Final report on progress made with innovations in MAIA, and contributions to the implementation and development of a global standard for SEEA EEA

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EXECUTIVE SUMMARY

This deliverable reports the progress made within the MAIA project on ecosystem accounting innovations, detailing the implications for the implementation of the recent UN System of Environmental Economic Accounting – Ecosystem Accounting (SEEA-EA) standard for biophysical ecosystem accounts, and for the further development of recognized statistical principles for monetary ecosystem accounts into a future standard. Different methodologies are discussed conceptually an applied experimentally in Bulgaria, Germany, Greece, the Netherlands, Spain, France, Finland, and Norway.

Target Audience

The report targets both ecosystem accounting practitioners and the potential users of these accounts. For producers, it summarises the technical approaches tested by MAIA partners. For potential users, it illustrates the possibilities for generating key indicators and analyses that can help inform decision-making.

Research aim / questions

The research question addressed are (i) detailing the state of the art of accounting efforts related to water regulation services, (ii) exploring big data sources for quantifying cultural services (iii) valuing ecosystem services and ecosystem assets, (iv) biodiversity accounting and (v) marine ecosystem extent and condition accounts.

Methods

Different methods are applied. Among others, these include big data and artificial intelligence methods, systematic reviews of the literature, simulated exchange value methods, Bayesian networks, maintenance cost approaches and interviews.

Relevance of findings for mainstreaming NCA

The different innovations discussed below are all closely related to the research agenda outlined at the end of the recently published SEEA EA 2021. In each case we detailed below the part of this research agenda that is closely related.

Next steps and recommendations

The biophysical accounts of the SEEA-EA became a global standard during the duration of the MAIA project. Following this, an amendment to EU regulation No 691/2011 on European environmental economic accounts is expected to include ecosystem accounts as new modules. However, monetary ecosystem accounts were not adopted as statistical standard and are thus expected to be incorporated into EU regulation at a later stage. This implies that research efforts in this direction are particularly valuable, as the debate will probably focus on incorporating these monetary accounts into the standard in the foreseeable future. Furthermore, SEEA-EA 2021 has established a research agenda for the next years that is completely in line with the different issues discussed below.

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1 INTRODUCTION

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 –Ecosystem Accounting (SEEA-EA) as the conceptual and methodological basis for NCA (UN 2021). The SEEA EA 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 a satellite to the System of National Accounts, used by statistical agencies world-wide to produce economic accounts and other statistics. In MAIA, a flexible approach has been followed, allowing for adaptation of the SEEA EA framework to the conditions of the individual EU MS.

The SEEA-EA (UN 2021) became a global standard during the duration of the MAIA project. Furthermore, the SEEA-EA 2021 has established a research agenda for the next years that is completely in line with the different concepts and issues discussed below. However, the valuation chapters (8 to 11) of SEEA-EA 2021 were not adopted as a standard. Instead, they were adopted as internationally recognized statistical principles and recommendations for monetary ecosystem services and environmental asset valuation. This implies that research efforts in this direction are particularly valuable, as the debate will probably focus on monetary accounts in the foreseeable future, to make sure that at the next iteration the SEEA EA can become a statistical standard also for monetary accounts.

The next section is divided into five subsections, corresponding to the following research questions: (i) detailing the state of the art of accounting efforts related to water regulation services, (ii) exploring big data sources for quantifying cultural services (iii) valuing ecosystem services and ecosystem assets, (iv) biodiversity accounting and (v) marine accounts. The last section concludes.

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2 MAINSTREAMING NCA: A SELECTION OF FIVE TOPICS

2.1 Water regulation services

Water regulation is considered as one of the main regulating ecosystem services by SEEA-EA. It includes water retention, storm and high water protection (including flood control) and it is also closely related to erosion and sedimentation control, as well as water purification. Characterizing and assessing these ES is challenging for three main reasons: first, all of these ES can be regarded as both final and intermediate services (Boyd and Banzaf, 2007). Second, both assessment and accounts of water regulation services need various data which are usually not available through direct or indirect measurements, therefore modelling approaches of water regulation are much needed. These can provide data for different aspects of water cycles that cannot be extracted through direct measurements (Vigerstol and Aukema, 2011). Modelling water regulation is often data-intensive and also analytically complex and generally requires the use of hydrological models (UN, 2017).

