Review of available science-policy interface tools and respective theoretical background

Acronym: MOVE

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Summary

In Part 1, this report identifies the principles and stakes of public participation into public-decision making, more specifically regarding spatial and environmental planning. We describe the benefits and the risks associated with stakeholder participation and the increasing importance of Public Participatory Geographic Information System to support this participation. In Part 2, we use published scientific literature reviews and on-line tools explorers to identify and describe Decision Support Tools (DSTs) usable for the mapping and assessement of ecosystem services public policies. The successful implementation of DSTs requires an understanding of decision-making processes to bridge gaps in the science-policy interface. DSTs are often complementary and must be used at the right management stage, according to the objectives of the project.

Publishable Summary

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1. Introduction

This report aims to assess and compare geographic decision support tools (DSTs) that can potentially promote public participation to support decision-making for the design and implementation of ecosystem services-based public policies. The investigation method is organized in two parts. The first part identifies the principles and stakes of public participation into public-decision making, more specifically regarding spatial planning. The second part uses published scientific literature reviews and on-line tools explorers to describe DSTs usable for the mapping and assessment of ecosystem services public policies.

2. Stakeholder participation in environmental planning

2.1 Definitions

Conceptually, the participation represents the idea of being part of, taking part in, or even contributing to a bigger whole. The concept of «participation» covers plural situations or uses that are subject to interpretation. Since there is no universal acceptance of the definition of participation, a discourse in the literature has developed about the meaning and operationalization of the concept within a range of fields (Imms et al., 2016), including economics, philosophy, and politics.

Definitions of "participation" depend on decision-making processes and who should participate (Luyet et al., 2012). The World Bank (1996) defines participation as "a process through which stakeholders influence and share control over development initiatives and the decision and resources which affect them". The purpose of stakeholder participation is to enhance the quality of the project (Luyet et al., 2012; Rowe and Frewer, 2000).

In this report, we restrict our investigations of the concept to the field of political sciences. Participation is defined as the instances and mechanisms that allow community members to play a role in a decision-making process. This can take two forms, either in an institutional framework or under individuals' initiative from civil society. In this framework, the citizen is recognized as an independent constituent of public action (Blondiaux, 2007). He is a stakeholder aware of the issues

and problems of its "community", although many stakeholders are not aware they have a stake in a policy issue.

The participation of citizens remains relatively weak in the public decision-making process. It is within this "minimalist approach to democracy" that the place of the citizen is called into question (Kingston, 2007). Echoing the Athenian and Rousseauist conception of democracy where the citizen was led into a more direct and egalitarian political role, participation reflects possible ways of operationalizing a democratic ideal by insisting that the citizen can compete on the decisions that concern him (Todorov, 2009).

The concept of so-called «participatory democracy» finds its meaning and is supposed to reconstitute the link between the political sphere and the civil society through the participation of citizens (Fauchard and Mocellin, 2012). The participatory democracy invites the citizen to take part in power and recalls the natural meaning of the word democracy (Blondiaux, 2007).

Depending on how it is initiated, participation takes different forms. It includes a certain number of actors who can interact more or less together, depending on the objectives sought. Nevertheless, these definitions of participation provide ample opportunity for varied interpretations of the concept and hence varied approaches to measurement, leading to imprecision and confusion in what is found and reported (Imms et al., 2016).

2.2 Forms of participation

Institutionalized participation is built upon a set of conceptual frames, rules, methodologies, and tools in order to formalize conciliation spaces (Blatrix, 2002). A wide range of institutional tools is available to operationalize participation through institutional structures and processes (Blondiaux, 2007): local neighborhood councils, citizen juries, consensus conferences, public hearings, town planning workshops, youth councils, public debate commissions, deliberative polls, participatory budgets…

The multiplicity of this type of instrument tends to respond both to the issue of transparency in decision-making processes but also to the desire for the participation of the individual considering himself to be increasingly excluded from the political sphere (Rosanvallon, 2008). The public authority thus affirms its acceptance of citizen expertise, as well as its

subversive power, and puts the individual citizen back in the central position of the democratic process to both increases the quality and approves the legitimacy of the decision (Combe, 2010).

