Increasing uptake of ecosystem service assessments: best practice check-lists for practitioners in Europe

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Abstract

Aiming at understanding the role of plural values in decision-making, the IPBES Values Assessment defined nature valuation broadly as including biophysical, economic and socio-cultural assessments, including ecosystem service assessment. IPBES reviews of scientific literature revealed a lack of documentation of uptake by stakeholders across method types. The EU project SELINA aims to contribute to increasing uptake of ES assessments at different governance levels. This paper reviews guidance in national and local applications by compiling study design recommendations for ES assessments from 111 guidance documents on ES assessments covering 12 European languages. Guidance documents are evaluated for seven diagnostic topics suggested to increase relevance and robustness of ES assessments: ecosystem condition variables; capacity-potential; supply-demand; spatial scaling and resolution capability; social and health benefit compatibility; economic valuation compatibility; and uncertainty assessment. The paper develops the guidance recommendations across these topics into a set of checklists for practitioners and contractors of ES assessments. We find synergies between these study design features and gaps in guidance in relation to the policy cycle. Checklists are aimed at projects self-assessing and improving their design and implementation to increase robustness of their ES assessment. From a knowledge supply perspective, this is expected to increase the likelihood of uptake of results by stakeholders. We end the paper with some cautions on limitations to uptake from different perspectives and the demand for and political uses of ES assessment knowledge.

Keywords

ecosystem condition, social benefits, health benefits, economic valuation, ecosystem accounting, spatial scale, spatial resolution, ecosystem capacity, ecosystem potential, uncertainty

Introduction

Mapping and assessment of ecosystem services includes biophysical, socio-cultural and economic techniques (Santos-Martin et al. 2018). With the aim of understanding the role of plural values in decision-making, the IPBES Values Assessment (VA) identified biophysical, monetary and socio-cultural value indicators as all types of valuations of nature (Termansen et al. 2023). The IPBES VA argued that understanding how methods to assess nature, including biophysical assessments, represent different kinds of broad and specific values and value indicators can help explain stakeholders use of different types of knowledge (Pascual et al. 2023).

Two IPBES VA reviews of the scientific literature independently revealed a lack of documentation of uptake in ecosystem service assessment publications across method types, including Ecosystem Service (ES) assessments (Barton et al. 2022, Termansen et al. 2022). Several recent reviews of scientific literature on the assessment of ecosystems and their services in the last decade have had similar findings (Laurans et al. 2013, Vardon et al. 2016, Saarikoski et al. 2018, Chan and Satterfield 2020, Mandle et al. 2020). 'Documented uptake' refers here to scientific publications reporting on the use of assessment outputs by stakeholders (Barton et al. 2022). Laurans et al. (2013) found that only 2% of economic ecosystem service valuation documented uptake. A decade later, reviews by IPBES Values Assessment show little improvement in the evidence of uptake in policy (Barton et al. 2022, Termansen et al. 2022).

The IPBES VA identified potential blindspots with regard to legitimacy, credibility, salience, timeliness, process documentation and study cost to explain the lack of uptake of assessments (Barton et al. 2022). In their synthesis of the IPBES VA findings, Pascual et al. (2023) recommend increasing relevance by clearly defining purpose and targetting assessment in relation to stages in the policy cycle. The policy cycle has evolved during the last decade to Mapping and Assessment of Ecosystems and their Services (MAES) increasingly being recognised as supporting EU policy frameworks, such as the Biodiversity Strategy and in specific regulation, such as environmental economic accounting and the proposed EU Nature Restoration Law.

The findings on uptake from the scientific literature reviews contrast somewhat with recent developments in EU policy. The EU Biodiversity Strategy for 2030 (European Commission 2020) calls for developing an EU-wide methodology to map, assess and achieve good condition of ecosystems, so they can deliver benefits to society through the provision of ecosystem services. Vallecillo et al. (2022) propose an EU-wide methodology for ecosystem condition, building on MAES and related integrated framework (Burkhard and Maes 2017). The MAES framework includes different methods of ES quantification using biophysical, monetary and social-cultural approaches. The first EU mapping and assessment of ecosystems and their services was published in 2020 (Joint Research Centre (European Commission) et al. 2020). Planning is underway for the second EU ecosystem assessment in 2026. MAES in Europe were initially carried out for the purpose of generally informing, raising awareness and agenda-setting amongst the public, in business and in government (Schröter et al. 2016). While more than a dozen national MAES projects have been carried out in recent years, one of the greatest challenges remaining is policy uptake, particularly due to the lack of evaluation of uncertainty (Vári et al. 2024).

In 2024, the European Parliament reached an agreement on the EU Nature Restoration Law (NRL) for a target of restoring 20% of the EU's land and sea by 2030 (European Parliament 2023). Some of the law's specific targets refer to indicators of ES (e.g. enhancing stock of organic carbon) and others to ecosystem condition variables (e.g. amount of deadwood in forests, no net loss of green space in urban ecosystems by 2030, with a total increase by 2040). If the NRL is approved, Member States will have to adopt targets in national restoration plans. The implementation of this law would require practitioners guiding EU Member States to undertake ES assessments that address no net loss and positive gain targets.

