
# Report on Social Mapping and Assessment Methods for Ecosystem Services

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**ESMERALDA**

**Enhancing ecosystem services mapping for policy and decision making**

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## Preface

Mapping and assessment of ecosystems and their services (ES) are core component to the EU Biodiversity (BD) Strategy. They are essential if we are to make informed decisions. Action 5 sets the requirement for an EU-wide knowledge base designed to be: a primary data source for developing Europe's green infrastructure; resource to identify areas for ecosystem restoration; and, a baseline against which the goal of 'no net loss of BD and ES' can be evaluated.

In response to these requirements, ESMERALDA (Enhancing ecoSysteM sERvices mApping for poLicy and Decision mAking) aims to deliver a flexible methodology to provide the building blocks for pan-European and regional assessments. The work will ensure the timely delivery to EU member states in relation to Action 5 of the BD Strategy, supporting the needs of assessments in relation to the requirements for planning, agriculture, climate, water and nature policy. This methodology will build on existing ES projects and databases ( i.e. MAES, OpenNESS, OPERAs, national studies), the Millennium Assessment (MA) and TEEB. ESMERALDA will identify relevant stakeholders and take stock of their requirements at EU, national and regional levels.

The objective of ESMERALDA is to share experience through an active process of dialogue and knowledge co-creation that will enable participants to achieve the Action 5 aims. The flexible methodology proposed will integrate biophysical, social and economic mapping and assessment methods. ESMERALDA is organized based on six work packages, which are organised through four strands, namely policy, research, application and networking, which reflect the main objectives of the project (Figure 1).

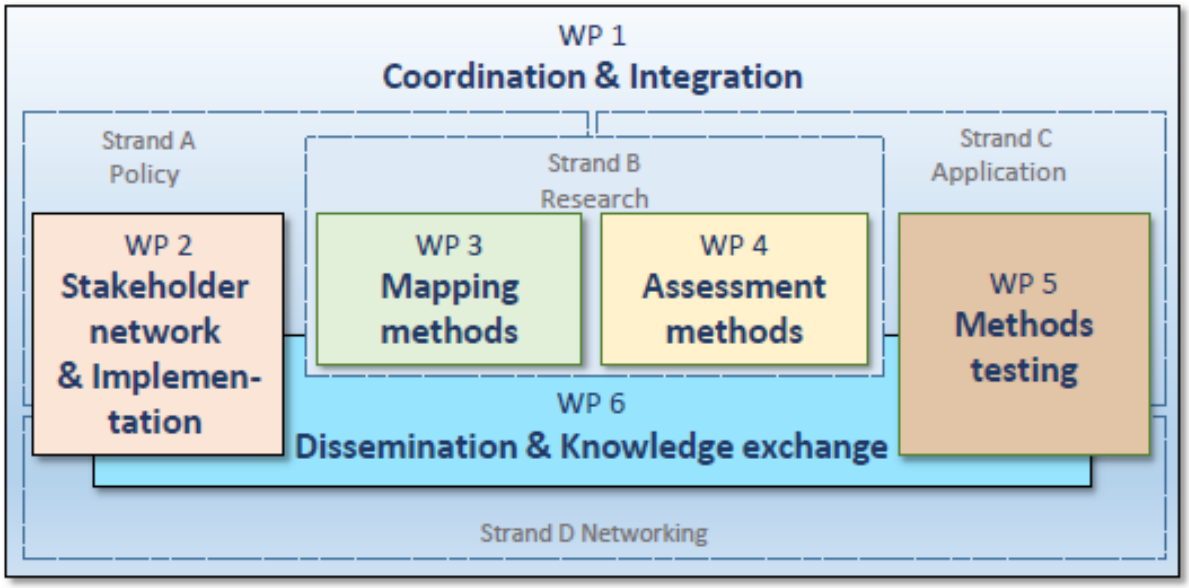



**Figure 1:** ESMERALDA components and their interrelations and integration within the four project strands.

This report sits within work packages WP 3 "Mapping methods" and WP4 "Assessment Methods". When making the proposal, the original idea was to investigate similarities and differences when using methods for the mapping and/or assessment of ecosystem services; as a result the effort was split across two different work packages, namely WP 3 "Mapping methods", and WP4 "Assessment

Methods". The work found that it was very difficult to make a clear distinction between social methods for mapping and/or assessment methods; there was also potential duplication of material between the two elements. A discussion within the project community, led to the decision to merge deliverables on social methods for mapping (WP3) and assessment (WP4) of ecosystem services.

## Summary

This report provides an overview of the main social methods for mapping and assessment of ecosystem services. It addresses the challenge of improving the applicability of these methods with specific examples, particularly with respect to the MAES process and the ESMERALDA case studies. In this context, the term "mapping" is used to mean the description and representation of spatial variation. Mapping therefore includes both the representation of data on maps and/or the process of accounting for spatial variation in the phenomena under consideration. Social methods for mapping of ecosystem services examine spatial variation in social preferences of ecosystem services.

The process of mapping ecosystem service falls within the broader process of ecosystem service assessment (Potschin-Young, M. et al., 2018). The term "assessment" is defined in ESMERALDA as "the analysis and review of information derived from research for the purpose of helping someone in a position of responsibility to evaluate possible actions or think about a problem. Assessment means assembling, summarising, organising, interpreting, and possibly reconciling pieces of existing knowledge and communicating them so that they are relevant and helpful to an intelligent but inexpert decision-maker". Assessment therefore focuses on how information on ecosystem services can be structured to support decision-making.

Social methods for mapping and assessing ecosystem services principally involve measure individual and collective preferences in order to support the operationalization and further development of the ecosystem service concept. As such, social methods operate on the right side of the ecosystem services cascade model to quantify the benefits to humans (Potschin and Haines-Young, 2011). Any social mapping or assessment therefore fundamentally can be complementary with biophysical data and methods (Vihervaara et al. 2018) to quantify the capacity of ecosystems to supply ecosystem services (i.e. the left side of the cascade model). Social methods can also be used in combination with economic methods (Brander et al. 2018) to gain a broader understanding of the importance of ecosystem services to society (i.e. the right side of the cascade model).

There is a broad spectrum of options to map and assess ecosystem services from a social perspective depending on the type of data and the objective of the study. In this report which aims at providing a general comprehensive review, we focus on eleven methods: Time-use assessment; Photo-elicitation; Geo-tagged photo series analysis, Preference assessment, Narrative assessment, Q-methodology, Public participatory GIS, Participatory scenario planning, Deliberative assessment, Multi-criteria analysis.

This report therefore provides an overview of the main social methods for mapping and assessment of ecosystem services and different examples on how to apply them for different purposes and at different scales. This report also emphasizes the need to operationalize social methods in decision-support. We highlight how social methods can be applied at different policy instruments and decision contexts, highlighting that the social mapping assessment methods described in this report are each applicable to various stages of policy implementation. Overlooking social methods to map

and assess ecosystem services can blind society to the variety of services provided by ecosystems and can act as an obstacle for mainstreaming ecosystem services across societal sectors and decision-support.

Finally this report provides a potential link to integrate information from social, economic and biophysical methods. ESMERALDA reports D3.2 and D3.3 specifically provide guidance on economic and biophysical methods for mapping and assessment of ecosystem services. ESMERALDA report D3.4 provides guidance on how social, biophysical and economic methods can be linked within an ecosystem service assessment and on methods for integrating information outputs across disciplinary domains; and report D4.4 provides guidance on integrated assessment of ecosystem services. At the end all these Deliverables addresses the challenge of improving the applicability of these approaches with specific examples, particularly with respect to the MAES process and the ESMERALDA case studies.

# 1. Introduction to social mapping and assessment methods

There are basically three different types of methods to map and/or assess ecosystem and the services they provide: biophysical, economic and social. Biophysical methods describe how ecosystems contribute to the supply of services to society (Maes et al., 2013), while economic and social methods both reflect on the relative importance of ecosystem services to people, thus revealing the demand side of ecosystem services. Additionally social methods are distinguished from economic ones, because they are not expressed in monetary terms (de Groot et al., 2010) and demonstrate the multi-dimensional nature of human well-being.

Social methods for mapping and assessing ecosystem services are increasingly gaining attention by academics and policy makers. However, many authors on the one hand argue that these approaches do not yet constitute a formalized methodological framework because they frequently rely on coarse and arbitrary indicators, and in consequence the results are often difficult to interpret (Kelemen et al., 2016). On the other hand, social methods are a crucial component of ES studies because they can be applied at various stages of ecosystem planning and management, i.e. problem framing, public participation, resolve social conflict and bring environmental awareness (Maes et al., 2013). The same way that biophysical approaches are well-suited for measuring and quantifying ecological processes, as are economic approaches to give them a monetary value; social assessment approaches are better suited for capturing values of difficult or non-measurable monetary value (i.e. sense of place, existence value) and ecosystem services that do not strictly rely on ecosystem functions but social-ecological ones (i.e. spiritual values, aesthetic beauty).

Social mapping and assessment methods for ES were developed and have been applied widely in various scientific disciplines, ranging from ethnography and sociology to political ecology, geography or alternative approaches to economics such as ecological or feminist economics (Kelemen et al., 2014). As a consequence of this diversity of disciplines, these methods vary greatly in terms of which processes and measures they elicit and how they express the values of ecosystem services (IPBES, 2015). However a key similarity among all social methods is the assumption that preferences of ecosystem services are rooted in individuals, and at the same time shaped by the environmental, economic, social and cultural context in which individuals are embedded (Turnley et al., 2008). Therefore they aim at assessing ecosystem services in a contextualized way by discovering the psychological, historical, cultural, social, ecological and political contexts and conditions, as well as social perceptions that shape individually held or commonly shared values (Chan et al., 2012).

The literature of social methods of ecosystem services has grown substantially in the last ten years, mostly related to the category of cultural ecosystem services (Scholte et al., 2015). Although social mapping and assessment methods are often used to elicit cultural ecosystem services it is important to highlight that these are not exclusive features for this ecosystem service category. For example, one can highlight provisioning or regulating services through social assessment methods (Plieninger et al., 2013); in turn, one can also assess cultural ecosystem services through economic (Brander and van Beukering, 2015) or biophysical approaches (Zander et al., 2010). The recent increase of scientific papers on social assessment methods coincides with the development of the Intergovernmental Platform of Biodiversity and Ecosystem Services (IPBES), and these methods are expected to contribute to solving some of its challenges, such as the inclusion of different knowledge-systems or the recognition of integrated assessment approaches (Díaz et al. 2015).

In spite of such increasing interest and international recognition, social methods do not yet constitute a formalized research topic as the biophysical or economic methods. Moreover, successive systematic reviews on different ecosystem types reveal there is still a certain bias towards biophysical and economic approaches within ecosystem service science (Fagerholm et al., 2016; Nieto-Romero et al., 2014; Vihervaara et al., 2010). Therefore ESMERALDA in general and this Deliverable report in particular aim to contribute to this challenge through the review of the main social mapping and assessment methods which have been frequently used to elicit social values of ecosystem services in the context of Europe. We approached this challenge by highlighting with empirical case studies applications, that ecosystem services studies that incorporate social methods to assess individual and collective preferences can better support the operationalization and further development of the concept of ecosystem services with the aim to identify: (i) ecosystem services that are relevant for people, (ii) potential social conflicts due to different needs and perceptions, and (iii) trade-offs among ecosystem services and stakeholders and ecosystem service bundles. Based on a series of examples application of social methods at various scales and complexity level (tier approach) we examine the importance, preferences, needs or demands expressed by people towards nature, and articulate plural values through qualitative and quantitative measures. With these exemplary applications we demonstrate the multi-dimensional nature of human well-being and show that economic methods are just one way to show the importance that people assign to nature amongst others, i.e. symbolic, cultural, health and spiritual values.

In this report, social methods are used as an umbrella term for those approaches that aim to analyse human preferences towards nature in non-monetary terms. Under this umbrella, terms, such as ‘socio-cultural valuation’, ‘social valuation’, ´non-monetary valuation´, ‘deliberative valuation’, ‘qualitative valuation’ and ‘subjective assessment’, are examples of the approaches that aim to uncover individual and group values and perceptions of ecosystem services (Kelemen et al. 2014).

## 2. Review of existing frameworks to classify for social methods

There is a broad range of possibilities to map and assess ecosystem services using social approaches depending on the type of data and the methodological process. Social methods include quantitative and qualitative research techniques (i.e. surveys, interviews, models), participatory and deliberative tools (focus groups, citizens juries, participatory or rapid rural appraisal (PRA/RRA), Delphi panels, etc.), as well as ways of measuring in quantifiable terms (i.e. preference assessment, time use studies). Some methods are focused on the spatial representation of ecosystem services using maps as entry point for the assessment (i.e. Public Participatory GIS) (Kelemen et al., 2016). Due to this large heterogeneity, the FP7 project OpenNESS[1] developed a classification of Non-Monetary Valuation (NMV) methods with the objective to characterize smaller and more coherent subgroups of similar techniques, while maintaining the plurality of methodological approaches within the field (Figure 2).

[1] Operationalization of natural capital and ecosystem services (OpenNESS), FP7 grant agreement No 308428, http://www.openness-project.eu

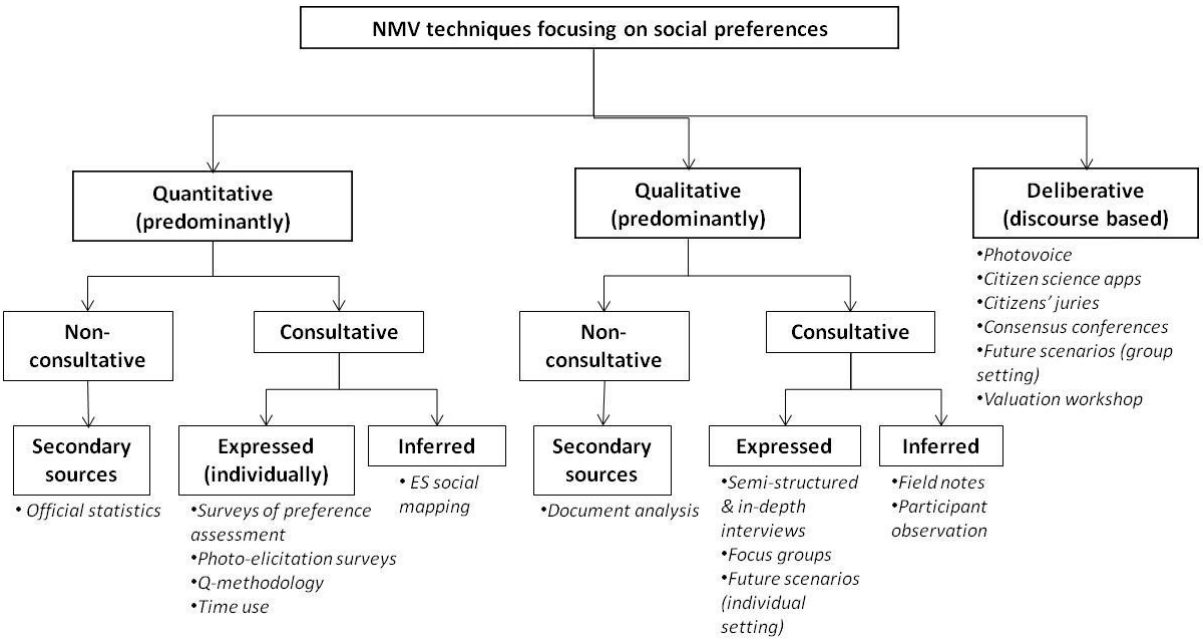



**Figure 2:** Classification of Non-Monetary valuation (NMV) approaches according to methodological similarities in data collection. Source: OpenNESS (Kelemen et al., 2016).

Also based on the results form FP7 OpenNESS project, Harrison et al. (2018) developed a three decision trees to structure and guide the process of method selection for socio-cultural approaches (Figure 3). The user of the tree decision for Socio-cultural methods is confronted with two major directions within social scientific research: following a hermeneutic approach that focuses on the understanding of human perceptions of ecosystem services, or applying an explorative-descriptive research strategy that creates numeric data on people's preferences of services (Figure 3). The first direction leads to the family of narrative methods, including interviews among others. The second direction is further specified according to data requirements and the preferred format of the results (level of quantification, spatial explicitness, visualization), which leads the user to diverse socio-cultural techniques, such as preference assessment, photo-elicitation, photo-series analysis and time use studies depending on their methodological needs (Harrison et al., 2018).

