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Research Article

Adequacy of ecosystem services assessment tools and approaches to current policy needs and gaps in the European Union Overseas entities

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Abstract

The paper presents the current policy needs and gaps identified in the European Union (EU) Outermost Regions and Overseas Countries and Territories to implement Mapping and Assessment of Ecosystem and their Services (MAES) methodology. Then, a selection of the most appropriate tools and methods for mapping and assessing ecosystem services (biophysical, economic, socio-cultural – and decision-support) is provided to address local needs. Using a performance matrix to assess the effectiveness, efficiency and sustainability of these tools, key factors required to facilitate the implementation of an ecosystem services framework are identified by considering local needs and possibilities in terms of data availability, mapping support, ecosystem services assessment and decision-support. Our results show how effective and accurate various methods (e.g. process-based models, integrated modelling and most Decision-Supporting Tools) can be, or how efficient other methods are (e.g. value transfer, spatial proxy methods and replacement cost) in data-scarce regions. Participatory approaches score well in terms of sustainability as they allow the assessment of multiple ecosystem services (covering the biophysical, economic and social-cultural components of the assessment) with local stakeholders' contribution, therefore contributing to the awareness-raising dimension. There is no one-size-fits-all approach. Instead, there is a need for flexible, guidance-based ecosystem services

mapping and assessment approaches in the EU Overseas entities to facilitate MAES implementation and to adapt and integrate those methods into scenario analysis and decision-supporting tools for better uptake of MAES outputs at the decision-making and policy levels in the EU Overseas entities.

Keywords

European Union Overseas entities; ecosystem services valuation tools; decision-support; policy needs; MOVE project

1. Introduction

The concept of 'natural capital' started to develop in the 1970s (Westman 1977) due to ecological concerns resulting from natural resources uses, degradation and loss. Nature's services could be more explicitly incorporated in economic decision-making if expressed in monetary terms. The term 'ecosystem services' (ES) was first used in 1981 (Ehrlich and Ehrlich 1981). The sustainable development debate overtook this novel approach in the 1980s, but ES came back in the 1990s, marked by the 1997 global assessment of the natural capital and ES (Costanza et al. 1997). Following this study, the Millennium Ecosystem Assessment launch in 2001 and the release of the synthesis report in 2005 (Millenium Ecosystem Assessment 2005) constituted another milestone that firmly placed the ES concept on the global scale policy agenda. The work of this group, initiated by the United Nations, made it possible to define a first "official" nomenclature of ES, taken up and subsequently refined by The Economics of Environment and Biodiversity (TEEB). This global initiative, commissioned in 2007, has delivered study reports (TEEB 2010) that have been highly influential in integrating environmental economics into decision-making (Chaudhary et al. 2015, De Groot et al. 2017). In 2010, the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) was established and committed to bridging the gap between science and policy, advising governments to halt further degradation. The IPBES provides a science-policy interface where scientific information is analysed and synthesised to provide information for decision-making and influence global conventions. ES were institutionalised in international policies, such as the CBD strategic plan 2011–2020, with the adoption of the Aichi targets, some of them being highly relevant to ES (Strategic Goal A - Targets 1 and 2; Strategic Goal D – Targets 14, 15 and 16). The efforts to achieve these targets in Europe coordinated by the MAES contributed much to greater awareness of nature's many benefits and gave them more weight in everyday decision-making. Later, the European Environment Agency revised the classification of ES with the Common International Classification of Ecosystem Services (CICES), first released in 2013 and thoroughly revised in 2018 (Haines-Young and Potschin 2018). According to their definitions, "final ecosystem services corresponds to the contributions that ecosystems make to human well-being. These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or artificial) that most directly affect the well-being of people" (Haines-Yong and Potschin 2012). The standardisation of ES allows for ecosystem accounting methods to be developed and comparisons to be made.

Despite a growing scientific literature on ES and key global achievements in integrating ES into international directives, much remains to be done to further embed the concept in everyday policy and practice. The concept is becoming broadly accepted. However, its multi-disciplinarity has often raised various concerns (ecological, economic, social and political), debates and criticisms. One of the major drawbacks is the anthropocentric focus of the ES concept, excluding nature's intrinsic values (McCauley 2006). Without appropriate context and acknowledgement of limitations, planning and conservation strategies, based solely on ES, could shift conservation efforts at the expense of biodiversity (Ridder 2008). The monetisation of ES might also encourage exploitative approaches (Brockington et al. 2008). Changes in the classification of ES and definitions, starting with MEA, then revised in TEEB, CICES and lately Nature's Contributions to People (NCPs), may also have added some confusion within the scientific and practitioners' communities. In a fragile science-policy interface, any doubt regarding the valuation's reliability or difficulty in delivering a shared vision is a constraint to convince policy-makers.