MAIA aimed to provide an overview of efforts in modelling water regulation ES. With this aim in mind, a systematic review of the literature was undertaken. Furthermore, testing was done (in Czech Republic) on how the hydrological ecosystem service can be quantified for the purpose of accounting. This latter work is still ongoing. The results of the review are synthesised below.

Integrated modelling frameworks, such as InVEST, provide simple and low data-intensive tools that require less expertise in comparison to complex hydrologic models (Vigerstol and Aukema, 2011). Integrated modelling frameworks are the second most used group of models when considering all papers included in the systematic review, but its share decreases when considering only the accounting related papers. This is in contradiction with the current tendencies in the technological development in these tools towards more specific ES assessment and accounting applications. For instance, ARIES modelling platform allows for data and model integration to produce accounts (Capriolo et al., 2020), and provides a tool for natural capital accounting (Zhongming et al., 2021). The consideration of accounting applications being very recent, the time frame of our review may not have captured this new trend in scientific publications. Yet, the potential of these

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tools can be highlighted by the variety of ES (including water regulation services) that they cover, and their easy-to-use approach.

For accounting-related papers, the use of hydrologic models increased for flood prevention and mitigation studies. Other water-based models (category 4) were used predominantly for water quality studies, while GIS tools were applied only to water yield and water retention assessments. Water modelling approaches (category 6) were applied only to water quality and water yield studies.

In general, the predominant number of papers was related to physical accounting while monetary accounting was less studied. Most of the papers were related to one of the core accounts and only eight had a relation to both physical and monetary accounts. Five of them were from the group that had accounting among their purposes, which means that half of this group of papers had a relation to both biophysical and monetary accounts. ES supply accounts were mentioned in most papers (35 which are 66% of all papers accounting-related papers), while the other three core accounts of the biophysical accounting (extent, condition, and service use) were almost equally distributed among the reviewed papers (17-18 papers, 36-38%). The distribution of the studies in the monetary part was almost equal between the three components with service use representing the highest number. There were only two papers that dealt with all seven accounting components and few others covered between four and six components. Most papers (79%) covered between one and 3 components.

The SEEA EA research agenda refers several times specifically to the monetary valuation of water resources, in the context of the alignment with the SEEA Central Framework and with the SNA. Concerning the latter, one can read “A motivation in the conceptual design of the SEEA EA is the potential to compare and align estimates from the ecosystem accounts with measures of income and wealth from the SNA. As economic and environmental contexts change, all statistical standards are subject to reconsideration and hence to ensure the ongoing alignment between the SEEA EA and the SNA there are several emerging asset boundary issues that deserve ongoing and joint consideration among relevant experts. In several cases, these issues are emerging because of ongoing changes in institutional arrangements and markets structures in response to the effects of climate change and other environmental challenges. The issues include the treatment of stranded assets such as […] the valuation of water resources.” Given that our systematic review of the literature has shown that past analyses have focused mainly on

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the biophysical part, more effort is needed on monetary accounts to respond to the research agenda proposed by the SEEA EA.

2.2 Exploring big data sources for quantifying cultural services

Big data applications in ecosystem accounting include the use of remote sensing data for extent and condition accounts, as well as various social media platforms that can provide data on people's physical location, activities, and preferences. Big data from social media platforms provides an opportunity to produce new spatially explicit statistics on cultural ecosystem services (CES). The MAIA project sought to develop methods and techniques for using big data to produce reliable statistics on ecosystem services consistent with the requirements of SEEA EA. In one study, a novel conceptualisation of cultural ecosystem services in the context of big data and the SEEA EA was developed, following a review of existing conceptualisations and big data sources. Several models using this conceptualisation were developed in the Netherlands. In another study, new techniques using big data and artificial intelligence were developed for application in ES assessments. In the research, a model using computer vision was applied to millions of Flickr images to capture landscape aesthetics. When validated against crowdsourced survey data, Flickr was found to be a sufficiently accurate source of data on individuals' revealed preferences for aesthetic services at large spatial scales required for ecosystem accounting. Finally, based on this work, a new, experimental aesthetic ES model was developed which is currently being applied in selected EU countries. The work conducted for the project has found that comprehensive, timely, high-resolution, and scalable statistics for the SEEA EA can be achieved with the use of big data.

Defining CES for the purposes of spatial quantification has been challenging because it has been difficult to spatially model CES. Now, rapid increases in mobile network connectivity and the use of social media have generated huge amounts of crowdsourced (big) data which offer a new opportunity to define and spatially quantify CES.