Standardisation of ecosystem accounting internationally (United Nations et al. 2021) is being implemented in the EU and Member States. Recent signs of uptake at the EU policy level include EUROSTAT's collaboration with national statistical offices on a proposal for the amendment of EU regulation 691/2011 on environmental economic accounts. The amendment covers ecosystem extent for all ecosystem types, a selection of condition variables and biophysical ES accounts to be estimated in selected ecosystem types. Standardisation is promoted through user-friendly tools and guides for national level implementation of ES models are being developed, such as the INCA Tool (Buchhorn et al. 2022). Despite standardisation, bottlenecks in implementation of ES assessment methods in accounting remain on the research agenda (United Nations et al. 2021). Ecosystem accounting standards for the purpose of national accounts, will not necessarily be relevant or robust for ES assessment at local government or project level.

Burkhard et al. (2018a) called for integrated ecosystem assessment linking biophysical assessment to human well-being within complex interlinked Social-Ecological Systems. Their integrated MAES framework proposed nine steps focused on spatially explicit ecosystem type, condition and services mapping that could be used 'to set-up related research and development initiatives and to guide involved scientists, decision-makers and practitioners' (op. cit.). The integrated MAES framework recognises that the demand for ES assessment is determined by a complex system, but Burkhard et al. (2018a) do not address the detail of what linking to SES entails. Socio-ecological systems (SES) include 'governance systems' and 'actors' acting within 'social, economic and political settings' (McGinnis and Ostrom 2014). Assessment of ecosystem services in social ecological systems, faces challenges to uptake as do methods for valuation of nature more broadly (Barton et al. 2022). The plural valuation approach of the IPBES VA can complement biophysical ES assessment in the MAES framework, by recognising biophysical metrics as one set of values and designing an assessment process that also recognises stakeholders' other plural values (Pascual et al. 2023, Termansen et al. 2023, Schaafsma et al. 2023, Jacobs et al. 2023).

This paper aims to strengthen the recent trend in increased uptake at the EU level and the MAES experiences in Member States. Based on a synthesis of guidance documents developed in different European countries, we develop design questions for ecosystem service assessment to increase uptake. The IPBES VA reviews of uptake of nature valuation (Barton et al. 2022, Termansen et al. 2022) did not address "grey" literature, such as guidance documents. This paper addresses this gap by reviewing best practice recommendations in guidance documents in different European languages, which were evaluated, based on selected diagnostic topics. Based on the review, we formulate our recommendations as a sets of checklist questions to support practitioners in carrying out a diagnostic of ES assessments. We classify the checklist questions in relation to their relevance for different steps of a policy cycle and compare them to the IPBES VA 5-step framework for plural valuation (Termansen et al. 2023). Moving forward, the SELINA project (https://project-selina.eu/) will test these checklists in demonstration projects in partner countries, with the aim of refining them into templates for terms of reference that can be used in future to commission and design ES assessment studies.

Identifying diagnostic topics to improve uptake of ES assessments

In this section, we describe how we develop the MAES framework and its integration with social-ecological systems and provide support for our choice of seven diagnostic topics. The diagnostic topics aim at increasing the likelihood of uptake by improving robustness and relevance of the knowledge supplied by practitioners. The diagnostic topics approach aims to strengthen both the biophysical assessment 'core' of the MAES approach, as well as its plural valuation characteristics, to better link to different dimensions of welfare in SES, as follows:

Strengthening biophysical ecosystem service assessment:

1. **Spatial resolution and scaling capability of assessments**. At the core of the MAES framework is mapping of extent, condition and ecosystem services at compatible scales and resolutions with available data (e.g. Andrew et al. (2015), Frank and Burkhard (2017), Martínez-López et al. (2019)). It involves determining the appropriate spatial scale and resolution at which ecosystem services should be assessed to ensure accuracy and relevance. In practical terms, high spatial resolution allows for more detailed and precise mapping of ecosystem services, which is essential for localised planning and management. Conversely, broader scaling capabilities ideally enable the integration of local data into larger frameworks, aiding in regional or national policy development and decision-making. In practice, the integration of locally-available data in large scale assessments is challenging. The challenge lies in balancing the need for detailed local data with the broader perspective required for large-scale environmental management.

2. **Ecosystem condition in ecosystem service assessment**. Ecosystem service assessments have the potential to be more relevant and robust by being sensitive to changes in both ecosystem extent and condition (e.g. Broszeit et al. (2017),Bruins et al. (2017), Kim et al. (2023)). This aspect of ecosystem service assessment emphasises the importance of evaluating the condition or health of ecosystems as a critical factor in understanding and quantifying the services they provide. Ecosystem condition refers to the quality and functionality of an ecosystem, which directly impacts its ability to deliver ES. Considering ecosystem condition in ES assessments provides a more holistic and accurate understanding of good ecological status as the capacity of ecosystems to deliver services.

3. **Identifying ecosystem service capacity, potential, supply-use and demand** is recommended to understand mismatches between supply and demand, assess sustainability of use and determine the lifetime of ecosystems as assets in accounting (e.g. Hein et al. (2016), Dworczyk and Burkhard (2021)). Hein et al. (2016) define capacity as "the ability of an ecosystem to generate a service under current ecosystem condition and uses, at the highest yield or use level that does not negatively affect the future supply of the same or other ecosystem services from that ecosystem". They define potential supply as 'the ecosystems' ability to generate services irrespective of demand for such services'. In implementation of indicators in ES assessment, these concepts are often equated with actual use and demand. Differentiating the concepts adds understanding of sustainable ecosystem management and policy-making. Better conceptual distinction and measurement will improve understanding and management of the mismatches between what ecosystems can sustainably offer (capacity and potential) and what is required or desired by human populations (current use and future demand). By identifying

these disparities, decision-makers can implement strategies to ensure sustainable usage, protect ecosystem condition and maintain the long-term viability of ecosystem services.

