State-of-the-art report on integrated valuation of ecosystem services

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Introduction

Responding to the call in the science and policy agendas

Since the United Nations Conference on Environment and Development (UNCED) of Rio 1992, international sustainability initiatives and intergovernmental organizations have called for the development of frameworks for integrating environmental, social, and economic information to inform decision making processes, including the World Commission on Environment and Development (1983-1987), the Agenda 21, the international System for Environmental and Economic Accounts (SEEA) and, more recently, the outcome document of the United Nations 2012 Conference on Sustainable Development, Rio+20.

For more than a decade, the literature on ecosystem services valuation has stressed the importance of integrating social, ecological, and monetary aspects of the values of ecosystem services and biodiversity in environmental decision making (de Groot et al. 2002; Farber et al. 2002) and the demand for a pluralistic value framework for ecosystem services has been echoed by the international ecosystem service initiatives like the Millennium Ecosystem Assessment (MA), The Economics of Ecosystem Services and Biodiversity (TEEB), and the Intergovernmental Platform for Biodiversity and Ecosystem Services (IPBES).

Despite formal recognition in science and policy of multiple values in ecosystems services (e.g. de Groot et al., 2002; Gómez-Baggethun & de Groot 2010; TEEB, 2010; Jax et al., 2013), the operationalization of an integrated ecosystem service valuation has remained largely elusive. For example, despite the rich body of theoretical literature endorsing the notion of plurality of values in environmental and ecosystem services valuation (Martínez-Alier et al. 1998; de Groot et al. 2002; Farber et al. 2002; Gómez-Baggethun & de Groot 2010; Dendonker et al. 2013), most of the empirical literature has addressed single values from disciplinary approaches (Vihervaara et al. 2010; Seppelt et al. 2011; Abson et al. 2014; Nieto-Romero et al. 2014). In fact, consideration of the multiple ways for expressing values by different analytical tools, the diversity of valuation perspectives by stakeholders and different processes for valuing (i.e., individual or deliberative frameworks; Keune & Dendoncker, 2013) are still ill represented in the ecosystem services literature, despite recent progress in this direction (Jax et al. 2013; Chan et al. 2012; Martin-López et al. 2014).

The same has also happened in outstanding international scientific collaborations or science-policy interfaces established to assess biodiversity and ecosystem services. The Millennium Ecosystem Assessment, for example, provides rich information in its volumes concerning the multiple value dimensions of ecosystem services and biodiversity. When it comes to the assessment itself, however, the measurement is largely reduced to biophysical measurements (MA 2003). Also the TEEB study acknowledges the existence of multiple and non-commensurable value dimensions in ecosystem services and biodiversity (Pascual et al. 2010; TEEB 2010), but the practical side of the study reduces the assessment to a single type of value, in this case to the monetary costs of inaction of halting biodiversity loss. The IPBES offers a new arena for moving integrated ecosystem services valuation from theory to practice. This science-policy interface has advocated a broad perspective of value pluralism and aims at developing a guide for assessing the multiple ways different human societies understand the importance of ecosystems and biodiversity. While IPBES defines its work program, this document provides basic standards and synthesis information aimed at contributing to its Objective 3, i.e., *Strengthening the science-policy interface with regard of the diverse conceptualization of values of biodiversity and nature's benefits to people including ecosystem services*.

A key challenge for ecosystem services research is thus to develop a sound integrated valuation framework. WP 4 in OpenNESS takes up this challenge by operationalising an integrated valuation framework that covers the monetary and non-monetary values of ecosystem services and by examining how these valuations link to, and support, wider EU economic, social and environmental policy initiatives. To do so, we adopt an analytical framework that bridges natural science and economics, conservation and development, and public and private policy (Braat & de Groot 2012). In doing so, it addresses both the ecosystem services delivery (supply-side) and their use, enjoyment and value by diverse stakeholders (demand-side) from local to global scales (Figure 1). Additionally, the framework adopted here explicitly recognizes the ecological, sociocultural and monetary values of ecosystem services and ther link to processes of decision making and planning.

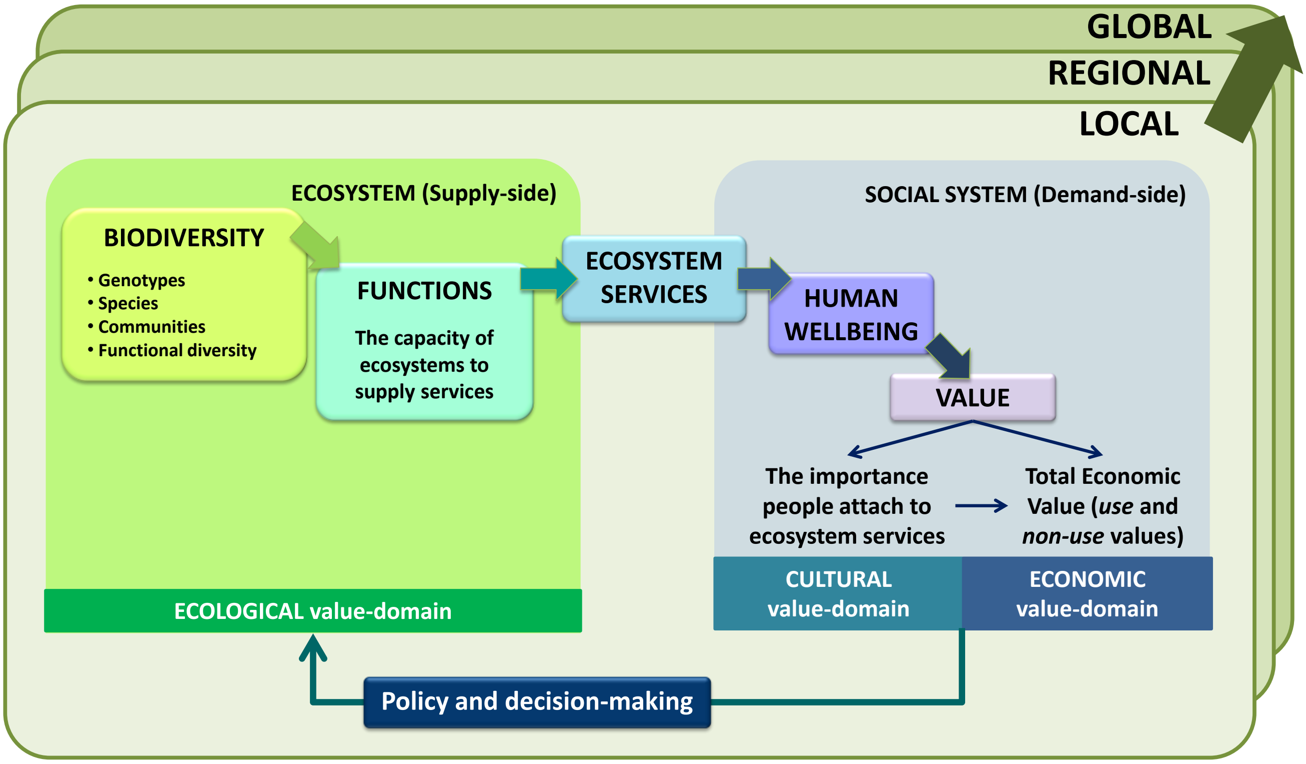

Figure 1. A multi-scale methodological framework for integrated valuation of ecosystem services which considers both the ecosystem services delivery (supply-side) and the use, enjoyment and value by stakeholders (demand-side), including ecological, cultural and monetary value-domains. Modified from Martín-López et al. (2014) building on Haines-Young & Potschin (2010).

