ecosystem assets—and flows from ecosystems—ecosystem services—to be defined in relation to each other and to a range of other environmental, economic and social information.

Through the adoption of a systems perspective on environmental assets, information organized within the context of SEEA Experimental Ecosystem Accounting is able to provide an indication of impacts (both positive and negative) of economic and other human activity on the environment and can highlight the potential trade-offs among the different combinations of ecosystem services that. In the context of MAIA, only four countries report information about the method used to measure ecosystem assets (Table 5).

Table 5: Ecosystem asset accounts by each MAIA country

	ASSETS	DATA
Belgium		
Bulgaria		
Czech Republic	Ecosystem asset based on the concept of the present value of ecosystem services	EKOSERV database for unit value transfer.
Finland		
France	Ecosystem asset based on the cost to maintain and restore ecosystems in good ecological status	Marine Strategy Framework Directive, literature on costs, statistical economic data
Germany		
Greece	Forest products, Drinking and irrigation water, Biodiversity	Forest products' data (Forest Service) River Basin Management Plans (Ministry of Environment and Energy) Biodiversity data (Natura 2000 dataset for Greece, Flora of Greece Web)
Netherlands	Crop, fodder and wood production, pollination, water and air filtration, nature-related tourism, amenity services.	Statistical economic data, such as national accounts statistics, production statistics, price statistics, tourism statistics, etcetera. Net present value method.
Norway		

Spain	National: Environmental assets accounting by considering four private activities (forestry, hunting, residential and private amenity) Regional: “Agroforestry Accounting System” (AAS)	

3.5.1. Czech Republic

They conducted an article about monetary ecosystem asset accounting through quantification of the present value of future ecosystem service flows. Based on the demonstration of approaches to ecosystem asset accounting, they discuss selected aspects of ecosystem condition measurements, valuation, and policy implications of ecosystem asset accounting at the national level (Vačkářů and Grammatikopoulou, 2019)

They used the EKOSERV database of ecosystem service values and quantified the economic value per unit area of the flow of ecosystem services derived from land cover types (Frélichová et al. 2014; Vačkář et al. 2018).

3.5.2. France

The study is at the methodology development of extent and condition accounts in biophysical units (to be finished at the end of 2020) and the economic valuation is planned based on data from the Marine strategy framework directive. We are not developing ES accounts in France, economic data will be used to develop the ecosystem asset account in economic terms, as the workshop organized in France to discuss policy needs for ecosystem accounts has identified. Restoration and maintenance costs techniques will be used to assess the costs needed to maintain ecosystems in a good ecological status as defined by the reference condition of ecosystems. This will be compared with the current expenses to restore and maintain ecosystems to produce an account of unpaid ecological costs.

3.5.3. Greece

Assets’ accounting in Greece will be focused on forestry products such as honey, timber and grazing, water supply and biodiversity. For the first two a wide range of indicators are easily conceivable and data availability is the factor determining the choice of one. On the other hand, biodiversity is a trickier subject to approach. Efforts are focusing on combining the information provided by the extent accounts infused with characteristics of biodiversity such as endemism, medical, nutritional or aromatic properties and locality to create accounts depicting it and its value.

3.5.4. Netherlands

The value of an ecosystem asset can be determined by calculating the net present value of the future flows of income associated with the different ecosystem services. This approach required assumptions on the future flow of ecosystem services, the discount rate, and the economic lifespan of ecosystem assets. In their project assets values by ecosystem type have been calculated for only one year (2015).

Important issue is a careful way of phrasing and showing the results since interpretation can be difficult. A distinction should be made in that the contribution of ecosystems to economic activities is measured and not the value of nature.

In addition, they have developed a method to integrate this monetary valuation with Statistical National Accounting information.

3.5.5. Spain

At national level, Spain is planning to use an input-output analysis of ecosystem assets through the implementation of an environmental and social accounting matrix. As a first pilot, they are going to develop this method for the carbon sequestration ecosystem service.

As noted in the section 3.4.5, at regional level there is a long accounting experience in Andalusian forests (Campos et al. 2019a). For the ten activities considered in the application, four private activities (forestry, hunting, residential and private amenity) and six public activities (mushroom picking, carbon sequestration, water, recreation, landscape and threatened biodiversity), the AAS methodology applied integrates manufactured capital and environmental assets. As mentioned above, the main aim of the AAS methodology is to estimate total income, splitting it into labour income, manufactured capital income and environmental income, which implies to integrate estimations for ecosystem services and environmental assets. The environmental income concept is one of the main contributions of the AAS, as it integrates ecosystem services and changes of environmental assets.

3.6 Gaps and needs

In this section, we provide a summary of the main gaps and needs for the implementation on the pilot accounts identified during the individual interviews.

It is normal that gaps and needs are different between countries, because there are countries that are at a more advanced stage in the development of ecosystem pilot accounts and other countries that are in an initial stage.

The countries in the first group reported gaps and needs related to collaboration and political support issues. The countries in the second group reported gaps and needs concerning the lack of data and the need to clarify the frameworks and methods (Table 6).

Table 6: Summary of identified gaps and needs in developing ecosystem core accounts by country

	GAPS	NEEDS
Belgium	Lack of clear guidelines. Availability of good quality data. Resolution of European data is not enough for a region with a wide variety of land uses on a small surface area. Flemish data is often also not fit for purpose (availability, reliability, timely, validated …). How to measure and deal with uncertainties (stemming from data, knowledge, models …)? Lack of ES knowledge (especially where data is lacking) to build appropriate ES models.	More intensive (more frequent and in-depth) exchange of experiences between partners with respect to approaches and methods, policy applications / use of results, communication of results, dealing with uncertainties … both actively (via webinars) as passively (via exchange of in-depth reports).
Bulgaria	Data availability; Lack of clear guidance on working with available data. Key challenge is the lack of readily available and sufficiently detailed georeferenced data at national level (often national classifications are used and corresponding tables must be elaborated). Key data sets at national level at the INSPIRE Portal (e.g. land planning, flood reduction, climate adaptation, agriculture, cohesion policy) are missing, but they are essential for ecosystem accounts developing. Unclear guidelines on the integration of administrative data sources, according to the principles proposed for physical and monetary evaluation of EA and ES	Policy support in developing of the ecosystem asset accounts, thematic accounts for biodiversity, and in determining the most appropriate model, based on the available data. A case study on thematic biodiversity accounts and methods of linking biodiversity data with monetary accounts. Expertise and further study of data availability through collaboration with key Bulgarian Stakeholders, ministries, academia, mapping agencies and nongovernmental organizations that are active in the monitoring land cover/land use, ecosystem extent and condition. Application of GIS methods for biophysical and monetary evaluation of ES. Experience with implementation of NCA. Policy support.
Czech Republic	Training material and best practice examples for water filtration, carbon sequestration SUT accounts as well as biodiversity thematic accounts. We also need guidance on how to allocate supply of ES to beneficiaries.	A platform of close collaboration the MAIA partners who are under the same tasks and WPs; a space to exchange experience and transfer knowledge and where partners can post questions and discuss processes.

	One last point we need guidance refer to the dissemination/communication practices.	
Finland	Data availability	
France	Lack of data in the ocean and the homogeneity with terrestrial data. Lack guidance on standards for the structuration of information and the creation of metadata for spatially explicit information that supports the creation of (biophysical) accounts. If ecosystem accounts were to be extended to land areas in France (outside of MAIA), spatially explicit maps of LULUCF, ecosystem types, and biodiversity indicators are currently lacking to produce extent and condition accounts and maps.	The environmental statistics division (SDES) of the Ministry of the environment (MTES) in France is not aligned with the current developments of the SEEA EEA on ecosystem services and needs more visibility on the use of maintenance and restoration costs. Need to formulate a benchmark of economic valuation approaches consistent with the SEEA EEA, including the place for maintenance and restoration costs. Following a first workshop organized by SYKE, a second workshop on marine accounts would be very helpful to share results, discuss differences and gaps and produce a synthesis paper. This could be organized by AgroParisTech once countries have produced marine accounts.
Germany	Data availability is the main problem. Partly different data collection and ecosystem/habitat type classification systems in the different federal states.	Harness existing data, perhaps also mainstream work across federals states. National statistical office will provide more support for NCA in the future (respective staff recruitment ongoing).
Greece	Efforts are ongoing to acquire more concrete databases. Timeseries are scarce and problematic. Data gaps are to be addressed through stakeholder engagement.	A coherent methodological approach is needed for implementing NCA, which is currently missing, creating misconceptions and misunderstandings, especially in Greece, where, accounting is not existing so far. Although SEEA-EEA accounting procedures are to be followed, there is a need for clarification of terms and technical support on valuation and modelling.
Netherlands	Support in marine ecosystems.	Better understanding of what is done for biodiversity assessment and accounting. Improve the network connections to share methods and knowledge
Norway	Local and regional initiatives, the key gap is found in communication.	Policy support. Improve the stakeholder's knowledge of the initiatives included the use, purposes and importance of ecosystem accounting.
Spain	Specific frameworks, which helps in different accounts in a replicable and scalable manner.	More political and legislative initiative

4. CONCLUSIONS

This Deliverable D3.2 report on co-design pilot ecosystem accounts in the European countries participating in MAIA project reveals results from the individual interviews with relevant stakeholders and shows that pilot accounts have been implemented in all 10 analysed countries. This should provide a good base for further development and cooperation in improving existing and designing further accounts in order member states to fulfil the requirements of Action 5 of Target 2 of the EU Biodiversity Strategy 2020 and its current phase of MAES (Mapping and Assessment of Ecosystem and their Services). Natural capital accounting is at the core of the current MAES phase.

The implementations of pilot accounts are, however, at varying levels, and partly follow different methodologies. This ranges from countries at very early stages of implementation to already relatively advanced countries. The analysis was based on the outcomes of the state-of-the-art of NCA implementation assessment done for MAIA Deliverable D3.1 and subsequent individual interviews with key stakeholders in each country. The combination of both data sources proved to be a suitable and straight-forward approach to gather the information that is included in this Deliverable report.