Besides formal institutional participation (i.e. top-down), spontaneous informal participation (i.e. bottom-up) is a non-institutional and less rigid form of participation that arises spontaneously in order to satisfy a need or an interest of the community where there is often unease (conflicting issues) between the political sphere and civil society. The citizen thus manifests his gaze on society in different ways: demonstrations, petitions, occupations, etc. In this frame, each citizen can pretend to be a skilled politician with a mobilizable "knowledge" able to improve the decision so that it best matches the needs of society as a whole (Chambers, 2006; Sintomer, 2008). Rosanvallon (2008) brings the concept of «counter-democracy» to describe the context, forms, and new risks of spontaneous mass participation. Those informal forms of participation can later be integrated into formal institutional participation processes.

2.3 Stakeholder participation

Participation calls for a form of exchange and sharing of decisions between different actors. It basically constitutes a social space of confrontation where the stakeholders of the decision-making process interact around shared stakes and issues.

The word "stakeholder" has assumed a prominent place in public management theory and practice since the 1980s (Bryzon et al., 2007). A stakeholder can be defined as «a person, group or organization that has interest or concern in an organization» and who «can affect or be affected by the organization's actions, objectives and policies» (Post et al., 2002). Stakeholder can also be defined as "any group of people organised, who share a common interest or stake in a particular issue or system" (Grimble and Wellard, 1997). Moreover, stakeholders are all affected by policy choices, and they all have interests in both the decision-making process and the final decisions (Heilbig et al., 2015). Bryzon et al. (2007) urge consideration of a broader array of people, groups, or organizations as stakeholders, including the nominally powerless.

For Thomas (2012), the public plays three roles when participating in public management: the citizen role, the customer role, and the partner role,

where members of the public assist the government in producing a service. Separately and in combination, these three roles likely capture most interactions between the public and public managers in public participation (Thomas, 2012). Luyet et al. (2012) consider the public as one specific stakeholder, and therefore, they use the term stakeholder participation rather than public participation. We also adopted this terminology.

2.4 Degrees of stakeholder participation

The principle of participation arises from the collaboration of different actors, and depending on the desired aim, different degrees of citizen involvement can be defined (see the pioneering and influential study by Arnstein, 1969). Participation itself can then be specified by differentiating the various levels at which power is delegated to members of the public (Rowe and Frewer 2005; Creighton 2005)

The degree of civic involvement and empowerment in decision-making processes can be measured on a scale with categorized levels of participation. To this purpose, the «Arnstein scale of participation» still serves as a reference (Figure 2) (Arnstein, 1969; Pomeroy and Douvere, 2008). The degrees of participation range from providing information to co-controlling a decision. Indeed, depending on how the process is instructed, either by the institution or by a group or association of citizens, for instance, the intensity of public involvement may vary. Communication, which constitutes the first level of a participatory process, forms the basis for integrating citizens into decision-making processes, whether in terms of territorial planning or any other practice (Habermas, 1987).