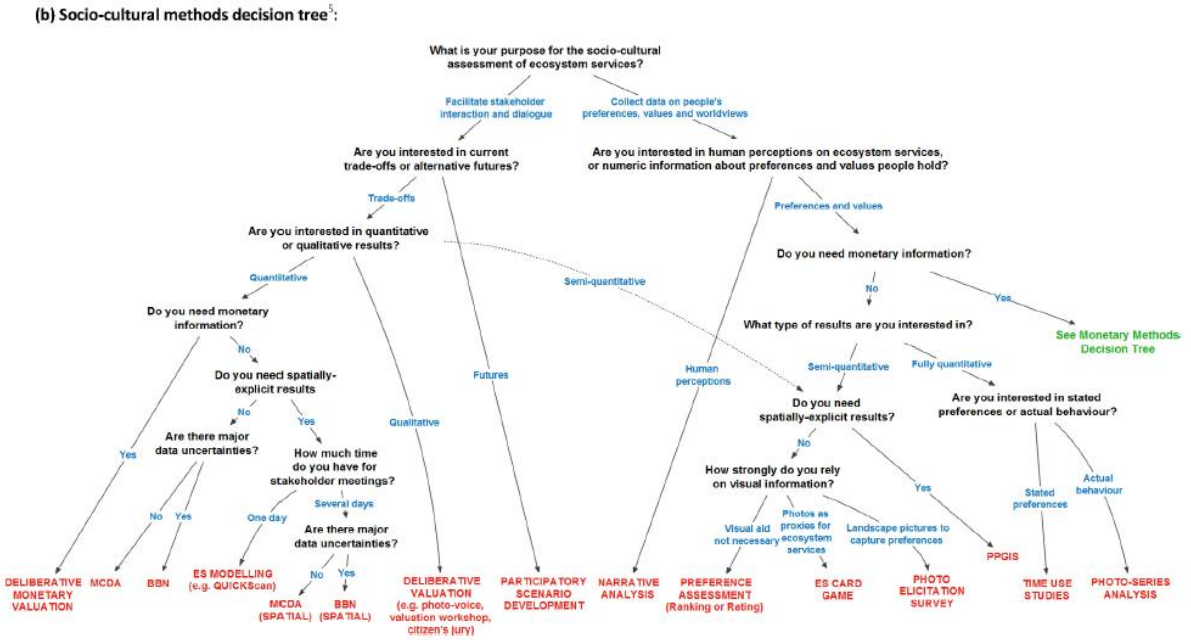



**Figure 3**. Decision tree for socio-cultural method (Source: Harrison et al., 2018)

Another attempt to classify social methods has been published by Scholte et al. (2015) who present a framework for the potential determinants of socio-cultural values of ecosystem services (Figure 4). The clarifications of the concept of socio-cultural valuation and the structured listing of the available methods facilitate a better integration of socio-cultural values into ecosystem service assessments and can help researchers to choose methods from the available portfolio.

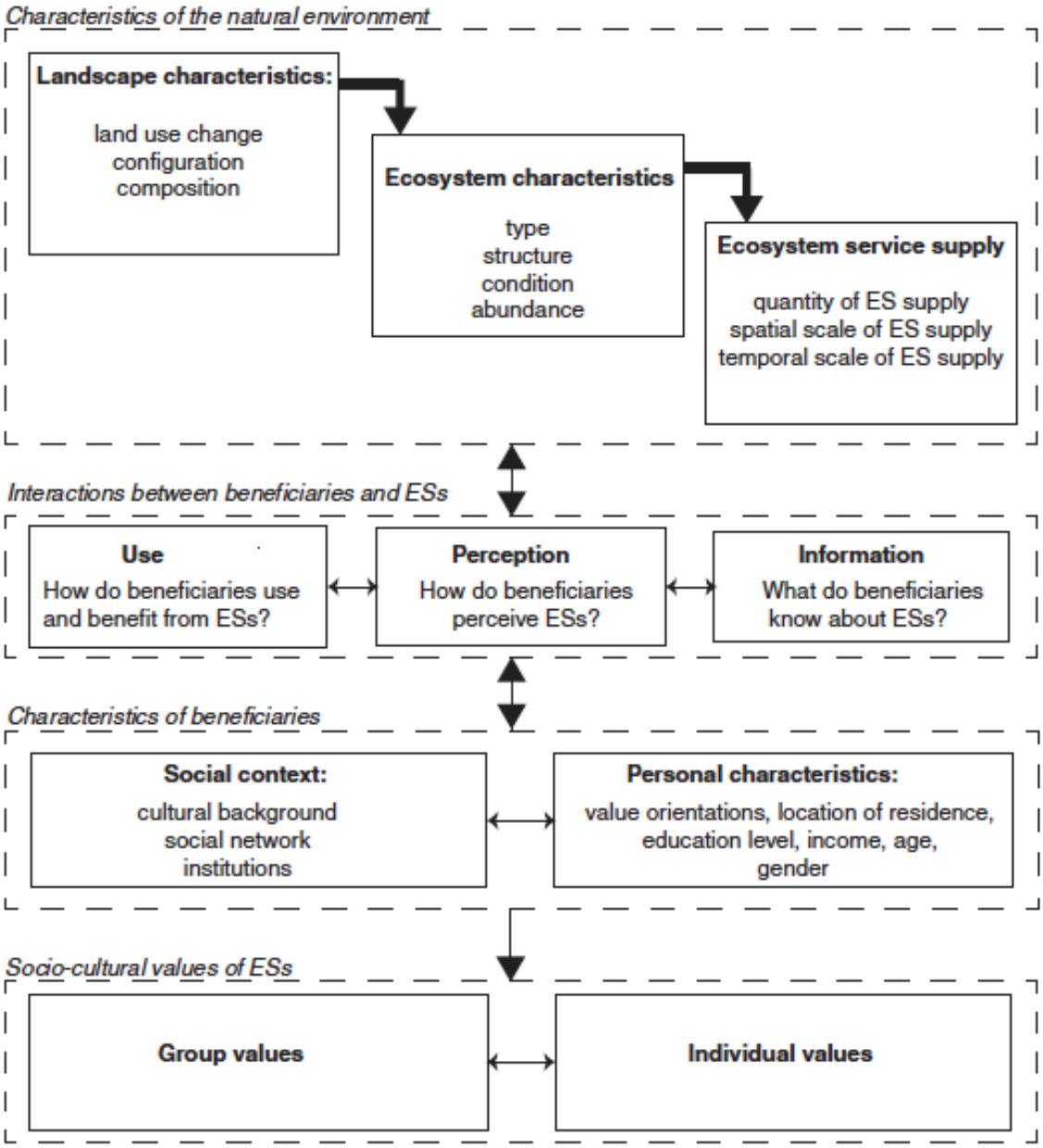



**Figure 4**. Framework that describes the potential determinants of socio-cultural values of ecosystem services and how are connected with main characteristics of beneficiaries. Source: (Scholte et al, 2015)

A final example of frameworks that classify of social methods in relation to ecosystem services was presented by Santos-Martín et al. (2017), relating to three axes: (1) Type of methods in terms of social preferences (i.e. individual vs. social); (2) Type of methods in term of rationality attributed to study providers (i.e. self-oriented vs. others-oriented); (3) Type of methods in terms of the dominant approach of handling data (i.e. qualitative vs. quantitative) (Figure 5).

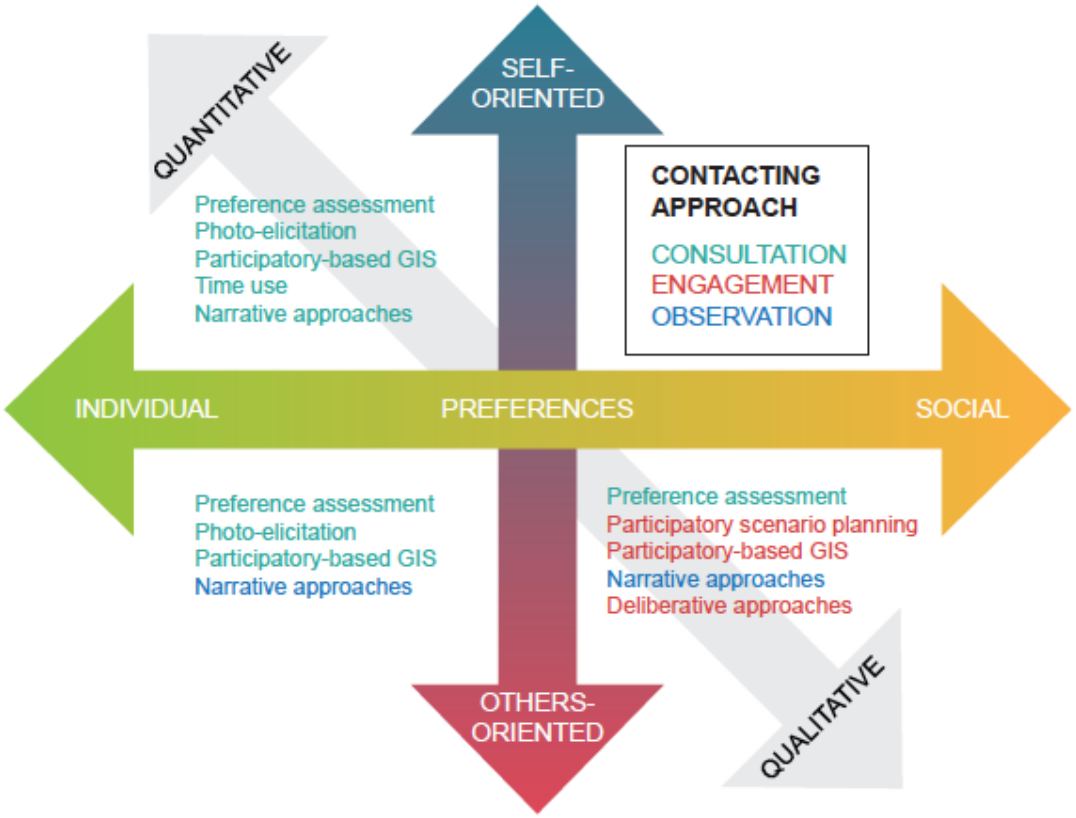



**Figure 5.** Classification of socio-cultural methods in relation to three axes: (1) type of study in terms of socio-cultural preferences (i.e. individual vs. social); (2) type of rationality attributed to study providers (i.e. self-oriented vs. others-oriented); (3) and the dominant approach of handling data (i.e. qualitative vs. quantitative). **Source:** (Santos-Martín et al., 2017).

A key similarity amongst all social classification methods frameworks presented above is the assumption that preferences/perceptions/motivations/values of ecosystem services are rooted in individuals and, at the same time, shaped by individuals' social and cultural context. In fact, social approaches have the capacity to elicit collective and shared values of ecosystem services through participatory and deliberative techniques that go beyond the aggregation of individual preferences. As a result and based on the review of some social methods classification frameworks, we came with the conclusion that there are three main options to involve participants and collect their preferences/perceptions/motivations/values of ecosystem services: (1) ask participants to **directly observe** and report their preference, if participants have a direct relation with the subject of assessment (i.e. they frequently use or enjoy some specific ecosystem services); (2) participants can be **consulted** although they do not have a direct relation to the subject of assessment (i.e. they can be asked via questionnaires or interviews about their perceptions of ecosystem services); (3) in case we suppose that participants preferences/perceptions/motivations/values have not yet existed or are still in the forming phase (i.e. participants do not have a priori knowledge about, or have not faced others' perceptions of certain ecosystem services), we can **engage** participants in a joint formation process to elicit their non-observable preferences associate to ecosystem services.

Because the aim of ESMERALDA is to advance the knowledge and utility about different social methods and not developing a new conceptual framework, in this report we provide a simple and practical classification of social methods based on the three main options in relation to engage participants and collect their preferences/perceptions/motivations/values of ecosystem services.

## 3. Classification of social methods in ESMERALDA

By definition social methods need to involve people in the process. In this report we divided social methods into the three broad groups in relation to how they engage participants and collect their preferences/perceptions/motivations/values of ecosystem services (Figure 6): (1) **Observations methods** are usually developed in collaboration with researchers. They require multiple observations as they elicit quantitative data (i.e. time-use and photo-elicitation). Their main goal is to demonstrate the social importance of ecosystem services by analysing social preferences and associated values of ecosystem services. Some practical applications of this type of methods are for example to uncover socio-cultural factors behind consumer preferences, but they can also be used to understand social demands and priorities for conservation. (2) **Consultation methods** are based on qualitative data that are usually applied in collaboration with non-academic stakeholders (i.e. narratives, Q-methodology). These methods are usually articulated through in-depth and semi structured interviews that allow participants to express their motivations and the diverse values of ecosystem services through their own stories and direct actions (both verbally and visually). These types of methods are usually applied to understand and describe the variety of motivations behind the social value that different stakeholders attribute to nature. (3) **Engagement methods** are able to gather qualitative and quantitative data by collaborating with researchers and non-academic stakeholders (i.e. Public Participatory GIS, participatory scenario planning and deliberative assessment). These methods are usually articulated through participatory and deliberative tools (focus groups, citizens' juries, participatory or rapid rural appraisal (PRA/RRA), Delphi panels, etc.). This third group of methods can contribute to solve social conflicts by co-learning and knowledge co-production as they foster discussion between different stakeholder groups regarding trade-offs among different ecosystem services (deliberative valuation), their spatial distribution (PGIS) and the future trends of ecosystem services and their implications for human wellbeing (participatory scenario planning).

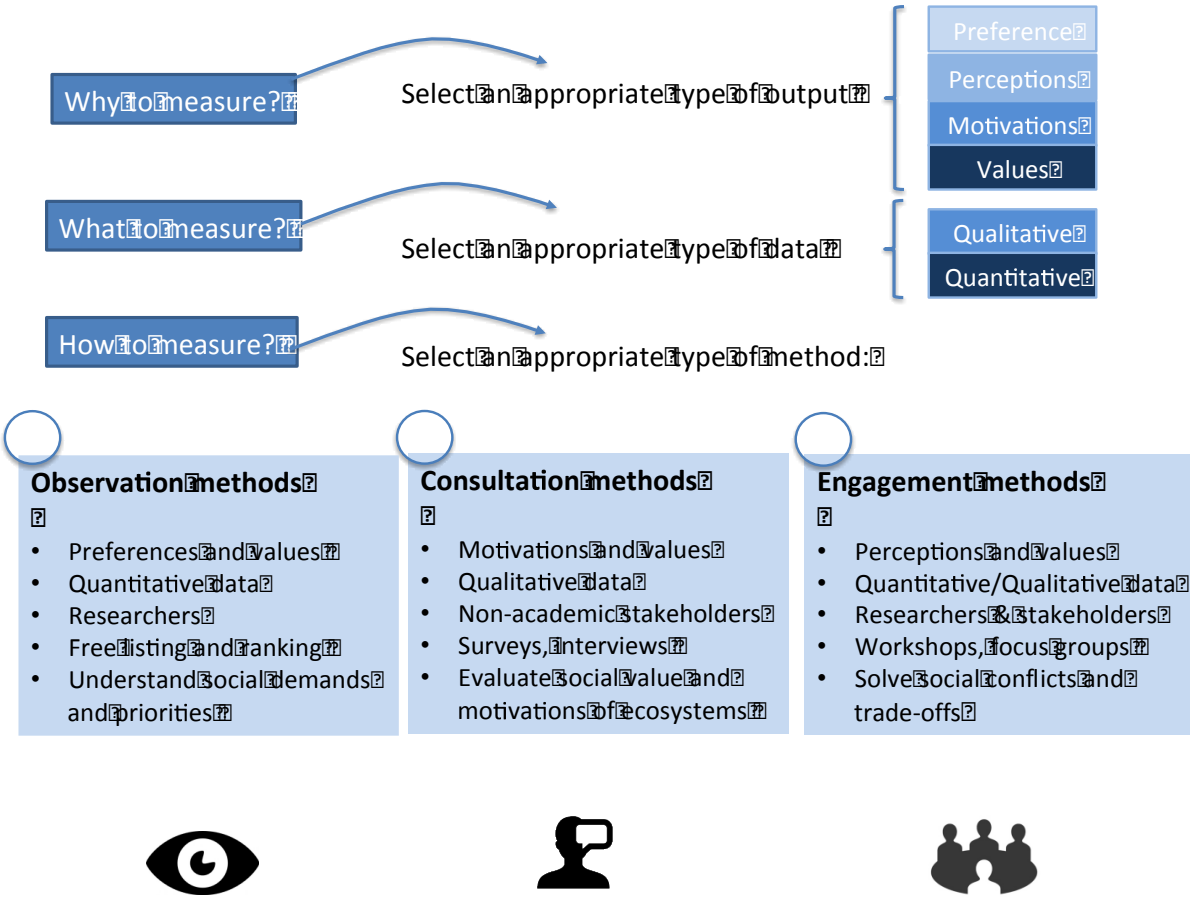



**Figure 6.** ESMERALDA broad classification of social methods to map and assess ecosystems and their services based on the contacting approach (Icons by Freepik).

The broad classification of social methods described above is determined by different methodological requirements (Table 1). As a result social methods were characterized according to 9 key main aspects whether they have the capacity to: (1) provide spatial outputs for different geographical areas (mapping) or estimating representative social values of ES without spatial explicit information (assessment); (2) elicit collective and shared values of ecosystem services that go beyond the aggregation of individual preferences; (3) to engage, observe or consult participants and collect their preferences/answers; (4) to provide results that are applied at local, regional, national or even broader spatial scales; (5) to provide appropriate and explicative results at tiers I, II and II ; (6) to work with different types and amount of quantitative and/or qualitative data; (7) elicit diverse or single range of values associated with nature; (8) to integrate results with other biophysical and economic methods; (9) to be applied in collaboration with researchers from different fields in collaboration with non-academic stakeholders; and (10) to be implemented using different levels of time and monetary resources.