It can also be noted that most, but not all countries and all accounts, follow the framework provided by SEEA EEA. Looking at the five SEEA-EEA core accounts, a diverse level of implementation can be observed in the 10 countries that are part of MAIA. For instance, a lot of work has been done related to ecosystem type classification and mapping, often building on an existing classification and datasets such as MAES, CORINE land cover or EUNIS. Also, ecosystem condition accounting seems to be quite well-developed in several countries, following diverse approaches. Many countries developed biophysical ecosystem services accounts, followed by monetary ecosystem services accounts. Ecosystem asset accounts seem to be a bit behind in their development still. Most NCA-related studies were carried out at national spatial scale, followed by the regional scale, only a few considered the local scale.

The results will help the MAIA consortium and other interested parties and stakeholders to mainstream their ecosystem accounting implementation activities, to share knowledge and create synergies of efforts and to co-design their accounts. The following tasks of MAIA Work Package 3 will directly build on the knowledge base of Deliverables D3.1 and D3.2 in order to mainstream natural capital and ecosystem accounts in participating countries (Task

2.3) and to coordinate and integrate mainstreaming activities in all participating countries (Task 2.4). The information collected from the countries will be used by the other MAIA Work Packages in their activities to support NCA implementation, including improved involvement of stakeholders (WP 1), testing of ecosystem accounting methods (WP 3) and the promotion of replicability of ecosystem accounting (WP 4).

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6. ANNEX

Annex 1. Belgium

Agency: Instituut voor natuur en Bosonderzoek (INBO)
Researchers: Lieven De Smet and Raïsa Carmen
Interviewers: Fernando Santos and Adrián García

1. **What Natural Capital Accounting (NCA) are you doing?**

We are developing NCA for Flanders (the Northern region of Belgium). We will develop and test various accounts: ecosystem extent, ecosystem condition, ecosystem services use and supply, both in physical and monetary terms, and possibly also an ecosystem asset account. We will set up pilot studies for the ecosystem services wood production, carbon storage in biomass, health effects of nearby green space and water availability. And we will also pilot a biodiversity account for Flanders.

1. Extent accounts: They developed a regional land cover map for the Flemish region.

   a. What has each MAIA country done on ecosystem extent accounts at a national or regional level?

i. Ecosystem extent accounts have been developed by the Nature Reporting Unit of the Flemish Government, describing state and trends for the MAES EU ecosystem classes. This has been done for two sets of data, using (1) the best available spatially explicit data for Flanders combined in the Landgebruiksbestand 2013 and 2016 and (2) Corine Land Cover data for 1990 and 2018. Strengths and weaknesses of the two sources of land use and cover data have been assessed. Based on this work we concluded the resolution of Corine Land Cover data is insufficient for a region like Flanders with a wide variety of land uses on a small surface area.

ii. The ecosystem extent accounts that are based on the Landgebruiksbestand have been validated thoroughly. Based on this, the way the data layers are combined in the Landgebruiksbestand has been revised for natural capital accounting purposes. The following step is now to quantify the uncertainties.

   b. What are planned activities for developing extent accounts as part of MAIA?

i. See the above point. Besides, we will evaluate the implications of the uncertainties associated with the extent accounts. What does this mean for the use of these accounts? What are the priorities and possibilities for reducing uncertainties? Also, the extent accounts will be evaluated for their compatibility with our MAIA pilots on accounting for water availability, wood production, carbon

storage and health benefits and recreation.

c. What kind of approach/methods are used to develop Extent accounts (just a brief description; e.g. cadaster data combined with CLC?, etc)

i. Ecosystem extent accounting is based on the 'Landgebruiksbestand' for Flanders. The Landgebruiksbestand combines the best available set of spatially explicit information (GIS-layers and other (spatial) data sources). This includes data from administrative databases, satellite imagery, aerial orthophotos and field recordings. Some key layers are the Biological Valuation Map (BWK), the Green Map (differentiating between 'agriculture', 'low green', 'high green' and 'not green' areas on a 1x1 meter grid), Agriculture use parcels (indicating what crops have been grown on a specific plot of land in a given year) and Cadastral map (CADMAP).

Based on a thorough validations exercise the way the data layers are combined in the Landgebruiksbestand has been revised.

2. Condition accounts: To be developed. We will develop multi-indicator based ecosystem specific condition accounts for Flanders based on work done by the Nature Reporting Unit of the Flemish Government in the framework of (1) the Regional Ecosystem Assessment (REA) for Flanders INBO published in 2014 (see: https://www.inbo.be/nl/natuurrapport-2014 and https://www.inbo.be/en/flanders-regional-ecosystem-assessment-state-and-trends-synthesis-report) and (2) the evaluation of the EU Biodiversity Strategy to 2020. For this we will use data from the Water framework directive, Marine strategy framework directive, Habitats Directive, Forest Inventory and various biotic and abiotic monitoring networks will be used. Next to indicators covering ecological quality we will also include condition indicators that cover ecosystems' capacity to supply ecosystem services.

3. Ecosystem services: In the framework of the Regional Ecosystem Assessment (REA) for Flanders INBO published in 2014 (see: https://www.inbo.be/nl/natuurrapport-2014 and https://www.inbo.be/en/flanders-regional-ecosystem-as nt-state-and-trends-synthesis-report) supply and use maps were developed for 16 ecosystem services: Game production, Production of energy crops, Wood, Food and Water production, Greenspace for outdoor activities, Coastal protection, Regulation of noise pollution, Maintenance of soil fertility, Regulation of water quality, Regulation of erosion risk, Regulation of flooding risk, Pollination, Pest control, Global climate regulation and Regulation of air quality. When developing NCA for Flanders those services will be included progressively, taking into account policy demand/relevance and data availability. The first pilot accounts deal with wood production, carbon storage in biomass, health effects of nearby green space and water availability. Especially the latter two are innovative in the sense that they broaden the scope of ES accounts and follow new approaches.

4. Biodiversity: Within INBO three different approaches are explored at this moment to develop a Biodiversity Account for Flanders: 1. An improved 'Living Planet like' system (based on species occurrence) including vegetation data; 2. A biodiversity account based on data on the main drivers for biodiversity degradation, and 3. an approach based on long-term and upscaled implementation of the biological valuation mapping, a field based expert mapping of biological habitat quality. We will now evaluated their adequacy for NCA using a number of criteria.5. Water accounts: Focus on the availability of water for drink, industry, agriculture, and the relation of health and water. A NCA pilot study is being developed.

2. Which method(s) used?

1. Extent accounts: See our answers under section 1. Every three years a new version of the The Landgebruiksbestand will be available.

2. Condition accounts: To be developed. We will develop multi-indicator based ecosystem specific condition accounts. Next to indicators covering ecological quality we will also include condition indicators that cover ecosystems' capacity to supply ecosystem services.

3. Ecosystem services: To be developed. We are assessing various methods for wood production, carbon storage in biomass, health effects of nearby green space and water availability. For all services will have to decide between a modelled approach, a data based method (e.g. using field recordings) or an hybrid approach. ES wood production, carbon storage in biomass and health effects of nearby green space will mostly be data based methods while the ES water availability also relies on (hydrological) modelling. Especially the methods used for the ES health effects of nearby green space and water availability are innovative in the sense that they broaden the scope of ES accounts and follow new approaches, combining various data sets with modelling.

3. What key datasets used or developed?

They have a website visor of the spatial information in https://geo.inbo.be/ecosysteemdiensten/

1. Extent accounts: The Landgebruiksbestand which will be the principle basis for ecosystem extent accounting in Flanders combines the best available set of spatially explicit information (GIS-layers and other (spatial) data sources). This includes data from administrative databases, satellite imagery, aerial orthophotos and field recordings. Some key layers are the Biological Valuation Map (BWK), the Green Map (differentiating between 'agriculture', 'low green', 'high green' and 'not green' areas on a 1x1 meter grid), Agriculture use parcels (indicating what crops have been grown on a specific plot of land in a given year) and Cadastral map (CADMAP).The principal sources of information for the this map are satellite images, official statistical data, aerial orthophoto, cadastre information, and field information for validation.

2. Condition accounts: Data from a variety of sources as there are theWater framework directive, Marine strategy framework directive, Habitats Directive, Forest Inventory and various biotic and abiotic monitoring networks and data. 3. Ecosystem services: A variety of sources: administrative data, census data, data from field recordings, market prices, stated preferences, avoided costs, dose effect relationships ….

4. With who?

The main developers at this moment are

- Instituut voor natuur en Bosonderzoek (INBO)
- VITO

Bu also other organisations are involved as co-developers and we are working set up o model where data holders and users will be invited to be co-developers

- Flemish Planning Bureau for the Environment and Spatial Development
- Flemish Environmental Agency
- Agency for Nature and Forest
- Statistics Flanders

The development of NCA in Flanders is still in an early phase so there is no use of natural capital accounts (in the sense of SEEA-EEA) yet.

5. What gaps?

Lack of clear guidelines.

There are important gaps in data and knowledge and these, of course, relate to the ambition level. The higher the ambitions, the lager the gaps. For now, we have encountered problems with the availability of high quality spatially explicit data on ecosystems and their use for ecosystem extent accounting. We are now assessing the associated uncertainties and will then evaluate the implications. Are the uncertainties larger than the observed trend? What does this mean for the use of extent accounts? What are the priorities and possibilities for reducing uncertainties? Similar issues will arise with the other accounts, but we have only started exploring this.

Availability of good quality data. Resolution of European data is not sufficient for a region with a wide variety of land uses on a small surface area. Flemish data is often also not fit for purpose (availability, reliability, timely, validated …). How to measure and deal with uncertainties (stemming from data, knowledge, models …)?

Lack of ES knowledge (especially where data is lacking) to build appropriate ES models.

6. What do you need or miss?

More intensive (more frequent and in-depth) exchange of experiences between partners with respect to approaches and methods, policy applications / use of results, communication of results, dealing with uncertainties … both actively (via webinars) as passively (via exchange of in-depth reports).