If agreed upon, policy-makers and practitioners have to make the best capital decision, manage risks, uncertainties and address people's needs, whilst social sciences have been under-represented in the ES valuation approaches (Daw et al. 2011, Lakerveld 2012, BSR 2013). However, there was no clear direction on integrating the ES concept into policy- and decision-making, nor was there a clear direction on how to make trade-offs and which ES is to be prioritised over others (BSR 2013). As a result, many efforts have been put to develop decision-supporting tools (DST) and bridge the science-policy gap. In 2013, Bagstad et al. (2013) published the first complete review of DST for ES assessment, followed by Grêt-Regamey et al. (2017), who reviewed 68 tools used for integrating ES into decision-making, illustrating the strong development of DST.

Major advances were made recently in the science-policy interface regarding integrating natural capital into policy-making in practice. For instance, the United Nations Statistical Commission (UNSC 2021) adopted, at its 52nd session in March 2021, the System of Environmental-Economic Accounting – Ecosystem Accounting (SEEA-EA), supported by the use of ARIES as a global open-source tool to build the four ecosystem accounts: ecosystem extent, ecosystem condition, ecosystem services and monetary ecosystem asset. Furthermore, the Dasgupta Review (Dasgupta 2021) advocates for complementing traditional economic indicators, such as GDP, with the *Inclusive Wealth* indicator, defined as the sum of the accounting values of produced capital (tools, machines, buildings and infrastructure), human capital (knowledge, aptitude, education, health and skills) and natural capital (plants, animals, air, water, soils and minerals). The Inclusive Wealth indicator acknowledges the inclusion of Natural capital as a stock asset to assess a country's progress towards sustainable development.

As the concept of ES became more and more accepted and integrated amongst researchers (Egoh et al. 2008) for its ability to bridge natural sciences with society and policy (Drius et al. 2019) and, as a result, for its added value in spatial planning and management, the number of tools and approaches to assess the same service increased substantially. Remote sensing tools are the perfect example of rapid technological improvements, giving us access to higher resolution data. The development of specific algorithms is still increasing, along with the possibility to include machine learning.

However, at the local scale is still very complicated, even more so in the European Union (EU) Overseas entities (Ferraro et al. 2021). Furthermore, the poor involvement of stakeholders in the design of ES assessments tends to disconnect the results from decision-makers' needs and current policy priorities (Dicks et al. 2014). Therefore, assessing stakeholder needs and preferences before designing an ES study and engaging with stakeholders in an iterative way along with the development of the study are critical steps to implement further and operationalise ES mapping methods (Beaumont et al. 2017). Choosing from a wide possibility of assessment techniques to answer a specific question is no easy task for researchers or practitioners new to the field. Choosing wisely can strengthen the message to decision- and policy-makers, as highlighted by Harrison et al. (2018). A simple framework in which ES assessment should be implemented follows the one developed by Maes et al. (2014) and Burkhard et al. (2018):

1. Identification of political needs and gaps (question and themes identification).
2. Identification of the right ES mapping and assessment approach (i.e. methods, level of complexity, data requirements and availability, cost).
3. Identification of the best approach for decision support (dissemination and communication of results to policy-makers).

As such, the following sections will present the current policy needs and gaps identified in selected EU ORs and OCTs, as well as the framework for the integration of ES. Information and data have been collected during the lifespan of the EU project MOVE - Facilitating MAES to support regional policy in Overseas Europe: mobilizing stakeholders and pooling resources (Grant agreement Nº 07.027735/2018/776517/SUB/ENV.D2) from April 2018 to September 2021, (see www.moveproject.eu).