4. **Uncertainty assessment.** Documenting uncertainty in all steps of the ES assessment and communicating uncertainty contributes to the robustness and reliability of the study results and can increase uptake of ES findings in policy (Hou et al. (2013), Schulp et al. (2014), Hamel and Bryant (2017), Bryant et al. (2018), Lautenbach et al. (2019), Rounsevell et al. (2021)). Uncertainty in ES assessments can arise from various sources, including data limitations (e.g. gaps in data, variability in data quality), model uncertainties (e.g. assumptions, simplifications) and inherent variability in ecological systems. It can also stem from socio-economic factors, such as changing land-use patterns or economic fluctuations. Methods to document and address uncertainty include statistical analysis, scenario planning, sensitivity analysis and using a range of models or approaches to cross-verify results. Moreover, clearly communicating these uncertainties, both in scientific publications and in more accessible formats for policy-makers and the public, is key to ensuring that the findings of ecosystem service assessments are understood and used appropriately.

Strengthening plural valuation:

5. **Compatibility of biophysical ES assessment with economic valuation** has been a persistent challenge (Boyd et al. 2015) and is in focus in implementing ecosystem accounting (NCAVES and MAIA 2022). Economic valuation methods that are compatible with both ecosystem service and condition metrics are expected to be more valid and reliable in value transfer for multiple decision support applications (Johnston et al. 2021, Grammatikopoulou et al. 2023).

6. **Compatibility with social benefits and justice assessment** will make ES assessments more relevant for local communities and, by addressing justice issues such as unequal access to services, can facilitate more inclusive and legitimate assessment processes (e.g. Calderón-Argelich et al. (2021), Gould et al. (2020), Loos et al. (2023), Schaafsma et al. (2023)).

7. **Compatibility with health benefit assessment** further extends ES assessments' relevance for human welfare (e.g. Oosterbroek et al. (2016), Remme et al. (2021)). Demonstrating human health impacts of ecosystem degradation is also a strategy for mobilising wider policy support for values of nature (Pascual et al. 2023).

Methods and materials

In this section, we first describe the materials of the guidance document review and then describe the IPBES Values Assessment policy cycle and five steps of plural valuation used to further classify the diagnostic topic checklists.

Materials

After reviewing and collating guidance documents from across Europe, we expect to describe current best practices for ES assessment. Guidance documents can be reports resulting from research projects, official policy documents for national assessments, instruction manuals written for specific management programmes or for a range of other applications. Our review included some peer-reviewed papers offering guidance. One common factor for all these sources is that there is no common repository for these. Therefore, the review team collected documents by using expert knowledge on the latest state-of-the-art in using ES assessment for supporting European policy- and decision-making. Experts were from 50 project partners in the EU SELINA project in 27 Member States and Norway, Switzerland, the UK and Israel. During the document collection period, SELINA members could submit any document they considered a relevant guidance document and, based on scanning the document, mark it for relevance for each of the diagnostic topics. The following requirements were placed on whether a document was relevant for the review:

- The document should not be published before 2018, representing the last major review of guidance conducted by the EU ESMERALDA project;
- The document could be in any of the languages of EU Member States with SELINA partners;
- The document must address at least one of the diagnostic topics as described in Table 1 in the context of ES assessment.

A total of 122 documents were collected for review. These were written in either English, Bulgarian, Croatian, Danish, Dutch, Estonian, French, German, Hungarian, Norwegian, Polish or Swedish. Five of the documents were unavailable for download and six were not guidance documents, but peer-reviewed scientific publications, leaving 111 guidance documents to be distributed amongst the diagnostic topic groups for review. Each document could be marked as relevant for multiple topics, leading to a final number of reviewed documents per topic as shown in Table 1. For a full overview of all 111 documents included in the review, see Supplement S8 (Suppl. material 1).

Each diagnostic topic was assessed independently by groups of 5-7 co-authors with a range of ES assessment experiences and language skills. Each diagnostic topic group developed a survey in Google Forms for reviewing the documents. For each diagnostic topic, these surveys aimed to cover to what extent it was addressed in the guidance document, how it defined the topic and to what extent the guidance was specific to certain stages of the policy cycle.

All groups summarised their findings into a working paper (Immerzeel et al. 2023). Each review team for diagnostic topics reworked the recommendations in the working paper into one checklist of questions per diagnostic topic. The checklist questions were classified into one of the five plural valuation steps by each review team. Each recommendation checklist was collated to provide an overview of thematic coverage across the assessment steps and the relative knowledge gaps across steps. The review teams discussed potential knowledge gaps in the guidance documents from their perspectives as ES assessment practitioners. These knowledge gaps were then formulated as additional batteries of checklist questions. Each group formulated hypotheses about linkages and synergies amongst the seven diagnostic topics in ES assessment. Finally, limitations and potential for testing in real world use cases was discussed by each group. Narratives of each review team's approach can be found in Supplements S1-S7 (Suppl. material 1). Due to resource constraints, we did not carry out duplication reviews for consistency checks. Validation will be carried out through future testing of checklists by potential commissioners of ES assessments in demonstration projects.