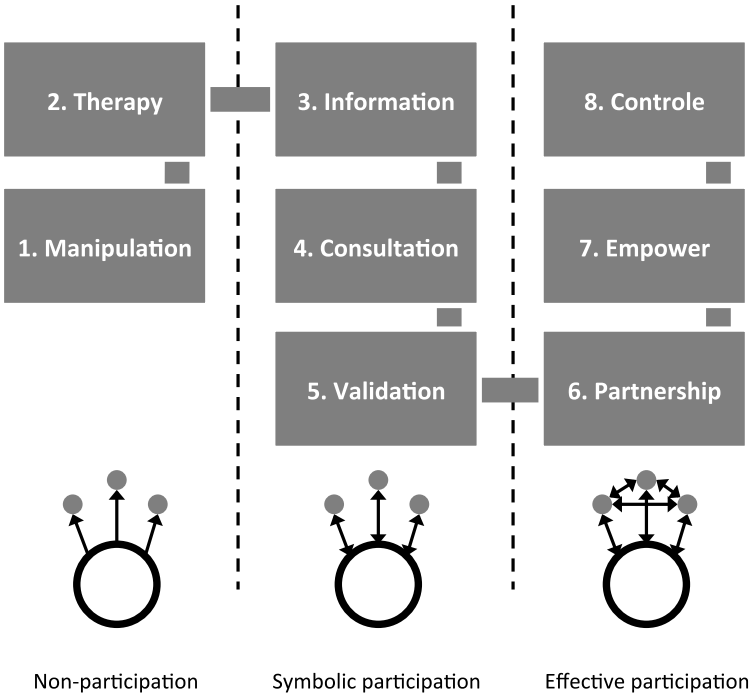

Figure 1 - Degrees of public participation (adapted from Arnstein et al. 1969)

Information and communication technologies (ICT) represent ideal methods for improving stakeholder participation. Likewise, the Internet and social media play an increasingly important role in mobilizing the public on issues of social responsibility and sustainable development. (Nuojua et al., 2008). The public is no longer defined as a simple passive receiver but as a potential active partner. The web 2.0 enabled a space of socialization in which the notion of participation is consubstantial (Roche et al., 2011; Maguire, 2008). The development of the web, or more generally of ICT, participated in the renewal of practices and contributed to re-establishing public participation, this is the so-called electronic democracy or e-democracy (Joliveau et al., 2013; Péribois, 2008). Civic technology, or civic tech, encompasses ICT aiming to support how we « govern, organize, serve, and identify matters of concern for communities » (Boehner and DiSalvo, 2016).

2.5 Advantage and risks of stakeholder participation

There are not only benefits to stakeholder participation in decision-making or policy design process; there are also costs that shouldn't be ignored. Luyet et al. (2012) listed the benefits and risks associated with stakeholder's participation.

Table 1. Benefits and risks of public participation (adapted from Luyet et al., 2012)

Advantages of participation	Costs of participation
- Better trust in decisions - Improving project design using local knowledge - Better understanding projects and issues - Integration of various interests and opinions - Optimizing implementation of plans and projects - Public acceptance of the decisions - Fostering and developing social learning	- Expensive process - Time-consuming process - Potential stakeholder frustration - Identification of new conflicts - Involvement of stakeholders who are not representative - Empowerment of an already important stakeholder

2.6. Principles and challenges of participatory spatial planning

Territorial planning aims to guide the organisation of a spatial environment to meet the demands of society (Ligtenberg et al., 2004). Territorial planning is defined as a process that consists, for a given territory, in planning a set of operations in order to harmoniously organize the spatial allocation of people and their activities. One of the objectives of spatial (i.e. territorial) planning is to anticipate changes in the territory in order to orient private and public development actions in a way that is profitable for the population while considering future changes in the environment.

Several definitions of territorial planning exist. However, three important characteristics stand out (Desjardins, 2007): i) the public authority is the author of the approach, ii) the process takes a forward-looking prospective approach, and iii) the final objective of the process is to guide the spatial allocation of human activities in the geographic space according to legal and/or financial measures.

The participatory territorial planning process involves a set of stakeholders engaged in a collective decision-making process in order to improve the democratic deficit and the adequacy and effectiveness of spatial planning decisions (Cinq-Mars and Fortin, 2007). In this report, we don't distinguish between territorial planning and spatial planning since spatial

planning is applied to territories. We also consider that territorial planning implies environmental decision-making.

On recent decades, there has been an increased interest in stakeholder participation for territorial decision-making (Luyet et al., 2012). Territorial planning research and practices induce a renewal of methods to support greater integration of citizens into public decision-making processes. Territorial planning therefore appears as a favorable field to develop and test innovative methods and tools for public participation (Ehler and Douvere, 2009; Foley et al., 2010; Roche et al., 2011).