2. Policy needs and gaps in Outermost Regions and Overseas Countries and Territories

Some EU Member States and the United Kingdom have part of their territory located in areas of the globe remote from Europe. There are nine Outermost Regions (ORs) and 13 Overseas Countries and Territories (OCTs). ORs are an integral part of the EU. Therefore, EU law and all the rights and duties associated with EU membership apply to the ORs. However, they benefit from derogations from some EU laws due to their geographical remoteness from mainland Europe. OCTs do not form part of the EU, though they cooperate with the EU via the Overseas Countries and Territories Association. The geographical distance between Europe and its Overseas entities also reflects in the gap between the implementation of MAES methodology in the EU mainland and its EU Overseas entities, which has increased over time (Sieber et al. 2018). The project MOVE supports the implementation of MAES within the participating ORs and OCTs. In response to the requirements of Action 5, Target 2 of the EU Biodiversity Strategy 2020, the MOVE pilot project intends to fill the increasing gaps in MAES implementation between the continental EU Member States and their Overseas entities (Sieber et al. 2018). Examining the reason for the existence of such gaps required an in-depth study of specific ORs and OCTs (Fig. 1).

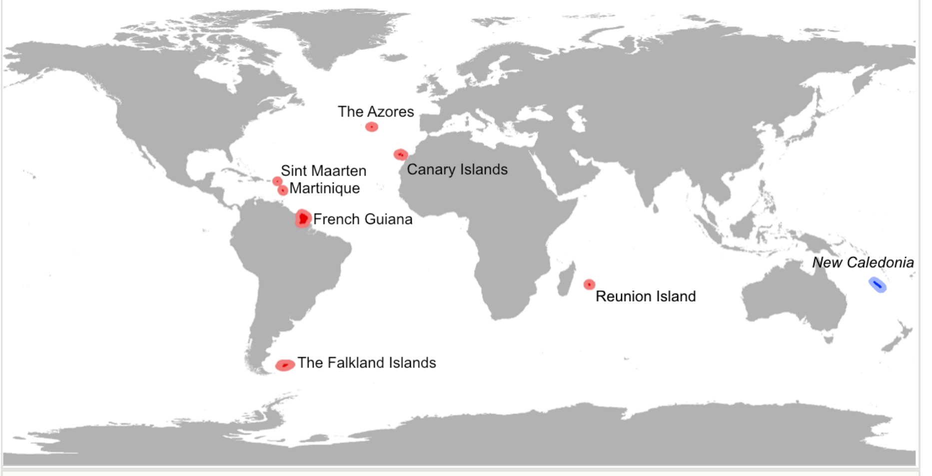

Figure 1.

European Overseas entities included in MOVE. In red: regional case studies developed, in blue: additional territory included in the surveys (adapted from Casas et al. 2021b).

Valuable pieces of information were collected and analysed from the various questionnaires, interviews, literature reviews and workshops delivered during the MOVE project. Such information comes from a wide variety of stakeholders (e.g. Universities and Research Institutions, Local/Regional/National Administrations, Small and Medium Enterprises, Non-Governmental Organisations, Associations) and covers the Overseas entities included in MOVE and more. Overall, five stakeholders' and policy needs stand out: raising awareness of the concept, mapping support, ecosystem services assessment, policy- and decision-support and resources.

2.1. Increase awareness of the concept of ecosystem services

The concept of ES is, in general, poorly used in the relationships between stakeholders and ecosystems, according to the diversity of words collected from stakeholders in the European Overseas entities, to express what the concept of ES means to them (Cillauren and David 2019). The poor use of the ES concept was confirmed by the semi-structured interviews implemented in governmental agencies across different ORs and OCTs (Ferraro et al. 2021). The lack of knowledge and understanding of ES amongst politicians and decision-makers has been reported in various EU Overseas entities, while scientific communication and dissemination are still relatively poor in these areas. The relatively low awareness of the concept is not unique to the EU Overseas entities. Outside of scientists and some policy-makers, most people do not understand the term *ecosystem services* (Norgaard 2010).

2.2. Mapping support

Mapping resolution is often the main drawback in most assessments. However, the higher resolution has a cost that tends to rise exponentially. The correct resolution is the one relevant for the question to be answered or to the stakeholders/decision-makers' needs. In Macaronesia and the Caribbean biogeographic regions, the requirements were mainly for very high or high-resolution images (from 1 to 5 m). Developing high-resolution maps for ecosystems or species distribution is a fundamental baseline to MAES. In the South Atlantic UK territories, users were more inclined towards medium resolutions (provided by LANDSAT - 30 m), which are, in fact, much easier to access, analyse and process (Cillauren and David 2019).