This deliverable reviews the state-of-art of the integrated valuation of ecosystem services, covering (i) the rationale behind an integrated valuation of ecosystem services and terminological issues with regard to value and valuation (section 2); (ii) the major value dimensions to be covered by an integrated valuation of ecosystem services (section 3), and (iii) monetary and non-monetary techniques for ecosystem services valuation (section 4). We conclude by outlining defining characteristics of integrated valuation, advancing a tentative working definition, and suggesting future steps for the research agenda.

The rationale for integrated ecosystem services valuation

Terminological considerations on value and valuation

An important and necessary clarification in the application of the ecosystem services concept is the notion of value. Within the discourse about ecosystem services 'value' is easily misread as merely denoting monetary value (Gómez-Baggethun 2010; Chan et al. 2011; Jax et al. 2013). For example, Wikipedia refers to 'ecosystem valuation' as "a widely used tool in determining the impact of human activities on an environmental system by assigning an economic value to an ecosystem or its ecosystem services"[1]. Likewise, much of the economic literature on ecosystem services uses 'valuation', 'economic valuation', and 'monetary valuation' interchangeably, witnessing the disciplinary appropriation of a notion that has traditionally been used with different meanings in a wide diversity of disciplines of the social and natural sciences.

However, even if it is true that much research has put the focus on the monetary value dimension (e.g. Costanza et al. 1997; Balmford et al. 2002; Bateman & Turner 2003; Freeman 2003; Heal et al. 2005; Barbier et al. 2009; TEEB 2010), from both the history of the ecosystem services concept, as well as from many of its current uses, 'value' is by no means restricted to monetary value (Gómez-Baggethun et al. 2010). The word 'value' comes from Latin 'valor', which itself comes from '*valere*', that can be translated as 'being strong, having some kind of importance' (in Dendoncker et al. 2013). The first entry in the Oxford Dictionary defines 'value' as "the regard that something is held to deserve; the importance, worth, or usefulness of something". The second entry defines it as "[…] one's judgment of what is important in life". **The key word here is 'importance'.** Here, we endorse this broader understanding of value, following some of the relevant references of ecosystem services valuation (e.g. Costanza 2000; de Groot et al. 2002; 2010). De Groot et al. (2002; 2010) for example equate 'value' to 'importance'. Accordingly, valuation consists of an estimation of the worth, meaning, or importance of something. According to Costanza (2000), value is ultimately originated in the goals to which a society aspires. In consequence, **valuation refers to the understanding of the worth or importance of something and may be defined as "the act of assessing, appraising or measuring value, as value attribution, or as framing valuation** (how and what to value, who values)" (Dendoncker et al. 2013).

The case for value pluralism

The search for a 'fundamental value' or common substance conferring 'value' has long been the philosopher's stone of value theorists. Classical economists like Ricardo and Marx searched for the common substance of value in labour. For moral philosophers of classical utilitarianism like Bentham or Stuart Mill, the fundamental value is pleasure (defined as utility), and all the other objects we think valuable are so because they contribute to pleasure. Neoclassical economists brought this principle into economic analysis making the case that utility could be measured in money and calculated by people's willingness to pay. Finally, some authors from the natural sciences sought to find a common substance of value in energy or its derivate (such as exergy or emergy) the common substance of value. Despite the large ideological and epistemological differences that are apparent in these perspectives, all of them share an important common characteristic: they all endorse a monist theory of value (see Gómez-Baggethun & de Groot 2010).

[1] http://en.wikipedia.org/wiki/Ecosystem_valuation

While recognizing the synthetic power of monist approaches, prominent contributors to the debate on environmental valuation have argued that these approaches are bound to fail in their quest to capture an all encompassing picture of nature's importance (O'Neill 1996; de Groot et al. 2002; Martínez-Alier 2002). Georgescu-Roegen (1975; 83) and others after him have criticized monist theories of environmental value, either economic or biophysical, as forms of value reductionism capable of capturing only one dimension of nature's importance (see O'Neill 1996; Martínez-Alier 2002; Gómez-Baggethun & Ruiz-Pérez 2011).

Value pluralism is the idea that there are multiple values which in principle may be equally correct and fundamental, and yet in conflict with each other (Mason 2006; 2013; Norton & Nooman 2007). As opposed to value monism, value pluralists argue that there are several distinct values, and that they are not reducible to a unique value. The perspective of value pluralism thus departs from the assumption that recognizing multiple values is required to capture the diversity of needs and wants that nature can contribute to fulfill for society and individuals. This include physiological and subsistence needs, safety and protection, affection and sense of belonging, esteem and identity, and other possible components of quality of life (Maxlow 1943; Max-Neef 1992; MA 2005; Zorondo et al. 2014). Figure 2 shows the hypothetical relations between values, human needs (on the basis of the Maxlow's pyramid), and ecosystem services.

For the sake of our discussion, a value pluralism perspective comes from the assumption that valuation of the environment involves dealing with multiple and often conflicting valuation languages, whereby values may be combined to inform decisions, but may not be reduced to a single metric (Martínez-Alier et al. 1998; Gómez-Baggethun & Barton 2013). Value pluralism postulates that in many cases, conflicting values may be weakly comparable (Martínez-Alier et al. 1998), or and often incommensurable along a single rod of measurement (Neurath 1925; Kapp 1983; O'Neill 1996; Gómez-Baggethun 2010; Chan et al. 2012).

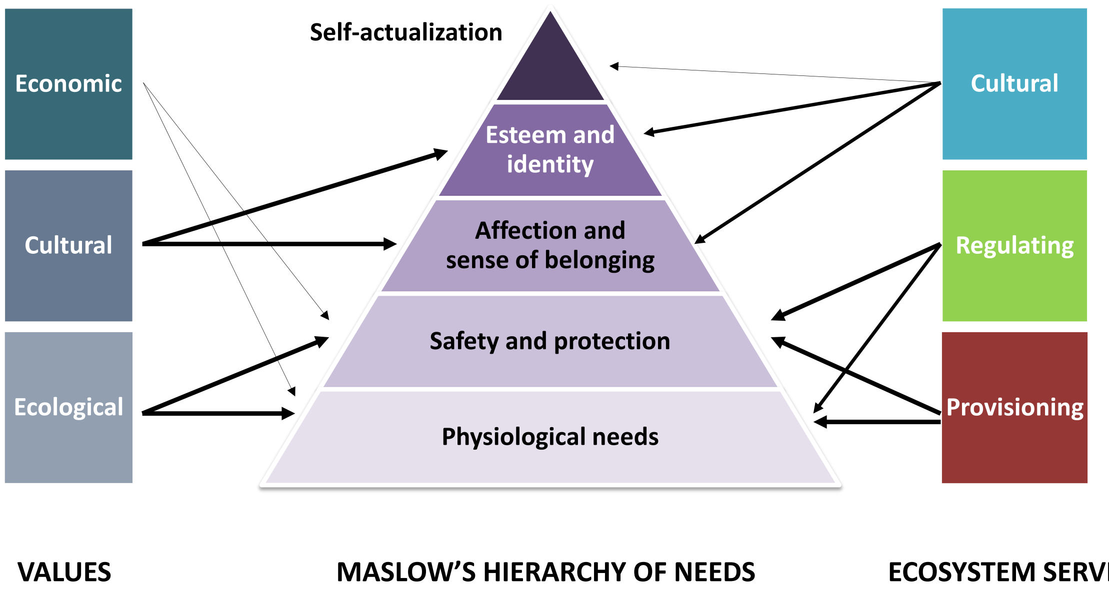

Figure 2. A hypothetical model that shows interlinkages between ecosystem services values (i.e. ecological, cultural, monetary), fundamental human needs as defined by Maxlow (1943) and categories of ecosystem services. The width of arrows indicates the level of contribution.