7. What can Maia team do?

MAIA countries could provide a list of problems to design their pilot accounts and how they solve them. Frontrunners have the skill to inspire the other countries with details of the design. Use cases for well-developed accounts can also provide insight into how the accounts can be used in practice by stakeholders.

MAIA progress of work

VITO participated in the tasks of WP 1 and WP 2 to provide country information together with the other Belgian partners. We attended the partner and stakeholder meetings already organized.

The main pilot accounts VITO was planning to perform were not only selected and co-designed (task 2.2.) but already developed and compiled (task 2.3). Therefor a large part of WP 2 and also contributions to WP3 are performed a bit sooner than planned.

Task 1.1. Stakeholder meetings (together with EVINBO):
The pre-feasibility analysis indicated that a prerequisite for NCA accounts to be part of the official statistics is to have users of the statistics and agencies that are willing to collect and provide the required data. To assess the interests and data capacities of stakeholders and agencies, stakeholder meetings were organized, focusing on 5 pilots that address a wide range of issues (wood production, CO2 capture in biomass, water supply, cultural services and mineral raw materials. A general workshop was organized, with follow up discussions per pilot. For each pilot, main interests were prioritized, as well as linkages to other ongoing studies and activities.

Tasks 2.2 and 2.3:
Extent accounts
Extent accounts were developed for 2013 and 2016, building on the best available data in land use maps at 10x10m for Flanders. The limitations of these extent accounts are assessed per pilot theme. Possibilities and limitations of extent account data to assess the evolution between 2013 and 2016 for different supply and use accounts are examined.

Supply and use accounts:
- In the scoping phase, for each pilot, the expectations and priorities of stakeholders were assessed against the available understanding, methods and data for Flanders.
- For two pilots (water supply and public health impacts of green areas) methods were further developed and data were collected to ensure that NCA data meet the request of stakeholders.
- For water supply, models and data were collected to develop physical supply accounts that – by means of detailed water balance sheets - identify the contribution of water infiltration in ecosystems to groundwater supply which in turns feeds surface water supply. For groundwater, supply accounts were made for Flanders, and for surface water, supply accounts were demonstrated

for one basin. Data to develop physical accounts for all water uses were collected and examined. Interim results were discussed with stakeholders, and shows the relevance of the concepts for drought indicators and policies. (also contributed to task 3.1.)

- For cultural services, the focus is on health impacts from green environments. Supply and use accounts were developed, both in physical and monetary terms. To that purpose, literature review was organized to select dose-response functions, and these were discussed with public health agencies. To develop monetary accounts, data were collected for avoided health costs, productivity gains and welfare costs of suffering, in line with requirements for national accounting. (also contributed to task 3.3)
- For wood supply and use, supply and use accounts are developed, based on existing methods and data. Gaps in understanding, methods and data were identified and discussed.

Further tasks that we see in the next part of the project are mainly linked to translate methods and results into “good practice’ examples (as much of the work is done in Dutch) for facilitating knowledge exchange between partners and supporting organizations (task 2.4). Furthermore, lessons learned (task 1.3.) will be derived. Also, VITO swill deliver input into the guidelines for monetary valuation and contribute to further mainstreaming ecosystem accounting by demonstrating the use of it in decision support (WP4).

Annex 2. Bulgaria

Agency: National Institute of Geophysics, Geodesy and Geography. (NIGGG-BAS)

National Statistician Institute (NSI)

Executive Environment Agency (ExEA)

Researchers: Boian Koulov (NIGGG), Stoyan Nedkov (NIGGG), Miglena Zhianski (NIGGG), Mariana Nikolova (NIGGG), Bilyana Borisova (NIGGG), Stelian Dimitrov (NIGGG), Ivailo Rangelov (NSI), Radoslav Stanchev (ExEA), Genoveva Popova (ExEA), Doichin Delichev (ExEA)

1. **Which NCA studies in Bulgaria?**

Finished (in terms of the work package in the project):

Extent and Condition: Pilot test of ecosystem extent and condition accounts; Improve the usefulness of existing data source and extending the source data available, including geo-referenced data.

Capacity building and developing a community of practice organizing workshops, conferences or seminars with national stakeholders dealing with specific aspects of ecosystem accounting and potential users;

Enlarge the knowledges of statisticians about ecosystems and ecosystems accounting.

Considering the initial stages of work, the review of the data sources will include physical asset accounts, but not monetary ones.

More information in Petrov P., Tsonev S., Rangelov I., Yaneva L. (2019). Pilot test of ecosystem extent and condition account in physical unit. National Statistical Institute of Bulgaria.

Marine ecosystem extent: Results from EEA grants 2009-2014 BG03. The Marine Ecosystem was divided into subtypes according EUNIS classification (level 2)

Partially finished and partially on-going:

1. Physical flow and Asset Accounts: Forest account

Export & transformation of zem. files (Forest Management Plans) for every State Forest and Hunting Enterprise located in Regional Forest Directorates. Calculation of the area of the forest ecosystems aggregated by type. Align and present the data according to the table structure for opening and closing stock of forest and woodland land.

2. Specific Ecosystem Service Supply and Use Accounts: Cultural ecosystem services supply and use account (local)

3. SEEA EEA Thematic Accounts:

- Carbon account (for forest areas);
- Biodiversity account;
- Water account (modelling water regulation services);
- Urban account.

Future project:

Calculation of the net changes in Ecosystem extent for the period from 1990 to 2018 on different levels:

- NATURA 2000 sites and Protected Areas (PAs)
- Biogeographical level
- National Economic Area
- District and Municipality Area
- Agricultural land and land use

2. Which method(s) used?

Ecosystem extent and condition accounts: In developing ecosystem extent, we have strictly followed the typological approach which divides different ecosystem assets into ecosystem types – classes that can occur at more geographical locations (i.e., temperate broadleaf and mixed forests). They conducted an ecosystem extent accounting including stock and change of area for 10 ecosystem types at national level, based on Corine Land Cover (CLC) for the period 1990 – 2018.

The two methods used are elaborated below:
1. CLC Datasets and Population Grid 1 km2. (For ecosystem calculations the 44 land cover classes are aggregated into 10 types of ecosystems, according to MAES typology.)
Procedure
Our approach, based on Corine Land Cover data, includes aggregation and splitting of the Corine Land Cover polygons into the standard 1x1km2 population grid.
As a result, the obtained information about the area of every Grid cell is distributed by land cover classes. The sum of the distributed area equals to 1 km2. This way the attributive table of the grid is stored into Excel file.

2. ArcMAP GIS software
Procedure:

1. Crop CLC2018 and CLC 1990 datasets in frame of terrestrial land, including Bulgarian borders without the marine area (CLC is only for terrestrial data) and terrestrial parts outside borders.
2. Link MAES classification and CLC codes from both datasets.
3. Generate final GIS layer merging data from datasets (CLC 2018 and CLC 1990) with MAES ecosystem types
4. Compare polygons with changes in the CLC classes and select those with changes in Ecosystem types.
5. Generate a layer with the changed Ecosystem types.
6. Re-calculate each polygon in km2 using GIS tool „Calculate geometry".
7. Export dataset in MS Excel.
8. Pivot procedure in MS Excel, SUM all polygons for each ecosystem type that has changed in the 1990 – 2018 period.

Forest account: Main focus: change of area: calculation on additions, due to afforestation & natural expansion & reductions, due to deforestation & natural regression.

1. **What key datasets used or developed?**

Ecosystem extent and condition accounts: Corine Land Cover (CLC), a Copernicus Land Monitoring Service; BANSIK Bulgarian Survey of the Agricultural and Economic Conjuncture; Natura 2000 maps; MAES maps; Bulgarian Geodesy, Cartography and Cadastre Agency maps; Institute of soil science, agro-technologies and plant protection "Nikola Pushkarov" (ISSAPP) maps;GEOSTAT 1km2 population grid.

Forest account: Cartographic sources of LC & Copernicus monitoring services, mainly official CLC data (ExEA), ExFA – Forest Cadastral Units (Forest Divisions & Subdivisions) from Forest Management Plans, others: LULUCF – ExEA, State Cadaster Results.

Biodiversity accounts: list of parameters for biodiversity thematic accounts: Species richness; Abundance and occurrence; Number of individuals, pairs, etc.; Distribution at national level, bio-geographical regions and within the National Ecological Network NATURA2000; Assessment of the state or changes in the conservation status of species and habitats.

Data availability: Red Book of Bulgaria (2015); Red list of threatened species; Reports of Bulgaria under the Habitats Directive; Wild Flora and Fauna; Birds Directive; National Biodiversity database from monitoring activities.

2. **With who?**

Integrated Team of experts:

- Bulgarian Academy of Sciences (BAS),
- Sofia University (SU),

- National statistical institute (NSI),
- Executive Environment Agency (ExEA)

3. **What gaps?**

No information about the reasons for the changes during the individual periods of time, respectively the parameters of the SEEA-EEA accounting tables, "Managed expansion", "Natural expansion", "Upward reappraisals" to the parameter "Addition to extent", respectively "Managed regression", "Natural regression" and "Downward reappraisals" to the parameter "Reduction in extent" remain unfilled.

Forest data Data is available in 10-year time frames, while forest management planning - in 5-year frames.

4. **What do you need or miss?**

Implementation of statistical methods or models for primary data processing, concerning species and habitats/ecosystems and other aggregated data.

Participation in one or more case-study on calculation biodiversity accounts.

Additional meteorological data which will be base for developing of models and scenarios for better understanding and assessment of species distribution and status.

<u>About SEEA-EEA revision:</u>

The proposed IUCN Red List of Ecosystems (RLE) typology has not been used yet.

Which are important parameters to consider (soil, climate, water regime, species and habitats) - no information on abiotic characteristics?