Engagement methods have the capacity to elicit collective and shared values of ecosystem services that go beyond the aggregation of individual preferences. They can also be applied to map and assess ES values at national scales (and international in the case of scenarios) while the first two groups are not usually applied at such broad scales. PPGIS is also the most suitable method to provide spatial outputs, although preference assessment, time use, photo-elicitation and geo-tagged might also contribute with spatially explicit results by estimating the average value in different

geographical areas. In this way, PPGIS is particularly able to identify ecosystem services benefiting areas, i.e. places where use, demand, or value of ecosystem services converged. Further research and innovative techniques are also being tested to find the link between preference assessment and mapping, as is the case of SolVES. Through this technique, social values collected during preference assessment methods are translated into spatially explicit formats. Variability among all socio-cultural methods the categories capable to work with different types and amount of quantitative and/or qualitative data, elicit diverse or single range of values associated with nature and to integrate results with other biophysical and economic methods.

**Table 1.** Social methods classification based on key variability aspects according to their suitability to map and assess ecosystems and their services. Methods are classified according to their suitability to map and assess ES based on qualitative aspects: (●) highly appropriate, (●) less suitable, (●) not appropriate; and according to the level of requirements in terms of quantitative aspects: (●) high degree, (◑) medium degree, (◔) low degree

| SOCIO-CULTURAL METHODS | Approach | | Preference | | Procedure | | | Scale | | | Tier | | | Data | | | Values | | Integration | | Collaboration | | Resources | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Mapping | Assessment | Individual | Social | Observation | Consultation | Engagement | Local | Regional | National | Tier I | Tier II | Tier III | Amount | Qualitative | Quantitative | Diverse | Single | Biophysical | Economic | Researcher | Stakeholder | Time | Monetary |
| **Observation methods** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Time use assessment** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ◑ | ◑ |
| **Photo-elicitation** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ◑ | ◑ |
| **Geo-tagged photographs** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ◑ | ◔ |
| **Consultation methods** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Preference assessment** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ◑ | ◑ |
| **Narratives assessment** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ● | ◑ | ◑ |
| **Q-methodology** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ◔ | ● | ◑ | ◔ |
| **Engagement methods** | | | | | | | | | | | | | | | | | | | | | | | | |
| **Participatory GIS** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ◑ | ● | ◑ | ◑ |
| **Scenarios planning** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ◑ | ● | ◔ | ◑ |
| **Deliberative assessment** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◑ | ● | ● | ● | ● | ● | ● | ◑ | ● | ◑ | ◑ |
| **Multicriteria analysis** | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ◔ | ◑ | ◑ |

## 4. How to choose the appropriate social methods based on a tier approach

Based on the conceptual classification of the tiered approach that Grêt-Regamey et al. (2017) developed for all ecosystem services mapping methods, we adapted that framework only for social methods (Figure 7). Particularly, we adopted the social methods classification based on key variability aspects according to their suitability to map and assess ecosystem services (see table 1) to the tiered approach. In this classification, social methods are classified into three tiers levels based on information about reliability, accuracy and precision of social methods to map and assess ecosystem services. In particular, they differ in the level of engagement of participants ranging from observations (tier 1) to consultations (tier 2) and finally engagement (level 3). This additional classification is important for users to determine their suitability in a specific context and can help them to select the appropriate type of method.

In general, a tier 1 approach is suitable for a rough overview for example of hot- and cold spots of ecosystem services provision and demand. If the ecosystem services study is used to evaluate management measures or the suitability of different locations for an intended use, then a tier 2 approach is suitable. A tier 3 approach should be applied if explicit measures are implemented that affect not only the service itself but also other components of the system, which was defined in the first step. In case data and other resources are severely limited, it is possible to choose a lower tier yet efforts should be made to achieve the originally identified tier to best support decision-making.

Approaches assigned to higher tier levels require a higher level of detail of input and output data as they should inform specific management questions. This high level information can either be estimated through rather complex models combining different datasets, through the extrapolation of primary data or through a combination of both. One very precise field survey might therefore substitute several other datasets that would have been used to estimate the survey values. Thus, the amount of datasets is also not a criterion to distinguish the different tiers but rather the level of detail.

Most methods can be implemented at different levels of detail: An assessment based on geo-tagged photographs can simply present the amount of pictures taken at specific locations to get a first impression which would be suitable at a tier 1 level. However, the pictures can be further categorized and analysed according to their content which would be an appropriate approach for higher tier levels. Surveys as a typical method of social assessments can be relatively simple including few questions and/ or choices but can also become very detailed and complex. Similarly, scenarios can be very sophisticated interlinking several aspects or can be simple storylines of possible future development.

Based on this new classification, social methods were broadly classified into three categories: **Tier I** includes observation methods mainly relying on expert knowledge, include expert estimates of ES values for example in lookup tables. Examples are geo-tagged photographs from web-services such as Flickr or Instagram, time-use assessments or photo elicitation. For these methods, the interaction with participants and experts is limited. **Tier II** covers consultation methods which are characterized by a higher level of interaction and usually include more additional sources of information: ES are estimated based on well-known relationships between ecosystem services and spatial information retrieved from literature or statistics. Examples include deliberative and narrative assessments as well as Q-methodology. **Tier III:** Engagement methods directly link social approaches that estimate

ecosystem services based on primary data such as participatory GIS surveys to spatial information. Scenario planning, preference assessments and participatory GIS are examples of this tier level.

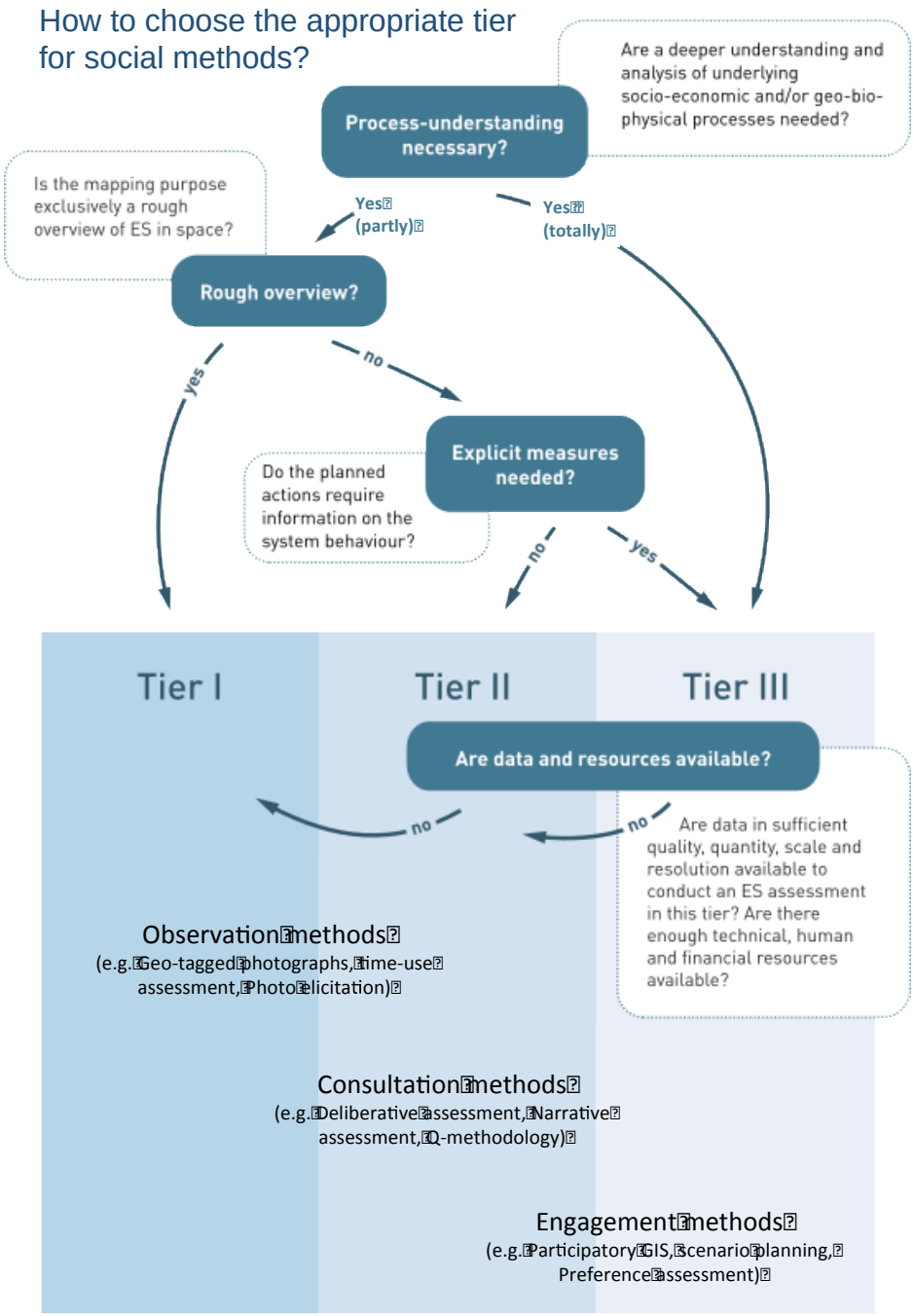



**Figure 7.** Classification of social methods based on a tier approach (Adapted from Grêt-Regamey et al. 2017).

## 5. A comprehensive review of social methods and applications in EU

In the following sections we briefly describe each social method individually and provide some example applications at different scales within the EU.

### 5.1. Time-use assessment

Time use study is an innovation of the contingent valuation approach. This method estimates the value of ecosystem services by directly asking people their wiliness to invest time (WTT) for a change in the quantity or quality of a given ecosystem service or conservation plan. In this case, the measure is labour hours rather than monetary units (Kenter et al., 2011). Methodologically is in the same line as preference assessment, but with the objective to create a new indicator to measure social support towards conservation, time use studies create hypothetical scenarios for willingness to invest time. Besides being an appropriate approach in scenarios where people can invest time for particular activities related to nature; this approach is also useful in areas with income constrains where money is basically used for essential goods (Higuera et al. 2012). Time use studies through WTT can be an appropriate indicator for uncovering socio-cultural factors behind consumer preferences, but they can also be used to understand social demands and priorities for conservation.

The **main advantages** of this method are: (1) Useful in contexts where severe income constrains makes monetary studies inappropriate (Higuera et al., 2012; Kenter et al., 2011); (2) Avoids incommensurability issues resulted from the assignation of monetary value to service properties that cannot be monetarily measured (García-Llorente et al., 2011); (3) Can be used to assess a range of ecosystem services at the same time, and to estimate the importance people attach to biodiversity in general (García-Llorente et al., 2016); (4) When activities are well-defined, respondents do not need to have a fairly good understanding of the delivery of ecosystem services because this link can be done at a later time by researchers; (5) WTT can be understood as a holistic indicator of human time-sharing initiatives in nature and, thereby, it is able to raise awareness about our ability to harmonize our lifestyles with the rhythms of nature (García-Llorente et al. 2016); (6) Beyond the estimation of the value of ecosystem services through the WTT; its development can engage stakeholders with environmental activities, increase collaboration, social learning and knowledge co-generation (Higuera et al., 2012; García-Llorente et al., 2016).

The **main constrains/limitations** are: (1) WTT is unsuitable for application to cases in which the respondents have little time availability; (2) Modelling WTT processes requires the inclusion of time available as an explanatory variable. Therefore, a daily time analysis should be included in the questionnaire, which is however time consuming and often tiring for respondents; (3) Classical methodological biases from conventional stated preference methods can occur; (4) It is important to provide a clear description of the activities (and how they relate to ecosystem services) in which time could be invested in the hypothetical scenario. If not, the activities might be selected because of respondents' preconceived ideas or because of the physical effort required for performing them.

**Box 1. The value of time in biological conservation and supplied ecosystem services in Spain**

This study analysed social support for biodiversity conservation and ecosystem service delivery in semi-arid environments in Spain, based on the willingness to give up time. Authors took into consideration different types of conservation activities and different ecosystem service categories. In addition, authors explored the effect of the respondent's place of residence and gender. Overall, the satisfaction of conserving species continues to be the prominent driving force in engaging public support for conservation programs over ecosystem services. However, it was found significant differences by place of residence and gender, with implications for the promotion of social engagement. Urban respondents were particularly interested in allocating time to activities associated with protected-area programs, while rural inhabitants were willing to engage in activities related to cultural services. With respect to gender, women were highly motivated to support activities that enhance rural areas. The results show that the willingness to give up time reflects socio-cultural factors behind consumer preferences. In addition, its application could promote collaborative work and strengthen community values and beliefs.

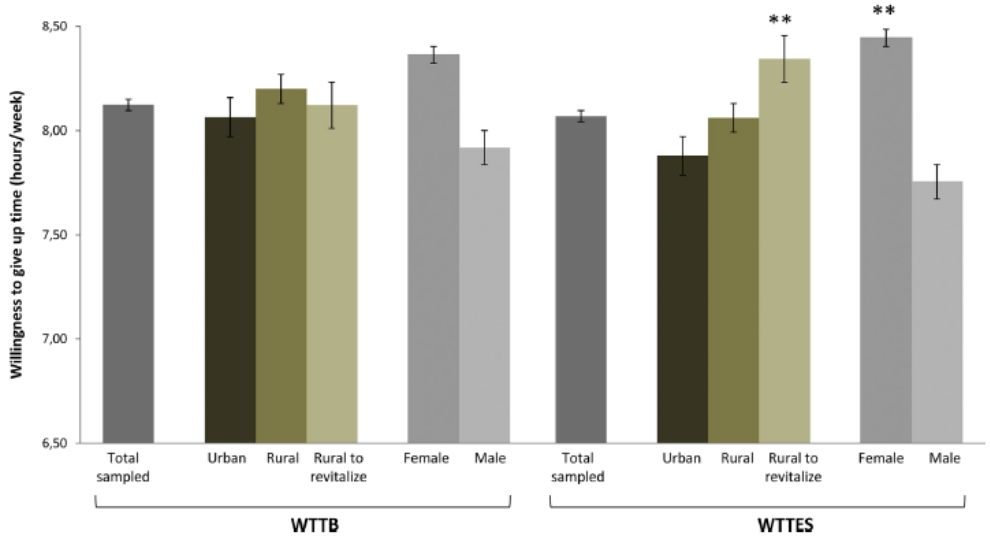



**Fig. 2.** Mean scores for willingness to give up time for biodiversity conservation (WTTB) and willingness to give up time for ecosystem services delivery (WTTES) expressed in hours/week. The results shown are for the total sample, by type of municipalities and by gender. Asterisks above the bars (**) indicate statistical significance at the ** = 5% level when running non-parametric tests to compare WTT estimations (both WTTES and WTTB) with respect to the type of municipality and gender.

**Source:** Garcia-Llorente et al. (2016): http://dx.doi.org/10.1016/j.jaridenv.2015.07.004

### 5.2. Photo-elicitation surveys

Photo elicitation survey is a method to translate people's visual experiences and perceptions of landscapes in terms of ecosystem services (García-Llorente et al., 2012). It is a quantitative method, based on the simple idea of inserting a photograph into a research interview. It can be used to assess a range of landscape views at the same time. Respondents specify the principal ecosystem services provided by each landscape from a list of potential services provided by the area. The difference between interviews using images and text, and interviews using words alone lies in the ways people respond to these two forms of symbolic representation. This is some of the reasons why photo elicitation interview are not simply an interview process that elicits more information, but rather one that evokes a different kind of information. The use of the approach depends on the decision context to which it has been applied, but it can be used for; 1) awareness raising, 2) to inform

priority setting processes (hot spot analysis) and for 3) instrument design through the identification of the areas where specific ecosystem services are supplied and the identification of the human settlements where there is a high demand for such services (Casado-Arzuaga et al. 2014; Casalegno et al. 2013)..

The **main advantages** of this approach are: (1) Easy to understand and very dynamic, as long as respondents are receptive to its application; (2) Can be used to assess a range of landscape views at the same time; (3) It makes it possible to connect landscape views with ecosystem services or with more general landscape characteristics such as land-use patterns; (4) Suitable to assess cultural services across a range of value types ( i.e. spiritual, heritage, aesthetic); (5) Results can help to identify potential conflicts between social groups through exploring the differences between stakeholders coming from different environments ( i.e. rural-urban gradient).

The **main constraints/limitations** are: (1) Some ecosystem services are not easily linked to the landscape views, being less visually evident ( i.e. some regulating services); (2) Photos only show a limited and framed view of the surrounding, captured at a specific moment in time (Petursdottir et al., 2013); (3) In some cases, participants learn about ecosystem services during the interview or questionnaire. This 'learning happened' should be taken into account when interpreting results; (4) Problems of generalisation with scale. It is important to have in mind that the higher scale, the more generic the photo description of the ecosystem services.