In the meantime, territorial planning processes must undoubtedly juggle with increased consideration of complex and uncertain environmental issues shared and dispersed across multiple organizations and domains (Kettl, 2002). The multiplication and diversity of stakeholders involved, their economic and cultural differences, their skills and abilities, their asymmetric power relationships challenge the operationalization of participatory spatial planning. Hall (1985) defined asymmetric relationships as "those in which one party is capable of disproportionately imposing her/his will on the other and setting conditions, making decisions, taking actions, and exercising control which are determinative of the relationship".

Raymond et al. (2010) argue that to manage the scope, complexity and uncertainty of global environmental problems, it is important to take account of different types and sources of knowledge. In response to these challenges, there has been a considerable shift in approaches to environmental management, moving from a positivist reductionist stance to a post-normal approach attenuating the differences between different forms of knowledge toward a new social contract linking science and society to manage coupled social-ecological systems (Scoones, 1999). Indeed, quality of information, including geographic information, along the planning process plays a key role in a participatory planning process, as long as all stakeholders receive it on time and correctly. Nevetheless, Joliveau et al. (2011) argue that a point of balance should also be defined between the expert and non-expert stakeholders involved in participatory spatial planning. Following Ericsson (2006), expertise is defined as the possession of domain-specific knowledge that is acquired through experience or training and that leads to superior, reproducible performance in domain-related tasks.

2.7. Role of maps

The map can be defined as being a "socially constructed" product based on selective cognitive processes in which it provides form and material in order to facilitate understanding of the space (Chapuis and De Golbéry, 2000). Relevant to visual language, it is ideal for formulating the representation of space. The map is part of an approach of communication, interaction and transmission of knowledge between several people and it is one of the most essential elements in the spatial planning process (Roche et al., 2011). Similarly, it is important to examine the ethics and the very benefits of maps (Chambers, 2006; Harley, 1991). The map is an instrument of power and/or of counter-power, which combines contestation and territorial negotiation by justifying the assimilation of the logics of the different actors in order to support the subjects of interest of each (Bakis and Valentin, 2010). Ultimately, it is a normative vector for participation; it strengthens the integration of civil society in decision-making processes and thus contributes to a better-shared perception of space with an improved understanding of the challenges of the territory. The result is a mutual graphical representation of the geographic space developed and shared between expert and non-experts stakeholders.

2.8. Public Participatory Geographic Information System (PPGIS)

Public Participatory GIS (PPGIS) (Leclerc, 2011) aims to give power back to civil society by integrating everyone's perceptions and representations (Ramasubramanian, 2008). However, there is no real consensus, hence the confusion, on the definition of *participatory GIS (PGIS), Public Participation GIS (PPGIS)* or *Community GIS (CIGS)*. Because these technologies are designed as solutions to issues related to citizen participation and territorial issues, they redefine the relationship between space and people in the territory through digital maps (Pak and Verbeke, 2014).

Indeed, since the 1970s, information and communication technologies have greatly contributed to initiating the participatory dynamic within territorial decision-making processes. They bring dynamism, accessibility, interactivity and interoperability at a relatively low cost (Leclerc, 2011; Roche et al., 2011). The organization of the spatial planning process is then articulated under the idea of empowerment, where the greatest forces

grant more responsibilities to the less well-equipped, either towards the citizen to recognize the legitimacy of his knowledge (Goodchild, 2007).

PPGIS combined with the Internet, increased the potential for social interactions and participation beyond the expert sphere. The most sophisticated features of geographic information systems (GIS) become user-friendly within everyone's reach. This process leads to the democratization of GIS (Butler, 2006; Goodchild, 2007). Geographic information is thus organized on the Internet through direct or indirect georeferencing on the earth's surface, defining the so-called *geoweb* (Joliveau et al., 2013). From the culture of contribution of web 2.0, the *geoweb* or the *geographic web* is built on these new production methods and on both sides, users can contribute and create content (*user-generated content*). Geospatial technologies and mapping Application Programming Interface (APIs) are thus propagated in a more user-friendly and logical way through a wide range of web-mapping applications. These applications take a position and define themselves as an instrument of participation and interaction between different stakeholders for the mobilization of collective intelligence (Roche et al., 2011). Geographic information can then be produced on the principle of *crowdsourcing* through participatory information production by using the creativity, intelligence and knowledge of a large number of voluntary contributors (*voluntary geographic information*) (Roche et al., 2011). In this outsourcing by the crowd, the average user becomes an active contributor to *citizen science data*, with for example, OpenStreetMap.