In a collaborative effort between WUR and CBS, a CES definition and typology for the spatial quantification of CES was proposed based on an inventory of established CES conceptualisations and sources of crowdsourced data. This definition conceptualised CES as information-flows. A general typology of eight services was proposed which, for

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example, defined aesthetic services as those generated when ecosystems communicate a sensory configuration of beauty. This flow of information is registered and shared on sites such as Flickr, Instagram and Twitter. Different sources of big data from different social media platforms have different user populations, content and representativity of the population at large which need to be understood and corrected for the purpose of accounting (e.g., Venter et al. 2021).

To support the conceptualisation of CES, three spatial models employing big data to measure CES on Texel, a coastal island in the Netherlands were also developed which produced distributions consistent with known areas of cultural importance. Still, user representativeness and measurement uncertainties were found to affect the results. Ethical considerations must also be considered. Still, big data was found to be a valuable source of information to define and model CES due to the level of detail available. This can encourage the representation of CES in ES assessments using the SEEA EA framework (for details, see Havinga et al. 2020).

Big data by itself is difficult to interpret, mostly due to its volume and velocity. Capturing CES using big data therefore requires the development of methods which can process these large quantities of data. To respond to these challenges, the working group has turned to artificial intelligence, or ‘AI’, to develop the technical methods available to produce CES measures in line with the requirements of the SEEA EA.

One key way in which ecosystem generate cultural value is the aesthetic quality of the landscape during peoples’ recreation. However, the survey methods available restrict modelling at large scales. As a result, most studies rely on environmental indicator models, but these do not incorporate peoples’ actual use of the landscape. Now, social media has emerged as a rich new source of information to understand human-nature interactions.

Social media and AI-based models of aesthetic landscape quality were developed, and their accuracy were tested using a crowdsourced survey in Great Britain. This novel modelling approach was found to generate a high level of accuracy, independence of the scale of measurement and a direct measure of individuals’ aesthetic enjoyment, an important methodological feature in the context of ES modelling. The work supports significant advances in modelling the aesthetic contributions of ecosystems for ES assessments (for details, see Havinga et al., 2021).

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The concepts and techniques developed during the project are now being applied at large scales in on-going collaborative work for further publication in academic journals. The research effort introduces a complete aesthetic ES model which has been developed for application in EU countries. The model uses information extracted from social media images using AI as well as the associated textual information available. A final ecosystem service measure is produced using the number of images and their "scenicness" as a conceptual basis.

Pilot studies have now been conducted with the model at national level in the Netherlands, Spain and Great Britain. In Spain and the Netherlands, collaborative work between WUR, CBS and URJC is now focused on confirming the "scenicness" ratings produced by the AI model in these local contexts using study participant data. These checks are being carried out to prepare an application at EU-level (for details, see Havinga and Hein, 2020).

Considering the relationship with the SEEA EA research agenda, MAIA contributions are closely related to the data standards and availability section, where one can read "The compilation of ecosystem accounts will involve the collation and integration of a wide variety of data, many of which may be unfamiliar to statistical offices. As part of the implementation process, the development of shared data tools, frameworks to assess data quality, and expectations on quality would be a significant platform. Areas of focus in this work include: Principles and practices for the development of infrastructure for spatial data to support ecosystem accounting; determination of a minimum set (tier 1) of account ready data; principles and practices for accessing and sharing data including tools to support the interoperability of data and systems; bridge tables and cross-walks from SEEA EA reference classifications and lists for ecosystem types and ecosystem services to other related classifications, lists and typologies; development of spatial sampling methods and strategies; and articulation of data quality assessment frameworks, tools and process, especially concerning spatial data." The research efforts undertaken in the MAIA project, speak directly to these issues.

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2.3 Valuing ecosystem services and ecosystem assets

The valuation of ecosystem services and assets is yet not standardised in SEEA EA. Different methodologies for valuing ecosystem services and assets have been discussed conceptually an applied experimentally in Spain, France and Norway.

The use of simulated exchange values in ecosystem accounting has been discussed, illustrating the discussion with a regional application in Andalusia (Spain), a local application in Oslo (Norway) and an ongoing national application in Spain. The SEV is basically an extension of the approach proposed in §3.123 in the SNA of using prices from simulated markets where none presently exist. In a nutshell, the method simulates market values that one could obtain from a given ES if it were commodified, using the demand for the ES estimated using any method that simulates a monetary exchange situation for the ES (e.g., contingent valuation, choice experiments or travel cost method), including a credible supply function and the adequate market structure with acceptable allocation of use rights. The applications developed within the MAIA project show that the method can be applied at large scale (Campos et al., 2019a, 2021). Relationships to alternative approaches and a more solid foundation of the method have also been analysed and developed (Caparros, 2022, Caparros and Oviedo, 2022).