The proposed IUCN Red List of Ecosystems (RLE) in last draft version of SEEA-EEA is based on ecosystem assembly theory and focuses on ecosystem function. In addition, levels 1 and 2 are on a strictly ecological basis (i.e. organization in biomes) – not applicable at the moment. There is no crosswalk table with other relevant national classifications (mainly MAES) linking with biome (Level 1) and ecosystem functional group (Level 2) – still missing

For SEEA-EEA purposes, additional socio-economical organization is appropriate as it helps to build the links and to integrate with other statistics. Ownership and land use are the first ones, which must be considered for distinguishing of economic units.

Annex 3. Czech Republic

Agency: Czech academy of sciences
Researchers: Ioanna Grammatikopoulou

1. **What Natural Capital Accounting (NCA) are you doing?**

Pilot accounts were compiled with special focus on ecosystem extent and condition accounts, and monetary asset accounts.

1. Extent accounts: The extent account at the national level based on the Consolidated Layer of Ecosystems of the Czech Republic (CLES), which has been made by CzechGlobe together with Nature Conservation Agency of the Czech Republic in 2012. For detecting extent change, Corine Land Cover was used. In the case of biodiversity, they have a portal in Arcgis online with information about natural mapping.
https://aopkcr.maps.arcgis.com/home/gallery.html?mapid=MapoMat4&view=grid&sortOrder=desc&sortField=modified

2. Condition accounts: Condition accounts were constructed based on the Mean Species Abundance (MSA) which was used as indicator that reflects the divergence from the original natural state

3. Ecosystem services: They are working in carbon regulation, water potential retention, and recreation service. Additionally, they have a project in integrated Life for Natura 2000 areas.

3.1 Carbon sequestration
Physical metrics: At this stage carbon sequestration is compiled based on a look-up table approach, which assigns quantities of ES flows to land cover units (Remme et al, 2014).
Monetary metrics: We applied the avoided damage approach using the social cost of carbon (SCC) as in Remme et al., (2015). The SCC is calculated based on damage costs of climate change. The SCC is based on the estimated economic damages of a marginal increase in CO2 emissions, usually measured in metric tons per year.
We aim also to collect primary data of C seq. for ecosystem type categories in extent account. If this will not be feasible then we will extent the look up tables with more updated literature references and LULUCF inventories. This could be complemented by nation-wide modelling (e.g. using carbon-related models).

3.2 Water retention
Physical metrics: Volume of direct runoff is affected by volume and intensity of precipitation, vegetation parameters (canopy storage, surface retention…), soil hydraulic properties and slope topography. Direct runoff computation method which considers these variables and is easily

applicable is empirically derived SCS Curve number method. In this method direct runoff is computed according to curve numbers representing potential retention which are derived from lookup table matching land cover types and soils classified into four hydrological groups (from A to D according to infiltration speed rate) and corrected by slope steepness. The difference between setting with actual ecosystem occurrence and potential artificial surface effect gives us the ecosystems effect on runoff regulation.

Next, we aim for the following:

1. Compilation of all possible data sources for soil hydrologic groups derivation (national as well as globally available data)
2. Creating maps of curve numbers matching hydrologic soil groups and particular Corine land cover layers and correcting by digital terrain model
3. Definition of places potentially benefiting from ES (urban classes from CLC placed in active 100yr flooding zones)
4. Calculation of potential direct runoff regulation from precipitation with 100yr probability of recurrence.

3.3 Water filtration

Physical metrics: It is still under consideration.

Monetary metrics: We will employ the same approach as in Horlings, et al., 2020. Similarly, as in Remme et al. (2015), they value water filtration by the replacement cost approach (the difference in production costs of drinking water from groundwater relative to surface water).

We aim to acquire time series data of physical metrics from the Czech Statistical Office and Ministry of Agriculture. Data on the price of water, water supply (production of drinking water from groundwater surface water) and water production costs will be provided by water suppliers, the Czech Statistical Office and Ministry of Agriculture.

3.4 Nature based recreation account

We will use two complementary approaches to assess the different way that people interact with nature – nature recreation (short distance and quite regular visits to nature) and nature motivated tourism (tourism revenues related to tourism motivated by nature). It will be based on approaches developed in previously published studies, one implemented in the Netherlands (Remme et al. 2015, Horlings et al. 2020); and second developed by the Joint Research Centre for an EU wide application (Vallencillo et al. 2018, 2019).

For Nature motivated Tourism Account (NTA) - methods and data: Using estimates of economic spending (GDP) in the tourism sector in the country and survey information, NTA combines the below

data to estimate what is the resource rent that occurred because of visits that were motivated by nature. This value is then proportionately distributed to ecosystem types according to official survey of the office of national statistics about public engagement with nature in the region. The account was constructed following as closely as possible approach by Remme et al. (2015).

- ➔ Ecosystem Extent accounts;
- ➔ Estimates for tourism revenues: data on annual spend and portion of trips that were business-oriented;
- ➔ Market surveys focused on tourism in the country: reasons for visiting in the region (nature, family, shopping etc.);
- ➔ SNA data: Input-Table providing costs structure for the tourism sector to calculate resource rent for tourism (Remme et al. 2015);
- ➔ Spatial distribution of nature trips in the country that would enable proportionate distribution of estimated resource rent to individual ecosystem types.

For Nature Recreation Account (NRA) - methods and data: This approach (for details please see Vallencillo et al. 2018, 2019) is based on two steps. First focuses on the biophysical modelling of outdoor recreation. It employs advanced look up table that combines multiple layers of spatial information and assigns to individual spatial units a score concerning its potential for nature based recreation and leisure. It combines two aspects of outdoor recreation – capacity of ecosystem to provide outdoor recreation opportunities and accessibility for recreation (proximity to human settlements and roads). Second step focuses determining the actual use (probability) of recreation in nature and estimating its monetary value. This step uses a mobility function and a zonal travel cost method which first estimates number of probable visits to ecosystems that could provide recreation services, given spatial distribution of population, and then derives demand curve associated with these visits provides the benefits of this ecosystem service. It is possible to value the service by both welfare value and exchange value approaches which is what we plant to experiment with.
The team members implemented the two approaches in another case study, in UK, and hence the focus now will be to adapt the approaches to the Czech context

2. Which method(s) used?

They are developing an ecosystem accounts based on the United Nations System of Environmental-Economic Accounting (SEEA).

1. Extent account: Regarding ecosystem extent accounting, in cooperation with the Czech Statistical Office, we tested the methodology of European Environment Agency on Land and Ecosystem Accounting and applied this approach using Corine Land Cover data. This approach enables to classify extent changes and detect major trends in ecosystem change. Based on this input, Czech Statistical Office compared extent of agricultural land from different data sources (e.g.

cadastre, CZSO, CLC etc.).

2. Condition account: Concerning to biodiversity and protected areas, they are a biodiversity monitor the status of species of European importance (EVD) and habitat types (TPS) into the Habitat Directive reported trying to join this monitory with SEEA-EEA framework. The monitored phenomenon of European importance includes a total of 60 habitat types (Annex I of the Habitats Directive) and 174 species (Annexes II, IV of the Habitats Directive). Every year, monitoring is carried out at nearly four thousand monitored sites by approximately four hundred monitors delivering data, the number of which is tens of thousands per year.

3. Ecosystem services: Monetary asset accounts were investigated by applying the value transfer method to estimate the value of future flow of ecosystem services from ecosystem assets. https://oneecosystem.pensoft.net/article/25508/.

Into the WP4 of MAIA, they are going to develop a method based on social networks and recommendation analysis of clicks in online photographs to recreation service.

3. **What key datasets used or developed?**

1. Extent account: The CLES utilizes Habitat Mapping Layer (made initially to identify the Natura 2000 sites), Corine Land Cover (2006), Urban Atlas, ZABAGED geographic data, and other specific data for water bodies (DIBAVOD).

2. Condition account: Condition accounts were constructed based on the Mean Species Abundance (MSA).

3. Ecosystem services: They have developed EKOSERV database for unit value transfer at the national level. The EKOSERV database has been updated using the systematic review protocol we tested to collect relevant data for ecosystem service valuation at the national level.

4. **With who?**

Developers
* Czech academy of sciences
Users
* Czech Statistical Office
* Ministry of the Environment
* Ministry of Agriculture
* Nature Conservation Agency.

5. **What gaps?**

The key gaps are the lack of data usefulness per ecosystem for the extent account. They need a more update ratio of CLES dataset.

Concerning SEEA framework, in some points, has a lack of clear guidelines to implement.

The political demand does not exist in the Czech Republic; the principal source of funding is European initiatives as EEA grants and H2020 funds. So, it will be challenging to continue with the implementation of an ecosystem accounting after the MAIA project unless there is a political will increase.

6. **What do you need or miss?**

We need to improve the technical capacity of the team per physical part beyond training courses, technical seminars, more specific ways to implement the methodology.

7. **What can Maia team do?**

We want more systematic communication between MAIA partners to share information, experiences, and lessons learn. We want training courses, webinars, or seminars for the partners most advanced, for we will able to improve our technical and other useful skills.

Annex 4. Finland

Agencies: Finnish Environment Institution (SYKE)

Researchers: Oinonen Soile, Pohjola Johanna, Salminen Jani, Viikki Latokartanonkaari

FOR FINISHED STUDY

Information in the database about:

* Improving data quality, applicability and transparency of national water accounts - A case study for Finland

* An order of magnitude: How a detailed, real-data-based return flow analysis identified large discrepancies in modeled water consumption volumes for Finland

1. What problems did you face?

Data availability is generally a problem but could be sufficiently overcome. We used several data sources and developed methodology to assess the reliability of the data. We think that the availability of public company-level data has improved significantly over the course of the past 10 years. This is because companies are committed to sustainability reporting (GRI). Even though feasible, the data collection was very labour intensive.

Some problems are linked to contradictory or non-feasible guidelines. For instance, the concept of so called “green water footprint” or “soil water consumption” are, in our view, very theoretical. They may be applicable to regions/countries, where urban or human-generated environment (fields) dominate. However, in countries like Finland, semi-natural forested areas are dominant, and also large natural protection areas exist. Also the idea of used fresh water returned to the sea being calculated as water consumption is very problematic for countries with large coastal settlements. This concept mixes place-based (spatial) data with the concept of accounting, which is very problematic. We will not go into details here but refer to the discussion sections or our papers.