PPGIS are considered to be instruments of collaboration, but there may still be a form of manipulation where participation remains symbolic or even faked. PPGIS, and public participation processes in general, can be motivated by political strategies to gather public support through communication, rather than by genuine participation objectives of sharing and negotiating. Indeed, *Top-down* participatory mapping initiatives are orchestrated in such a way as to distinguish firstly the communication of information and then, if necessary, the participation of new actors (Joliveau et al., 2013). Consequently, there is a need to question the asymmetric modalities of power where PPGIS can constitute controversial instruments of participation that serve particular interests.

3. Decision Support Tools (DSTs) for ecosystem services policies

3.1 DSTs and ecosystems services

DSTs can be be mobilized to support knowledge synthesis for environmental decisions in general, although not all Knowledge Synthesis Methods (KSM) involve the use of DSTs. Dick et al. (2017) reviewed a panel of 21 KSMs and evaluated their sthrentgh and weaknesses for environmental decisions.

This reports focuses on DSTs as interfaces between science and policy to support decisions for ecosystem services planning and management. Evidence-based decision-making is an essential process for sustainable, effective, and efficient spatial planning and, in that sense, DSTs are now considered to be the primary assistant of spatial planners (Pınarbaşı et al., 2017).

DSTs have the "capacity to manage data, integrating databases and models under a graphical user interface, at the same time that expert knowledge from different sources can be included" (Castillo et al., 2016). DSTs range from simple spreadsheets to more complex software packages that integrate, explicitly or implicitly, a spatial dimension (Bagstad et al., 2013) such as Geographic Information Systems (GIS). DSTs remain difficult to characterize due to the diversity of their occurrence, objectives, and context of use (Pınarbaşı et al., 2017). Sharp et al. (2017) insist that «given the variety and complexity of these tools increases, there is a need for comparative studies across a range of settings, allowing users to make an informed choice».

Ecosystem services have become an increasingly used conceptual framework to plan the management of coupled social-ecological systems. A large and rapidly growing body of research seeks to identify, characterize, and value ecosystem goods and services – the benefits that ecosystems provide to people (Bagstad et al., 2013). Several DSTs are being developed for integrating ecosystem services into public decision-making processes. DSTs embed models that "enhances a person or group's ability to make decisions" (Power et al., 2015).

Jakeman et al. (2011) (cited in Grêt-Regamey et al., 2017) identified "the need to diagnose elements that lead to successful process, training for professional and technical competencies, and increased access to stable

platforms and interchangeable models and modelling tools" as key challenges of integrated modelling for environmental decision support

3.2 History and motivation of the mains DSTs reviews

Bagstad et al. (2013) published the first complete review of DSTs for ecosystem services assessment and mapping. Before that, only reviews and comparisons of 3-4 tools were available. Bagstad et al. (2013) described 17 DTSs. This study addressed a public demand from the U.S. Department of Interior-Bureau of Land Management (BLM) that manages nearly 100 million hectares of land. The BLM, in association with the U.S. Geological Survey (USGS), wanted to determine which methods for valuing ecosystem services were ready for operational use and which ecosystem service tools and analysis were relevant for the private sector to assist the BLM. Latter, Grêt-Remarey et al. (2017) published the most complete review of DSTs (n=68) for ecosystem services to date. Their review was undertaken in the framework of the EU FP7 project OPERAs (https://www.operas-project.eu/), in collaboration with the EU H2020 ESMERALDA Project (http://www.esmeralda-project.eu/).