Methods – policy cycle framework

We also assessed the extent to which EU guidance documents cover different 'political settings' defined here by stages in a *policy cycle* (IPBES 2022, Pascual et al. 2023). Steps of the policy cycle are defined as in Fig. 1:

1. aiding agenda setting and support of agreed goals;
2. providing technical assistance for policy formulation by, for example, agreeing on the alternatives under consideration or the design of economic incentives, such as payments for ecosystem services (PES);
3. supporting decisions for policy adoption and assessing cost-effectiveness of alternatives for policy action;
4. facilitating adjustments to implementation measures or budget allocations; and
5. helping undertake retrospective policy evaluation.

Review teams screened all the diagnostic topics according to the relative frequency by which guidance document recommendations could be associated with a particular policy cycle stage. In the results section, we report these relative frequencies by policy stages for each diagnostic topic. This coarse scanning of guidance documents provides a sketch of where the strength of guidance for ES assessment currently lies.

Methods - plural valuation framework

The review of guidance documents sorted recommendations into the seven 'diagnostic' topics. These were reformulated to a series of checklists for ES assessment practitioners and commissioners. The aim of checklists is to support a practitioner who has a preselection of methods under consideration and/or is designing their implementation. Before the final study design and data collection, the practitioner will want to do a check of whether the valuation process has the characteristics likely to increase uptake. During a study, practitioners may also wish to conduct an internal audit of their study process to check progress against planned study design. The use of checklists can also make it easier for external parties to question and, if necessary, facilitate the contesting of the study, thereby increasing legitimacy and potential for uptake (see Discussion section for example of such cases). In the case of a commissioner of an ecosystem service assessment, the checklist can serve as a guide to undertaking a "due diligence" evaluation of terms of reference for a study, before putting it out for tender.

Drawing from the IPBES Values Assessment, Termansen et al. (2023) recommend a 5-step valuation framework to embed plural values in decision-making (Fig. 2.

The seven diagnostic topics defined contribute to strengthening ES assessment in any of the five steps. We used the following definitions of the plural valuation steps to further classify the checklist questions:

1. **Invest in a legitimate process** to ensure that the providers of assessment information are explicitly defined and that there is transparency in the robustness of the assessment, particularly regarding representation and participation.
2. **Define the purpose with stakeholders** with certain societal goals and decision-making purposes.
3. **Establish the scope considering plural values**, identifying which metrics will be explored or addressed by the assessment. The IPBES VA emphasises the importance of addressing different value types, including different ecosystem service assessment metrics.
4. **Choose and apply methods** that realise, recognise and represent the full extent of value diversity held by stakeholders and entailed by the purpose of the assessment.
5. **Communicate results to provide information for decisions** with effective and transparent communication, that is also an honest reflection of the limitations and omissions of the assessment process, facilitating contestation.

Results of the guidance document review

In this section, we first present an overview of the coverage of how ES assessment guidance documents cover the policy cycle. Second, we present the checklist questions for each diagnostic topic derived from the guidance documents and classify them according to plural valuation steps.

Guidance coverage of the policy cycle

The policy cycle stages best covered by guidance are agenda setting, policy formulation and policy implementation. The least covered are policy evaluation and policy adoption. Supporting choice between options and evaluating those choices are forms of decision-support. Broadly speaking, ES assessment guidance literature is the least rich in offering ex ante support for choice between policy options and ex post evaluation of the outcomes of those options. This relative knowledge gap was also reflected by the IPBES VA review finding that a majority of nature valuation studies made only cursory reference to their relevance for decision-support (Barton et al. 2022), (Fig. 3).

Diagnostic checklists

The results of the grey literature review are presented as a series of checklists for practitioners covering the seven ES assessment diagnostic topics. The full-length checklists can be found in Supplementary Material S1-S7. In the next steps, the checklists will be tested and validated in real world ES applications within the EU SELINA project. Validation will entail involving researchers and stakeholders in each application case to determine whether the checklist questions identify assessment design features that are likely to increase uptake. The validation of these checklists is beyond the scope of this paper.

Fig. 4 visualises this two-dimensional classification – there is a variable number of questions per diagnostic topic, as derived from the guidance document review. The number of checklist questions per diagnostic topic presents the relative richness of recommendations in the guidance documents reviewed. Note that the relative number of checklist questions *is not* proportional to the number of guidance documents that were reviewed per topic (Table 1). For example, the smallest number of guidance questions was derived from the topic with the largest number of documents reviewed (capacity-potential[...]), whereas the topic with the smallest number of reviewed documents resulted in a comprehensive checklist (uncertainty documentation).

Some broad thematic patterns can be discerned from the classification according to the 5-steps of plural valuation. Spatial scaling and resolution guidance does not provide recommendations on the 'purpose' of assessments. This can perhaps be explained by spatial scale and resolution being general features that must be adapted to any ES assessment purpose. Guidance on the topics of 'ecosystem condition' and ES 'capacity-potential-supply-use-demand' did not cover recommendations for 'investing in a legitimate assessment process'. This supports the hypothesis that assessment guidance on biophysical methods of condition and ecosystem services is largely focused on scientific-technical study design issues, not addressing stakeholder benefits. All of the ES assessment outcomes, related to benefits (economic, social, health), have checklist recommendations on engaging stakeholders in the assessment process.