2.3. Ecosystem Services assessment

In the assessment of ES, stakeholders have highlighted the need to consider a broad range of ES, including socio-cultural and economic components (Casas et al. 2021c). In that sense, MAES procedures need to be socially and culturally framed (requiring a greater understanding of the local context), carefully designed and implemented. The engagement of stakeholders can be determinant and valuable to contextualise the assessment and frame it to the local needs, with local and reliable data being much more meaningful to policy- and decision-makers. However, the accessibility and sharing of data between experts and EU Overseas entities is a common bottleneck (Hessenberger et al. 2021). The multi-disciplinarity inherent to MAES could facilitate the centralisation of information and resources between different institutions and secure the availability of produced databases, summary documents and environmental spatial information. Finally, stakeholders also highlighted the need to consider the human impacts on ecosystems and their services, as shown in the MOVE case study in Martinique (Maréchal et al. 2021). Assessing the ecological condition of an ecosystem under a gradient of human pressures over a long time series is a more detailed, yet fundamental, knowledge to propose future scenarios, considering management measures and the effects of climate change and anthropogenic pressures. In that sense, monitoring ecosystems' ecological conditions and pressures are equally important. Further efforts are needed to develop the appropriate tools to allow constant monitoring of pressures on the environment.

2.4. Decision-support approaches for better management of resources

Stakeholders believe that mapping helps to study ES and their use in managing natural environments and further into the territory (Cillauren and David 2019). However, to translate the mapping and assessment of ES into decision-making, most decision-makers need support (from researchers or appropriate tools and software) and require new technical skills to make the most informed decision. Stakeholders also expressed the need for future projections to define pertinent management plans, optimising MAES outputs' pertinence in EU ORs and OCTs (Casas et al. 2021c).

2.5. Resources

Relying on proper funding to secure MAES application and communication is fundamental to enhance, highlight and share its capabilities with society (Casas et al. 2021c). Financial resources were listed as the main bottleneck to the implementation of MAES in most EU Overseas entities. Some 22% of respondents declared the high need for additional financial resources. Therefore, according to the main constraints and needs, MAES tools and approaches must be cost-effective, easy to implement and, at the same time, increase awareness around the concept of ES. Easy interpretability of MAES outputs is key to expand the capabilities of these tools to reach policy-makers. A key element to consider before engaging with the public and decision-makers is the outputs' reliability. Validation of the results with ground-truthing (especially for mapping) or assessing the uncertainty of the results can build trust between scientists and policy-makers.

3. Selection of MAES tools and approaches to facilitate the uptake of ES in EU Overseas entities

In the following sections, a selection of MAES tools and approaches are presented, starting with the mapping tools, the ecosystem services valuation tools and the DST.

3.1. Mapping tools

The first step in the assessment of ES is to identify the ecosystems providing a service. In a second step, those ecosystems should be mapped to determine their extent and conditions, ultimately informing us of the number and quality of services they provide. Only when ecosystems and their services are mapped can they eventually be integrated into natural resources and spatial planning management. The quality of mapping is determinant to provide the most accurate information to decision-making.

Over the last decades, the technological evolution of mapping tools has considerably facilitated Geographic Information Systems (GIS) democratisation, along with the development of freeware to process and analyse mapping information (e.g. Quantum GIS, Open Jump, SAGA). Mapping tools include, amongst others, primary data collection on the field, airborne and fixed camera photography, radiometric reception with satellite images, radar and Lidar, collection of pre-existing databases, to the production of maps and GIS using the information provided by users through interviews, questionnaires and focus groups. The range of methods has been used almost completely in all EU Overseas entities surveyed in the MOVE Project (Cillauren and David 2019). If the targeted ecosystem has not been mapped yet, field measurements are almost inevitable to collect primary data or validate the classification using remote sensing tools. Other alternatives exist in data-scarce EU Overseas entities by engaging local stakeholders and local communities into participatory GIS, where spatial information is provided by end-users (see the following section on the valuation of ES).

Satellite imagery can retrieve optical images, radar and Lidar, at different resolutions, some being free to use. Therefore, we have reviewed remote sensing sensors that provide free-to-use satellite images (Suppl. material 1 - Table A.1). Sources of satellite images used in the different case studies implemented in the MOVE project (Casas et al. 2021b) are indicated in Suppl. material 1- Table A.1.

3.2. Ecosystem services valuation tools

The ES classification has changed over time, starting with MEA, then revised in TEEB and CICES and lately, through the introduction of NCPs by the IPBES Platform. However, the categories have remained roughly the same:

1. Provisioning services.
2. Regulation and maintenance services.
3. Cultural services.

In CICES v.5.1 classification, there are 59 biotic services and 31 abiotic services. Knowing that one must choose between multiple methods for one ES and no standard protocol exists for each method, it can be quickly overwhelming to implement an ES assessment in a given territory if not already familiar with the concept.