**Box 2. Validation of a landscape metrics-based assessment by visual estimation of the scenic beauty in Germany**

This study presents a landscape metrics-based assessment approach. Then authors tested the approach for a set of nine different landscape types in a model region in Saxony, Germany. For validating the developed methodology, authors carried out a survey with 153 participants in order to investigate their subjective preferences for the different landscape types. These preferences had to be expressed by rating the landscape types on a scale from 1 (very ugly) to 5 (very beautiful). The study was based on three different data sets, namely photographs of the landscape types, satellite images, and land cover maps. Statistical tests were applied (a) to investigate the impact of personal factors on the ratings, (b) to detect whether abstraction levels are suitable for preference studies, and (c) to compare the results of the objective approach (landscape metrics) and the subjective approach (visual assessment). Personal factors did not influence the visual assessment results significantly. We found the highest correlation of the landscape metrics-based assessment with the visual assessment results of the photographs. We conclude that the three landscape metrics might be applied to the monitoring of landscape aesthetics.

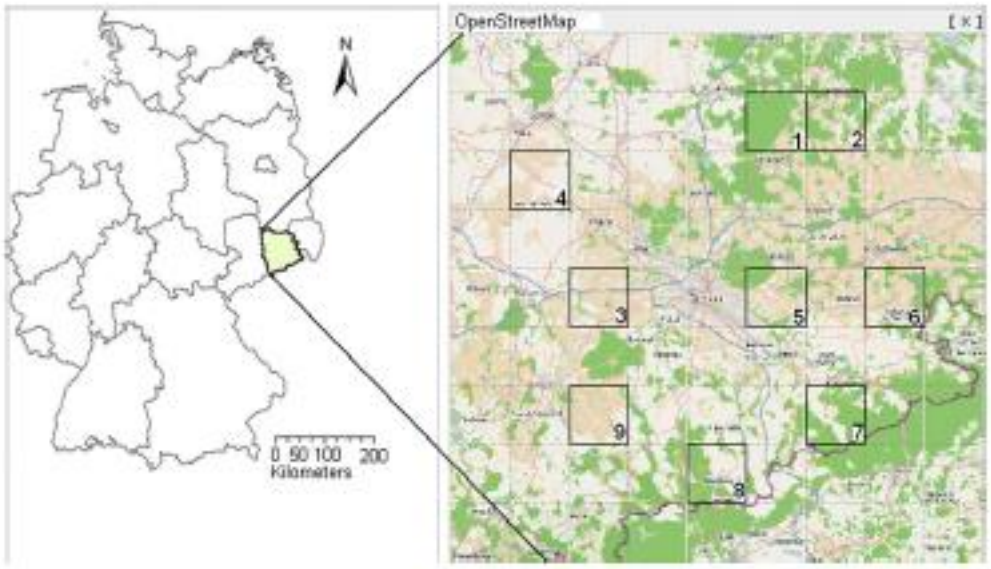
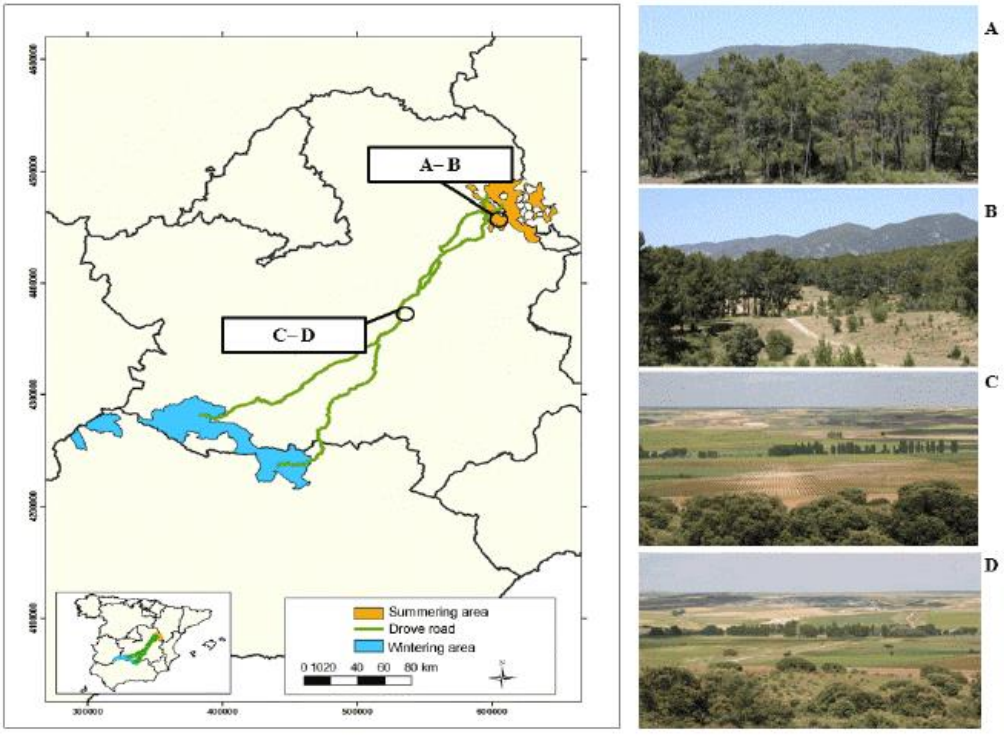



**Fig. 1.** Model region and focus areas (highlighted squares).

**Source:** Frank et al., 2013.https://doi.org/10.1016/j.ecolind.2013.03.026

**Box 3. Using visual stimuli to explore the social perceptions of ecosystems services in Spain**

This study used visually based landscape interpretation to evaluate social perceptions of ecosystem services provided by the Conquense Drove Road transhumance landscape in Spain. Face-to-face questionnaires (N = 314) were given to a sample of local inhabitants, visitors, and urban inhabitants. The questionnaires contained two pairs of photographs depicting images of croplands and pine forests associated with the transhumance landscape, with one photograph in each pair containing a drove road. We compared the social perceptions of 16 ecosystem services supplied by these two landscapes. Overall, respondents recognized the higher capacity of forests to deliver a wider range of ecosystem services to society compared with croplands. Provisioning services were mostly associated with cropland, whereas regulating services and cultural ecosystem services tended to be related to forests. Differences in the visual perception of ecosystem services supply and preference for transhumance landscapes emerged in relation to certain socio-demographic and cultural respondent characteristics such as a previous relationship with transhumance and agriculture, rural/urban origin and identity, environmental awareness, and cultural attachment to a place. We discuss the applicability and usefulness of the proposed approach for evaluating ecosystem services in cultural landscapes and for informing policy-making processes.




**Source:** López-Santiago et al., 2014. http://dx.doi.org/10.5751/ES-06401-190227

## 5.3. Geo-tagged photo-series analysis

The analysis of geo-tagged photographs from social networks can be used to assess the actual provision of different cultural ecosystem service (CES) categories, including recreation, aesthetic,

intellectual and existence (van Zanten et al., 2016). This method revealed preference for CES and spatially-explicit data on location for nearby CES provision can be obtained from popular social networks. Geo-tagged databases can be acquired from photo-sharing platforms such as Flickr and Instagram. The analysis of community contributed photos from these platforms has also been used in recent studies to assess ecosystem services belonging to the broad category of CES (i.e. Gliozzo et al. 2016; Tenerelli et al. 2016; Casalegno et al. 2013) as well as to assess the aesthetic value of landscapes as specific sub-category of CES (Tenerelli et al 2017; Martínez Pastur et al. 2015; Richards and Friess 2015; Nahuelhual et al. 2013). These studies demonstrated that user-contributed and geo-tagged photo collections can provide insights into CES provision supplying important evidences for understanding people's engagement with ecosystems while inferring landscape perceptions.

The **main advantages** of the approach are: (1) Photo-series analysis represents a pragmatic way of gathering space-and time-referenced data on observed people's preferences related to CES which are difficult to obtain in a cost-effective way through traditional data gathering techniques ( i.e. social surveys); (2) It allows further understanding on the spatial distribution of CES in areas with low baseline information (); (3) It permits the identification of socio-biophysical features of landscapes that are associated with the provision of CES and with the spatial trade-offs and synergies among CES; (4) Allows for spatially explicit analysis and the identification of focus areas where people benefit from cultural ecosystem service provision; 5) Another comparative advantage of the method is to obtain trajectories of users and be able to compare local vs visitors preferences towards key landscape features and places

The **main constraints/limitations** of the approach are: (1) In order to obtain information related to the user characteristics extra work is needed in order to complement the work with questionnaires that could be sent to the users content; (2) People's attitude to taking photographs change with the different recreation activities (van Zanten et al., 2016). (3) The photo-sharing community may not be representative of specific social groups: the represented population will then be dependent on the level of access to information technology, education and age, and the user's ability/willingness to correctly geotag the photos; (4) To appraise the importance of CES services through the number of uploaded photographs entails an inherent bias related to the interpretation of the photos by researchers and to the capacity to photograph certain CES.

**Box 4. Crowdsourcing derived indicators for cultural ecosystem services including aesthetic services in a complex mountain landscape in France**

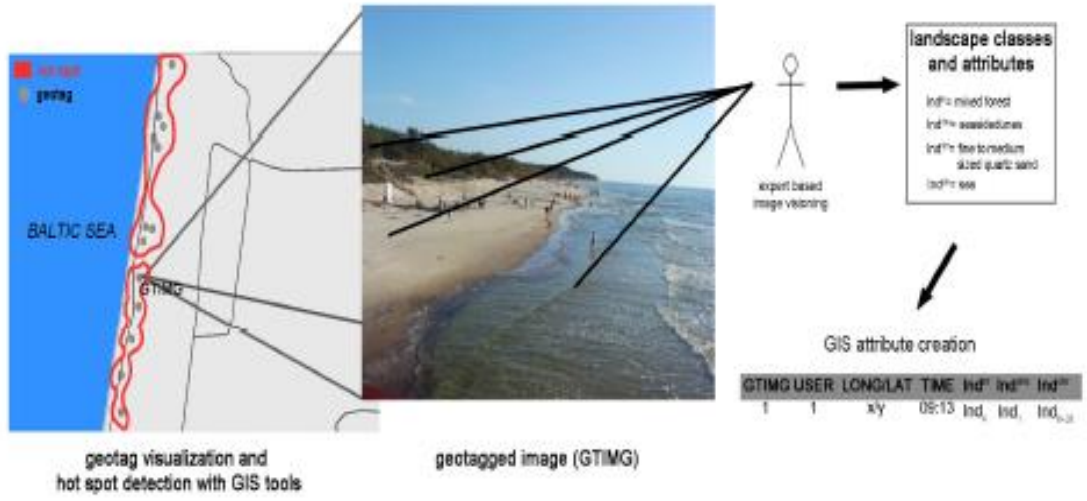
This study investigates how the actual provision of cultural services is distributed across the landscape according to spatially varying relationships. The first objective was to analyse how landscape settings are associated to people's preferences and perceptions related to cultural ecosystem services in mountain landscapes. We demonstrated a spatially explicit method based on geo-tagged images from popular social media to assess revealed preferences. A spatially weighted regression showed that specific variables correspond to prominent drivers of cultural ecosystem services at the local scale. The second objective was to assess the relationship between landscape visual character and scenic beauty based on the same crowd sourced geographic information. We demonstrated the use of an empirical method for mapping the scenic beauty of complex mountain landscapes from the perspective of observers which are realistically exposed to the environment being evaluated. The combination of crowdsourcing images storage with landscape metrics allowed a systematic analysis of landscape scenic beauty properties and facilitates the interpretation of the landscape information function

The results of the explanatory approaches can be used to integrate the cultural service dimension into land planning by taking into account specific benefiting areas and by setting priorities on the ecosystems and landscape characteristics which affect the service supply Whereas at the same time understanding how specific landscape characters contributes to aesthetic service provision. Authors finally concluded that the use of crowdsourced data allows identifying spatial patterns of cultural ecosystem service preferences and their association with landscape settings and landscape character.


**Source:** Tenerelli et al. 2016 http://dx.doi.org/10.1016/j.ecolind.2015.12.042

**Box 5. Aesthetic value characterization of landscapes in coastal areas in Lithuania**

This study presents a framework for aesthetic value characterization in coastal zones using geotags from a web based photo sharing service named Panoramio as data source. A GIS tool for visitor hot spot detection in Lithuanian coastal areas was developed. At selected visitor hot spots, an expert based image content analysis was applied and indicators for the aesthetic value characterization were developed. In total over 63 visitor hot spots were detected along Lithuania's mainland coast and the northern tip of the Curonian Spit. Around 73% of all hot spots cover landscapes in proximity of water bodies. Aesthetic values assessment in hot spots are determined by the variety of anthropogenic and natural landscape attributes in the coastal zone. Authors conclude that the application of webbased photosharing services and the modelling for aesthetic value characterization can serve for tourism activity planning such as scenic pathways identification, landscape attribute based trip advisory, assessment tool for landscapes changes due to intensive tourism activity and invasive construction projects.




**Source:** Depellegrin et al., 2012. Doi: 10.1109/BALTIC.2012.6249166

## 5.4. Preference assessment

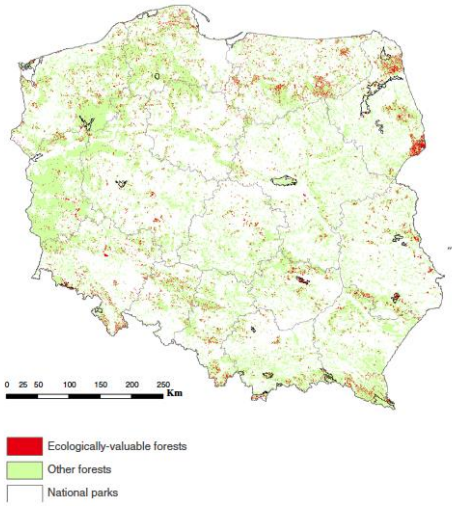
Preference assessment is a direct and quantitative method to understand which ecosystem services are perceived as the most vulnerable, or which make the greatest contribution to human wellbeing (Martin-Lopez et al, 2012). It can also be used to demonstrate the social importance of ecosystem services by analysing social motivations, perceptions, knowledge and associated values of ecosystem services demand or use (Kelemen et al., 2016). Data can be collected through free-listing exercises, ecosystem service ranking, rating or selection mechanisms. It could be used with an emphasis on individual perceptions or collective preferences (Castro et al., 2014). Preference assessment could be a useful approach for identifying relevant services from different stakeholder perspectives with diverging interest or needs. As a consequence, its application could help to uncover trade-offs or/and synergies on the ecosystem service demand, as well as the motivations behind these preferences (Martin-López et al., 2012).

The **main advantages** of the approach are: (1) It assesses a range of ecosystem services at the same time, and could be used for all different service categories; (2) It can provide robust quantitative information (from a representative sample) (Scholte et al., 2015); (3) It avoids incommensurability issues resulting from the assignation of monetary value to service properties that cannot be monetarily measured (Martinez Alier et al., 1998; García-Llorente et al., 2011); (4) The standardisation of the questions included could promote comparability with other case studies ( i.e. Martín-López et al., 2012).

The mains **limitations/constrains** are: (1) preference assessment captures a point in time, not a trend. In addition, sometimes, extra qualitative information is needed to understand the reasons behind the responses given; (2) Key stakeholders can be ignored if the surveys focus on characteristics which are relevant for a very limited percentage of the population, (3) Answers focused on the contribution of ecosystem service to an individual respondents' human wellbeing fails to take into account shared and social values of ecosystem services (Kenter et al., 2015). For a comparison between individual wellbeing and social wellbeing (i.e., shared and social values) by using this technique, see Oteros-Rozas et al. (2014).

**Box 6. Providing preference-based support for forest ecosystem service management in Poland**

This study examines people's preferences for changes in selected ecosystem services resulting from new management strategies of forest areas in Poland. The study revealed interesting connections between respondents' current forest recreation patterns and the importance they place on the various attributes of forests. The paper particularly focuses on respondents' unobserved and observed preference heterogeneity, as well as scale heterogeneity, and the study demonstrates how heterogeneity can improve the models and provide insight into how users and non-users of forests may benefit from introducing a particular policy.