In the following, we provide a narrative summary of the checklist questions through the lens of the plural valuation steps. We comment on elements that are specific to ES assessment and contrast them with the recommendations on plural valuation from the IPBES VA, as summarised by Termansen et al. (2023).

Invest in a legitimate process with stakeholders. The review of ES guidance documents recommends a participatory approach that validates and grounds the classification and spatial representation of ecosystem services in the needs, perspectives, knowledge and values of people who rely on the ecosystem services. The process should make it possible for stakeholders to also contribute to the design of the assessment as it proceeds and to evaluate the predicted outcomes of ES assessment in the policy cycle after the study is completed. Facilitating a legitimate process requires adequate time and budgets. Despite these broadly useful points in line with plural valuation, our review showed that guidance, specific to designing an ES assessment process, is limited, especially for biophysical assessments. In comparison to IPBES VA recommendations, we can note that, adapting ES classification and representation to local stakeholder perceptions, is a recommendation that may be at odds with standardised ES classifications, such as CICES or ecosystem accounting at the national level (IPBES 2022). Furthermore, ES assessment guidance focuses on relevance to humans, whereas legitimacy in a plural valuation process also considers non-human individuals, groups and communities (Termansen et al. 2023).

Define the purpose with stakeholders. With the exception of checklists for ecological condition, the review of guidance documents provided limited advice in defining different purposes of ES assessment. Understanding context-specific policy and social needs is required to identify the data needed for assessing capacity, supply and demand. Specifying purpose can increase the cost-effectiveness of the ES assessment by calibrating data use to the minimum requirements for robustness for a specific purpose, while considering available resources. Through the policy cycle, the method and data infrastructure development, advocacy and awareness raising, policy design, decision-support, implementation and management and ex post policy impact evaluation all have different requirements for robustness that need to be understood before starting ES assessment. In the IPBES VA, understanding the purpose of the assessment goes beyond simple identification of where in the policy cycle the assessment finds itself. It should also include an understanding of which stakeholders are being addressed and their decision-making roles. Additionally, understanding is needed of the policy windows for ES assessment outcomes to be able to influence decisions and the constraints on decision-making procedures impacting nature (Termansen et al. 2023).

Establish the scope considering plural values. Existing guidance on ES assessment is limited in its interpretation of 'scope' to the considerations of spatial scaling and resolution. The spatial scale and extent of the ES assessment should align with the management or policy decision to be assessed and be defined explicitly before methods are chosen. Identification of the beneficiaries of each ecosystem service is key to identifying economic valuation methods (Newcomer-Johnson et al. 2016). The initial geographical scope or range of ecosystem services that can be assessed with available data and resources may be incomplete relative to expected impacts of policy. To address such limitations, economic valuation also considers the scope for value transfer from existing study sites. In the IPBES VA, the interpretation of scoping to also critically consider the different values held by the stakeholders affected is not predominant in assessment guidance on ecosystem condition and biophysical ecosystem service assessment. In plural valuation, the scoping stage also includes an inventory of stakeholders, including rights holders, that are affected by changes in nature and their instrumental, relational or intrinsic value types affected (Termansen et al. 2023). This promotes a more representative choice of assessment methods.

Choose and apply methods. ES assessment guidance is diverse in providing recommendations on methods. Method recommendations cutting across diagnostic topics include appropriate choice of spatial resolution of assessments to match both the spatial scale and the required spatial and temporal accuracy demanded by stakeholders for their decision-support purposes. This includes considering potential future changes and the spatiotemporal dynamics that need to be described by the assessment methods. With the notable exception of ecosystem accounting, common knowledge gaps include the lack of treatment of temporal variation in the ES assessments (e.g. Burkhard et al. (2014)) and the impacts of temporal mismatches between supply and demand and, ultimately, on sustainable use. Guidance documents emphasise the challenge of identifying causal pathways and integrated biophysical model compatibility between ecosystem structure, condition and services. The biophysical metrics used must match the methods for assessing actual use and demand. Doing this is recognised as challenging because interactions across economic, social and health benefits must be acknowledged and controlled. Integrating assessments across long causal chains from action to ES benefits and value outcomes potentially leads to error propagation (Barton et al. 2012, Barton et al. 2018). Uncertainty should be documented and reported. Checklist recommendations include using a modelling approach that evaluates policy targets directly associated with ecosystem condition.

The IPBES VA plural valuation recommendations emphasise making and documenting informed method choices, considering trade-offs between relevance, robustness and resource availability, taking into account the previous steps of legitimacy of the assessment process, its purpose and scope. Recent guidance on MAES (e.g. Grêt-Regamey et al. (2017), Burkhard et al. (2018b)) and Ecosystem Accounting (NCAVES and MAIA 2022, United Nations 2022) acknowledge such trade-offs through a tiered approach to method selection. Even with such 'tiered' guidance, there are risks that those in power to commission the studies, as well as practitioners' disciplinary and professional biases, may determine method selection. By undertaking 'due diligence' documentation of method selection, practitioners can mitigate the risks that the study will not necessarily realise, recognise or represent the full extent of value diversity entailed by the purpose as determined by a legitimate valuation process (Termansen et al. 2023).