From the list of methods (biophysical, economic and cultural) described in the MAES methods Explorer tools (www.maes-explorer.eu), we have reviewed the ones that have been the most used for ES valuation in ORs and OCTs according to the extensive literature review made in the project MOVE (Sieber et al. 2018, Sieber et al. 2020). Note that many of those tools were used in the different case studies implemented in the MOVE project (Casas et al. 2021c). Those that were used in the MOVE project have been indicated in Suppl. material 1- Table A.2.

- **Biophysical methods** are used to quantify ecosystems' capacity to deliver ecosystem services (Maes et al. 2014). They are often used as input data to economic valuation methods. We selected the following methods: 1) Spatial proxy methods; 2) Process-based methods; 3) Statistical models; 4) Integrated modelling.
- **Economic methods** in MAES involve measuring the economic value representing the quantity and quality of service. They rely strongly on the biophysical data and methods, but can also be combined with socio-cultural methods. We selected the following methods: 1) Choice modelling; 2) Market price; 3) Travel cost; 4) Contingent valuation; 5) Participatory valuation; 6) Replacement cost; 7) Value transfer.
- **Cultural or social methods** are distinguished from economic ones because they are not expressed in monetary terms (De Groot et al. 2010) and demonstrate human well-being's multi-dimensional nature. However, they can be used in combination with economic methods to convert them into monetary terms. We selected the following methods: 1) Participatory GIS; 2) Participatory scenario planning; 3) Preference assessment; 4) Photo-elicitation surveys.

Based on the method factsheets developed in previous work (e.g. ESMERALDA method application cards, OpenNESS methods factsheets), we summarised each method's intended use, strengths and weaknesses and gave a quick overview of the amount of data required and time/economics resources in Suppl. material 1- Table A.2. We considered that the strength and weaknesses identified for each method in previous works remained valid for EU Overseas entities. However, we acknowledge that each method could be implemented slightly differently; therefore, some degree of flexibility should be considered when interpreting the analysis.

3.3. Decision-supporting tools

The integration of ES into everyday decision-making is still in its infancy in EU Overseas entities due to cognitive, political and organisational difficulties (Ferraro et al. 2021). One of the main bottlenecks is in the Science-Policy interface because of poor communication between the two. The Science-Policy interface can be bridged only when scientists understand this policy process and work with policy-makers to reduce political and policy risk rather than simply providing scientific facts (Perrings et al. 2011).

Decision-supporting methods (e.g. cost-benefit analysis, multi-criteria analysis, scenario analysis) can pave the way towards a stronger Science-Policy interface, through the engagement of policy- and decision-makers into the process of ES mapping and assessment, but also through a shared platform where scientists and policy-makers meet and work towards a common objective. With the growing popularity of ES, a variety of "ecosystem-based management tools" have emerged; for example, the Ecosystem-Based Management (EBM) Tools database contained 183 tools as of November 2012 (Ecosystem-Based Management 2012, Bagstad et al. 2013). Grêt-Regamey et al. (2017) reviewed 68 decision support tools to operationalise the ecosystem services concept. Lagabrielle (2021) provided an additional selection of DSTs that was made specifically for ORs and OCTs (see Suppl. material 1- Table A.3) as to:

1. Be quantitative and spatially explicit.
2. Involve low time requirements (for non-expert users).
3. Be in the public domain or with a purchasable low-cost software licence.
4. Have a good level of development and documentation.
5. Fit for use at a local scale.
6. Be generic ("one tool fits all").
7. Provide information that incorporates multiple valuation systems.
8. Be affordable by institutions.

DSTs have also been selected to cover relevant sectors in ORs and OCTs, such as agriculture and rural development, marine and coastal areas, spatial planning and conservation and protected areas. DSTs have been selected to cover different steps in the MAES procedure, namely the screening (e.g. to evaluate ES of importance), mapping and assessment, valuation (monetary or not) and planning and management (including stakeholder participation). Multiple tools could be used together to fill different ES assessment needs.