2. How did you resolved them?

By doing hard work. Some issues that we found conceptually problematic or “non-viable” we didn’t carry out and present reasoning why in our papers.

FOR ON-GOING STUDY

The planned pilot accounts cited in the National workshop report:

• Pilot marine ecosystem extent and condition account

• Pilot forest ecosystem extent, condition and ecosystem services supply account

For now the pilot accounts are in one line in the database. It is possible to make 2 different lines in order to be more specific.

1) What NCA are you doing ?

Assessing water use sustainability by comparing regional water use and water asset accounts

What NCA are you doing ? What kind of accounts? Extent, ES supply and use

Where are you doing the NCA? City-scale, regional scale and river basin district scale (thus, in 3 scales)

2) Which method(s) used?

SEEA-water, SEEA-EEA

3) What key datasets used or developed?

Data types used :, Statistical data, Data on natural resources (surface and ground water bodies), National water accounting data, Regional economic data.

How are these data used in NCA?

They are used to downscale the national-level water accounts to generate regional water accounts, and to compile regional water asset accounts. The two are compared to assess the sustainability of regional water use.

Data types developed:

The units of the data develop Physical.

About the planned NCA you do:

Water emission accounts' link to condition accounts (surface waters)

Annex 5. France

Agencies: AgroParisTech

Researchers: Harold Levrel and Adrien Comte

In the database, French records:

* Project VALMER: 2015

* Study part of MAIA project: 2012, NCA focus

* Book Nature and the wealth of Nations, 2015: 3 chapters on accounting : 1 from Vanoli, 1 from Devaux (application of Vanoli conceptual framework of unpaid ecological costs) 1 from Weber

ABOUT VALMER project

Mix approaches: Not NCA focus as 1 study out of 6 has done accounting.

Golf du Morbihan = evaluation + accountings (production accounts).

See with Nicola Beaumont and Jean-Christophe Martin for more information on case studies or with Remi Mongruel for a global vision.

Scale: local as it is with local applications

What problems did you face?

For the study in the Golf du Morbihan, the problems faced was linked to the lack of data in the ocean and the homogeneity with terrestrial data.

ABOUT THE ON-GOING NCA

1) What NCA are you doing?

“Ecosystem accounting in support of the transition to sustainable societies –

the case for a parsimonious and inclusive measurement of ecosystem condition”

On-going NCA focus studies – part of MAIA WP4.

Planned to end in 2021

Focus on condition accounting (following the working paper)

Focus on Extent, condition, monetary, assets and unpaid ecological cost account, and biodiversity (following the online survey record)

Costal and marine ecosystems at National scale.

2) Which method(s) used?

Based on the SEEA EEA, development of a condition account method in process. Development of economc accounts of unpaid ecological costs in process

3) What key datasets used or developed?

Data types used: GIS data, Remote sensing data, Statistical data, Expert opinion/Survey, Field Data, Literature, Other

Data types developed: Physical or monetary? Yes

Did you used National database? where it comes from?

International database?

Water framework directive, Marine strategy framework directive and Habitats Directive.

How this data is used in NCA? For now we are at the methodology development so

Biophysical evaluation: extent spatial units' development based on several biophysical types of data (end at the end of 2020)

Economical valuation: data from the Marine strategy framework directive (sygle est DCSMM (?)

For now we are at the methodology development so the implementation process is not defined.

4) With who?

Who lead this? AgroParisTech

Which partners? MTES - French Ministry for an Ecological and Social transition AFB - French Biodiversity Agency

Who finance the work?mEU H2020 (MAIA project)

FOR ON-GOING STUDY

1. What gaps?

What are key data gaps, key bottlenecks and how can they be filled?

For now, no gap or problem faced. We felt the need to work in some concepts of the SEEA-EEA related to maintenance costs.

2. What do you need or miss?

Too early to know

3. What Maia team can do?

No need for now.

Other point discussed:

* It is possible that there is other NCA or accounting study in France that we don’t know about but it would more certainly be local one. Jean-Christophe Martin could have more information about other projects.

* Adrien: the viewer developed in MAIA is interesting to change maps in accounts and to be used as communication tool.

Annex 6. Germany

Agencies: Leibniz Institute of Ecological Urban and Regional Development - k.grunewald@ioer.de

Researcher: Karsten Grunewald

Which NCA studies in Germany?

Finished (in terms of the work package in the project):

- Ecosystem extend accounts – national scale. actual paper: in current submission in OneEcosystem and German paper accepted

To complete the information of this study, agreement to send the German accepted paper and the scientific paper soon submitted.

Agreement to present this study in 1-2 pages for the D3.2 of MAIA.

Partially finished and partially on-going:

- Pilot study – end in March 2019

Soil fertility / agricultural use; green urban areas; biodiversity

Indicators of ES developed partially and also ongoing. In discussion of implementation.

(MAES not implemented yet)

On-going:

- Marine accounts by BfN- no more information – no need for help

Future project:

- Starting summer 2020: NCA-DE to be more detailed (discussion of roadmap during the NCA-DE meeting the 3rd of March).

Related: Project with Russia on NCA (TEEB Russia)

About the Ecosystem extent accounts

1. **Which method(s) used?**

SEEA-EEA: Extend accountings by LULC assessment and LULC change assessment

2. **What key datasets used or developed?**

Data types used: GIS data, Remote sensing data, Statistical data, Expert opinion/Survey, Field Data, Literature

The units of the data develop: Physical

3. **With who?**

Bundesamt für Naturschutz (Federal Agency for Nature Conservation) with resources from the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

+ experts (project advisory board), German Statistical Office (Destatis)

4. **What gaps?**

For the extend accounts, the problems faced were related to the data source. It was needed to merge LULC of different regions of Germany with different degree of accuracy. The second problem has related to the low quality of the data for some green area.

In general the data source is the problem, not the approach developed.

The next step is to determine how to implement these results in the SNA of Germany.

5. **What do you need or miss?**

In general, the project and the approach used in Germany is good and there is no specific needs as there is international collaboration

6. **What Maia team can do?**

Nothing to be highlight for now.

Annex 7. Greece

Researchers: Konstantinos Kotsiras

ABOUT THE Finished studies

What studies have been done?

Although Natural Capital Accounting was not applicable so far in Greece, there are four (4) completed studies related to management plans, regarding river basins and forests. These studies are part of the datasets available for supporting comprehensive natural capital accounts in Greece.

ABOUT THE ON-GOING NCA

Forest Map is a continuous assessment of forest cadastre at National.

There is missing information in the database which will be completed.

Also we will add the information on a Biodiversity quantification with Ecosystem service assessment and NCA. It would concern floral and fauna biodiversity: It is a study at it early stage with the methodology definition.

When it is possible, the following questions would be answered for the Biodiversity study:

1) What NCA are you planning?

Biodiversity accounts – on-going project

2) With who and which data?

Hellenic Cadastre / Ministry of Environment and Energy

3) What do you need or miss?

The need identifies would be for technical support about methodology(ies) to follow in order to be homogeneous with other EU countries.

Need of basic understanding of what is done for biodiversity assessment and accounting. In order to exchange, workshops could be interesting.

3.1 Data gaps and needs

Data are available in respective agencies for internal use. Efforts are ongoing to acquire more concrete databases. Timeseries are scarce and problematic.

3.2 Methodological constraints and bottlenecks

A coherent methodological approach is needed for implementing NCA, which is currently missing, creating misconceptions and misunderstandings, especially in Greece, where, accounting is not existing so far.

3.3 Capacity building needs

Although SEEA-EEA accounting procedures are to be followed, there is a need for clarification of terms and technical support on valuation and modelling.

3.4 Progress made addressing data gaps and methodological development of MAIA to date

Data gaps are to be addressed through stakeholder engagement, made possible by the National Workshops and personal contacts.

3.5 Way forward on capacity building, collaboration and excange of experiences in MAIA in the remainder of the project.

It is apparent to increase engagement between project's partners. Especially when it comes to experience and knowlegde transfer, in an effort to create a united response to accounting problems.

Ecosystem accounting in Greece and especially for natural ecosystems is currently in its infancy. Only few studies try to assess ecosystems, most of them under the perspective of the potential for recreation supply (e.g. for coastal areas and mountainous sites, including rivers, as touristic destinations) or by assessing one major resource e.g. drinking and irrigation water supply. More data are available for forests productivity and their outputs, but this is limited to the areas where timber production occurs. Adequate data for ecosystem accounting is available for agricultural ecosystems (cultivations), but only for the monetary value of their products. Accounting for biodiversity and other regulating and maintenance services, as well as their cultural value (especially at traditional cultivated land) are unknown. One useful tool approved by the State for its use for woodland and forest areas in Greece is the “Methodology for estimating the value of forest land in Greece” (Albanis et al. 2015). The proposed methodology for forest area valuation will be (i) used for forest ecosystems accounting in Peloponnese and (b) the basis for developing valuation models for all types of terrestrial ecosystems and in detail for the proposed case-studies (i.e. mountainous areas, wetland and a major river) as well as for their attributes (e.g. biodiversity, water quality and quantity).

Biodiversity accounting will be based on the information provided by (a) the Flora of Greece Web project, (b) fauna databases available for the Peloponnese, (c) habitats Directive database, (d) water framework directive dataset, (e) soil data and (f) climatic data. A literature review will be held to assess the current state of the Art in the field. The above-mentioned data will be combined to initially assess the condition of biodiversity (at all levels from ecosystem type- to species- level) and thus provide a concrete indicator to be used for the accounting. This will result a biodiversity-based accounting, following the EU MAES framework, which places biodiversity at the centroid of the natural environment attributes. Subsequently, a typology will be created and proposed linking biodiversity attributes to ecosystems. Cumulative accounting will be based on the MAES ecosystem types classification (Maes et al. 2013), at MAES level 3.