Communicate results to provide information for decisions. Our review of ES assessment guidance also shows ample recommendations on both direct communication of results, as well as mechanisms for increasing uptake once the assessment is completed. Common recommendations refer to communicating outcomes in maps which clearly show the spatial resolution of ES indicators and resolution and variation of the input data. Standardising the communication of model assumptions and levels of uncertainty is also a general recommendation. Recommendations also include iterative assessment of ecosystem-based adaptive management, as opposed to simple before-after assessment. Meetings with stakeholders and options to make assessment corrections during the study should be considered. Input data can be validated with local communities. Assessments should plan for open consultation of ES assessment results with external audiences. Mechanisms should be in place to hear and record local stakeholders' feedback. Iterative improvement in ES assessment and adaptive planning should be considered. An iterative, stepwise approach to integrating study results into decision-making implies that integrated ES assessment runs through all the stages of a policy cycle. The IPBES VA recommends explicitly evaluating the factors limiting uptake in this process, honest reflection of the limitations and of any omissions in the assessment process. It also recommends that practitioners explicitly provide opportunities for contesting the conclusions reached by the stakeholder (Termansen et al. 2023).

Discussion

In this section, we address the relative blindspots uncovered in current ES guidance recommendations by using extended checklist questions. We discuss the potential interlinkages between assessment design features that can increase uptake. Finally, we discuss the policy demand side, for example, how ES knowledge may be taken up in different ways by a political process, independently of how practitioners may supply that knowledge.

An extended checklist for ES assessment

Each diagnostic topic review group also proposed a number of additional checklist questions to address relative gaps between diagnostic topics in checklist questions shown above in Fig. 4. The additional checklist questions were defined, based on the review groups' own experience as ES assessment practitioners. The extended checklists area visualised in Fig. 5 – the full text checklist questions can be found in Supplements S1-S7.

A notable characteristic of these extended checklists is the large number of questions added to evaluate social and health benefits, relative to the recommendations found in the ES guidance literature. The rationale for this is the relative lack between diagnostic topics of guidance, in particular for the health sector, on how to employ ES assessments. A lot of emphasis is placed on additional questions to achieve legitimate involvement of local communities and identifying purpose and scope that are compatible with justice dimensions and health outcomes. Notable also are the many additional checklist questions to address methods gaps in spatial scaling and resolution and understanding ecosystem service capacity-potential, supply-use-demand relationships. Guidance on ecological condition was considered mostly sufficient. Notably, no additional questions were added to uncertainty checklists – at the time of writing, this topic was the subject of a separate dedicated review of the scientific literature which had not concluded.

Given the vast variation in assessment contexts, it is not likely that all checklist questions are relevant for each application site. The extended checklists are designed as menus of potentially relevant features for practitioners to use in a 'self-audit', aimed at increasing likelihood of uptake. Practitioners and stakeholders collaborating in real world ES assessments can revise and consolidate them to fit their purposes. Checklists will be tested and validated in real world ES applications within the EU SELINA project, where stakeholders will be asked to assess whether the checklist questions identify assessment design features that are likely to increase uptake.

Potential synergies between study design features and increasing the likelihood of uptake

Diagnostic topic review teams also identified potential synergies between assessment design features (Fig. 6). Common to all diagnostic topic groups in the question checklists was the recommendation that spatial and temporal scale and resolution should be explicitly chosen to integrate across ecosystem condition, ecosystem services and economic, social and health benefit outcomes. A second common feature was that adequate definition of ecosystem condition is expected in conjunction to improve the robustness and relevance of ecosystem service and economic, social and health metrics. Specifying ecosystem condition is also expected to improve economic valuation, social justice and health outcome evaluation independently of whether ecosystem service modelling is conducted or not. Thirdly, economic, social and health benefits are mutually determined and should, resources permitting, be assessed together. Fourthly, all the above study design features require documentation of uncertainty individually and also in terms of their propagation across integrated ecosystem service assessments.

The limitation of checklists - intended purposes of ES assessment versus actual use for political interests. Defining the purpose of ES assessment can help the practitioner to choose robust methods with the available resources. However, this definition of purposes is from the 'supply' perspective of a knowledge provider. Checklists for assessment design only go as far as the knowledge supplied by the practitioner. Political actors' use of the knowledge may mean that actual uptake is determined by power and political expediency. To this end, Jacobs et al. (2023) outline political valuation typologies which can provide an understanding of why ES assessment is not taken up or may even be misused, relative to the purpose intended by the practitioner. We briefly paraphrase the Jacobs et al. (op. cit.) typology in terms of ES assessment and comment on its relevance for the diagnostic topics:

Affirmative ES assessment legitimately represents all stakeholders and recognises their plural values 'actively counterbalancing injustices built into history, place and social arrangements'. This use of ES assessment puts particular emphasis on assessment of social justice dimensions. The checklists in this paper assume this 'best possible' use case with mutual reinforcement of all the seven topics of ES assessment design.

Confirmative ES assessment still brings a diverse set of values to the table, but 'is often applied to justify decisions already taken and builds credibility and acceptance within broader actor groups'. While practitioners aim to identify biophysical services, economic values, health and social impacts, stakeholders wishing to confirm a status quo may not be favourable to documentation of uncertainty, since it can shed light on knowledge gaps which serve to justify inaction and the status quo power of some actors.