Interdisciplinary approaches like ecological economics[2] have endorsed value pluralism as one of their core conceptual foundations (Martínez-Alier et al. 1998) and in recent years multiple authors have called for the adoption of this principle in ecosystem services valuation (Gómez-Baggethun & de Groot 2007; Pascual et al. 2010; Gómez-Baggethun & Ruiz-Pérez 2011; Chan et al. 2012; Luck et al. 2012; Dendoncker et al. 2013; Gómez-Baggethun & Barton 2013; Jax et al. 2013; Luck et al. 2013; Reyers et al. 2013; Martín-López et al. 2014). Integrated valuation expands the scope of traditional ecosystem services valuation by explicitly endorsing the view of value pluralism as a core foundation.

The challenge of integrated valuation is now a frontier in ecosystem services science. Members of the Ecosystem Services Partnership (ESP) have recently set up a thematic working group on 'Value integration', which they define as 'the methodological challenge of consistently combining a diversity of value systems in resource use decisions'[3]. In addition, along with OpenNESS major international consortia conducting research on ecosystem services, including, OPERAs (http://operas-project.eu/), URBES (http://urbesproject.org/), and Greensurge (http://greensurge.eu/about/) have adopted (explicitly or implicitly) a value pluralism perspective and are currently addressing both monetary and non-monetary values of ecosystem services as a part of their research agenda.

IPBES has adopted from the outset a value pluralist perspective and is working on a deliverable on "Policy support tools and methodologies regarding the diverse conceptualization of values of biodiversity and nature's benefits to people including ecosystem services". On its webpage, IPBES affirms: "The assessment of tools and methodologies regarding multiple values of biodiversity to human societies is important for guiding the use of such methodologies in all IPBES work. Different valuation methodologies will be evaluated according to different visions, approaches and knowledge systems, and their policy relevance based on the diverse conceptualization of values of biodiversity and nature's benefits to people including provisioning, regulating and cultural services. This assessment will result in a guide, and subsequently promote and catalyse the further development and use of tools and methodologies on these issues. The aim is that such policy support tools will help guide decision-making by taking into account the multiple values of nature and its benefits."[4] In addition, IPBES recognizes that "All Nature's benefits have anthropocentric values [...] that can be expressed in diverse ways", recognizing the value pluralism of ecosystem services[5].

The frame or context dependency of values, that is, the recognition that value judgments are conditional on decision contexts (Kahneman and Tversky 2000; Vatn 2005) has been undercommunicated in the discourse on valuing ecosystem services. When conducting ecosystem services valuations, a critical preliminary step is defining the purpose or policy context that valuation aims to inform, e.g. awareness rising, priority setting, environmental accounting etc. Moreover, we may find high levels of heterogeneity within given valuation contexts, as the formation of values is conditional on stakeholders, their ability to form preferences, and alternatives/option/prospects, which are time and location specific. Determining at what

[2] The discussion on value pluralism has been major point of contention between two of the academic communities that have contributed more widely to the literature on ecosystem services valuation: environmental economics and ecological economics. For a review on the differences between ecological economics and environmental economics, see Munda (1997) and Venkatachalam (2007), and Braat and de Groot (2012).

[3] http://www.fsd.nl/esp/81931/5/0/50

[4] http://www.ipbes.net/work-programme/objective-3/45-work-programme/461-deliverable-3d.html

[5] http://ipbes.net/images/K1353197-en.pdf

resolution to recognize this heterogeneity is a practical problem for valuation, be it along monetary, cultural or ecological dimensions of value. Figure 3 shows that a specific ecosystem services may have different monetary, cultural and ecological values depending on the framing of the informed by valuation, meaning that different valuation techniques have to be considered. Valuation within OpenNESS will cover the major challenges address in the project in response to research priorities by the European Commission: human well-being, sustainable ecosystem management, good Governance and competitiveness (see Potschin et al. 2014).

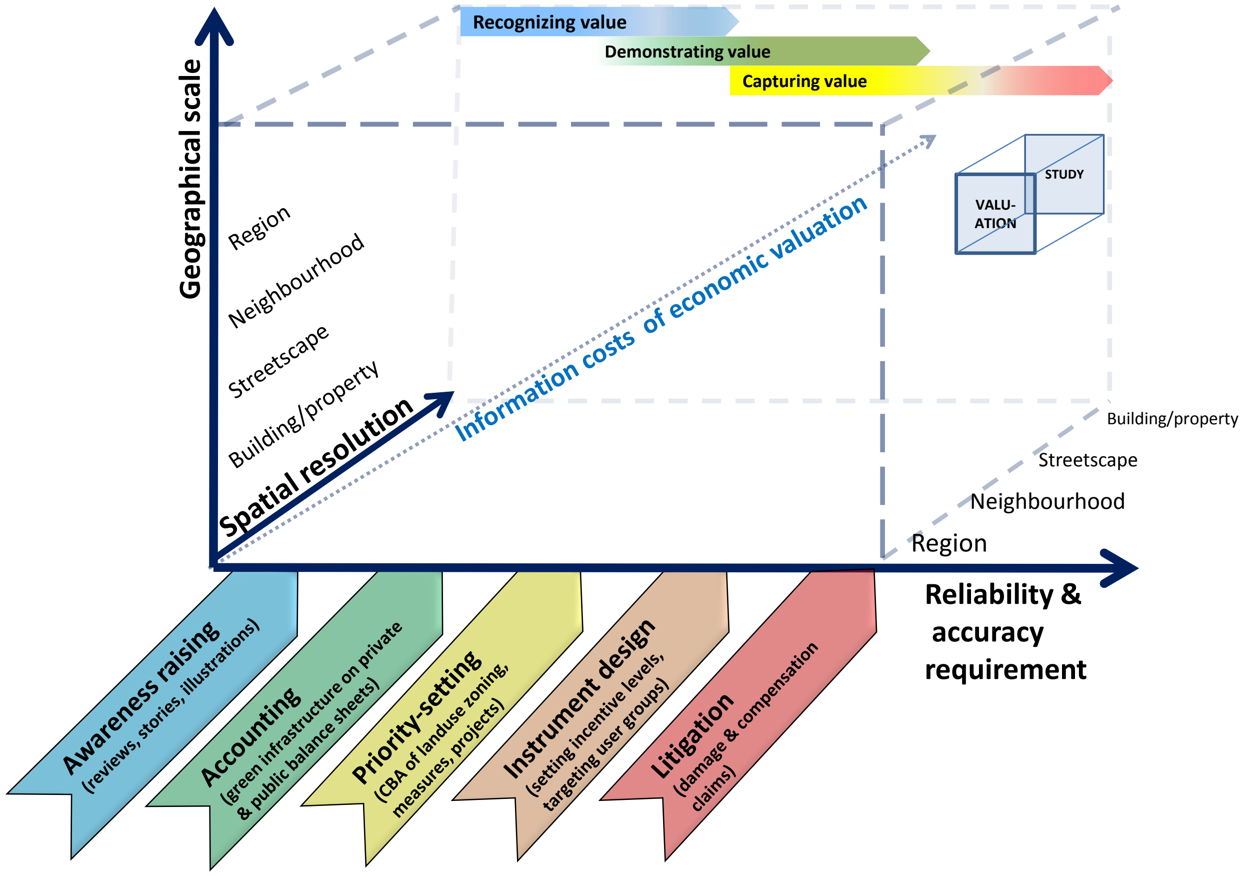

Figure 3. The purpose of the valuation and the policy context to be informed (along with the required level of accuracy) should be defined early in the valuation process to choose appropriate valuation techniques. Adapted from Gómez-Baggethun & Barton (2013).