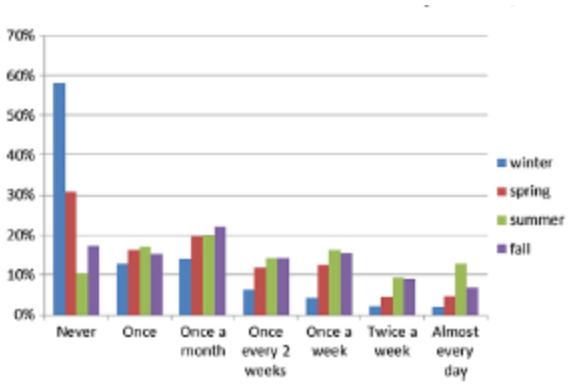
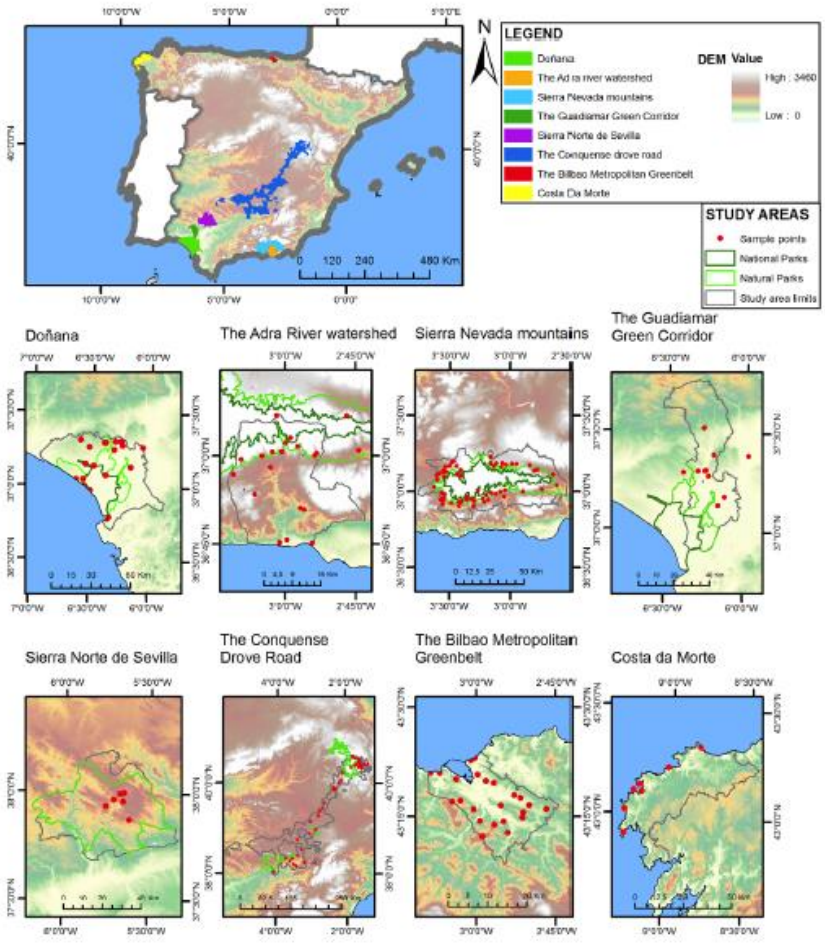




Fig. 2. Frequency of recreational trips to forests by season.

Source: Czajkowski et al., 2014 https://doi.org/10.1016/j.forpol.2013.11.002.

**Box 7. Uncovering ecosystem service bundles through social preferences in Spain**

This study examined how ecosystem service bundles and trade-offs emerge from diverging social preferences toward ecosystem services delivered by various types of ecosystems in Spain. Authors conducted 3,379 direct face-to-face questionnaires in eight different case study sites from 2007 to 2011. Overall, 90.5% of the sampled population recognized the ecosystem's capacity to deliver services. Formal studies, environmental behaviour, and gender variables influenced the probability of people recognizing the ecosystem's capacity to provide services. The ecosystem services most frequently perceived by people were regulating services; of those, air purification held the greatest importance. However, statistical analysis showed that socio-cultural factors and the conservation management strategy of ecosystems (i.e., National Park, Natural Park, or a non-protected area) have an effect on social preferences toward ecosystem services. Authors concluded that sociocultural preferences toward ecosystem services can serve as a tool to identify relevant services for people, the factors underlying these social preferences, and emerging ecosystem service bundles and trade-offs.




Source: Martin-López et al., 2012. DOI: 10.1371/journal.pone.0038970

## 5.5. Narrative assessment

Narrative methods aim to understand and describe the importance of nature and its benefits to people with their own words (Kelemen et al, 2016). By using narrative methods we allow the research participants (residents of a certain place, users of a certain resource, or stakeholders of an issue) to articulate the plural and heterogeneous values of ecosystem services through their own stories and direct actions (both verbally and visually). Narrative methods usually collect qualitative data from individuals, but they can be also suitable to measure some aspects of human-nature relations in quantitative or semi-quantitative terms (Kaplowitz and Hoehn, 2001). They can be combined with more structured socio-cultural methods such as preference assessment, time use study or multi-criteria decision analysis (MCDA). Narrative methods are frequently applied to collect background information on actual land use patterns and the motivations and perceptions driving land use decisions of individuals, households or communities (de Oliviera and Berkes 2014). They can also be useful in highlighting gaps between scientific and local knowledge (Rodríguez et al. 2005, Kaplowitz and Hoehn 2001). Information collected through narrative methods can be feed into awareness raising campaigns but can also be used to inform priority setting processes or instrument designs as part of deliberative processes, suggested by some complex valuation studies ( i.e. Pereira et al. 2005,). Narrative methods are suitable to apply at lower spatial scales (from property to municipality or to a region including several municipalities). The spatial boundaries should be well-defined and meaningful to the participants. If narrative valuation is combined with Participatory GIS, fine resolution can be achieved (Palomo et al. 2011).

The **main advantages** of the approach are: (1) Makes it possible to include local and traditional knowledge in the process of valuation; (2) The valuation process and its results are inclusive and accessible for a large variety of different stakeholders; (3) Allows participants to articulate the values of ecosystem services in their own terms and worldviews; (4) Allows the elicitation of plural and heterogeneous values; (5) Highlights the bundled qualities of ecosystem services.

The **main constraints/limitations** are: (1) The process is often lengthy and may require significant inputs from scientists; (2) The topic of the research or some of the prompts can be difficult to conceptualize by local resource users, avoiding scientific jargon is therefore crucial; (3) Since the researcher is personally involved in the study, her/his presence can influence the outcomes; (4) Uncertainty about the quality of answers exists, therefore triangulation of data sources and methods might be necessary; (5) Produces lengthy textual outputs (descriptions, narratives) which are difficult to quantify and to generalize at larger spatial or social scales; (6) Strong responsibility on the scientists' side to not 'overuse' the participants.

**Box 8. Narrative assessment of ecosystem services in a mountain community in Portugal**

This study was part of the Portugal Millennium Ecosystem Assessment and it was conducted in the rural community of Sistelo in northern Portugal. The main purpose of our study was to assess the linkages between human well-being and ecosystem services at the local level, as perceived by the community. Authors used a range of tools that included participatory rural appraisal and rapid rural appraisal as well as other field methods such as direct observation, familiarization and participation in activities, semi structured interviews, trend lines, well-being ranking, and other ranking and scoring exercises. Sistelo has a unique landscape of agricultural terraces that are now being abandoned because of the depopulation of the region, a common trend in mountainous rural areas of Europe. From the community perspective, some components of well-being such as material well-being have been improving, whereas some ecosystem services, i.e., food production, have been declining. People recognize many of the services provided by ecosystems, in particular, provisioning, cultural, and regulating services, although they feel that provisioning services are the most important for well-being. It is apparent that, for the Sistelo community, there is an increasing disconnect between local well-being and at least some local ecosystem services. This disconnect is associated with greater freedom of choice at the local level, which gives the local inhabitants the power to find substitutes for ecosystem services. The consequences of land abandonment for human well-being and ecosystem services at different temporal and spatial scales are discussed.

Source: Pereira et al., 2005. URL: http://www.ecologyandsociety.org/vol10/iss2/art14/

### 5.6. Q-methodology

Q-methodology combines quantitative and qualitative information to explore social perspectives on a particular issue. The name "Q" comes from the form of factor analysis that is used to analyse the data. Q factor analysis reduces the many individual viewpoints of the subjects down to a few "factors," which are claimed to represent shared ways of thinking. Q-methodology has been used as a research tool in a wide variety of disciplines. The Q-methodology is particularly suitable for social-ecological analysis studies as it enables elicitation of the personal views of stakeholders involved in conservation on arguments associated with biodiversity conservation, and the identification of commonalities and differences in their perspectives in a quantitative manner (Berry et al., 2016). While, the qualitative information obtained during the Q-interviews allows for deeper investigation of the reasons underlying personal views. It has been broadly applied to investigate a range of environmental issues, for example: potential for sustainable forestry (Swedeen 2006) and small scale forestry and market reform in the Ukraine (Ninjik et al. 2009); motivations for urban biodiversity conservation (Dearborn and Kark, 2010); or portrayal of climate change (O'Neill et al. 2013) and values and attitudes of locals living along the Tisza River, Hungary, to water issues and adaptation (Marjaine Szerenyi et al. 2011).

It also provides the opportunity to understand how different stakeholders, characterised by a variety of points of view, perceive an issue (i.e. attitudes to conservation on private land in Poland; Kamal and Grodzinska-Jurczak 2014; landscape preferences of locals in southern Transylvania, Romania (Milcu et al. 2014); identifying which are the greater points of conflict; but also, uncovering the common ground of agreement and shared understanding between different actors (i.e. Chamberlain et al. 2012).

The **main advantages** of the approach are: (1) it has proved useful in revealing a range of perspectives existing on a particular topic; (2) It is an exploratory tool that gives qualitative data some quantitative support; (3) it results in the identification of a discourse area of interest with a collection of a full range of statements about the discourse; (4) it provide a sorting of the participants according to their level of agreement with a particular statement.

The **main constraints/limitations** are: (1) a lack of possibility to generalise the findings to a larger population, (2) the concern as to whether the concourse selected represents the full range of views on the particular topic and (3) the potential to affect participants' opinion by forcing them to sort the statements into the normal distribution, which may not fully represent their views and biased interpretation of the factors by the researcher (Kampen and Tama´s, 2014)

**Box 9**. **Application of Q-method for navigating conflicting landscape aspirations in Transylvania (Romania)**

This study used a photograph-based Q methodology study – interviewing 129 residents from 30 villages – to understand and explore the diverse range of landscape preferences held by locals in Southern Transylvania. Authors clarified these preferences by identifying groups of participants who shared similar viewpoints regarding local landscapes and their changing purpose. Their findings revealed five different "preference narratives" about Transylvanian landscapes, namely (1) landscapes for prosperity and economic growth; (2) landscapes for traditions and balanced lifestyles; (3) landscapes for human benefit; (4) landscapes for farming; and (5) landscapes for nature. Our systematic assessment of narratives showed areas of consensus and disagreement among participants. They relate the five preference narratives to current management approaches targeting rural landscapes. Authors conclude by suggesting policy approaches to tackle the diversity of opinions and interests found in this culturally and ecologically diverse landscape. Important policy priorities include fostering economic diversification and improving social capital.


Source: Milcu et al., 2012. DOI:, http://dx.doi.org/10.1016/j.landusepol.2014.06.019

### 5.7. Participatory GIS

Participatory GIS (PGIS) evaluates the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders via workshops and/or surveys (Palomo et al., 2013). It

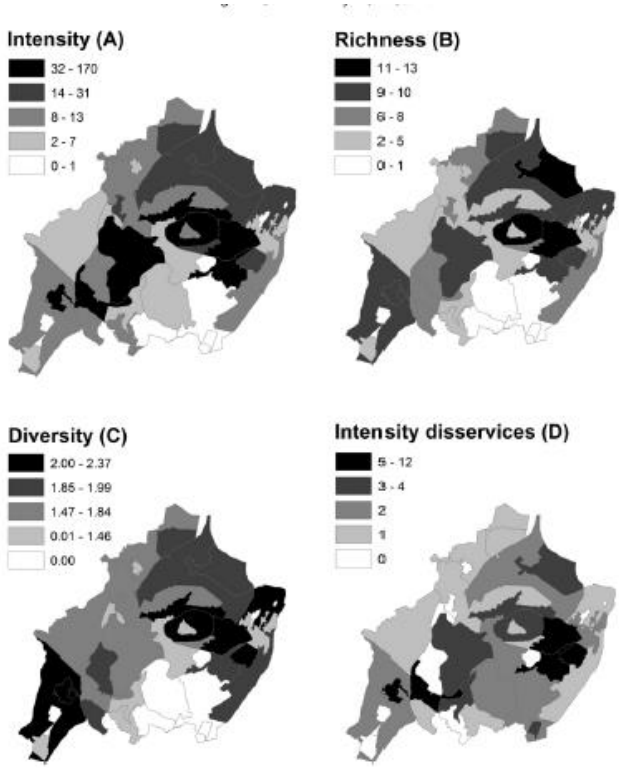
encompasses different approaches including Participatory GIS (PGIS) and Public Participation GIS (PPGIS) (see Brown and Fagerholm, 2014) to which we broadly refer here as PGIS. PGIS allows for the participation of various stakeholders in the creation of an ES map ( i.e. community members, environmental professionals, NGO representatives, decision-makers) in the identification of ES 'hotspots' on a map, and integrates their perceptions, knowledge and values in the final maps of ecosystem services. Frequently used in social assessment methods it focus on the integration across knowledge sources, disciplines and data types. PGIS can therefore integrate the perceptions, knowledge (local-based or technical) and values of different stakeholders and presents the outputs in the form of a map of ecosystem services (Fagerholm et al., 2012; Raymond et al., 2009). The results obtained allow similar data treatment as for non-participatory mapping methods (analysis of trade-offs, correlation analysis among services or with other aspects such as land use change, etc.) (Palomo et al., 2014). PGIS is being increasingly used in recent years due to its potential for: including stakeholder´s perceptions in ecosystem services spatial assessments, incorporating different types of knowledge, mapping ecosystem services in data scarce regions, enhancing capacity building and social learning, and integrating stakeholders in a democratic process-oriented approach to decision-making (García-Nieto et al., 2014).

The **main advantages** of the approach are: (1) Integrates stakeholder perceptions, knowledge and values regarding ecosystem services (methodological and operational advantage); (2) Allows the involvement of multiple stakeholder types and thus creates awareness and fosters social learning related to ecosystem services (methodological and operational advantage); (3) Some ecosystem services (such as cultural services) fit well with this mapping approach (methodological and operational advantage). (4) Permits mapping ecosystem services in areas where spatial data is unavailable (methodological and operational advantage); (5) The GIS skills needed to develop this method are relatively simple (methodological advantage).

The **main constraints/limitations** are: (1) The development of best practices or guidelines for the method is still ongoing; (2) PGIS methods have been mostly applied at local scales and integration of results into decision-making at larger scales has been elusive; (3) The comparability among studies is usually low; (4) The spatial resolution of the results and accuracy might be lower for certain services than for other approaches.

**Box 10. Mapping and assessing cultural ecosystems services at community level in Germany**

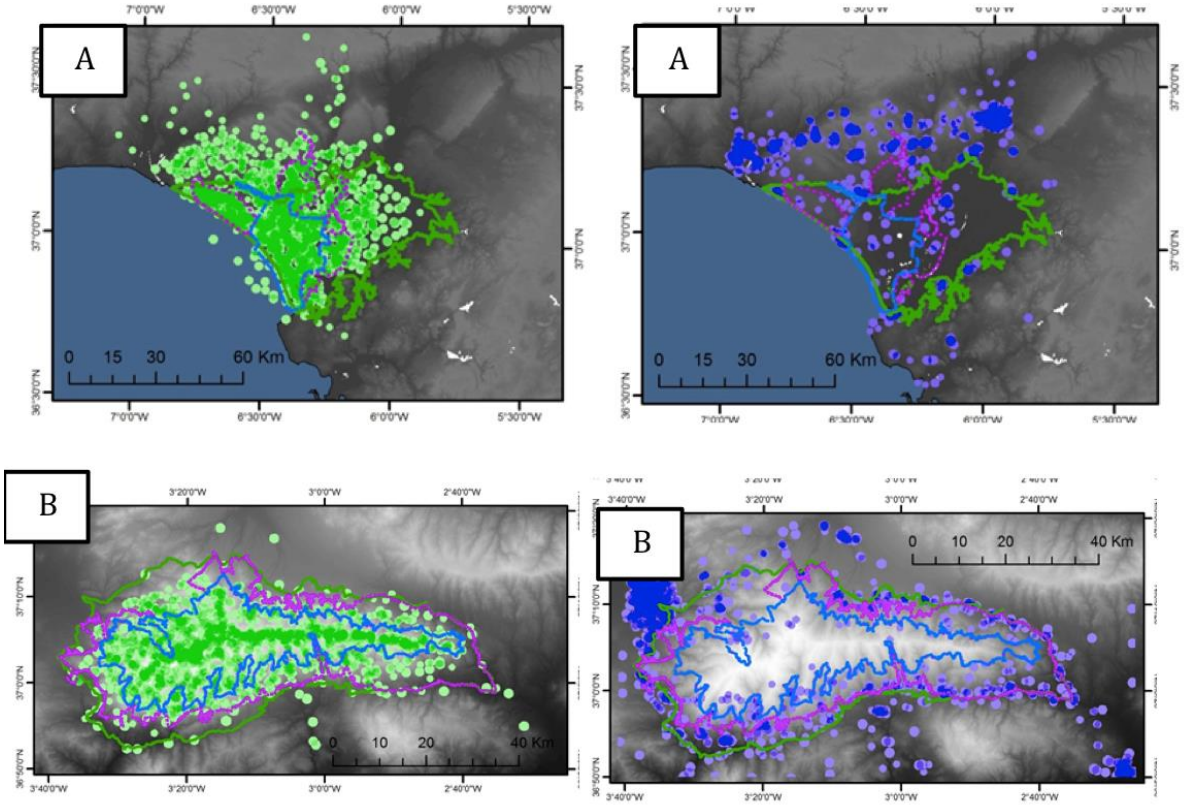
This study performs a spatially explicit participatory mapping of the complete range of cultural ecosystem services and several disservices perceived by people living in a cultural landscape in Eastern Germany. The results stem from a combination of mapping exercises and structured interviews with 93 persons that were analysed with statistical and GIS-based techniques. The results show that respondents relate diverse cultural services and multiple local-level sites to their individual well-being. Most importantly, aesthetic values, social relations and educational values were reported. Underlining the holistic nature of cultural ecosystem services, the results reveal bundles of services as well as particular patterns in the perception of these bundles for respondent groups with different socio-demographic backgrounds. Cultural services are not scattered randomly across a landscape, but rather follow specific patterns in terms of the intensity, richness and diversity of their provision. Resulting hotspots and coldspots of ecosystem services provision are related to landscape features and land cover forms. Authors conclude that, despite remaining methodological challenges, cultural services mapping assessments should be pushed ahead as indispensable elements in the management and protection of cultural landscapes. Spatially explicit information on cultural ecosystem services that incorporates the differentiated perceptions of local populations provides a rich basis for the development of sustainable land management strategies. These could realign the agendas of biodiversity conservation and cultural heritage preservation, thereby fostering multifunctionality.