Moving away from the ideal contexts of ES assessment in academia, so called a *ppropriative ES assessment* sets up assessment processes to be 'participatory, representative and/or inclusive', but, in the end, a powerful minority uses these qualities to push for an outcome that advances their private benefits'. In such a setting, those commissioning an assessment may not want uncertainty documentation because it could cast the foregone conclusions of the study's sponsors into doubt.

Moving yet further from an academic ideal, a *repressive assessment* may covertly design an assessment process with potentially opposing actors to ‘thereby utilising their time, energy and buy-in otherwise available for opposition’. Overtly repressive assessment would even aim to ‘discredit or dismiss legitimate claims of opposing actors', as Jacobs et al. put it ‘with arguments such as ‘actor subjective perceptions’ versus ‘expert facts’.

In *discriminative ES assessment,* powerful actors carry out or commission an assessment ‘directly in their own interest and use this as a power lever to trump other actors’ interests and values’. Such an assessment would not use methods reflecting economic, social or health impacts of societal stakeholders that were not allied with actors in power.

The latter political uses could be expected to go undocumented in scientific literature and may seem unusual for practitioners in some European countries. However, Jacobs et al. (2023) typology offers a perspective on the risks of not investing in, or not being allowed to invest in, ‘legitimate assessment processes’ in the first step of an ES assessment.

Conclusions

Mapping and assessment of ecosystem services (MAES) is increasingly used in EU and Member State policy, such as the EU Biodiversity strategy to 2020 and 2030 and the proposed EU regulation on ecosystem accounting. Policy targets for nature positive restoration may also come into force through the proposed EU Nature Restoration Law, requiring assessment of ecosystem services. Recent scientific literature reviews on valuation of nature, including mapping and assessment of ecosystem services (MAES), have at the same time concluded that, during the last 20 years, there has been a lack of uptake of valuation results by stakeholders for use in decision-support. The reviews of scientific literature did not evaluate methodological guidance documents in the 'grey literature' and their recommendations for improving ES assessment. We therefore reviewed 111 guidance documents on ES assessment from across Europe. Based on the review, we collated guidance recommendations across seven diagnostic topics aimed at strengthening integrated MAES. We formulated recommendations into checklist questions for each diagnostic topic – the questions are available in method supplements S1-S7. Checklists are aimed at increasing the relevance, robustness and efficiency of knowledge supplied on ecosystem services at different levels from practitioners to policy-makers.

We classified checklist questions according to the policy cycle and the IPBES Values Assessment 5-step recommendations for plural valuation, aiming to strengthen the integration of ES assessment with welfare assessment from a social-ecological systems perspective. In relation to the policy cycle, we found that there is relatively little guidance available on supporting policy adoption and policy evaluation, pointing to possibilities for strengthening future methodological guidance work. We examined potential synergies between diagnostic topics. We concluded that assessing ecosystem condition is key to increasing robustness of not only ecosystem service models, but also economic valuation of ES benefits, social and health benefits. Our plural valuation screening also uncovered some knowledge gaps in current guidance. We therefore extended checklist questions to cover these gaps. Checklist questions available in method supplements will next be tested in collaboration with stakeholders in real world ES applications as part of the SELINA project. Finally, we recognise that our recommendations are limited to the ES knowledge 'supply side' – the likelihood of uptake may be limited by political agendas beyond the awareness and influence of ES assessment practitioners.

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Conflicts of interest

The authors have declared that no competing interests exist.
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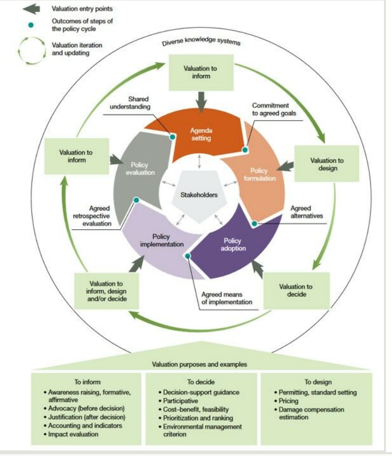

Figure 1.

Policy cycle and potential entry points for uptake of ES assessments. Source: Pascual et al. (2023).

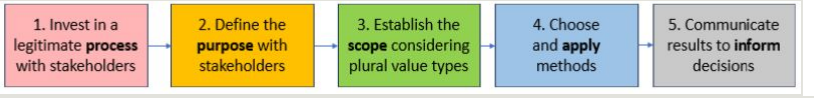

Figure 2.

General IPBES 5-step valuation framework to be applied to ES assessment. Source: based on Termansen et al. (2023).

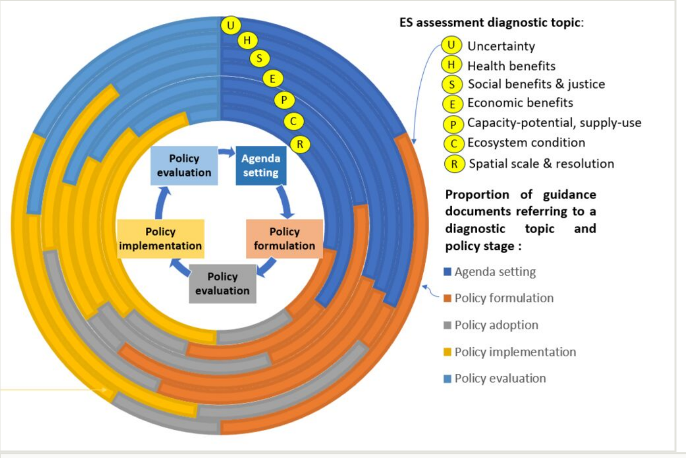

Figure 3.