Plural values in ecosystem services and biodiversity

The literature on ecosystem services valuation refers to multiple types of value, including ecological, economic, social, cultural, spiritual, symbolic, therapeutic, insurance and place values. For simplicity and consistency with previous value typologies in the ecosystem services literature (e.g. Farber et al. 2002; Howarth & Farber 2002; Limburg et al. 2002; Wilson & Howarth 2002; de Groot et al. 2002; 2010; Dendoncker et al. 2013; Castro et al. 2014), here we group values addressed in the ecosystem services literature into three broader categories or families: monetary, sociocultural, and ecological values. In

practice, the boundaries of these value types are often blurred. For example, the contribution of ecosystems to create employment, for example, may be seen as an economic values as much as a social one. Thus, this value categories should be seen to represent ideal analytical categories in a Weberian sense[6] (Weber 1949).

Monetary values

Monetary valuation[7] of the environment has traditionally conceived ecosystem services that are delivered and consumed in the absence of market transactions as a form of positive externalities that, if valued in monetary terms, can be more explicitly incorporated in decision-making processes (TEEB 2010). In order to capture a more comprehensive picture of the economic value of the environment, the literature on environmental economics identifies different types of monetary values that are generally added up to give the so-called Total Economic Value (e.g. Heal et al. 2005), which be understood as an heuristic displaying the different value dimensions that are of importance for the economic value. The Total Economic Value framework usually divides the economic value of ecosystem services into use- and non-use value categories, each subsequently disaggregated into different value components (Pearce and Turner 1990).

Use values include direct use, indirect use, and option values. Direct use values are derived from the conscious use and enjoyment of ecosystem services by individuals and stakeholders groups. These may be extractive, such as agriculture or fishing, or they may be non-extractive, such as recreational activities, nature tourism, and aesthetic enjoyment of landscapes. Hence, extractive direct use values are strongly related to provisioning services, while non-extractive direct use values are strongly related to cultural services. Indirect use values are associated with regulating services (e.g. soil fertility, water purification, climate regulation, pollination, etc.), without entailing awareness about the causal ecological chains that ensure their provision. Finally, option values are related to the future (potential) direct and indirect uses of biodiversity by individuals and stakeholders groups. The consideration of option value as a true component of the Total Economic Value (TEV) has been contested by Freeman (1993). Option value can be understood as a way of framing TEV under conditions of uncertainty or as the value of waiting for the resolution of uncertainty. An example of uncertainties surrounding the potential future uses and related option value of ecosystems and biodiversity is bioprospecting to discover potential medicinal uses of plants, which involve the question of whether or not any particular organism will prove to be of commercial use in the future.

Non-use values from ecosystems are those values that do not involve direct or indirect uses of the ecosystem service in question. They reflect satisfaction that individuals derive from the knowledge that biodiversity and ecosystem services are maintained and that other people have or will have access to them

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[6] Weber believed that we cannot understand a particular phenomenon just by describing the great diversity ways in which they are manifested in the real world. To avoid getting lost in complexity, functional classifications have to abstract from such diversity to synthesize many concrete individual phenomena into unified analytical constructs.

[7] Here we define monetary valuation pragmatically as those valuations that use money as a measurement unit. If the bulk of the litterature uses monetary and economic valuation as interchangable concepts, our choice for the term monetary is motivated by the observation that 'money' is a less contested concept than 'economics'. For example, the difference established by Aristotle between 'economics' (understood as the broader fulfillment of human needs), and 'chrematistics' (with a focus on money and market transactions) is sometimes used within schools of economic thinking (e.g. feminist, institutional, ecological) engaged in the the debate on valuation, where money is often seen as a specififc domain within the broader aspects covered by economics and valuation.

(Kolstad 2000). In the first case, non-use values are usually referred to as existence values, while in the latter they are associated with altruist values (in relation to intra-generational equity concerns) or bequest values (when concerned with inter-generational equity). Even non-use values as existence values are framed in a decision context, i.e. the decision about whether to maintain species and their habitats or not (where, when, and for whom, whether for own, altruistic or bequest motives).

Framing non-use values in monetary terms has been often criticized on the grounds that it represents a form of commodification in discourse that extends market values and norms to values that do not pertain to the monetary domain (Martínez-Alier et al. 2002; Gómez-Baggethun & Ruiz-Pérez 2011; Kallis et al. 2013).

Sociocultural values

People hold material, moral, spiritual, aesthetic, therapeutical, and other values towards the environment, all of which can affect their attitudes and actions toward ecosystems and the services they provide. These include emotional, affective and symbolic views attached to nature that in most cases cannot be adequately captured by commodity metaphors and monetary metrics (Norton & Hannon 1997; Martínez-Alier et al. 1998; Gómez-Baggethun & Ruiz-Pérez 2011; Daniel et al. 2012; Chan et al. 2012). Here, we refer to these values broadly as cultural values. Cultural values are included in all prominent ecosystem service typologies (de Groot et al. 2002; Millennium Ecosystem Assessment 2003; TEEB 2010). Yet, compared to monetary and ecological (or biophysical) values, cultural, experiential and other non-material values have generally received less attention (but see Chan et al. 2012; Daniel et al. 2012; Nieto-Romero et al. 2014).

The ecosystem services literature has variously defined cultural values as “aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems” (Costanza et al. 1997) or as “non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience” (MA 2005). Cultural values include intangible things such as the place value that emerge from people’s emotional and affective bonds to nature (Altman & Low 1992; Feldman 1990; Williams et al. 1992; Basso 1996; Norton & Hannon 1997; Brown et al. 2002), spiritual value where the conception of nature is intertwined with sacredness (Stokols 1990; Milton 2002), heritage value (Throsby 2001), sense of community (Doolittle & McDonald 1978; Chavis & Pretty 1999), and social cohesion (Lin 2001; Sable & Kling 2001; Doolittle & McDonald 1978; Gómez-Baggethun et al. 2012). All these values are created in the mind of the ecosystem services beneficiaries and therefore the same flow of ecological information may be differently labelled inspirational, educational or spiritual depending on who is the observer.

Finally, the fact that people are not willing to pay for specific ecosystem services does not mean that they do not value them in cultural terms (Gómez-Baggethun et al. 2009). Findings from empirical research show that those people who are not willing to pay money for maintaining ecosystem services can be the same people that are willing to contribute more time to conservation and restoration activities (that is, to pay in terms of energy and time) (Higuera et al. 2013). Time in nature is perceived as a means can fulfills basic affection and social needs, such as identity, good social relations, and freedom (Maxlow 1943; Max-Neef 1992). Recent research has made substantial progress in the quest to better integrate social perspectives and cultural valuation techniques into the ecosystem services framework, enabling a wider representation of cultural values in ecosystem service research and practice (e.g. Chan et al. 2012; Hernández-Morcillo et al. 2013).

Ecological values

The literature on environmental valuation has used the notion of ecological value in various contexts and with very different meanings, ranging from monetary values of ecosystems, to biophysical values, to intrinsic values of species, to values associated with ecosystem resilience and stability. In this sense, ecological values can be seen to cover instrumental (i.e., the value that services contribute to sustaining life on Earth and the provision of ecosystem services) as much as intrinsic values (i.e., the value inherent to biodiversity and ecosystems) (Turner et al. 2003). Because the ecosystem service approach has an obvious anthropocentric focus (Jax et al. 2013), whether ecological importance should be seen as a final value (direct input for decision making) or as an intermediate value that ultimately translates into sociocultural and economic values remains an open debate (Gómez-Baggethun 2010; García-Llorene et al. 2011). Ecological value is the least internally consistent of the value categories presented here and our characterization is expected to evolve as OpenNESS case studies test the usefulness and limitations of this notion when applied on the ground.