Source: Plieninger et al., 2013. http://dx.doi.org/10.1016/j.landusepol.2012.12.013 or:

**Box 11. Participatory GIS for managing ES supply and demand in protected areas in Spain**

Participatory GIS was used in two National Park of Spain (Doñana and Sierra Nevada) with the aim to represent the demand side of ecosystem service. For that aim, and as ecosystem service assessment should be "inspired by" and "useful to" users, the authors organized a deliberative workshop with researchers and policy-makers to map ecosystem service flows. During the workshops, several ecosystem services were mapped, allowing further ecosystem service trade-offs and bundle analyses, and in which the spatial mismatch between ecosystem services supply and demand was highlighted. Being Sierra Nevada and Doñana two National Parks, the ecosystem service assessment highlights the different benefits that ecosystems covered by protected areas provide, which shall foster support for the conservation and sustainable use of these areas. These maps also give insights for establishing priority areas for conservation and show how protected areas, rather than being isolated entities, are connected in many ways to society and ecosystem services beneficiaries.




Source: Palomo et al. 2013. DOI 10.1007/s10113-013-0488-5

## 5.8. Participatory scenario planning

Scenarios can be used to explore how ecosystem services might change in the future and how these changes can influence human well-being. Participatory scenario planning applies various tools and techniques ( i.e. brainstorming or visioning exercises in workshops, often complemented with modelling) to develop plausible and internally consistent descriptions of alternative future options (Johnson et al. 2012). Assumptions about future events or trends are questioned, and uncertainties are made explicit (Bohensky et al. 2006). Participatory scenario planning typically takes place in a workshop setting, where participants explore current trends, drivers of change and key uncertainties, and how these factors might interact to influence the future (Schoemaker 1995). Therefore by comparing and evaluating scenarios we can also reveal the value of related ecosystem

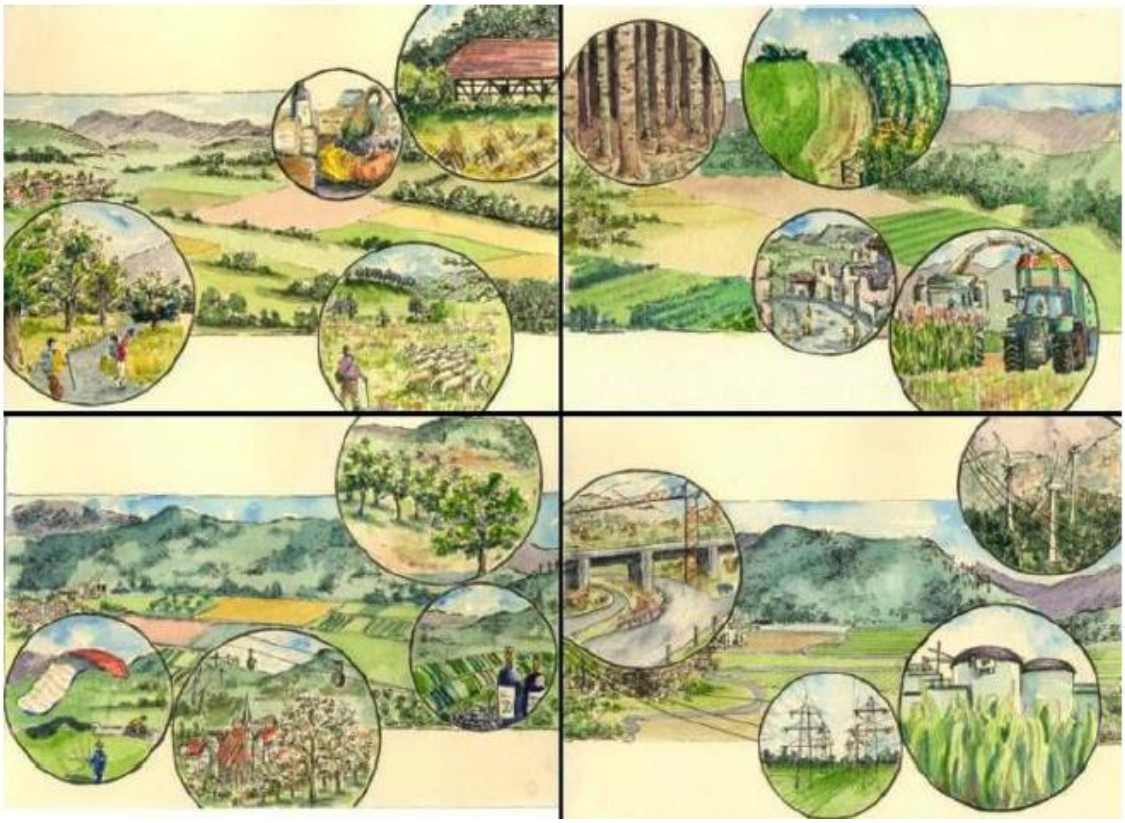
services (Palomo et al., 2014). Scenario planning is primarily used as a decision support tool. It can be used to assess the possible future impacts of various drivers of change (including external drivers such as climate change or internal drivers such as different policy interventions) (Priess & Hauck 2014). Scenarios can combine qualitative and quantitative data collected from various information sources. They can take into account uncertainty and complexity inherent to many decision making situations, especially if a larger time horizon is involved in the decision (Peterson et al. 2003). The process of scenario development – if it follows a participatory approach – can accommodate creative thinking and social learning (Johnson et al. 2012), and can therefore support joint problem definition and consensus building (Priess & Hauck 2014).

The **main advantages** of the approach are: (1) Addresses complexity and uncertainty in a transparent and creative way; (2) Facilitates learning and allows for the integration of diverse knowledge forms and plural and heterogeneous values; (3) Well-established approach, there are global and regional scenarios available in the literature ( i.e. IPCC, MEA, IPBES is in progress) which can be used for comparison and down-scaling; (4) Scenarios can be developed in a participatory way which makes possible the active engagement of different stakeholders and hence can create a science-policy-public interface; (5) It is possible to consider a range of policy or response options, and assess how robust those options are to the different scenarios developed.

The **main constraints/limitations** are: (1) Robustness and internal consistency of scenarios is a key requirement which can only be guaranteed if quality control mechanisms are built in the process; (2) The quantification and modelling of narrative scenarios is often highly demanding in terms of expertise, time and other resources; (3) A participatory scenario planning process requires good facilitation skills and resources; (4) Participatory scenario planning is time consuming for local stakeholders.

**Box 12. Exploring futures of ecosystem services in cultural landscapes through participatory scenario development in Germany**

This study assess the possible future drivers of cultural landscape changes and their likely impacts on ecosystem services provision as perceived by local actors. Authors present stakeholder-based scenarios for the Swabian Alb, a biosphere reserve in southern Germany, projected to the yr 2040. Authors explore the possibilities and limitations of local civil engagement for landscape conservation and development in the face of increasing global influences. The steps of the process are (a) identifying the key driving forces of landscape change, (b) developing contrasting narratives about alternative landscape futures, (c) refining the narratives, (d) discussing scenario impacts, and (e) exploring local management strategies. Four contrasting scenarios created by the stakeholders are presented. Outcomes show that cultural landscape development may come to a crossroads over the next 30 years, with either combined land abandonment and landscape industrialization scenarios or multifunctional, locally distinct landscape futures being possible. The scenario narratives envision that the most powerful way to develop and protect distinct landscapes is to foster local people's links to cultural landscapes, to build social capital around them, and to direct consumption patterns toward localized food production. We find that participatory scenario processes have strengths in terms of the credibility, transferability, and confirmability of the insights gained, but are often weak in ensuring dependability.



Source: Plieninger et al., 2013. http://dx.doi.org/10.5751/ES-05802-180339

## 5.9. Deliberative assessment

Deliberative methods are an umbrella term for various tools and techniques engaging and empowering non-scientist participants (Raymond et al. 2014). These methods ask stakeholders and citizens to form their preferences to ecosystem services together in a transparent way through an open discourse (Kelemen et al., 2016). It may combine different social techniques, i.e., interviews, focus groups, in-depth groups, citizens' juries, etc., to flexibly adapt to local contextual factors and stakeholder needs. Deliberative assessment allows consideration of ethical beliefs, moral commitments, and social norms beyond individual and collective utility (Aldred, 1997) and helps respondents articulate a wide range of non-utilitarian values together with utilitarian ones (Satterfield, 2001). Furthermore, deliberative assessment gives voice to marginalized stakeholder groups and often sheds light on social conflicts that accompany ecosystem service trade-offs. The results of the assessment process are socially accepted arguments about ecosystem services and their importance. Open discourse, generated by deliberative techniques, is able to unfold relational values and reflect upon the social context of valuation. Therefore, deliberative methods are also proposed to account for social equity issues in valuation (Wilson and Howarth 2002). Deliberative assessment is particularly suited for understanding the meanings that people attribute to ecosystems and their services, such as holistic concepts of the land, and it can accommodate diverse world views and forms of information. Therefore, deliberative assessment is found helpful for addressing cultural ecosystem services such as traditional knowledge, sense of place, spiritual value and cultural diversity ( i.e. Chan et al. 2012, Kenter et al. 2011), and can also be used to promote social learning (Kenter et al. 2015) by engaging the general public in an open discussion about the intrinsic (ecological) value of ecosystem functions and processes ( i.e. Kelemen et al. 2013) or the value of nature for future generations (i.e. bequest values).

The **main advantages** of the approach are: (1) Contributes to balancing the power asymmetries between stakeholders by giving voice to more marginalized social groups and by empowering them (if necessary) ; (2) Integrates various knowledge forms ( i.e. local, traditional, expert, scientific); (3) Allows for social learning among the participants and the general public ; (4) Improves the understanding of plural and incommensurable values and hence contributes to framing and managing conflicts; (5) Increases the legitimacy of decisions that build on the outcomes of deliberation.

The **main constraints/limitations** are: (1) Operates with small samples which are not statistically representative; (2) Timely process requiring professional skills; (3) It has to be combined with other approaches ( i.e. MCDA) to reach quantitative results; (4) Its success of partly depends on participants' availability and general debating culture; (5) Participation fatigue might emerge; (6) Some institutional contexts are less open towards public participation.

**Box 13: Farmers' perceptions of biodiversity using discourse-based deliberative assessment method in Hungary**

Authors of this study carried out a deliberative assessment to understand the institutionalised mechanisms affecting farmers' choices that are often in conflict with nature conservation. The major aim of this study was to help local stakeholders and decision-makers move towards a more sustainable landscape management system. To this end, in-depth and semi-structured interviews and focus groups were applied. Moreover, authors carried out deliberative assessment to understand how farmers relate to biodiversity and whether it has different meanings and values to different groups of farmers. A deliberate assessment was carried out to mobilise community members and collect information on their knowledge, opinion and feelings related to ecosystem services. This was then channelled into a participatory scenario planning process, combined with modelling, to enable stakeholders and experts to explore alternative future options and choose the most desirable one(s) together. This long lasting research process was able to highlight multiple dependencies between local inhabitants and their surrounding environment. Authors were able identify plural and heterogeneous values and their possible changes across time and space.

Source: Kelemen et al., 2013. DOI: 10.1016/j.landusepol.2013.06.005

## 5.10. Multi-Criteria Analysis

Multi-criteria analysis (MCA) is an integrated assessment method useful for situations in which the relevant criteria (social, economic and biophysical) to the decision cannot be expressed in one unit, but can only be expressed in other units or in qualitative terms (i.e. impacts can be ranked in order

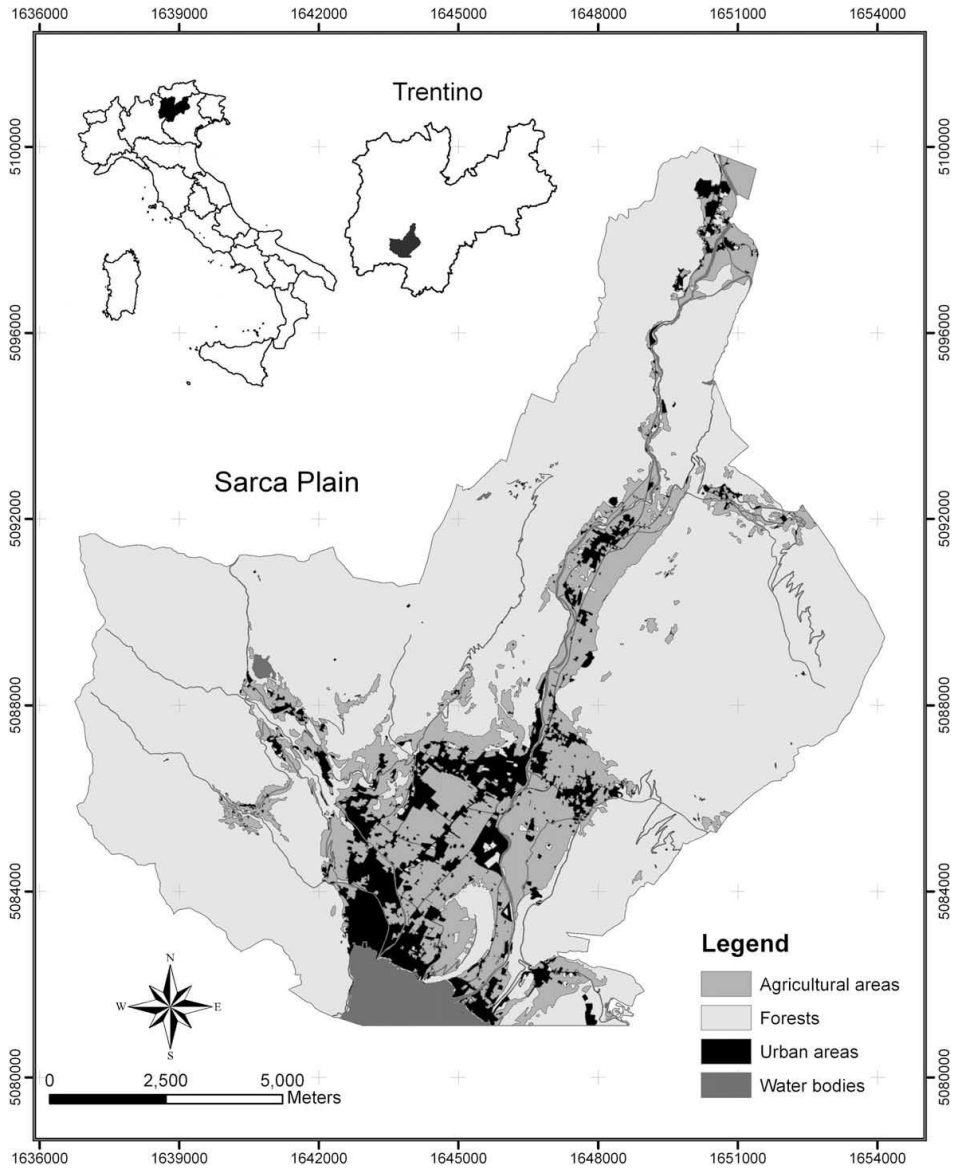
of importance). MCA does not generate primary data, but combines existing information in a logical and structured way to support decision-making (Belton and Stewart, 2002). It integrates socio-economic and biophysical data and encourages a common understanding of a decision problem. MCA combines two types of information: (i) Factual information: measurements or estimates about a given criterion ( i.e. food production of an agro-ecosystem in ton/year); (ii) Assessment-based information: refers to the opinions and judgments of stakeholders ( i.e., importance of those levels of food production as a contribution to the livelihoods of a given social group). MCA is rooted in operational research and support for single decision-makers but recently the emphasis has shifted towards multi-stakeholder processes to structure decision alternatives and their consequences (Kiker et al. 2005). MCA facilitate a dialogue on the relative merits of alternative courses of action, thereby enhancing procedural quality in the decision-making process (Mendoza and Martins 2006).