Intermediate product and own intermediate consumption in monetary ecosystem services, and the role of enhancement/degradation and different assumptions in asset accounts are also discussed, using a regional application to Andalusia (Spain) as an example (Campos et al., 2019b). The role of enhancement/degradations in asset accounts are analysed using the same application as an example (Campos et al., 2020). Relationships between the accounting methodology developed by CSIC's team and the SEEA EA can be found in Campos et al. (2020 and 2022).

Alternatives for the valuation of stormwater retention services for urban ecosystem accounts are also presented and applied. Physical ES and monetary accounts for changes in Oslo's built zone over the period 2015-2019 are computed. An institutional design simulating a stormwater retention fee is proposed, where the stormwater run-off fee level depends on the rights allocation assumption that properties are responsible for run-off from their property. The stormwater retention service and accounting tables are computed relative to different assumptions about reference level stormwater run-off .A combination of monetary valuation methods are used to simulate fees that would cover

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the full municipal costs of stormwater run-off: (i) collection and treatment costs of combined stormwater overflow (CSO), (ii) future costs of expanding CSO costs to meet run-off with climate change and (iii) water pollution costs of unmitigated CSOs.

In a further study from Oslo, MAIA explored tools for value generalization from a few study locations to a whole accounting area. Such value generalization is a general feature of ecosystem accounting where a sample of locations in an ecosystem is used to generate a wall-to-wall representation of ecosystem services generated from all asset locations in the accounting area. A Bayesian network model is used to generalize the value of regulating services from municipally managed trees to all tree canopy in Oslo (Norway). The Bayesian network is used to summarize the non-parametric correlation patterns between tree canopy extent-condition, regulating services as computed by iTree Eco for selected sites, and the monetary asset value per tree and per canopy unit area. These spatial correlations are used to extrapolate asset values to all municipal canopy cover. Bayesian networks are also used to assess the reliability of the value generalization from a limited sample to the whole 'ecosystem asset population'.

The use of restoration and maintenance cost approaches as an alternative indicator to SEEA EA recommendations for computing exchange values is discussed conceptually, and applied to marine ecosystems in France. Cost-based approaches aim to assess the costs required to protect ecosystems, but also the cost of in-kind restoration of the degradation of natural capital, to maintain a constant level of natural capital at a relevant scale. The goal has been to experiment with the implementation of ecosystem accounts on a national and regional scale, using the unpaid restoration costs method and the good ecological status defined by the Marine Strategy Framework Directive. The net present value of the projected difference between the restoration costs needed to bring ecosystem condition to good ecological status, and the current ecosystem maintenance costs, is defined as "ecological debt".

The developments discussed above are directly related to the "connections to complementary valuations of ecosystem services and ecosystem assets" section in the SEEA EA research agenda. In that section one can read: "The SEEA EA provides a clear valuation concept (i.e., exchange values) and a clear measurement boundary related to ecosystem services, that supports a consistent approach to the monetary valuation of ecosystem services and ecosystem assets for accounting purposes. The concept of exchange values is well-established in national accounting, but it has been less

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commonly applied in environmental valuation, where alternative economic valuation perspectives are used. Further discussion is appropriate, based on the concepts described in the SEEA EA and the complementary valuation measures described in chapter 12, to further refine and communicate the connections between exchange value-based estimates from the ecosystem accounts and other approaches to valuation of the environment. A particular focus should be on ensuring appropriate application and interpretation of different valuation concepts in different decision-making contexts. This work may consider complementary valuations such as the measurement of consumer surplus and changes in welfare; the assessment of ecosystem disservices and negative externalities; non-use values; wealth accounting based on shadow prices and restoration cost-based approaches to the measurement of ecosystem degradation." The work developed in the MAIA project is directly relevant for these issues.

2.4 Biodiversity accounting

This section provides a synthesis of the experiences and lessons learned in using national biodiversity monitoring data for ecosystem accounting by MAIA countries. It provides a contribution from the MAIA project to the body of research in implementing the System of Environmental Economic Accounting Ecosystem Accounts (SEEA EA) framework for mainstreaming biodiversity into decision-making.