Much of the literature on ecosystem services valuation associates ecological values to the ecosystem functions, processes and components on which the delivery of ecosystem services ultimately depends (de Groot et al. 2002). The 'ecological value' or importance of a given ecosystem, therefore, would be determined by the integrity of the regulation and habitat functions of the ecosystem, by ecosystem parameters, such as complexity, diversity, rarity, and stability (de Groot et al. 2003). In addition, ecological value may be seen as representing the integrity of 'service-providing units', i.e., the component populations, communities, functional groups, as well as abiotic components such as habitat type, that contribute to ecosystem service provision (Luck et al. 2003; Kremen 2005; Harrington et al. 2010), which in turn determine the values (monetary and sociocultural) of ecosystem services (Kontigianni et al. 2010; García-Llorente et al. 2011).

Ecological values have also been linked to the notion of 'insurance value' (Armsworth & Roughgarden 2003; Pascual et al. 2010; Gómez-Baggethun & Barton 2013). Insurance value relates to ecosystem resilience and refers to the role of biodiversity and ecological infrastructure in securing ecosystem capacity to deliver ecosystem services in the face of disturbance and change. Securing such capacity involves maintaining critical amounts of ecological infrastructure and key service-providing units for 'healthy' functioning, sometimes referred to as 'critical natural capital' (Deutsch et al. 2003). In daily practice, the status of critical natural capital and related insurance values are sometimes recognized by the precautionary conservation of stocks, or setting of safe minimum standards. The idea of insurance as connected to biodiversity and ecological structures stems from both empirical work and modelling exercises indicating that species diversity and functional diversity is thought to compensate fluctuations in individual species populations and the functions they perform within their systems (Ehrlich & Ehrlich 1981; Walker 1992; Loreau et al. 2001). 'Self-repairing' capacity of ecosystems (i.e. resilience) in the face of disturbance requires redundancy of species involved in performing specific ecosystem functions (Elmqvist et al. 2003; Mori et al. 2013).

Other authors link ecological valuation to the notion of biophysical measures (Martínez-Alier 1987) and ecologists have often used the word value in its broader understanding as numerical measurement or, more specifically, as "the numerical amount denoted by an algebraic term; a magnitude, quantity, or number" (third entry of value in the Oxford Dictionary). This broader definition, however, is ill suited to the definition we adopted on the outset of value as 'importance' because it does not explicitly define the importance for whom or for what. Biophysical measures such as tons of sequestered carbon, cubic meters

of timber, and joules of biomass energy represent environmental accounts (i.e. systematic records of stocks and flows of materials, energy and information), but do not automatically qualify in and of themselves as values. Biophysical measures qualify as values when put in relation to some attribution of societal importance, which often involves converting biophysical indicators into constructed scales (e.g. ranging from very low to very high importance for a particular purpose). If the ecosystem services literature often refer to biophysical measures merely as a prerequisite for conducting economic valuations it should be noted that biophysical measures can be used directly to guide environmental decision making and planning with no need for further conversions. Again, the choice for a meaningful metric depends on the policy context and valuation purpose. If the question is whether a given policy target of environmental quality has been reached (e.g. for air quality or offsetting of GHG emissions) biophysical measures can do the job, but if the question at stake is what is the most cost-effective alternative to reach a given environmental standard (e.g. abating CO_2 emission through a change in technology vs. planting trees) then translation to monetary terms will be required.

Grounding the definition of value in societal goals does not mean that objective measurement does not have a role to play in valuation. Furthermore, because some ecosystem services are essential to sustain human and non-human life, these services are objectively important for society, irrespective of where they may rank in valuations based on subjective preferences (Gómez-Baggethun & de Groot 2010). For example, maintaining the critical ecological infrastructure to secure a sustained intake of 2,000-3,000 Kcal per person per day is essential to fulfil the basic physiological needs of individuals. The same applies to critical supplies of services, like air purification or water regulation, when technological substitutes are not technically feasible or economically affordable. That people may not be willing (or able) to pay for essential ecosystem services does not make them less important from a perspective of objective physiological needs. Therefore, the ecological importance of biodiversity and ecosystem services roots in the fact that, on one hand, specific ecosystem services (e.g. food, freshwater, air purification, water regulation) satisfy physiological human needs of society and, on the other hand, ensure the maintenance of other ecosystem services (e.g. nature tourism, recreation activities, environmental education, local identity, or spiritual values) that are essential for satisfying other fundamental human needs, such as affection, identity, leisure, or creativity (Figure 2).

Monetary and non-monetary valuation techniques

Before the recent push towards integrated valuation, monetary valuation had come to be so dominant in the ecosystem services literature that - as discussed above -, the very notion of valuation came to be widely identified with monetary valuation. Yet, despite the dominance of monetary valuation in ecosystem services literature, some authors have argued that its use in current decision-making processes is deficient (Laurans et al. 2013; Laurans & Mermet 2014).

In recent years, some authors have referred to the monetary and non-monetary values of ecosystem services in an attempt to open up the narrow understandings of ecosystem services as monetization Gómez-Baggethun et al. 2009; Christie et al. 2012; Gómez-Baggethun & Barton 2013; Castro et al. 2014), and developed techniques for their elicitation (Calvet-Mir et al. 2012; Martín-López et al. 2014). Below, we use the monetary vs. non-monetary divide to summarize different methods and approaches used to capture different values in ecosystem services (Figure 4).