Annex 8. The Netherlands

Agency: Statistics Netherlands

Researcher: Linda de Jongh

1. What Natural Capital Accounting (NCA) are you doing?

The Netherlands are working at the national, regional and thematic level. At national level they have developed accounts for extent, condition, physical ecosystem services, monetary ecosystem services valuation, monetary ecosystem assets, and a first approach to join ecosystem services assets with statistic national accounting for 2013. Nowadays, they are working in the update of these accounts for 2018. These accounts are also available on a regional, i.e. provincial level. Before the development of the account on the national level, accounts for the province of Limburg were developed and published. Regarding the thematic accounts, they have developed a carbon account and a marine account for the North Sea, the latter mentioned include works in extent and condition accounts.

National level: The webpage reference is:

https://www.cbs.nl/en-gb/society/nature-and-environment/natural-capital

1. **Extent accounts:** The extent account shows information on the extent in terms of area of different ecosystem types and can be seen as a starting point of the natural capital accounts. Challenge is to cope with changing data source formats throughout time, for example from a line to a surface. Data sources used are topographical maps, Cadastre maps, geographical registries, geographical land use data. Definitions of certain type of ecosystems could be debatable. This is one of the topics currently taken up in the SEEA EEA revision process.

2. Condition accounts: The condition account shows the quality of an ecosystem asset and its potential to supply ecosystem services. Challenge with the condition account is to find recurring data sources to update these accounts on a regular basis. Data availability and consistency with ecosystem types chosen is difficult in addition. Data sources used are among other the Living Planet Index, Atlas Natural Capital, National Institute for Public Health and the Environment (RIVM) and EU Water Framework Directive.

Physical supply and use tables for ecosystem services Ecosystem services accounts show the supply of ecosystem services by nature and the use by economic branches. There are many ecosystem services to measure. The physical ecosystem services that are compiled are: crop and fodder production, drinking water production, wood production, biomass from non-agricultural sources, erosion prevention, protection against heavy rainfall, pollination, pest control, carbon sequestration in biomass, air filtration, nature related tourism and recreation. Data sources are national and provincial statistics, geographical registries, look-up tables from scientific research. Data availability and reliability, and the relevance for the Netherlands are factors when deciding on which services to focus. The detail and resolution differ a lot per ecosystem service model.

Monetary ecosystem accounts: Ecosystem services accounts in monetary terms show the supply and use of ecosystem services in monetary terms. The monetary asset account shows the monetary value of ecosystem assets to society. The ecosystem services that are compiled are: crop and fodder production, timber production, water filtration, pollination, carbon

sequestration in biomass, air filtration, nature related tourism and recreation and amenity services. To increase the reliability of figures on ecosystem services in monetary terms, it is important to choose a valuation method that is suitable for the service. This might be different per ecosystem service. Many different data sources are used in compiling the monetary assets and supply and use of ecosystem services. Mainly SNA production and income accounts, Agriculture Accounts, Tourism Satellite Account, Authority for Consumers and Markets, statistical publications of VEWIN (water), IPCC, Netherlands Enterprise Agency and scientific research. Important is a careful way of phrasing and showing the results since interpretation can be difficult. A distinction should be made in that the contribution of ecosystems to economic activities is measured and not the value of nature.

Regional level: The study of province of Limburg its disponible in:

Nocbs.nl/nl-nl/publicatie/2016/09/maatwerk-rapport-natuurlijk-kapitaalrekeningen

1. Extent accounts: They used the same map developed from national level. Ecosystem Unit (EU_NL) Map.

2. Condition accounts: They propose three sets of condition indicators based on Technical Recommendations for SEEA EEA.

3. Ecosystem services: The ecosystem services measures are: Crops, Fodder, Meat, Ground water, Capture of PM10, Carbon sequestration, Recreating (cycling), Nature tourism.

Carbon accounts: Webpage of the study:

https://www.cbs.nl/en-gb/background/2017/45/the-seea-eea-carbon-account-for-the-netherlands

The carbon account shows the stock and flows of all types of carbon, namely biocarbon, geocarbon, carbon in the atmosphere and carbon in the economy. Data sources used are SNA Energy Accounts, Material Flow Accounts, Air Emissions Accounts, Water Emission Accounts and the National Emission Inventory, Waste Accounts, and scientific research. The results of the carbon stock are affected by how deep into the ground is taken into account.

Biodiversity account: The biodiversity account comprises ecosystems and species. The genetic diversity aspect of biodiversity is left out due to lack of quality data. Many national figures can be derived, but this account is difficult to make spatially explicit with the currently available data sources. These data sources are mainly Living Planet Index, Red List indicators and occupancy modeling of distribution maps of several species.

North Sea accounts Webpage of the study:

https://www.cbs.nl/en-gb/background/2019/51/natural-capital-accounts-for-the-dutch-north-sea-2019

The initial focus of the ecosystem accounts in the Netherlands was on terrestrial ecosystems. To explore the potential of ecosystem accounting on coastal and marine ecosystems, the extension to the North sea has been made. Data sources used are different reports and statistical information.

2. Which method(s) used?

National level:

1. Extent accounts: Strategic combination of several maps and datasets covering the

Netherlands. Maps were combined following a strict hierarchical approach. Once a unit is assigned, it can no longer be changed. The resolution of this map is 10 meters and cover all country with thirty-one thematic categories. They have a thematic crosswalk with the United Nations System of Environmental-Economic Accounting (SEEA) and Mapping and Assessment of Ecosystems and their Services (MAES) initiative.

2. Condition accounts: In line with the SEEA-EEA, the condition account was compiled by ecosystem type. Each ecosystem type has distinct characteristics that should be considered in assessing its condition. In accounting tables, the data are presented for different themes (e.g. soil, vegetation) and for different ecosystem types (urban areas, agricultural land, surface water, heath lands etc.). For each ecosystem type, multiple indicators were used. These indicators may be relevant across different ecosystem types, or only for one or two specific ecosystem types.

3. Ecosystem services: Related to the ecosystem services and monetary valuation of them, we published a document with the valuation of ten ecosystem services in physical and monetary terms. The monetary translation method for bibliographic sources. They followed a top-down approach to the national level from the local level. Furthermore, they have developed a method to integrate this monetary valuation with Statistical National Accounting information.

Regional level:

1. Extent accounts: This presents a major refinement compared to the previous study carried out for Limburg, because ecosystem services can be linked to a more detailed and more accurate map.

2. Condition accounts: Physical state indicators: These indicators concern the recording of relatively fixed characteristics of ecosystem assets such as measures of soil type, slope, altitude, climate and rainfall. These are important inputs in the modelling of ecosystem services. Environmental state indicators: The second group reflects measures of impacts or pressures on the environmental state, for example, measures of pollution, emissions or waste. Accounting for these flows is described in the SEEA Central Framework although more spatial detail is required for ecosystem accounting purposes.

Ecosystem state indicators: These measures reflect for example, the degree of fragmentation, leaf area index, nutrient status of the ecosystem, biodiversity, the attractiveness of the landscape or the degree of ‘naturalness’ of vegetation.

3. Ecosystem services: Physical supply based on biophysical models for each ecosystem service.

Carbon accounts:

1. Use multiple approach for each type of carbon, in line with SEEA Central framework and LULUCF National Inventory Report.

2. Ecosystem services: stocks in biomass are in part considered as representing carbon in the

biosphere (e.g. forests, heaths and dune areas), and in part as representing carbon in the economy (non-perennial and perennial plants, grasslands) following SEEA-CF. To model carbon stocks in biomass, the same methodology was, however, followed for all categories of biomass.

North Sea accounts:

1. Extent accounts: Ecosystem map was based on a) water depth, b) degree of water count stratification and c) sediment type

2. Condition accounts: Indictors were based on data availability and alignment with the Marine Directive.

3. Ecosystem services: Ecosystem Service data Inventory categorised by types of biotic and abiotic ecosystem services on the Dutch Continental Shelf, data available at Rijkswaterstaat

3. What key datasets used or developed?

National level:

1. Extent accounts: The cadastral map, agricultural crops grown, address based business register, addresses of buildings, the basic topographical registry and land use statistics for the Netherlands.

2. Condition accounts: Based on field information per local area, national statistical information collected per different institutions and spatial information.

3. Ecosystem services: Statistical information for recreation services and advanced modelling for the other services.

Regional level: Datasets similar as for national level.

Carbon accounts: Datasets similar as for national level.

North Sea accounts:

1. Extent accounts: Maps for water depth and sediment type.

2. Condition accounts: A data inventory for the North Sea was done within Rijkswaterstaat and Statistics Netherlands, with the latter analysis focussing (especially) on economic data available at Statistics Netherlands. The Rijkswaterstaat data was obtained from an inventory of available data within the institute.

3. Ecosystem services: Ecosystem Service data Inventory of Rijkswaterstaat

4. With who?

Developers

- Statistics Netherlands
- Wageningen University

Users

- Province governments
- Water bodies agencies
- Agriculture organizations
- Ministry of agriculture
- Several research institutes
- National water agency

5. What gaps?

One of the principal challenges is to translate the information in biodiversity and ecosystem terms.

We try to include policymakers and other stakeholders in the accounting, and we need more detail per specific area, as marine ecosystems.

6. **What do you need or miss?**

We need support in marine ecosystems to develop national accounting of these ecosystems cuparable to terrestrial ecosystem accounting.

7. **What can Maia team do?**

Improve the network connections to share methods and knowledge between countries.

Annex 9. Norway

Agency: NINA

Researchers: David N. Barton

1. What Natural Capital Accounting (NCA) are you doing?

Norway are working in the three levels, national, regional and local.

Concerning to national level, they are developing an extent, condition, ecosystem services and biodiversity accounts.

1. Extent accounts: The Statistic Office are conducted a project to develop a land use and land use changes dataset at national level. These dataset appears in statistic form in the website of the Statistic office https://www.ssb.no/en/statbank/table/09594. The statistical information has an annual temporal scope since 2011, and a thematic scope of 19 general land covers and uses with 64 subcategories.