The SEEA EA describes thematic accounting for biodiversity as one of four themes in Chapter 13. Integrating national biodiversity monitoring data in the SEEA EA via thematic 'Accounting for Biodiversity' can support more coherent environmental-economic policy responses to addressing biodiversity loss. However, there are limited real world applications that demonstrate this in practice. The research effort described in this sub-section has been produced to address this gap by providing a collated set of experiences from MAIA countries in the field of thematic accounting.

The aim is to answer the following research questions: (i) how can existing national biodiversity monitoring processes (e.g., Norwegian Nature Index) be adapted for informing Accounting for Biodiversity and Ecosystem Condition Accounting? , and (ii) what specific biodiversity data items could be included in SEEA EA accounts (including Species) for better guiding decisions on biodiversity?

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The conclusions have been compiled based on case studies contributed by different MAIA countries and associated interviews. This was supported with literature research on any associated ecosystem accounts that have been published and scientific publications. This rich set of experiences was used to answer the research questions outlined above. The country experiences summarised relate to: Bulgaria, Finland, France, Germany, Greece, The Netherlands, Norway and, Spain.

With respect to Using National Biodiversity Monitoring, the report highlights the following: (i) established processes for organizing monitoring data for reporting on the EU Nature Directives and National Biodiversity Indexes can support ecosystem accounting; (ii) National IUCN Red List type assessments can be used to compile thematic ‘Species Accounts’; (iii) species abundance and richness accounts developed from national biodiversity monitoring data can inform ecosystem condition and cultural services accounts; (iv) where spatial referencing for national biodiversity data is limited, information on species can be assigned to different broad ecosystem types based on habitat preferences; and (v) structured frameworks such as Elite Index (Finland) and IBECA index (Norway) can be adapted to inform SEEA EA Ecosystem Condition Typology.

With respect to which biodiversity data items can be included in ecosystem accounts guiding decisions on biodiversity, we highlight the following: (i) integrating red list assessment data can help inform a more integrated planning for achieving conservation objectives; (ii) compositional state indicators need to be included in Ecosystem Condition Accounts as other condition characteristics do not adequately reflect trends in species assemblages; (iii) extended analyses by France and Germany allow for a “biodiversity debt”, underinvestment, and budgetary investments to be determined, (iv) integration of thematic ‘Protected Area Accounts’ into SEEA EA will be helpful for decision-makers evaluating different land use and sustainable development options, (v) biodiversity trends presented in ecosystem accounts need reference thresholds so decision-makers realise what is in good or poor condition, and (vi) science based policy targets provide reference levels to track progress towards national biodiversity objectives, and allow to define the biodiversity debt.

As in the previous sections, the relationship between the efforts undertaken within the MAIA project and the research agenda outlined at the end of the SEEA EA is clear. In relation to biodiversity accounts, the SEEA EA research agenda states: “Section E of the

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SEEA EA provides an introduction to a range of complementary presentations, thematic accounts and indicators that demonstrate the potential to use ecosystem accounts data to support decision making. As part of a wider implementation program, the advancement of applications and indicators building on ecosystem accounting can be continued. Specific areas of focus include: The development of guidance for SEEA EEA-based thematic accounts for biodiversity, climate change, oceans and urban areas".

Despite the progress reported above, there is a need for further experimentation and development of extended applications of the SEEA EA for mainstreaming biodiversity into planning processes. In-depth discussion with a broad range of potential users of these accounting outputs should be prioritized to see how they can best be developed to meet their needs. Where links can be made to policy targets and thresholds indicative of good condition for biodiversity, this will be particularly useful for guiding decision-makers. Collectively, this can foster the potential of the SEEA EA to inform on developments that delivers better outcomes for biodiversity and people.

2.5 Marine accounts

The capacity of an ecosystem to provide services for humans depends on the area covered (i.e. extent) and its quality (i.e. condition). Extent can be linked to various properties of the ecosystem, such as range, type, function or features of the ecosystem. The condition relates to the quality of ecosystems. Determining the present condition requires defining a reference condition against which the present state is compared. Good Environmental Status (GES) of the EU's Marine Strategy Framework Directive can be used as an example of existing indicators for reference conditions. MAIA researchers have developed two different approaches to develop biophysical marine ecosystem accounts. The first has been applied in Finland and the second in France.

In Finland, the marine ecosystem extent was assessed using an extensive underwater inventory data, collected by the Finnish Inventory Program for the Underwater Marine Diversity (VELMU) with ca. 170,000 sites visited. Environmental gradients from the shallow, turbid, bays to open archipelago areas with high water clarity have been sampled. Approximately 200 species distribution models (SDMs) were developed for vascular plants, algae and invertebrates.