To be powerful and reliable, DSTs are often highly demanding in terms of data to develop a ‘what-if’ scenario. Generally, they require robust modelling, GIS skills and specific training to use those tools. However, if implemented properly, they provide evidence-based spatial planning to optimise the benefits provided by ecosystems. Once those models have been developed locally (by a tierce organisation if needed), it becomes easier to adjust the scenarios, management strategies or climate change predictions. Note that previous approaches, like Participatory Scenario planning, are, in essence, a decision-support tool. Mapping ES is also a representation aid while monetisation of ES allows us to quantify them in a unit understood by all, which is the most likely to convey the relative importance and contribution of ecosystems to human well-being to decision-makers (De Groot et al. 2012, Costanza et al. 2014). When coupled with a cost-benefit analysis, monetisation can help to make informed decisions. In general, participatory mapping and ES valuation processes are a great way to engage local stakeholders to better uptake and understand the results. They have been shown to enhance the quality of decisions, if well designed (Reed 2008).

4. Effectiveness, Efficiency and Sustainability of MAES tools and approaches

Definitions of effectiveness, efficiency and sustainability were adapted from the Organisation for Economic Co-operation and Development (OECD) valuation criteria*[1] (see Table 1).

Table 1.

Definitions and criteria retained to assess the effectiveness, efficiency and sustainability of MAES tools and approaches.

	Effectiveness	**Efficiency**	**Sustainability**
Meaning	The extent to which the tools contribute to reach the objectives and planned results.	The extent to which the tools allow to deliver results in a timely and economical way.	The extent to which the net benefit of the tools continues or are likely to continue.
Effort orientated	No	Yes	Yes
Process orientated	No	No	Yes
Goal orientated	Yes	Yes	Yes
Time orientated	No	Yes	Yes

Based on those definitions, a performance matrix was developped for the tools and approaches selected in section 2, except for the mapping tools. The effectiveness was considered as a function of input ‘data’ (quantity and quality) and ‘robustness’ such as:

$$Effectiveness = \frac{Data + Robustness}{2}$$

The efficiency was considered as a function of ‘time’ (low) and ‘broadness’, meaning one approach can be used to assess multiple ES or to cover multiple domains (terrestrial, coastal, urban etc.), such as:

$$Efficiency = \frac{Time + Broadness}{2}$$

Finally, sustainability was considered as a function of ‘process’ in the form of the capacity of the tool to be integrated into the current decision-making process and ‘stakeholder engagement’, considering that, for a tool to be sustainable, it needs to engage local actors, practitioners and decision-makers to keep the use and implementation of MAES in the long term, such as:

$$Sustainability = \frac{Process + SHEngagement}{2}$$

Each component has been given a score, from 1 to 3, 1 being the lowest, 3 being the highest. The scoring was assessed by the authors of this present study, based on the analysis of the methods (see Suppl. material 1), considering the time required, the amount and quality of data, the SH engagement process and the intended use. We acknowledge that the scoring is a subjective interpretation from feedbacks given on methods by different sources (see Suppl. material 1- Table A.2 and A.3 for references). Details of the scoring are given in Suppl. material 1- Table A.4 for transparency.

The mapping tools were not included in the performance matrix since they all provide the relevant information (multispectral, Radar or Lidar). The resolution is not determinant since it is dependent on the scale of the assessment. As for the durability of such tools, satellites have been replaced or are most likely to be replaced by new ones of higher performance. The efficiency and effectiveness would depend on the type of analysis performed on the images, but it is out of the scope of this paper. For ES valuation tools and DST, a performance matrix is given in Fig. 2.

The performance matrix reveals how effective and accurate process-based models, integrated modelling and most DSTs can be, having the highest scores. Other approaches are quite effective, such as a market price, travel cost or participatory scenario planning.

Value transfer is probably one of the less effective methods because of the low amounts of locally collected data, resulting in less accurate or defendable results. However, it is undoubtedly one of the most efficient, along with spatial proxy methods, replacement cost (Bayley et al. 2021, Maréchal et al. 2021) and preference assessment. Seasketch appears as the most user-friendly DST and is, therefore, considered the most efficient.

In addition, the ability of Seasketch to be integrated into the decision-making process through the involvement of stakeholders reflects its high sustainability potential. Most DSTs tools are pretty complex to use, time-consuming and data-demanding. To be used in the long-term in EU Overseas entities, specific and regular training needs to be implemented locally. Decision-support methods, such as cost-benefit analysis, multi-criteria analysis, scenario analysis etc., can pave the way towards a stronger science-policy interface through the engagement of policy- and decision-makers into the process of ES mapping and assessment. Participatory approaches are well suited for sustainability as they allow the assessment of multiple ES with local stakeholders' contribution, including the awareness-raising dimension. Ultimately, every method or approach could be integrated into decision-making and be part of stakeholders' engagement, at least during the restitution of the results locally with the relevant actors, decision- and policy-makers. This step is often overseen and ES valuation remains in the scientific domain since few scientists invest in local initiatives, training or engage with media and produce educational materials (Shanley and López 2009).