Additional comment based on Norw. Environment Agency (NEA) response to SEEA EEA Revision Chapters 3-4 (ecosystem units, extent) (April 2020):

- The new IUCN classification of ecosystems is seen as an improvement by NEA
- NINA has declined to test the IUCN ecosystem classification in Norway, because the current official nature classification system – Nature in Norway (NiN) – is not compatible and there are no resources available to carry out such a test at national level
- NiN does not have main ecosystems as a classification level. NEA will look further at the compatibility of the IUCN classification with the aims of mapping extent of main ecosystems in Norway. Transition zones between ecosystems (ecotones) is a challenge.
- Further, there is no official classification of main ecosystems in Norway compatible with the current Indicator Framework for Good Ecological Status (Fagsystemet). There is not full compatibility between classifications in Government White paper (Meld. St. 14), the Nature Index for Norway and the Indicator Framework for Good Ecological Status.

See testing of mapping of open lowland ecosystem extent for Norway here: Venter et al. 2020 https://brage.nina.no/nina-xmlui/handle/11250/2625601?locale-attribute=no

See how Norway defines Land Use, Land-Use Change and Forestry (LULUCF) for the purpose of carbon accounts here (section 2.2.4):

Norwegian Env. Agency(2020) Greenhouse Gas Emissions 1990-2018, National Inventory Report: M-1643 | https://unfccc.int/documents/215704

2. Condition accounts: The Statistic Office has ongoing a project about Natural resource wealth and ecosystem services as umbrella project to integrate several works to valuation the wealth

and services of the ecosystems, with emphasis on biodiversity, in interdisciplinary cooperation with other research institutes and government agencies.

https://www.ssb.no/en/forskning/energi-og-miljookonomi/baerekraftig-utvikling/natural-resource-wealth-and-ecosystem-services

We could more information about this project in relation with the condition of the ecosystems.

Extract from ESMERALDA-MAIA Survey:

There is a national indicator framework published for mapping and assessing good ecological status (Nybø et al. 2017), which has been tested at regional level on terrestrial and marine systems in Trøndelag, Finmark and Svalbard (Nybø et al. ; Jepsen et al. 2019).

Additional comment based on Norwey Environment Agency (NEA) response to SEEA EEA Revision Chapters 5 (ecological condition) (April 2020):

- SEEA EEA proposal has clear parallels to Norway indicator framework, especially for the indexing method, aggregation of indicators to indexes, reference levels and reference conditions (NINA Report 1672)
- Important differences between SEEA EEA condition accounts and the Norwegian system are:
  - Different classification of indicators and weighting into indices
  - SEEA EEA use each indicator for only one characteristic/classe, while in the Norwegian system an indicator can represent different characteristics/classes. This has implications for indicators representativity
  - SEEA EEA does not assess uncertainty in the data or indicators, while the Norwegian system does
  - The interpretation of spatial units is fixed in SEEA (e.g. raster), but flexible in Norway. SEEA EEA emphasises spatial representativeness, whereas the Norwwegian approach aims at representing the total trend in ecosystem condition. The need to move towards spatially representative mapping of ecosystem condition is acknowledged.

3. Ecosystem services: The valuation of ecosystem services in Norway are reported in Government document called Natural benefits – on the values of ecosystem services published in 2013. https://www.regjeringen.no/en/dokumenter/nou-2013-10/id734440/sec2

4. Biodiversity: Norway is pioneer in establishing an overall Nature Index based on expert assessments and scientific data. This Nature index overall objective is to measure whether Norway is succeeding in halting the loss of biodiversity, as we have pledged under several international agreements. The index has been calculate since 1990 and nowadays are being updated to 2020.

https://www.nina.no/english/Environmental-monitoring/The-Norwegian-Nature-Index

Concerning to regional and local level, the focus of MAIA in Oslo is at local level and the surrounding region of the city called Greater Oslo as regional level (https://www.ssb.no/en/forskning/energi-og-miljookonomi/baerekraftig-utvikling/experimental-urban-

ecosystems-accounting-urban-eea-improving-the-decision-support-relevance-for-municipal-planning-and-policy),

NINA hasconducted a terrestrial ecosystem condition accounting test in the region of Trøndelag (https://brage.nina.no/nina-mlui/bitstream/handle/11250/2599977/1672.pdf?sequence=4&isAllowed=y). In the case of urban ecosystems, they focus on extent, condition and ecosystem services. Meanwhile the test of the region of Trøndelag focus on extent and condition accounts.

1. Extent accounts: The Oslo and Greater Oslo project will apply land use data from Statistics Norway and will contribute to research on ecosystem services and biodiversity in the context of indicators for sustainable development, and close cooperation with municipal authorities in order to obtain updated knowledge on land use.

In with the Trøndelag test they used the local dataset: National Land Resource Map (AR5) and the generalise version AR50 focus on mountains, forests, wetlands and seminatural lands.

2. Condition accounts: Concerning to urban ecosystems they are developing the adaptation of Norway nature index to urban, because of this ecosystem is the only not cover for their index.

About Trøndelag test they use an index protocol based on a list of indicators, measure from national datasets.

3. Ecosystem services: In Urban ecosystem project they measure on physical and monetary terms the follow ecosystem services: Pollination, Water regulation, Erosion prevention, Regulation of local climate, Water and Soil purification, CO2 sequestration, Noise mitigation, Food and

Crafts production, Water quality, Recreation, mental and physical health, Landscape quality, Tourism, Education and cognitive development, Place identity and cultural heritage and

Endangered species habitat and Biodiversity. In the case of the recreation service, they are conducting experimental method based on the information on the mobile phones of citizens of Oslo.

2. Which method(s) used?

Norway does not follow the United Nations System of Environmental-Economic Accounting (SEEA). At the National level the principal methods are the follows :

1. Extent account: Develop of land use and land use changes dataset based on local information as natural inventories.

    1. There are also county-wise extent accounts for agricultural and forest land with national coverage compiled by NIBIO Arealbarometer.

    2. See how Norway defines Land Use, Land-Use Change and Forestry (LULUCF) for the purpose of carbon accounts here (section 2.2.4):

    3. Norwegian Env. Agency(2020) Greenhouse Gas Emissions 1990-2018, National Inventory Report: M-1643 | https://unfccc.int/documents/215704

4. See testing of mapping of open lowland ecosystem extent for Norway here: Venter et al. 2020 https://brage.nina.no/nina-xmlui/handle/11250/2625601?locale-attribute=no

2. Condition account: Application of index similar to the Trøndelag test in line with condition SEEA-EEA framework.

- There is a national indicator framework published for mapping and assessing good ecological status (Nybø et al. 2017),, which has been tested at regional level on terrestrial and marine systems in Trøndelag, Finmark and Svalbard (Nybø et al 2018. ; Jepsen et al. 2019).

3. Ecosystem services: ecosystem services methods, because of the Government document called Natural benefits – on the values of ecosystem services only talk about recommendations and it is not talk about methods or data.

- Norway does not map or build official accounts of ecosystem services.

4. Biodiversity: The Norway Nature Index provides a good indication of the state of biodiversity in the large ecosystems of mountains, forests, wetlands, open lowlands, freshwater, coastal waters and the sea. This index is based on large number of indicators makes it possible to present their own theme indices for selected species groups, ecosystems and influences.

- Norway has compiled the Norwegian Nature Index (NNI) in repeated biodiversity accounts - 1990-2000-2010-2014.

To regional and local projects, the principal methods are the following:

1. Extent account:

Property level urban: About urban ecosystem they use a Blue-Green Factor (BGF) mapping. This type of land use map is explained in:

(https://www.nina.no/Portals/NINA/Bilder%20og%20dokumenter/Prosjekter/Urban%20EEA/NINA%20Report%201445%20-%20BGF%20in%20QGIS.pdf)

City level: landcover is used to model ecosystem services, e.g. run-off control.

About extent account in Trøndelag test they use a National Land Resource Map (AR5), with information of farms or forestry. Additionally, they use AR50 map with uses the information of AR5 map and satellite imagens from tree boundary.

2. Condition account:

Urban: mapping of tree crown area and height used as a basis for modelling regulating services: Hanssen, F., D.N. Barton, M. Nowell, Z. Cimburova 2019. Mapping urban tree canopy cover using airborne laser scanning – applications to urban ecosystem accounting for Oslo. NINA Report 1677. Norwegian Institute for Nature Research.

In the Trøndelag test they calculate some indicators about primary production, biomass distribution, functional trophic levels, functional important species and biophysical structures, landscape ecological patterns, biologically diversity and abiotic forms hold. These indicators are summarised in a integrate index of condition. The indicators change between ecosystems.

Planned MAIA application of natural index method for create a condition of urban ecosystem based on species indicators.

3. Ecosystem services: The principal methods of economic valuation that they are considered Hedonic pricing, Marginal values from demand functions, Contingent valuation and Restoration cost, valuation of time. To innovative approach of recreation service, they going to use big data techniques to extract information on anonymous mobile data about their natural recreational activities.

3. What key datasets used or developed?

Norway does not follow the United Nations System of Environmental-Economic Accounting (SEEA). To National level the principal methods are the follows:

Naturbase is a clearing house for geospatial data on Norwegian nature. Artskart is a clearing house for georeferenced species observations. It contains e.g. mapping and valuation of recreation areas conducted by municipalities. Also, the Nature Index documents the status of biodiversity within 5 different regions within Norway. Trends from 1990-2015 are shown. The database will be updated for 2020 https://www.naturindeks.no/

1. Extent account: Develop of land use and land use changes dataset based on local information as natural inventories. See reference above

2. Condition account: They follows an official reporting on sustainable development indicators, including the nature index, in cooperation with environmental statistics, as well as valuation and management of the national natural resource wealth.

See reference above Nybø et al. 2017),

3. Ecosystem services: Not implemented in Norway, except for extractive sectors

4. Biodiversity: The indicators are based on monitoring data or assessments by experts. The following research institutes have contributed data or assessments to the Nature Index: The Institute of Marine Research, the Norwegian Forest and Landscape Institute, the Norwegian Institute for Nature Research, the Norwegian Institute of Water Research and the Norwegian Institute for Agricultural and Environmental Research. Many other experts from biological institutes have also provided input to the assessments.