3.3. On-line DSTs explorers

A set of websites provide on-line navigation through DSTs. The U.K. Ecosystem Assessor list and describe a set of 14 tools (https://ecosystemsknowledge.net/tool-assessor-list-of-tools), The National Ecosystem Approach Toolkit (https://neat.ecosystemsknowledge.net/) and the ValuES project (http://aboutvalues.net/) offers an on-line navigation through a decision tree for the selection of ES tools illustrated with case studies (Grêt-Remarey, 2017). The website of the ESMERALDA Project (http://database.esmeralda-project.eu/home) provides the "MAES Methods Explorer" to explore methods for mapping and assessing ecosystem services. It enables the fluid exploration of tools, case studies and associated scientific literature. It also implements the Tiered Approach to MAES proposed by Grêt-Remarey (2015), based on the theoretical framework developed by Ostrom (2007). The Ecosystem-Based Management (EBM) Tools database is no longer being updated, but according to Bagstad, 183 tools were listed as of November 2012. Since then, the EBM Tools database has evolved toward a network focused on

information and training for planning and management tools for coastal-marine ecosystem-based management.

3.4. DSTs selection

A major initial challenge is to circumscribe what constitutes an ecosystem DST amidst the variety of emerging tools for conservation, land-use planning, and biophysical modeling (Bagstad et al., 2013). The selection of appropriate ES tools for a specific decision process further complicates the implementation of such tools, as there is no clear guidance available (Grêt-Remarey et al., 2017). To address this challenge, Bagstad et al. (2013) used literature reviews and discussions with a group of multi-disciplinary colleagues to finally identify and review 17 tools that assess, quantify, model, value, and/or map ecosystem services. Interestingly over the 17 tools listed by Bagstad et al. (2013), 15 are still operative in 2021. Grêt-Regamey et al. (2017) conducted a review of 68 DSTs used for integrating ecosystem services into decision making. Tools were selected following a systematic literature review of articles selected in an on-line academic search engine. Selection criteria of inclusion in the on-line navigator of DSTs are often non-explicit.

3.5. DSTs Assessement criterias

Bagstad et al. (2013) rated the performance of DSTs against eight evaluative criteria that gauge their readiness for widespread application in decision-making processes. The eight criterias selected by Bagstad et al. (2013) were: 1) Quantification and uncertainty, 2) Time requirements, 3) Capacity for independent application, 4) Level of development and documentation, 5) Scalability, 6) Generalizability, 7) Nonmonetary and cultural perspectives and 8) Affordability. For the purpose of the assessment, Bagstad et al. (2013) assessed DSTs across four potential steps in ecosystem services assessment (Figure 3): 1) Ecosystem services impact screening, 2) Landscape-scale modeling and mapping, 3) Site-scale modeling and 4) Monetary and nonmonetary valuation. In addition, they assessed the time needed to deploy and exploit the tools for a subset of 7 DSTs through a case study.