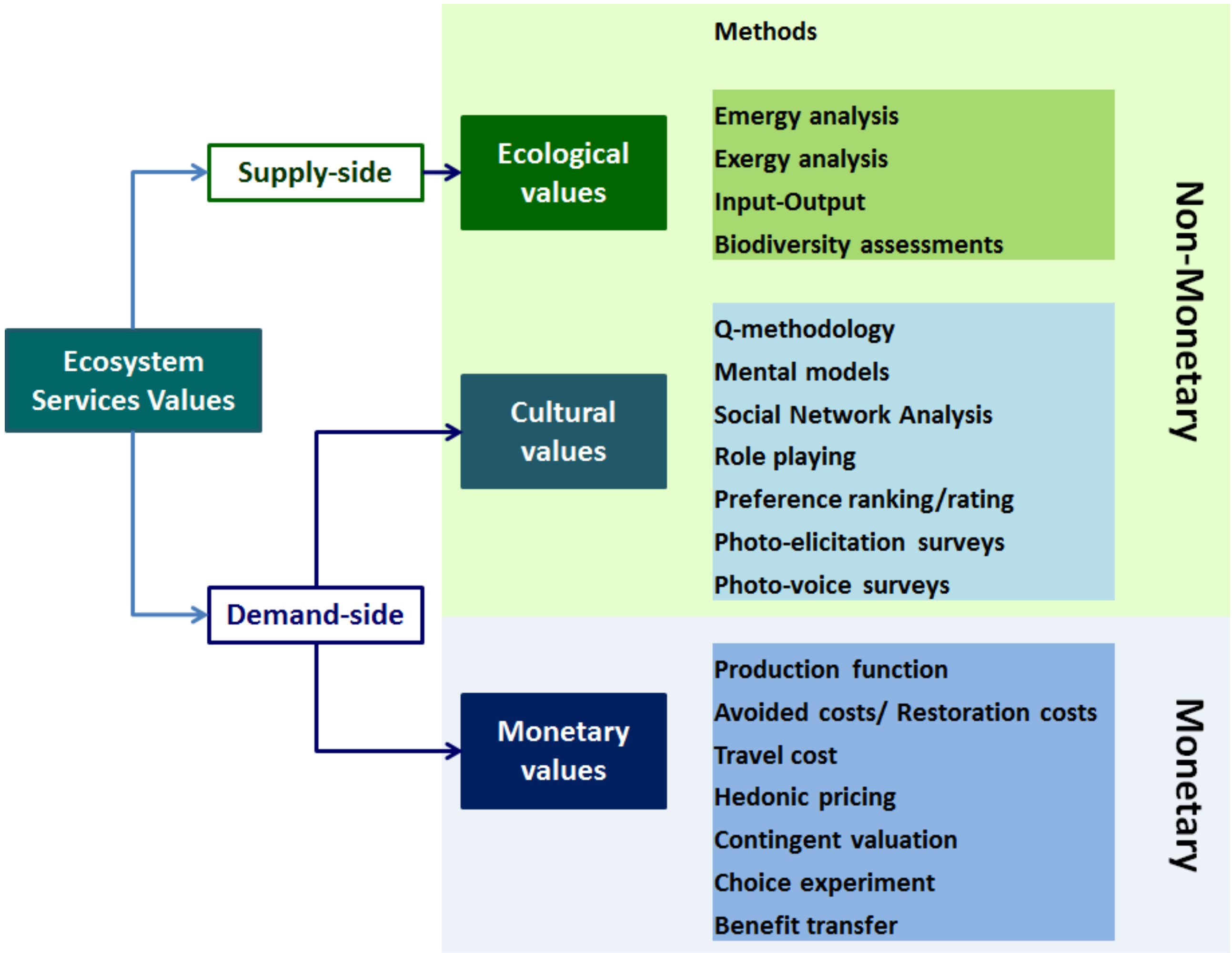

Figure 4. Methodological toolbox for an integrated valuation of ecosystem services which considers non-monetary and monetary valuation methods and the value-pluralism.

Again, the link of certain valuation methods with certain value dimensions represents broader connections and should not seen to be exclusive. For example, it is technically possible to use economic valuation methods or preference ranking methods to value ecological and cultural aspects and integrated frameworks such as CBA or MCDA can cover all value dimensions. Yet, the figure gives tentative guidance of the range of valuation techniques that may be suitable for addressing different types of values (see also Gómez-Baggethun & de Groot 2010; Pascual et al. 2010).

Monetary valuation

Since the 1960s, monetary valuation of environmental externalities has been the core focus in environmental economics. Environmental economics has expanded the scope of orthodox neoclassical economics by developing concepts, methods, and tools to value economic impacts on the environment (e.g. pollution and degradation) in economic terms (most often monetary, but also in terms of contributions to employment or health) and to design policy instruments to internalize external economic costs into decision making and economic transactions. In order to capture hidden costs and benefits in economic activity, monetary values that are not captured in conventional accounts for market transactions are measured and often incorporated into extended cost-benefit analysis (Hanley 2001; Balmford et al. 2002; Barbier et al. 2009; Freeman 2003).

In an attempt to render visible the hidden costs of economic development, the focus of monetary valuation of the environment was initially put on the valuation of negative externalities, like pollution or resource depletion. In recent decades, however, monetary valuation has extended to positive environmental externalities, such as ecosystem services whose benefits are not mediated by markets. An economic valuation of ecosystem services *avant la lettre* was implicit in Krutilla's rule. In the context of a cost-benefit analysis of dams, Krutilla gave a high economic present value to the loss of landscape amenities - a cultural ecosystem service in our jargon - (Krutilla 1967). Since Krutilla's publication, monetary value has generally been divided into use and non-use values, each subsequently disaggregated into different value components that are generally added up to the so-called Total Economic Value (TEV) framework (e.g. Heal et al. 2005). For the elicitation of these different value types, a range of monetary valuation techniques have been developed and increasingly refined (reviewed in TEEB 2010).

Within the TEV framework, values are derived, if available, from information on individual behavior provided by market transactions relating directly to ecosystem services. In the absence of such information, price information is typically based on proxies derived from parallel market transactions that are associated indirectly with the good to be valued (as in the case of the hedonic pricing method), or on observed consumed behavior (as in travel cost methods). In their absence, valuation studies have relied on expected consumer behavior in hypothetical markets simulated through surveys (stated preferences) as in the case of contingent valuation and choice modelling methods. The three situations described above correspond to a common categorization of the available techniques used to value ecosystem services: (a) direct market valuation approaches, (b) revealed preference approaches and (c) stated preferences approaches. Values from original valuation study sites are sometimes applied to other sites/situations through “benefit transfer” techniques (Barton 2002). However, the practice of benefit transfer is interesting from the point of view of “value heterogeneity” because the analyst performing the transfer makes assumptions about the decision context itself (unit value transfer), or the significant variables of the decision (benefit function transfer) being the same at all the sites values are transferred to. The requirements of benefit transfer are also of interest to ES mapping, which often extrapolate value estimates from specific study locations to a region. A detailed description of these techniques is beyond the scope of this document, but comprehensive syntheses are available in the literature (e.g. Heal 2005; Barbier et al. 2009; Pascual et al. 2010; TEEB 2010).

Non-monetary valuation

Non-monetary valuation of ecosystem services has gained growing in attention in recent years (Gómez-Baggethun et al. 2009; Christie et al. 2012). In the context of ecosystem services, non-monetary valuation has been used in reference to a heterogeneous collection of valuation approaches and methods whose only shared characteristic is not relying on market logics and monetary metrics (Kelemen et al. 2014). Non-monetary valuation expresses an explicit distinction from the valuation methods based on neoclassical economics as it examines the importance (including cognitive, emotional, and ethical arguments), preferences, needs, or demands expressed by people towards nature (De Groot et al. 2010; Chan et al. 2012; Castro et al. 2014). Furthermore, non-monetary valuation offers alternatives and solutions to some of the methodological difficulties and limitations of monetary valuation (Baveye et al. 2013).

In spite of the growing number of scientific papers that present ecosystem service assessments based on non-monetary methods (e.g. Lamarque et al. 2011; Calvet-Mir et al. 2012; Martín-López et al. 2012), non-

monetary valuation does not yet constitute a formalized methodological field in ecosystem services valuation. As such, it often applies coarse and arbitrary indicators (Hernández-Morcillo et al. 2013) and often produces results that are difficult to operationalize. In this context, developing the applicability of non-monetary methods to real world policies is paramount. Key challenges to be addressed towards the methodological formalization of non-monetary valuation of ecosystem services are the clarification of the contested terminology and delineation of the boundaries of this methodological field (Kelemen et al. 2014).

Contested terminology refers to the fact that there are various competing terms in the scientific literature applied to distinguish specific methodological approaches from monetary valuations. Terms, such as ‘psycho-cultural valuation’ (Kumar & Kumar 2008), ‘social valuation’ (James et al. 2013; Casado-Arzuaga 2013), ‘deliberative valuation’ (Howarth & Wilson 2006; Kenter et al. 2012), ‘qualitative valuation’ (e.g. Zendehdel et al. 2008) and ‘subjective assessment’ (Aretano et al. 2013), are examples of the broad umbrella of valuation approaches that emphasize stakeholder participation in expressing individual, as well as group values and perceptions and that consider joint and individual preference formation as part of the valuation process itself. The situation if further complicated by the fact that deliberative valuation can also be used in the context of monetary valuation (see e.g. Spash 2007). The terms ‘non-economic’ and ‘non-monetary’ valuation have been included in recent reviews of ES assessments (e.g. Calvet-Mir et al. 2012; Milcu et al. 2013, Christie at al., 2012) and as part of comprehensive categories of various social scientific and participatory methods (e.g. surveys, interviews, focus groups, citizens’ juries, etc.). Recently, ‘socio-cultural valuation’ has been applied as an umbrella term for preference ranking methods analyzing human preferences towards ecosystem services in non-monetary terms (e.g. Gómez-Baggethun et al. 2009; Calvet-Mir et al. 2012; Castro et al. 2014; Martín-López et al. 2014).