The **main advantages** of the approach are: (i) Openness to divergent values and opinions; (ii) Capability to incorporate qualitative and intangible factors; (iii) Accountability (systematic, transparent); (iv) Useful for conflict resolution and to help reaching a political compromise; (v) Encourages stakeholder participation; (vi) Preferences are revealed in a more explicit and direct way.

The **main constraints/limitations** are: (i) Potentially time consuming and complex; (ii) Perceived as a technocratic approach; (iii) Difficult comparison of case studies; (iii) Choice of stakeholders and timing of their participation; (iv) Experts/stakeholders are reluctant to share their knowledge and values; (v) Used in a top-down manner by decision-makers: Risk of “false” objectivity of decisions, that are, in fact, highly subjective; (vi) The same ecosystem can be evaluated from different perspectives, but it has to be clarified for what reason it is included; (vi) If there is more information on a specific category of ecosystems in comparison with others, there is a risk that it becomes over-represented in the analysis. (Gamber and Turcanu, 2007)

**Box 14. Combining stakeholder analysis and spatial multicriteria evaluation to select and rank inert landfill sites in Italy.**

This study presents a method based on the combination of stakeholder analysis and spatial multicriteria evaluation to first design possible sites for an inert landfill, and then rank them according to their suitability. The method was tested for the siting of an inert landfill in the Sarca's Plain, located in south-western Trentino, an alpine region in northern Italy. Firstly, stakeholder analysis was conducted to identify a set of criteria to be satisfied by new inert landfill sites. SMCE techniques were then applied to combine the criteria, and obtain a suitability map of the study region. Subsequently, the most suitable sites were extracted by taking into account also thresholds based on size and shape. These sites were then compared and ranked according to their visibility, accessibility and dust pollution. All these criteria were assessed through GIS modelling. Sensitivity analyses were performed on the results to assess the stability of the ranking with respect to variations in the input (criterion scores and weights). The study concluded that the three top-ranking sites are located close to each other, in the northernmost sector of the study area. A more general finding was that the use of different criteria in the different stages of the analysis allowed to better differentiate the suitability of the potential landfill sites.




Source: Geneletti, D. 2010. https://doi.org/10.1016/j.wasman.2009.09.039

## 6. Operationalizing social methods for policy and decision-support contexts

As we have seen in the previous section, social methods for mapping and assessments ecosystem services have increasingly been used to support environmental policies. In this section, we highlight how social methods can be applied for different policy instruments and decision contexts. As a summary, it is important to recognise that all the social mapping assessment methods described in this report are applicable to various stages of policy implementation. The choice of which social method to use will largely be determined by the type of decision problem and the availability of relevant information and other resources. Maes et al. (2018, forth coming) presented a list of policy questions that drive ecosystem assessments in the context of the EU Biodiversity Strategy (Table 2). This list of questions has been carried out in the framework of ESMERALDA. The initial list with policy questions has been updated and extended with business and societal questions, which require spatially explicit and quantitative information about ecosystems and ecosystem services. Although in this report we only provide some guidance recommendations for policy questions, a similar process could also be extend to business and societal questions. For the purpose of this report we have taken the proposed typology of policy questions so that different questions can be coupled to specific social methods. In this direction, table 3 illustrates gives an approximation of how suitable and reliable is each method to address the different policy questions.

**Table 2. Typology of policy questions which drive the implementation of mapping and assessment of ecosystems and their services (Source: Modified from Maes et al., 2018)**

| Category | Description |
|---|---|
| **Policy support questions**<br>○ Agricultural policy<br>○ Biodiversity policy<br>○ Climate policy<br>○ Disaster risk reduction<br>○ Economic policy<br>○ Impact assessment<br>○ Spatial planning | How ES can be used to support policy making and implementation |
| **Technical and methodological questions**<br>○ Spatial scale<br>○ Scenarios and uncertainty<br>○ Priorities and preferences | Questions for specific technical details of mapping ecosystem services |
| **Questions on resources and responsibilities**<br>○ Costs and resources<br>○ Governance | Questions about governance of ecosystem services and resources to implement ecosystem services based projects and programmes |
| **Application questions**<br>○ Applications of ES approach<br>○ Payments for ES<br>○ Cost Benefit Analysis<br>○ Communication | How to implement ES based approaches and how can mapping ES support real world applications |

**Table 3.** Operationalizing social mapping and assessment methods in relation to specific policy instrument that are used in decision-support process: (●) highly appropriate, (●) less suitable, (●) not appropriate

| Social Methods | | Policy support questions | | | | | | Technical questions | | | | Resources questions | | Application questions | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Agricultural policy | Biodiversity policy | Climate policy | Disaster risk | Economic policy | Impact assessment | Spatial planning | Spatial scale | Scenarios and uncertainty | Priorities and preferences | Cost and resources | Governance | Applications of ES approach | Payment for ES | Cost and Benefits | Communication |
| Observation | Time-use assessment | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Photo-elicitation survey | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Geo-tagged photographs | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Consultation | Preference assessment | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Narratives assessment | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Q-methodology | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| Engagement | Participatory GIS | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Participatory scenarios | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Deliberative assessment | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |
| | Multicriteria analysis | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● |

Additionally we have examined the relationship on how social mapping and assessment methods can be used to answer different types of policy questions depending its spatial scale, tier level and uncertainty level (Figure 7; Table 1). Conceptually we are highlighting that social methods can capture the importance, preferences, needs or demands expressed by people towards nature, and articulate them through different policy support contexts depending on their requirements for precision (reliability level), and complexity (tier level).

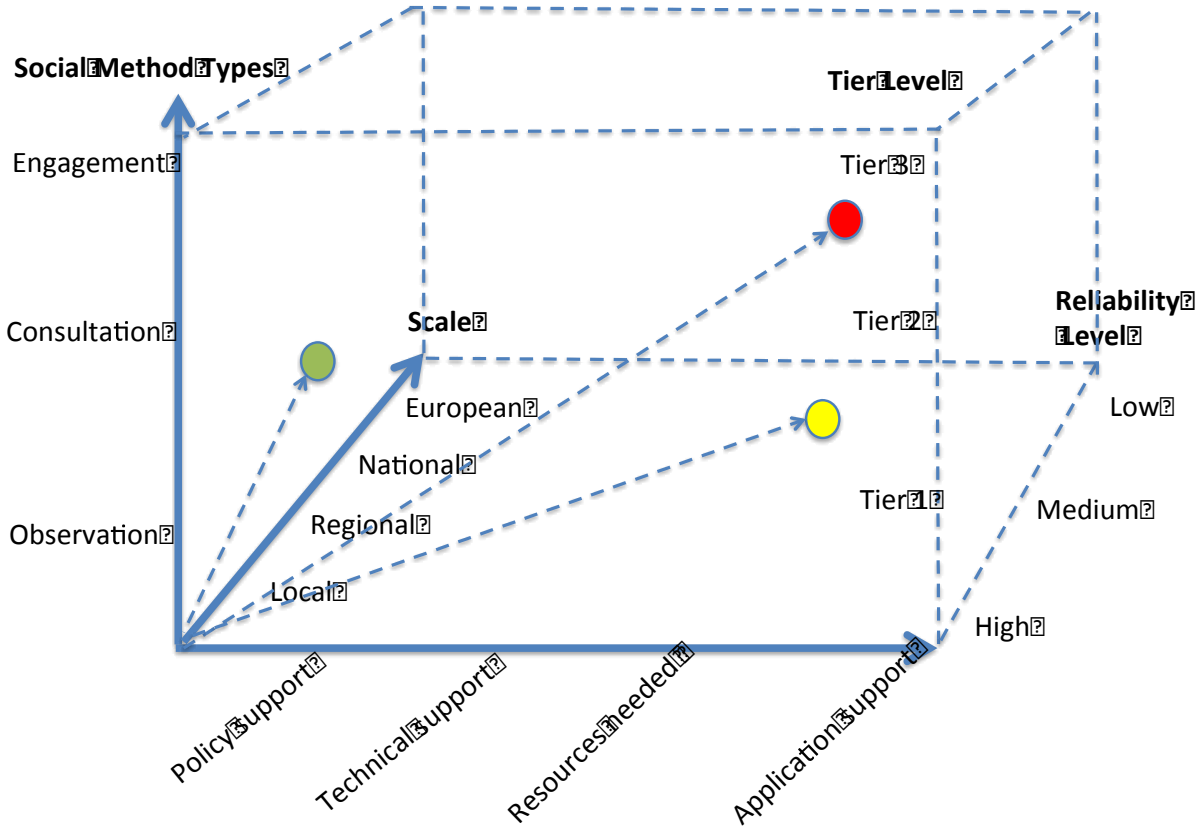



**Figure 7**. Relationship on how social mapping and assessment methods can be used to answer different types of policy questions depending its spatial scale, reliability level and tier level. Certain combinations will be highly appropriate (●), while others will be less suitable (●) or directly not appropriate (●). Inspired from Zulian et al. (2017).

As it has described along this report, no method can be used in every context so, prior to the start of a social ecosystem services mapping and/or assessment, all these previously described aspects should be critically evaluated. What kind of policy question is being addressed? What level of precision and at what scale are results needed? What resources are available? The suitability of a method for answering a specific policy question will depend on multiple context-based needs. Observation methods (i.e. time-use assessment) are usually well-suited for policy questions to be addressed at larger and tier 1 scales and do not require many resources. Consultation methods (i.e. Q-methodology) might be better suited for questions that require a Tier 2 approach. Finally, engagement methods will usually be better suited when resources are abundant and for questions to be addressed at a small scale with a tier 3 approach.

# 7. Potential integration of social methods with biophysical and economic methods

Social methods for mapping and assessing ecosystem services primarily focus on capture multiple values that other methods are not capable of. Social methods can identify how different stakeholders hold different preferences/perceptions/motivations/values toward ecosystem services and offer insights into the motivations for conserving nature, and the symbolic, cultural and spiritual values that are frequently invisible in other valuations approaches (e.g economic or biophysical). Additionally, social mapping and assessment methods can address new types of values ( i.e. relational values). For example deliberative methods allow the consideration of ethical beliefs, moral commitments and social norms. Therefore they are more likely to identify values related to virtues and principles if they are of concern to stakeholders, but social metrics have to be purpose-built for specific situations.

However, any social mapping and assessment methods of ecosystem services described in this report are fundamentally complementary with any outputs from economic or biophysical measurement or modelling of changes in ecosystem service availability. For instance social methods have a strong link to economic valuation, and in some of the case-studies social methods were identified as a precursor of economic valuation in an integrated assessment ( i.e. through a preference assessment). The flow of information from one set of methods to another can also travel in the other direction, with results from economic methods used as inputs in biophysical and social mapping and assessment applications. The reality is that methods defined by disciplinary boundaries are to a large extent complements rather than substitutes in providing information on the importance of ecosystem services in decision-making.

Borders between methods are blurry, for example outputs from social methods to define the scope of an assessment ( i.e. participatory GIS, narrative assessment, Q-methodology) or develop scenario storylines ( i.e. participatory scenario planning), can be used as inputs for economic ( i.e. revealed and state preference methods) or biophysical ( i.e. Spatial proxy models or State and transition models) methods. Furthermore, no method alone can aspire to assess with precision all ecosystem services. Instead, an integrated spirit that mixes different methods that belong to different categories, might have the potential to do so. For each of the potential integration of methods there is a need for examples, including a list of who and how they are using different methods into their mapping and assessments studies. This is the main reason why in the ESMERALDA online method explorer, it can be found a method interlinkage filter to search for most common combination of methods used in existing literature.

Mapping and assessment studies generally require the linking of biophysical, economic and social methods. By linking we mean that the outputs of one method are used as inputs into another method. A mapping or assessment application may involve several linked steps using multiple methods to produce a final map or other information that is presented to decision makers. ESMERALDA deliverable D3.4 provides specific guidance on how to link methods for mapping and assessing ecosystem services.

In addition to linking methods in a knowledge production process to produce policy relevant information, there may be a need to integrate separate outputs from biophysical, economic and social mapping and assessment applications. By integration we mean the combination of complementary pieces of information that address different aspects of an ecosystem service ( i.e. sustainability, value and distribution) to support decision making. ESMERALDA deliverable D3.4 also provides guidance on how to integrate information produced by biophysical, economic and social methods.

## 8. Conclusion

**1. Social methods emerge as a useful tool to map and assess ecosystem services and describe the relationship between multiple stakeholders**. The main focus of social methods is to identify how different stakeholders hold different preferences, perceptions, motivations, values toward ecosystem services. They are supposed to recognize perceived changes in the flows of ecosystem services, which can be an early warning signs of ecosystem degradation. They are also considered to explore how multiple values are interlinked (i.e. having bundled qualities) and contribute to human well-being.

**2. Social methods can help to broaden mapping and assessment scopes and to capture other type of information that biophysical or economic methods are not capable of.** Social methods can help identify plural and heterogeneous values that are relevant for different people ( i.e. different socio-demographic profiles, different cultures or cosmologies) across different spatial and temporal scales ( i.e. in different localities or seasons of the year). One advantage of social methods is that these capture the different stakeholder values of ecosystems services, according to specific use or non-use of that ecosystem service. They offer insights into the motivations for conserving nature, and the symbolic, cultural and spiritual values that are frequently invisible in other valuations approaches. Additionally, social assessment methods can address identified new types of values ( i.e. relational values).

**3. There is a broad spectrum of options to map and assess ecosystem services from a social perspective depending on the type of data and the objective of the study.** In this report which aims at providing a general comprehensive review, we focus on eleven methods: Time-use assessment; Photo-elicitation; Geo-tagged photo series analysis, Preference assessment, Narrative assessment, Q-methodology, Public participatory GIS, Participatory scenario planning, Deliberative assessment, Multi-criteria analysis. Some social methods that were considered but finally not included in the list provided are: (1) Mapping, and Quantifying the Social Values of Ecosystem Services (SOLVES); (2) Ecosystem services card game; (3) Historical social record methodology; (4) Agent based models; (5) Monitoring of ES through citizen science.

**4. By definition social methods need to involve people in the process. Therefore and for the purpose of ESMERALDA we divided social methods into the three broad groups in relation to how they engage participants** and collect their preferences, perceptions, motivations and values of ES: (1) *Observations methods* ( i.e. preference assessment, time-use and photo-elicitation; (2) *Consultation methods* ( i.e. narratives, Q-methodology); (3) *Engagement methods* (i.e. Public Participatory GIS, participatory scenario planning and deliberative assessment). For example engagement methods allow the consideration of ethical beliefs, moral commitments and social norms. Therefore they are more likely to identify values related to virtues and principles if they are of concern to stakeholders, but social metrics have to be purpose-built for specific situations.

**5. The broad classification of social methods is determined by different key variability aspects and methodological requirements**. This brings also a level of complexity, that justify the development of a practical guide like this deliverable report for selecting social methods according to key variability aspects to map and assess ecosystems and their services.

**6. Social methods are classified into three tiers levels based on information about reliability, accuracy and precision of social methods to map and assess ES.** In particular, they differ in the level of engagement of participants ranging from observations (tier 1) to consultations (tier 2) and finally engagement (level 3). This additional classification is important for users to determine their suitability in a specific context and can help them to select the appropriate type of method.

**7. Social methods can be based on large samples and can cover different spatial scales.** Mapping and assessment methods that claim to be representative for a population need to be based on large samples and require multivariate analysis to explain results if the population is heterogeneous. Social assessments allow for such sampling and analysis approaches, although many current social methods are small-sample approaches, aiming at describing specific actor and place-based values.

**8. Social methods integrate different forms of data ( i.e. quantitative and qualitative) and knowledge ( i.e. practices and beliefs) with the purpose to solve potential social conflicts related to different perceptions, needs and uses.** Social methods are often associated with principles and virtues, and contexts in which trade-offs and compensation against income are ill-defined and/or not accepted. Social methods also cover a wide range of 'tangibility', from some market-mediated, self-oriented individual physical recreational experiences that are routinely valued using travel costs and entry fees, to other-oriented, metaphysical and transformative experiences that are highly intangible.

**9. Social methods can serve as a tool to identify the impact of different management options on an ecosystem's capacity to deliver services and as a basis for decision-making processes.** Based on social preferences, the concept of ecosystem service bundles emerge as a useful tool for identifying ecosystem service synergies and trade-offs resulting from stakeholders' diverging interests and knowledge. Given the growing demand for the incorporation of the social dimension of ecosystem services in environmental policy agendas, understanding social preferences toward the protection of ecosystem services has become a research priority. For example trade-offs can be identified from social preferences as people's willingness to trade-off conservation of one ecosystem service against another. Additionally ecosystem service bundles can be identified from people's systemic representations of interrelationships between ecosystem services.