Relative representation of policy cycle stages and diagnostic topics in the ES guidance documents reviewed. Note: based on the guidance review in Immerzeel et al. (2023).

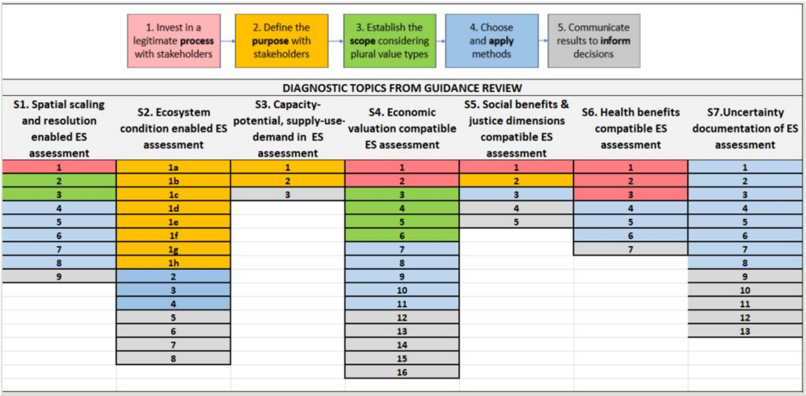

Figure 4.

Visualisation of checklist questions per diagnostic topic (columns) from the guidance document review, classified by plural valuation steps (colour coding). For the full checklist questions, please refer to Supplements S1-S7. Download supplement

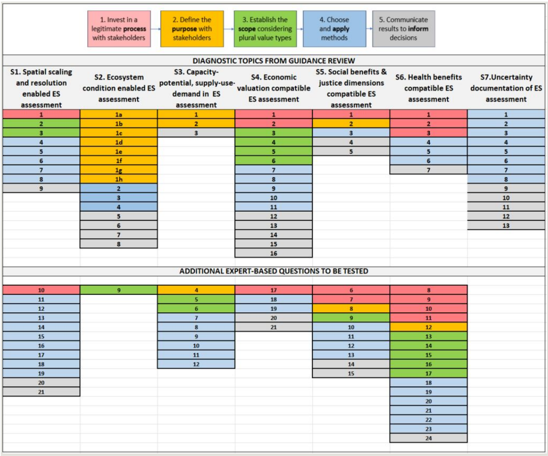

Figure 5.

Visualisation of additional checklist questions to cover knowledge gaps in the ES assessment guidance literature. Note: for full table of checklist questions, please refer to supplements S1-S7. Download supplement

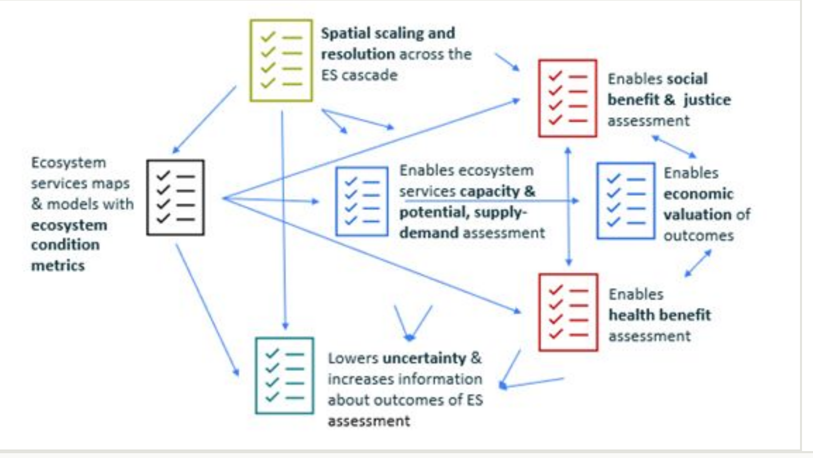

Figure 6.

Potential synergies between ES assessment features to be tested in real world case studies. Arrows in the diagram represent potential synergies identified by review teams.

Table 1.

Distribution of guidance documents for review across diagnostic topics.

Diagnostic topic	N umber of documents reviewed
Spatial scaling and resolution capabilities	74
Ecosystem condition variables in ES models	59
Capacity, potential and actual supply, use, demand	80
Economic valuation compatibility	56
Social benefit compatibility and dimensions of justice	48
Health benefit compatibility	44
Uncertainty assessment	21

Supplementary material

Suppl. material 1: *Increasing uptake of ecosystem service assessments: best practice check-lists for practitioners in Europe*

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Data type: Review summary tables and bibliography
Brief description: S1. Spatial scaling and resolution capabilities of ES assessments;
S2. Ecosystem condition variables in ES assessments;
S3. Capacity-potential, supply-demand in ES assessment;
S4. Economic valuation compatibility of ES assessments;
S5. Social benefit compatibility of and dimensions of justice in ES assessments;
S6. Health benefit compatibility of ES assessments;
S7. Uncertainty assessment;
S8. Full list of publications reviewed on ES assessment guidance;
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