To regional and local projects, the principal methods are the follow:

For extent-condition-services mapping in Oslo see Oslo Urban Nature Atlas:

1. Extent account: To Urban ecosystems they use a blue-green factor mapping based on high resolution Sentinel imagens (10 meters). In Trøndelag test they use an AR50 map that use AR5 information among other sources to create a map with a scale from 1:20.000 to

1: 100.000. The last version is from 2017. Time series maps for NDVI and tree cover.

2. Condition account: About condition of urban ecosystems, the indicators are based on monitoring fata or assessments by experts. For urban areas (Oslo) ecosystem condition indicators are easily confounded with extent indicators. See Urban Nature Atlas

3. Ecosystem services: Statistical data, climate information, mapping information etc. More information in Urban Nature Atlas and :

http://www.openness-project.eu/sites/default/files/NINA%20Report%201115%20%20-%20Valuing%20ES%20Oslo%20-%20Materials%20%26%20methods%20appendix%20-%20final_web.pdf

4. **With who?**

Developers

- Norwegian Environment Agency for the methodology. Some natural institution for the Nature Index method.
- NINA for local and regional approach
- Statistics Norway (SSB)national approach
- NIBIO (Norwegian Institute of Bioresearch – land use accounts)

Users

- Ministry of Climate and Environment of Norway
- Sabima (Umbrella organization for NGO)

5. **What gaps?**

The policy support is the principal gap at national level.

Nowadays, do not exist a mandate in Norway to create an official ecosystem account beyond the valuation of ecosystem services or the update of Nature index.

For local and regional initiatives, the principal gap is found in communication. It necessary improve the knowledge of the initiatives included the use, purposes and importance of ecosystem accounting.

6. **What do you need or miss?**

The political momentum of the ecosystem accounting should increase if we would like to improve the utilisation and support of these kind of initiatives. Seems as if the political support for ecosystem accounting has suffered a drop in the last years. Some movement increased interest most recently with revision of the SEEA EEA (promoted by MAIA).

7. **What can Maia team do?**

- Continue to facilitate feedback to SEEA EEA Revision from Norwegian agencies and ministries
- Promote better inter-agency coordination in Norway, by being a catalyst
- Continue to make Norwegian agencies aware of EU KIP-INCA experiences
- Promote best practice accounting examples – Norway looks to the UK often on NCA

Annex 10. Spain

Agency: URJC[1], CSIC[2], INE[3]

Researchers: Fernando Santos[1], Adrián García[1], Alejandro Caparrós[2], Pablo Campos[2], José L. Oviedo[2], Ana Luisa Solera Carnicero[3],

1. What Natural Capital Accounting (NCA) are you doing?

In Spain NCA is being developed at the national, while regional level results for Andalusia are already available. At the national level, they are designing an extent, condition, ecosystem services, and monetary valuation. They focus on sixteen categories based on MAES principal terrestrial ecosystems (urban, forest, grassland, shrubland, cropland, sparsely vegetation, wetlands, river & lakes, and marine inlets). In general, they are going to use official national sources of data complemented by European data sources and remote sensing. In Andalusia, past efforts (Campos et al. 2019a) analysed, using the "Agroforestry Accounting System" (AAS), four private activities (forestry, hunting, residential and private amenity) and six public activities (mushroom picking, carbon sequestration, water, recreation, landscape and threatened biodiversity). Current efforts for forests and open woodlands farms have allowed to detail the results for 12 private economic activities (timber, cork, firewood, industrial nuts, grazing (grass, acorn, browse, wild fruit), conservation forestry services, hunting recreation services, commercial recreation services, landowner residential services, livestock, agricultural crops and amenity service auto-consumption) and 7 public economic activities (fire services, public recreation services, mushrooms, carbon, landscape conservation services, threatened wild biodiversity preservation services and water supply stored in lowland watershed government reservoir). Current efforts within MAIA are also focused on further developing particular parts of the AAS methodology, e.g. the role of intermediate services (Campos et al., 2019b), and on linking this methodology with SEEA-EEA (Campos et al., 2020). 1. Core accounts: They are annual accounts for environmental taxes, environmental goods and services, environmental protection costs, environmental grants, waste, and water accounts at the same page to SEEA-CF, Eurostat and the European directives. The environmental goods and services are subdivided into atmospheric emissions, energy physic flows and material flows.

2. Extent accounts: In the context of the MAIA project, University of Madrid (URJC) is currently devolving a national level extent account following the SEEA-EEA framework. The spatial representation of Spanish ecosystems is based on the MAES (2013) EU ecosystem classification. To calculate the extend accounts for each ecosystem type, we used the official LULUCF dataset for Spain, developed by the Ministry of Ecological Transition and Demography Challenge of Spain. This multi-source dataset with digital information from 1970 to 2015 is the most complete and accurate (with a pixel resolution of 25m) that cover all national territory.

3. Condition accounts: They are developing a methodology based on indicators at the same page with SEEA-EEA framework and European initiatives per different types of ecosystems (urban, forest, shrubland, sparsely vegetation, grassland, cropland, and water categories). This development aims to create a reference level to condition account at a national level.

4. Ecosystem services: At national level, they measure in biophysical and monetary terms some ecosystem services based on the previous works as Ecosystem services Evaluation in Spain of Spanish Esmeralda H2020 works. The ecosystem services they are going to measure are carbon sequestration, crop production, livestock and timber production, freshwater supply, water

infiltration, soil fertility, carbon storage and nature recreation. They are going to use the suite of models InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs) to map and value the goods and services from nature that sustain and fulfil human life. For Andalusia, current efforts are exploiting the accounting data in the application described in Campos et al. (2019a) to provide in-depth analyses for various types of forests (Campos et al., 2019b). New efforts are also improving the accounting methodology in various aspects, e.g. intermediate ecosystem services, and are comparing the approach with the SEEA-EEA (Campos et al., 2020). In addition, the integration of biodiversity preferences in accounting efforts will be further developed through a new survey.

2. Which method(s) used?

1. Core accounts: They subdivided the accounts in two categories. Physical and monetary accounts. The physical accounts have difference units, for example emissions are in CO2 equivalent, material flows in tons, energy flows in Terajoules, while the monetary accounts are in euros. The accounts are based on imput-output account method, and they are segregated in economic activity sector as economic producers and households as consumers. The monetary accounts could be integrated with statistical national accounts (SNA).

2. Extent accounts: Related to the land accounts and flows at national level we created a Python script to automate the creation of land accounts tables and their flows from a time-series dataset, we calculated the total change for the period and the annual rate. For these land accounts, we measured the gross and net change, the swap between ecosystems, the stable stock, and a gains and losses statistical representative flows approach to distinguish between a systematic landscape transition and a seemingly random landscape.

3. Condition accounts: In line with the SEEA-EEA, at national level they are going to compile the indicators by ecosystem type. Each ecosystem type has distinct characteristics that should be considered in assessing its condition. For each ecosystem type, multiple indicators will be used. They are going to reference these indicators at temporal (ref.: 1970) and spatial (ref.: protected zones) reference to create an aggregation index of the condition by type of ecosystem, using machine learning approach.

4. Ecosystem services: At national level, the InVEST model will be used. InVEST models are spatially explicit, using maps as information sources and producing maps as outputs. InVEST returns results in either biophysical terms (e.g., tons of carbon sequestered) or economic terms (e.g., the net present value of that sequestered carbon). The spatial resolution of analyses is also flexible, allowing users to address questions at local, regional, or global scales. InVEST models are based on production functions that define how changes in an ecosystem's structure and function are likely to affect the flows and values of ecosystem services across a land- or a seascape. At regional level (Andalusía), the "Agroforestry Accounting System" (AAS) described in Caparrós et al. (2003) and Campos et al. (2019) is used, combined with the Simulated Exchange Value method described in Caparrós et al. (2003 and 2017).

3. What key datasets used or developed?

1. Core accounts: They have some sources to calculate the core accounts for physical accounts they use emissions, energy and material inventories. Monetary accounts they use an official statistical information aggregate a national level.

2. Extent accounts: They used the LULUCF dataset developed at the national level for the Ministry of Ecological Transition and Demographic Challenge with the main objective of monitoring and assessing ecosystem changes with a significant time series (1970-2015). This approach allows us achieving greater precision when classifying the different coverages, obtaining both a high spatial resolution (25 meters per pixel) and a high thematic definition. The LULUCF dataset developed for Spain has a multi-source approach to join European datasets as CORINE LAND COVER with local ecosystemic information as Spanish Forest Map and Geographic Information System of Agricultural Plots, to improve the quality of the result.

3. Condition accounts: The datasets they are going to use are based on field information as Spanish Forest Inventory, remote sensing as Landsat and Sentinel information, Copernicus products and Spanish and European statistics official information.

4. Ecosystem services: At national scale, they are going to use the same sources of information that condition accounts and the information related to the different projects conducted in Spain about ecosystem services. At regional scale, in-depth analysis developed within the MAIA project are based on the dataset for Andalusia described in Campos et al. (2019a).

4. With who?

Developers

- King Juan Carlos University
- Spanish National Research Council (CSIC)
- Statistical national office (core accounts)

Users

- Ministry of Ecological Transition and Demographic Challenge
- Statistical national office
- Universities
- Statistical regional offices
- Companies

5. What gaps?

The key gap is the lake of specific frameworks, which helps in the form of measurement of the different accounts in a replicable and scalable manner. These experimental accounts are a big challenge to manage data and novel methods.

About implement an ecosystem accounts into SNA need more political and legislative initiative to support the environmental accounting in EU countries.

6. What do you need or miss?

We miss a simple guide of applications of different accounts and lack shared methods from the different teams to progress in the different improvement areas.

7. What can Maia team do?

We want more systematic communication between MAIA partners to share information.