This diversity of related terms calls for an examination of which constitute equivalent concepts and otherwise what are the nuances and connotations that distinguish them from each other. A further question that follows is which one of the above terms should be used as a comprehensive umbrella concept? The term non-monetary valuation emerged and has proliferated at a time when the literature on ecosystem services valuation has been largely dominated by monetary valuation. In this context, non-monetary valuation challenges the vision that identifies valuation of ecosystem services with their monetization, thus promoting reflection upon the plurality of values attached to ecosystem services. Once the idea of value pluralism becomes widely accepted in the ecosystem services academic community, the term non-monetary valuation will be ready to be substituted by affirmative names that express the ‘*differentia specifica*’ of the various methods that are currently clustered within this label.

The second challenge identified by Kelemen et al. (2014) refers to blurred boundaries of the methodological field. A broad range of methods have been used to value ecosystem services in non-monetary terms, including quantitative and qualitative research techniques (i.e. surveys, interviews), participatory and deliberative tools (focus groups, citizens juries, participatory or rapid rural appraisal, Delphi panels, etc.), as well as methods expressing preferences in non-monetary but quantifiable terms (i.e. preference assessment, time use studies, Q-methodology, criteria weighting in multi-criteria analysis) (Christie et al. 2012; Castro et al. 2014).

Some studies also consider the spatial representation of ecosystem services (i.e. ecosystem services demand mapping) (e.g. Bryan et al. 2010; Garcia-Nieto et al. 2013; Palomo et al. 2013) and analytic tools

rooted in biophysical approaches (i.e. emergy-exergy analysis) as part of the broader family of non-monetary valuation tools (Naredo 2001). From the supply side perspective, biophysical valuation methods have been used to calculate physical costs (e.g. in time, energy, materials, area) involved in the production of ecosystem services (Gómez-Baggethun & de Groot 2010. Biophysical approaches assess value based on the intrinsic properties of objects by measuring underlying physical parameters (see Patterson 1998 for a review) and can be more useful for valuing depreciation of natural capital stocks than ecosystem services flows. Examples of biophysical valuation include energy analysis (Costanza 1980), emergy analysis (Odum 1996), exergy analysis (Naredo 2001), ecological footprint (Wackernagel & Rees 1997), material flow analysis (Daniels and Moore 2002) and land-cover flow (EEA 2006) (reviewed in Gómez-Baggethun & de Groot 2010).

While both pertaining to the family of non-monetary valuation techniques, sociocultural and biophysical valuation methods arise from radically different epistemological foundations (Figure 4). They have different theoretical roots, they define the subject of valuation and the meaning of value along different lines, and they are used to value essentially different ecosystem services, which begs the question of for how long these very different methods can be grouped together under one umbrella. Due to the high heterogeneity of non-monetary techniques, it is difficult (and probably not desirable) to arrive at the same level of methodological consistency of monetary valuation based on neoclassical economics. Dividing the large group of non-monetary valuation methods into subgroups expressing the different ontological and epistemological foundations within this field is desirable for both theoretical and methodological clarity. The formalization of non-monetary valuation is easier if smaller (and more coherent) subgroups of similar non-monetary techniques are created, which would also contribute to maintaining the plurality of methodological approaches within the field. Because different methods to value ecosystem services reveal different types of information (Martín-López et al. 2014) they can be applied in different contexts in order to better fit with the institutional regimes or with the diversity of ecosystems and stakeholders involved.

Towards an operational integrated valuation framework

Defining features of integrated valuation

Integration means combining one thing with another to form a coherent whole. **Integrated valuation should support decisions on the basis of a consistent integration of multiple types of value (e.g. ecological, cultural and monetary) to inform decision making processes**. The word ‘consistent’ is used here on purpose to denote that integrated valuation does not merely consist of putting together different ecosystem service values assessed independently to inform environmental decisions, but also to examine how these different values stand in relation to each another. This involves addressing questions like: what are the trade-offs involved, which values stand in conflicting or otherwise reinforcing relation to each other, and if a particular value may have veto power over other values (e.g. if the sacred character a community attributes to an ecological site or the impossibility of finding equivalent substitutes through human-made capital or ecological restoration renders meaningless its monetary valuation). Eliciting multiple values to inform decisions is thus a necessary but not sufficient condition for integrated valuation. **Valuations that measure multiple values but cannot address associated trade-offs or can do so only to a limited extent can be seen as repressing hybrid valuations rather than truly integrated valuations.** Just as multidisciplinary research is a preliminary step towards the development of interdisciplinary research (and

eventually towards the transdisciplinary ideal where disciplines are flawlessly orchestrated), hybrid valuations can be seen as a preliminary stage towards the development of integrated valuation frameworks. Defining conditions and contexts where different values may (or may not) be compressed into single units, and defining epistemological boundaries within which different valuation approaches can be consistently combined in a single framework, are critical tasks for the research agenda on integrated ecosystem services valuation.

Integration challenges in ecosystem services valuation extends beyond values to other relevant information aspects, including the integration of i) disciplinary domains, ii) knowledge systems, iii) qualitative and quantitative information, iv) values emerging at different levels of societal organization, and v) value articulating institutions. Firstly, because ecosystem services cross cut various environmental components (e.g. soil, water, biota) and societal domains (stakeholders, value-systems, distributive conflicts, power asymmetries, etc.), **integrated valuation typically involves an interdisciplinary effort comprising multiple expert domains from both the social and the natural sciences** (Vila et al., 2002). **Interdisciplinarity, transdisciplinarity, and methodological pluralism** (Norgaard 1989) **are key elements in integrated ecosystem services valuation.**

Second, **integrated valuation of ecosystem services should feed on different knowledge systems** (Tengö et al. 2014). Knowledge systems are the agents, practices, and institutions that organize the production, transfer and use of knowledge (Cornell et al. 2013). Relevant knowledge systems for integrated ecosystem services valuations include the formal scientific knowledge held by research communities, the lay knowledge held by practitioners and local actors affected by a given decision over ecosystem services, the traditional ecological knowledge (TEK) held by indigenous and peasant communities that have reached a deep understanding of ecological dynamics from long term observation and learning from crises and mistakes (Gómez-Baggethun et al. 2012). Over the last decade, a growing body of contributions from the scientific community have called for the recognition of local, indigenous, and TEK systems as critical sources of information to enhance our understanding of biodiversity and ecosystem services (Turnhout et al. 2012; Gómez-Baggethun et al. 2013; Tengö et al. 2014). Furthermore, the Convention on Biological Diversity's call to recognize and protect TEK for the conservation and sustainable use of biological diversity (CBD 1992, art. 8) has been taken up by major international initiatives for the protection of ecosystem services and biodiversity, such as the Millennium Ecosystem Assessment (Reid et al. 2006) and TEEB (Brondizio et al. 2010). More recently, IPBES has put a major emphasis on the importance of TEK in sustaining ecosystem services and biodiversity worldwide and one of its expert groups focuses on the development of procedures, approaches and participatory processes for working with indigenous and local knowledge systems[8].

Third, **integrated ecosystem services valuation should rely on both qualitative and quantitative information** (Patton, 2001; Zendehdel et al. 2008). Measuring ecosystem services requires a sophisticated systems-based approach that accounts for how services are generated, how they interact with each other, and how changes in the total bundle of services influence human well-being (Reyers et al. 2013). Yet, some ecosystem services renders themselves better for qualification than for quantification. For example, the difficulty of measuring ecosystem services in biophysical terms can be high in cultural ecosystem services,

[8] www.ipbes.net/work-programme/objective-1/45-work-programme/453-deliverable-1c.html

which usually lack a direct biophysical or monetary counterpart. Valuing cultural services thus often demand holistic approaches that may include qualitative measures, constructed scales, and narration (Patton 2001; Chan et al. 2012). In some cases, tools have been developed to quantify cultural services and values using scores and constructed scales as in the cases of sense of place (Williams & Roggenbuck 1989; Shamai 1991), aesthetic values (López-Santiago et al. 2014) and levels of TEK (Gómez-Baggethun et al. 2010b). In other cases, however, quantifying cultural services may be too difficult or simply meaningless (Chan et al. 2012). and yet in other situations, measuring ecosystem values in metrics that fail to capture the way in which the concerned stakeholders understand their importance may have detrimental effects for their protection (Turnhout et al. 2014). For example, extending monetary valuation to ecosystem services that are not expected to be governed by market values and norms can be counterproductive by producing the metrical technology required for their commodification (Robertson 2006; Gómez-Baggethun & Ruiz-Perez 2011). Sound articulation of social and cultural values in decision-making generally involves some sort of deliberative process, locally defined metrics, and valuation methods based on qualitative description, public discourse and narration (Sagoff 1998; Vatn 2009; Chan et al. 2012).