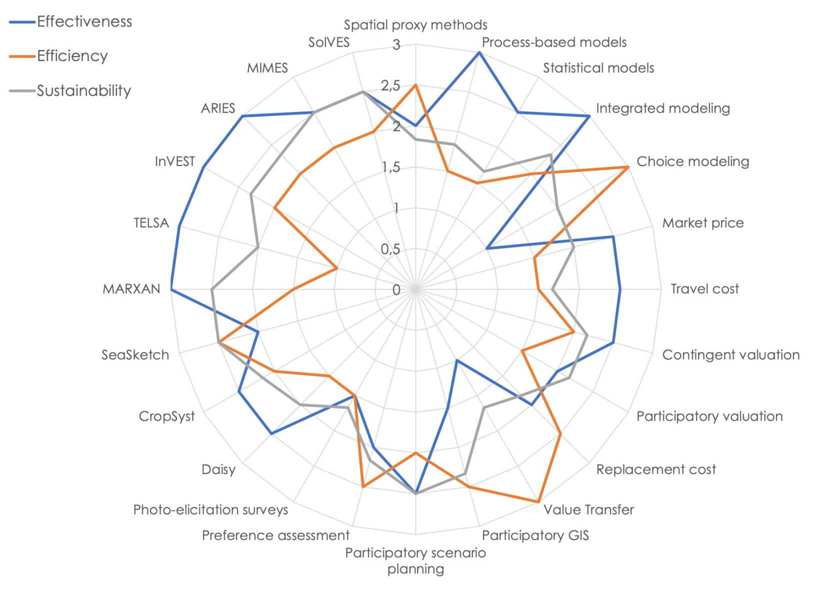

Figure 2.

Performance matrix of MAES tools in terms of effectiveness, efficiency and sustainability.

5. Discussion

From the overview of ES valuation techniques, few methods stand out by their appropriateness to different contexts and objectives. Some are more time-consuming than others (therefore costly), but allow the assessment of multiple ES at once (contingent valuation, integrated modelling, choice modelling, preference assessment). Therefore, those methods might be cost-effective and worth considering (in resources limited ORs/

OCTs) for a large ES assessment. Other methods are particularly adapted in increasing awareness of the concept of ES (participatory valuation, contingent valuation etc.). We have seen that most EU Overseas entities suffer from low stakeholders' awareness. Those methods are, therefore, very much appropriate and interesting in mediating conflicting interests. Some methods are largely used because they are easy to implement in a time-effective manner, such as value transfer (Casas et al. 2021a, Lagabrielle et al. 2021, Schmiedel et al. 2021) or market price (Bayley et al. 2021, Maréchal et al. 2021). Indeed, value transfer methods are a relatively expeditious and inexpensive means of obtaining ES value estimates and can be applied at any geographic scale. Those methods can be interesting in Environmental Impact Assessments or to have a preliminary overview of nature's contribution to people. Value transfer is mostly used for regulation and maintenance services, which generally requires high level in situ data (carbon sequestration rates, denitrification rates, fish biomass, wave attenuation rates etc.). In data-scarce regions, value transfer or participatory GIS is particularly suitable. For instance, in the French Guiana case study, Sieber et al. (2021) assessed 22 ES for marine, aquatic, forest, agricultural, urban and largely modified land cover using participatory GIS. This would have required much more time, data and resources otherwise. Participatory approaches, such as Participatory GIS and Participatory Scenario Planning, are preferred to enhance capacity building and social learning and integrate stakeholders in a democratic process-orientated approach to decision-making. Participatory scenario planning is, by itself, already a decision-support method. Indeed, most stakeholders are involved and actively engaged in the process, stimulating a science-policy interface, with the possibility to consider a range of policy or response options. As a result, this approach does not necessarily need to be complemented by additional. Given the vulnerability of EU Overseas entities to the effects of climate change (i.e. sea-level rise, extreme weather events, drought – Petit and Prudent 2008), participatory scenario planning is highly encouraged.

The selection of suitable methods is driven by the available data in the different ORs and OCTs. The frequent use of secondary data (e.g. value transfer) and simple modelling techniques is often explained by its data availability. These methods are easier to apply when there are restrictions in time, data or budget availability. Nevertheless, care must be taken to interpret those results, as over-simplification sometimes obscures complex processes and interactions between human pressure and ecosystem functioning, which can mislead the decision-making process (Seppelt et al. 2011). Making the right trade-off between effectiveness and efficiency in choosing tools and approaches is key for its implementation and its uptake to decision-makers.