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By using SDMs, the geographical distribution (in km^2) of key species producing ecosystem services was assessed. The potential effects of human activities, such as costal construction, dredging, dumping, shipping lanes, anchoring areas, and artificial shorelines, were assessed based on expert estimates on the magnitude and intensity of pressures. The condition is reported for human activities which lead to direct habitat loss per grid cell. The loss of an area is based on the average extent (m^2) of the activity in question, estimated from aerial images. For instance, small jetties which are on average 20 m^2, were identified from 58 850 grids. In this case, habitats lost (under the jetties) totals to 1,77 km^2.

In France, the system of accounts contains three categories of information: functionality, heritage, and capacity of ecosystems to produce services. The condition of pelagic and benthic habitats is assessed using three sets of indicators: the ability of ecosystems to maintain their overall functionality under disturbance (functionality dimension), the conservation status of species and habitats (heritage dimension), and the capacity to sustainably provide goods and services (capacity dimension).

As in Finland, physical damage caused by human activities in France was assessed based on a map of cumulative physical pressures that impact the marine environment (e.g. dredging, concrete building of the coastline, trawling). The degree of sensitivity of habitats to the different physical pressures was assessed using matrices provided by the Natural History Museum of France. For eutrophication, in contrast, the good environmental status (GES) of coastal waters was assessed using thresholds for concentration of 6 indicators (nutrients, chlorophyll a, photic value, toxic algae, etc.). Spatially explicit values are then aggregated by marine sub-regions to assess the percentage of areas that reach GES.

The ultimate aim is to assess costs required for the maintenance and restoration of the ecosystem extent and condition by comparing current observed costs and required maintenance costs (for reaching the ecological reference levels). This will provide a measure of unpaid ecological costs (see section 2.3).

The Finnish and French case studies provided an insight on methods and possibilities of assessing ecosystem extents and condition. In both Finnish and French case studies, condition was assessed considering activities that lead to habitat loss or severe disturbance of the habitats and, among others, ecosystem services provisioning. The

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more indirect effects, such as eutrophication, were considered only in France. Both approaches have their pros and cons. The Finnish approach provides a spatially more detailed account, but it requires very extensive data. Also, no valuation was attempted. The French approach encompasses both benthic and pelagic habitats and is not so sensitive of obtaining species-level data.

In Finland, the next steps should include: (i) linking the species and habitats directly to ecosystem services (ES accounts) that these produce, (ii) estimating the decline in the ES production capacity, and (iii) using different valuation methods for assessing the value of the current ecosystems, and its degradation/improvement (monetary accounts). An attempt to include pelagic environments in the accounts is recommended. In France, the extent account was static, and no change in extents is possible. All ecosystem changes are captured by the condition accounts. An attempt to assess the extents of key habitat forming species would allow a more comprehensive view on ecosystem's capacity to provide services for humans.

As already discussed in the previous sub-section, "Section E of the SEEA EA provides an introduction to a range of complementary presentations, thematic accounts and indicators that demonstrate the potential to use ecosystem accounts data to support decision making", including for SEEA-based thematic accounts for oceans. Thus, the research efforts reported above are also in this case completely in line with the SEEA EA research agenda.

3 CONCLUSION

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 – Ecosystem Accounting (SEEA-EA) as the conceptual and methodological basis for NCA. In 2021 the SEEA-EA became a global standard for biophysical accounts. In fact, the members of the MAIA project have contributed actively to the process that culminated with the publication of this landmark document. Moreover, MAIA researchers have contributed to the work of the EU Task

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Force on Ecosystem Accounts, directly or through their national contact points, by providing feedback to several working group documents.

However, the part on valuation of SEEA-EA 2021 was not adopted as a standard. This implies that research efforts in this direction are particularly valuable, as the debate will probably focus on monetary accounts in the foreseeable future, to ensure that at the next iteration the SEEA EA can become a statistical standard also for monetary accounts. MAIA has contributed to further recommendations for monetary accounts in a separate report (NCAVES and MAIA, 2022), in collaboration with the UNSD NCAVES project.

The SEEA-EA 2021 has established a research agenda for the next years which is, as discussed above, completely in line with the different concepts and issues discussed in this report. The innovations presented here can be seen as a first step towards the implementation of this research agenda.

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