Fourth, **integrated valuation should cover values emerging at different levels of societal organization, from individuals, to communities, to nations**. A key distinction in valuation is whether we consider values as individual preferences rooted in particular worldviews and perceptions, or whether we assume that valuation is actually a social process in which values are discovered, constructed and reflected in a dialogue with others. Sagoff (1998), for example notes that the values we express as consumers making choices on the basis of our individual preferences are very different from the values we express and citizens that take political decisions at an aggregated societal level. If the aim is to assess individual preferences, then the appropriate methods to elicit values may be valuation techniques based on surveys, either monetary such as the willingness-to-pay questionnaires, or non-monetary, as in socio-cultural valuation methods for preference ranking (e.g. Calvet-Mir et al. 2012). Ecosystem services with private good character such many provisioning services, are more amenable for valuation methods that are based on individual rationality.

At the community level, valuation methods based on group deliberation will be more suitable. These may include citizen juries or stakeholder forums where people can learn about the implications of alternative courses of actions on ecosystem services, and their importance to other people, and in consequence reconsider their initial value positions. According to Vatn (2009: 2211), deliberative methods are recommendable for valuing most ecosystem services. This is because most ecosystem services, such as carbon sequestration or water purification, are common goods the existence of which has consequences for other people, in other parts of the world, and across generations. These choices are fundamentally ethical and therefore Vatn argues that individual preferences—"What I want"—are not the best basis for societal choice concerning this type of ecosystem services. The right question is rather that "What are we entitled to", a claim that becomes negotiable by public standards (Pitkin 1981). When addressing values at larger levels of societal organization such as nations, where deliberation by small groups may not be representative of the values by society at large, it can be useful to look at values embedded in legal documents such as laws, constitutions and multilateral conventions. For example, national laws and European Union Directives for environmental protection (e.g. the Water Framework Directive) make explicit reference to ecological and economic values that are relevant for ecosystem services protection. Constitutions can also reflect the way a particular recognizes the importance of nature. For example, constitutions permeated by values of indigenous societies like of Bolivia and Ecuador, formally recognize

rights to nature, and the latter declares ecosystem services as public goods that may not be subject of private appropriation. Individual and group-based valuations are not necessarily mutually exclusive and may provide complementary information with regard to how values are expressed at different levels of societal organization. Furthermore, deliberative valuation is not necessarily at odds with monetary valuation because it is possible to combine group deliberation with monetary valuation (see e.g. Spash 2007, Wilson and Howarth 2002). It is not the unit of measurement which counts but whether the values are reached through give-and-take of arguments or individual consideration of what is in one's best interests.

Finally, **integrated valuation should be able to accommodate different valuation rationalities**. As discussed in the above paragraph, the various framing and measuring values are not neutral instruments that merely reveal the values people hold towards ecosystem services. Social processes of valuation, either monetary or non-monetary, are value articulating institutions, i.e., constructed set of rules that not only reveal values, but also contribute to shape and construct them in the valuation process itself (Jacobs 1997; Vatn 2009). Valuation methods and associated rationalities are frames invoked in the process of expressing values that regulate and influence which values come forward, which are excluded, and what sort of conclusions can be reached (Vatn 2005). People exhibit different preferences depending on the socio-institutional environment in which they express them. As Kallis et al. (2013) put it "Different values will be favored in a market than in a church". For example, experiment results by Liberman et al. (2004) found that when they repeated a Prisoner's Dilemma game labeled 'the Community Game', roughly twice as much respondents were willing to cooperate compared to when the game was labelled 'the Wall Street Game'. The analytical concepts and the methods chosen for ecosystem services valuation have important framing effects (Gomez-Baggethun et al. 2010). Just as concepts like natural capital and ecosystem services, set human-nature relations into an anthropocentric perspective (Jax et al. 2013), monetary valuation methods sets them into a relation of exchange, expanding to some extent the economic rationality of the profit calculus. Because there are multiple rationalities other than utilitarianism through which humans choose courses of action – such as consequential, rights-based, and procedural rationalities – (Martínez-Alier et al. 1998; O'Neill 2001; Spash & Hanley 1995; Spash 2012; Pacheco 2014), there are multiple relevant languages of valuation. For this reason, integrated valuation makes an ethical and epistemological plea, not only for plural values, but also for plural value articulating institutions. In this wide, integrated valuation should be interpreted as a process, approach or a management philosophy, rather than a method or even a framework.

Towards a working definition

Based on the characteristics described above, we advance a tentative definition of integrated ecosystem services valuation as "**the process of synthesizing relevant sources of knowledge and information to elicit the various ways in which people conceptualize and appraise ecosystems services values, resulting in different valuation frames that are the basis for informed deliberation, agreement and decision**". Given that integrated valuation is an emerging field of research, we take this as a working definition that will evolve as the literature on the field expands and that will have to be adjusted as it gets exposed to criticism.

Our definition of integrated ecosystem services valuation shares some characteristics with related notions that are well established in the literature, such as environmental assessment or Integrated Environmental Assessment (IEA). Environmental assessment has been defined as the process of gathering, synthesizing,

interpreting and communicating environmental knowledge from various expert domains and disciplines, to help policy actors think about problems or evaluate possible actions (Parson 1995). IEA as a multi- or interdisciplinary effort that should result in policy relevant output for an environmental problem (Toth & Hiznyik 1998). Integrated valuation shares with these concepts the interdisciplinary and applied character.

We contend that **the focus of ecosystem services valuation is primarily practical and aimed at serving operationalization and real-world applications of the ecosystem services concept. It belongs to the science-policy interface and should ideally render information that is digestible and useful for stakeholders, decision-makers, and planners, as well as should allow different stakeholders groups to express the plurality of values and perspectives they hold. Its scope of application can range from purposes of awareness rising (e.g. rendering values of biodiversity visible to society), policy instrument design (e.g. Payments for Ecosystem Services), priority setting (e.g. informing costs and benefits of land use change), and environmental litigations (e.g. to claims of compensations for environmental damage), among others**.

The conceptual foundations of integrated valuation of ecosystem services suggested here are expected to give path to the development of an operational framework or at least a well-defined approach for articulating social, ecological and monetary values in environmental decision-making and planning. **We contend that an integrated valuation framework should include at least four basic steps. First, the purpose of the valuation and the policy setting should be defined early in the process (Figure 3; Gómez-Baggethun & Barton 2013). Second, a scoping stage should follow in order to identify the relevant values, domains of expertise, knowledge systems, and information sources. Third, valuation methods selected on the basis of the previous steps are applied covering different values and valuation rationalities. Finally, the way in which the elicited values stand in relation to each other (e.g. cases of trade-offs, coexistence, and synergy) and related value conflicts among stakeholders should be examined and communicated in way that provides relevant information to the practitioners, decision-makers, and planners affected by the policy process.**

This document has synthesized the core theoretical foundations for an integrated ecosystem services valuation, including its rationale, definition, and basic methodological steps, thereby setting the grounds to build deliverable D4.2: Framework for integration of valuation methods to assess conservation policies.

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