In our attempt to guide the process of selecting remote sensing, biophysical, economic, socio-cultural and DST for MAES implementation in the EU Overseas entities according to policy needs identified, we recognise that methods are not completely independent of each other and that there may be advantages from combining methods to address a case study purpose, such as in a multi-tiered approach (Grêt-Regamey et al. 2015). This is especially true if a user has complex policy questions guiding the ES mapping process or wants to cover a full range of plural values attributed to ES, as most individual methods cannot grasp multiple value types without combining them with others (Harrison et al. 2018, Jacobs et al. 2018). Furthermore, multiple approaches could be applied within a single case study to better capture uncertainties associated with particular methods. The method itself is not important, but the methods' reliability and the associated uncertainty can be important factors when communicating the results to decision-makers. Indeed, different methods could provide similar outputs. For instance, the monetary value of coastal protection provided by mangroves forests in Martinique has been assessed, ranging from 10 to 26 M€ yr^{-1} (Trégarot et al. 2021), using a combination of statistical and process-based models, mapping and replacement cost for monetisation. On the other hand, using value transfer methods, the same service was estimated at 16 M€ and 16.6 M€ by Failler et al. (2010) and Giry et al. (2017), respectively. As Costanza et al. (2014) mentioned when defending their first valuation of the world's ecosystem services and natural capital, "there is not one right way to value ES. But there is a wrong way and that is not to do it at all".

Our study aimed to display the most appropriate methods and tools to address the policy needs expressed by local stakeholders. Those needs are not exhaustive and other tools and approaches might be more appropriate in a given context regarding data availability, technical skills, time and budget. A detailed decision tree that includes both ES valuation tools and DSTs have been provided by Harrison et al. (2018). Additional methods can be found in the MAES methods Explorer tools (www.maes-explorer.eu) with concrete examples and also from the EU Overseas entities, for reference.

6. Conclusions

Despite significant advances in the development of the ES concept across the science and policy arenas, the valuation of ES to guide sustainable development remains challenging, especially at a local scale and in data-scarce regions (Pandeya et al. 2016). EU Overseas entities biodiversity is exceptionally rich and is recognised as being of international importance. Most of the EU's biodiversity is in those Overseas entities, making the ORs and OCTs key actors for implementing international and regional conservation targets. However, their insularity brings challenges associated with their remoteness, with collecting data in marine and terrestrial environments and access to financial and trained human resources (Haase and Maier 2021). No tool can fit all policy needs. Rather, there is a need for flexible, guidance-based ES mapping and assessment approaches in the EU Overseas entities. To provide a comprehensive overview of the status of biodiversity, the ecosystems and the services they provide, we selected a few tools that are cost-effective, increase awareness, cover the biophysical, economic and social-cultural components of the assessment. Those tools can be used in modelling and multi-tiered approaches covering marine and terrestrial ecosystems and including stakeholders from multiple disciplines and sectors. Nonetheless, the methods should be adapted for scenario analysis and decision-support, for which there are plenty of options to choose from to facilitate MAES implementation in EU Overseas entities. Such an overview will help protect biodiversity and ecosystems, ensure a continuous supply of ecosystem services for human well-being and ensure effective and timely implementation of Action 5 of Target 2 of the EU Biodiversity Strategy.

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Grant title

MOVE – Facilitating MAES to support regional policy in Overseas Europe: mobilizing stakeholders and pooling resources

Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary material

Suppl. material 1: Selection of MAES tools and approaches to facilitate the uptake of Ecosystem Services in EU Overseas entities doi

Authors: Trégarot, E. and Failler, P.
Data type: Tables
Brief description: A selection of MAES (Mapping and Assessment of Ecosystem Services) tools and approaches to facilitate the uptake of Ecosytem Services (ES) in the EU Overseas entities is presented hereafter. This was made, based on their popularity across the EU Overseas entities (number of published papers) and their ability to address stakeholders and policy needs, meaning it can help to raise awareness on the concept of ES, can address different spatial resolution and multiple ES, facilitate decision-support and be time- and cost-effective.
Download file (62.97 kb)

Endnotes

*1 See: https://www.oecd.org/dac/evaluation/daccriteriaforevaluatingdevelopmentassistance.htm