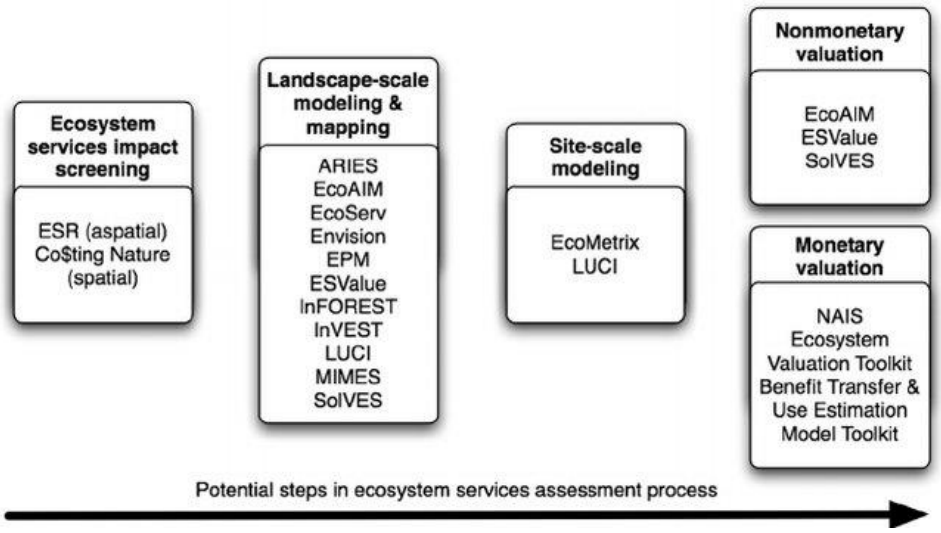

Figure 2 - Decision support tools (DSTs) (n=17), classified along four potential steps in ecosystem services assessment (from Bagstad et al., 2013).

Rather than assessing DSTs per se, Grêt-Remarey et al. (2017) investigated the policy sectors and ecosystems for which the DSTs were developed and applied. They listed 12 categories of policy sectors: air, water, soil, forest, agriculture and rural development, marine and coastal (including fisheries), spatial planning, climate, conservation and protected areas, bioenergy, transport and multiple (others). The categories of ecosystems for which the tool was designed were: marine, coastal, inland water, forest, dryland, island, mountain, polar, cultivated, and urban.

3.6. General finding of ES DSTs reviews

Current and future DSTs must address five challenges listed by Grêt-Regamey et al. (2017) that limit the policy application of spatially explicit ES assessment and mapping: 1) often too simplistic approaches and data, 2) insufficient level of precision and accuracy yet crucial for decision-makers, 3) interdisciplinary approaches to monetary valuation, 4) a wider scope of ES being investigated by research and 5) a better account for political and organizational aspects of decision making.

Overall, the successful implementation of DSTs requires an understanding of decision-making processes to bridge gaps in the science-policy interface (Grêt-Regamey et al., 2017). According to Bagstad et al. (2013), DSTs are often complementary and must be used at the right planning/management stage, aligned with the objectives of the project,

from the ecosystem service assessment phase up to the negotiation phase of the spatial planning process (using participation-oriented DSTs).

Grêt-Remarey et al. (2017) showed that some sectors, such as agriculture, forestry and water, are well equipped with DSTs since the 1990s but that tools are missing, for example, regarding landscape-scale cultural services. Grêt-Remarey et al. (2017) also found that ES DSTs are designed to support decision-making mostly at regional scales. Applications focusing only on islands, marine, mountain and dryland areas remain rare.

DSTs with a continuous record of scientific publications and targeting multiple ecosystems and sectors should be preferred for a regional assessment and mapping of ecosystem services. The following four DTSs listed in the review by Grêt-Remarey et al. (2017) and by Bagstad et al. (2013) address those selection criteria: InVEST (Arcidiacono et al., 2015), ARIES (Villa et al., 2014), MIMES (Boumans et al., 2015) and SolVES (Sherrouse et al., 2016).

4. Conclusion

In Part 1, we identified the principles and stakes of public participation into public decision-making, more specifically regarding spatial planning. We showed the benefits and the risks associated with stakeholder participation and the increasing importance of PPGIS to support this participation.

In Part 2, we highlight that the successful implementation of DSTs for ecosystem services assessment and management requires an alignment between the objectives of the decision-making processes and the DSTs being used. A set of DSTs has been identified and assessed based on the study led by Bagstad et al. (2013) and Grêt-Remarey et al. (2017).

This report (MOVE Project deliverable D.4.2.1), serves as a basis for the MOVE Project D.4.2.2 – *Technical Report on impact assessment and best practices guidelines for implementing spacially science-policy interface tools,* which objective is to link the assessment of DTSs (for the mapping and assessment of ecosystems services) with the socio-ecological profile of Europe's ORs/OCTs, so as to contribute to fulfilling the obligations of the EU Biodiversity Strategy 2020 in Europe's ORs/OCTs (Sieber et al. 2018).

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