**10. Provide a comprehensive list of social methods examples that have been used in different studies in Europe can help to understand the usefulness of these approaches in the implementation of policy agenda at different scales.** Social mapping and assessment methods report is the necessary first step in the development of the ESMERALDA main objective to develop a flexible methodology for mapping and assessment activities in the EU member states. However, the ultimate goal of this task is to contribute to the mainstreaming of social methods into all levels of decision-making (policies, plans, programmes and projects), as well as economic accounting and reporting.

## 9. Acknowledgements

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## 10. References

Aldred, J. (1997). Existence Value, Moral Commitments and In-kind Valuation. In: Foster, J. (ed) Valuing Nature? Economics, Ethics and the Environment. London: Routledge, p. 155–169.

Belton, V., Stewart, T.J. (2002). Multiple Criteria Decision Analysis: An Integrated Approach. Kluwer Academic Publishers, Boston.

Berry PM, Fabók V, Blicharska M, Bredin YK, García-Llorente M, Kovács E, Geamana N, Stanciu A, Termansen M, Jääskeläinen T, Haslett JR, Harrison PA. (2016). Why conserve biodiversity? A multi-national exploration of stakeholders' views on the arguments for biodiversity conservation. Biodiversity Conservation DOI 10.1007/s10531-016-1173-z

Bohensky, E.L., Reyers, B., Van Jaarsveld, A.S. (2006). Future ecosystem services in a southern African River Basin: A scenario planning approach to uncertainty. Conservation Biology, 20(4), 1051–1061.

Brander, L.M. and van Beukering, P.J.H. (2015). Trade-offs and decision support tools. In Bouma, J.A. and van Beukering, P.J.H. (Eds.), Ecosystem Services: From Concept to Practice. Cambridge University Press.

Brander, L.M., van Beukering P., Balzan, M., Broekx, S., Liekens, I., Marta-Pedroso, C., Szkop, Z., Vause, J., Maes, J., Santos-Martin F. and Potschin-Young M. (2018). Report on economic mapping and assessment methods for ecosystem services. Deliverable D3.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

Brown, G., Fagerholm, N. (2015). Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. ESs 13, 119-133.

Burkhard, B., Kroll, F., Nedkov, S., & Müller, F. (2012). Mapping ecosystem service supply, demand and budgets. Ecological Indicators, 21, 17-29.

Casado-Arzuaga, I., M. Onaindia, I. Madariaga and P. Verburg (2014). 'Mapping recreation and aesthetic value of ecosystems in the Bilbao Metropolitan Greenbelt (northern Spain) to support landscape planning', Landscape Ecology 29, 1393-1405.

Casalegno S, Inger R, DeSilvey C, Gaston KJ (2013) Spatial Covariance between Aesthetic Value & Other Ecosystem Services. PLoS ONE 8(6): e68437. doi:10.1371/journal.pone.0068437

Castro AJ, Martín-López B, García-Llorente M, Aguilera PA, López E, Cabello J. (2011). Social preferences regarding the delivery of ecosystem services in a semiarid Mediterranean region. J Arid Environ 75:1201–1208

Castro, A., García-Llorente, M., Martín-López, B., Palomo, I., Iniesta-Arandia, I. (2014). Multidimensional approaches in ecosystem service assessment. In: Earth Observation of Ecosystem Services, pp. 427-454.

Chamberlain EC, Rutherford MB, Gibeau ML (2012) Human perspectives and conservation of grizzly bears in Banff National Park, Canada. Conserv Biol 26:420–431.

Chan, K., T. Satterfield and J. Goldstein (2012). 'Rethinking ecosystem services to better address and navigate cultural values', Ecological Economics, 74, 8–18

Chan, K.M.A., Guerry, A.D., Balvanera, P., et al. (2012b). Where are Cultural and Social in Ecosystem Services? A Framework for Constructive Engagement. BioScience 62(8): 744-756.

Christie, M., Fazey, I., Cooper, R., Hyde, T., Kenter, J.O., (2012). An evaluation of monetary and non-monetary techniques for assessing the importance of biodiversity and ecosystem services to people in countries with developing economies. Ecological Economics 83, 67-78

Czajkowski, M., Bartczak, A., Gier giczny, M., Navrud, S., & Żyl icz, T. (2014). Providing Preference-Based Support for Forest Ecosystem Service Management. Forest Policy and Economics, 39 , 1-12. http://dx.doi.org/10.1016/j.forpol.2013.11.002

de Groot, R., Fisher, B., Christie, M., Aronson, J., Braat, L., Gowdy, J., Shmelev, S., (2010). Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. In: Kumar, P. (Ed.), The Economics of Ecosystems and Biodiversity: Ecological and Economic Foundations. Earthscan, London.

de Oliveira, L. E. C., & Berkes, F. (2014). What value São Pedro's procession? Ecosystem services from local people's perceptions. Ecological Economics, 107, 114-121.

Dearborn DC, Kark S (2010) Motivations for conserving urban biodiversity. Conserv Biol 4:432–440.

Depellegrin, D., Blazauskas, N., Vigl, L.E. (2012). Aesthetic value characterization of landscapes in coastal zones. In: Baltic International Symposium (BALTIC).IEEE/OES, pp. 1–6.

Díaz S, et al. (2015) The IPBES Conceptual Framework - connecting nature and people. Current Opinion in Environmental Sustainability 14: 1-16.

Frank, S., Fürst, C., Koschke, L., Witt, A., Makeschin, F. (2013). Assessment of landscape aesthetics - Validation of a landscape metrics-based assessment by visual estimation of the scenic beauty. Ecol. Indic. 32, 222–231. doi:10.1016/j.ecolind.2013.03.026

Gampera, C.D. and Turcanuc, C. (2007). On the governmental use of multi-criteria analysis. Ecological Economics. Vol 62. 2. P. 298-307.

García-Llorente M, Castro A, Quintas-Soriano C, López I, Castro H, Montes C, Martín-López B. (2016) The value of time in biological conservation and supplied services. Journal of Arid Environments 124:13-21.

García-Llorente M, Martín-López B, Iniesta-Arandia I, López-Santiago CA, Aguilera PA, Montes C (2012) The role of multi- functionality in social preferences toward semi-arid rural landscapes: an ecosystem service approach. Environ Sci Pol 19–20:136–146

García-Llorente, M., Martín-López, B., Montes, C. (2011) Exploring the motivations of protesters in contingent valuation: Insights for conservation policies. Environmental Science & Policy 142, 76-88.

García-Nieto, A. P., Quintas-Soriano, C., García-Llorente, M., Palomo, I., Montes, C., Martín-López, B. (2014). Collaborative mapping of ecosystem services: The role of stakeholders profiles. Ecosystem services, 13, 141-152.

Geneletti D. (2010). Combining stakeholder analysis and spatial multicriteria evaluation to select and rank inert landfill sites, Waste Management. 328-337. https://doi.org/10.1016/j.wasman.2009.09.039

Geneletti D. (2010). Combining stakeholder analysis and spatial multicriteria evaluation to select and rank inert landfill sites, Waste Management 328-337.

Gliozzo, G., N. Pettorelli, and M. Haklay. (2016). Using crowdsourced imagery to detect cultural ecosystem services: a case study in South Wales, UK. Ecology and Society 21(3):6.

Gómez-Baggethun E, Martín-López B (2015) Ecological Economics perspective in ecosystem services valuation. In: Martínez-Alier J, Muradian R. (eds) Handbook of Ecological Economics. Pp: 260-282. Edward Elgar, London.

Gould, R. K., Klain, S. C., Ardoin, N. M., Satterfield, T., Woodside, U., Hannahs, N. & Chan, K. M. (2015). A protocol for eliciting nonmaterial values through a cultural ecosystem services frame. Conservation Biology, 29(2), 575-586.

Grêt-Regamey, Adrienne, Bettina Weibel, Sven-Erik Rabe and Benjamin Burkhard. (2017). A tiered approach for ecosystem services mapping. In Mapping Ecosystem Services, edited by Benjamin Burkhard and Joachim Maes, 213-217. Sofia: Pensoft Publishers. doi.org/10.3897/ab.e12837

Higuera, D., Martín-López, B., Sánchez-Jabba, A. (2013) Social preferences towards ecosystem services provided by cloud forests in the neotropics: implications for conservation strategies. Regional Environmental Change 13, 861-872.

http://dx.doi.org/10.5751/ES-08436-210306

Iniesta-Arandia I, García-Llorente M, Aguilera PA, Montes C, Martín-López B. (2014) Socio-cultural valuation of ecosystem services: uncovering the links between values, drivers of change and human well-being. Ecological Economics 108:36-48.

IPBES (2015): Guide regarding diverse conceptualization of multiple values of nature and its benefits, including biodiversity and ecosystem functions and services, IPBES 15 Deliverable 3 (d)

Johnson, K.A., Dana, G., Jordan, N.R., Draeger, K.J., Kapuscinski, A., Smitt Olabisi, L.K., Reich, P.B. (2012). Using participatory scenarios to stimulate social learning for collaborative sustainable development. Ecology and Society, 17(2): 9.

Kamal S, Grodzin´ska-Jurczak M (2014) Should conservation of biodiversity involve private land? A Q methodological study in Poland to assess stakeholders' attitude. Biodiver and Conserv 23:2689–2704.

Kampen JK, Tama´s P. (2014). Overly ambitious: contributions and current status of Q methodology. Qual and Quant 48:3109–3126.

Kaplowitz, M.D., Hoehn, J.P. (2001). Do focus groups and individual interviews reveal the same information for natural resource valuation? Ecological Economics, 36: 237-247.

Keeler, B. L., S. A. Wood, S. Polasky, C. Kling, C.T. Filstrup, and J. A. Downing, (2015). Recreational demand for clean water: evidence from geotagged photographs by visitors to lakes. Frontiers in Ecology and the Environment, 13(2), 76–81.

Kelemen, E., Nguyen, G., Gomiero, T., Kovács, E., Choisis, J. P., Choisis, N. & Balázs, K. (2013). Farmers' perceptions of biodiversity: lessons from a discourse-based deliberative valuation study. Land use policy, 35, 318-328.

Kelemen, E.; García-Llorente, M.; Pataki, G.; Martín-López, B. and E. Gómez-Baggethun (2016): Non-monetary techniques for the valuation of ecosystem service. In: Potschin, M. and K. Jax (eds): OpenNESS Ecosystem Services Reference Book. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book

Kenter, J. O., Hyde, T., Christie, M., &Fazey, I. (2011) The importance of deliberation in valuing ecosystem services in developing countries—Evidence from the Solomon Islands. Global Environmental Change, 21(2), 505-521.

Kenter, J.O., O'Brien, L., Hockley, N., Ravenscroft, N., Fazey, I., Irvine, K.N., Reed, M.S., Christie, M., Brady, E., Bryce, R., Churche, A., Cooper, N., Davies, A., Evely, A., Everard, M., Fish, R., Fisher, J.A., Jobstvogt, N., Molloy, C., Orchard- Webb, J., Ranger, S., Ryant, M., Watsont, V., Williams, S., (2015). What are shared and social values of ecosystems? Ecological Economics 111, 86–99.

Kiker, G., Bridges, T., Varghese, A, Seager, T., Linkov, I. (20059. Application of multicriteria decision analysis in environmental decision making. Integrated Environmental Assessment and Management 1(2): 95–108.

Kovács, E., Kelemen, E., Kalóczkai, Á., Margóczi, K., Pataki, G., Gébert, J., Málovics, G., Balázs, B., Roboz, Á., Kovács, E.K. and Mihók, B. (2015). Understanding the links between ecosystem service trade-offs and conflicts in protected areas. Ecosystem Services, 12, pp.117-127.

Lamarque P, Quetier F, Lavorel S (2011) The diversity of the ecosystem services concept and its implications for their assessment and management. C R Biol 334:441–449

López-Santiago CA, Oteros-Rozas E, Martín-López B, Plieninger T, González E, González JA. (2014) Using visual stimuli to explore the social perceptions of ecosystem services in cultural landscapes: the case of transhumance in Mediterranean Spain. Ecology & Society 19 (2): 27. URL: http://www.ecologyandsociety.org/vol19/iss2/art27/

MA (Millenium Ecosystem Assessment), 2005. Ecosystems and human well-being — synthesis. World Health Vol. 5. Island Press, Washington DC (Retrieved from http:// www.who.int/entity/globalchange/ecosystems/ecosys.pdf)

Maes J., Teller A., Erhard M., Liquete C., Braat L., Berry P., Egoh B., Puydarrieux P., Fiorina C., Santos F., Paracchini M.L., Keune H., Wittmer H., Hauck J., Fiala I., Verburg P.H., Condé S., Schägner J.P., San Miguel J., Estreguil C., Ostermann O., Barredo J.I., Pereira H.M., Stott A., Laporte V., Meiner A., Olah B., Royo Gelabert E., Spyropoulou R., Petersen J.E., Maguire C., Zal N., Achilleos E., Rubin A., Ledoux L., Brown C., Raes C., Jacobs S., Vandewalle M., Connor D., Bidoglio G. (2013). Mapping and Assessment of Ecosystems and their Services. An analytical framework for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020. Publications office of the European Union, Luxembourg.

Marjaine, Szerenyi Z, Zsoka A. , Asvanyi K, Flachner Z. (2011). The Role of Adaptation to Climate Change in Rural Development. Reg and Bus Stud 3(Suppl 1):189–198.

Martín-López B, Iniesta-Arandia I, García-Llorente M, Palomo I, Casado-Arzuaga I, Del Amo DDG, Gómez-Baggethun E, Oteros-Rozas E, Palacios-Agundez I, Willaarts B, González JA, Santos-Martín F, Onaindia M, López-Santiago C, Montes C (2012) Uncovering ecosystem service bundles through social preferences. PLoS ONE 7(6):e38970 http://dx.plos.org/10.1371/journal.pone.0038970.

Martínez Pastur, G., P. L. Peri, M. V. Lencinas, M. García-Llorente, and B. Martín-López. (In press). Spatial patterns of cultural ecosystem services provision in Southern Patagonia. Landscape Ecology.

Martinez-Alier J, Munda G, O'Neil J. (1998). Weak comparability of values as a foundation for ecological economics. Ecological Economics, 26, 277–286.

Mendoza, G.A., Martins, H. (2006). Multi-criteria decision analysis in natural resource management: A critical review of methods and new modeling paradigms. Forest Ecology and Management 230: 1–22.

Milcu AI, Hanspach J, Abson D, Fischer J. (2013). Cultural ecosystem services: a literature review and prospects for future research. Ecol. Soc. 18 (3), art. 44.

Milcu AI, Sherren K, Hanspach J, Absom D, Fischer J. (2014). Navigating conflicting landscape aspirations: application of a photo-based Q-method in Transylvania (Central Romania). Land Use Policy 41:408–422.

Nahuelhual, L., A. Carmona, P. Lozada, A. Jaramillo, and M. Aguayo. (2013). Mapping recreation and ecotourism as a cultural ecosystem service: An application at the local level in Southern Chile. Applied Geography 40:71–82.

Nieto-Romero M, Oteros-Rozas E, González JA, Martín-López B. (2014). Exploring the knowledge landscape of ecosystem services assessments in Mediterranean agroecosystems: Insights for future research. Environ. Sci. Policy 37, 121–133.

Ninjik M, Ninjik A, Bizikova L. (2009). Analysing the development of small-scale forestry in central and eastern Europe. Small-scale For 8:159–174.

O'Neill SJ, Boykoff M, Niemeyer S, Day SA. (2013). On the use of imagery for climate change engagement. Glob Environ Change 23(2):413–421.

Oteros-Rozas E, Martín-López B, González JA, Plieninger T, López CA, Montes C. (2014). Socio-cultural valuation of ecosystem services in a transhumance social-ecological network. Regional Environmental Change 14: 1269-1289.

Oteros-Rozas, E., B. Martín-López, N. Fagerholm, C. Bieling and T. Plieninger. (2017). Using social media photos to explore the relation between cultural ecosystem services and landscape features across five European sites. Ecological Indicators,

Oteros-Rozas, E., Martín-López, B., González, J.a., Plieninger, T., López, C.A., Montes, C., (2013). Socio-cultural valuation of ecosystem services in a transhumance social– ecological network. Reg. Environ. Chang. http://dx.doi.org/10.1007/s10113-013-0571-y.

Palomo, I., Martín-López, B., López-Santiago, C., Montes, C. (2011). Participatory Scenario Planning for Protected Areas Management under the Ecosystem Services Framework: the Doñana Social-Ecological System in Southwestern Spain. Ecology and Society 16(1) URL: http://www.ecologyandsociety.org/vol16/iss1/art23/

Palomo, I., Martín-López, B., Potschin, M., Haines-Young, R., Montes, C. (2013). National Parks, buffer zones and surrounding lands: mapping ES flows. Ecosystem services, 4, 104-116.

Pearson, L. J., Park, S., Harman, B., & Heyenga, S. (2010). Sustainable land use scenario framework: Framework and outcomes from peri-urban South-East Queensland, Australia. Landscape and Urban Planning, 96(2), 88-97.

Pereira, E., Queiroz, C., Pereira, H.M. Vicente, L. (2005). Ecosystem services and human well-being: a participatory study in a mountain community in Portugal. Ecology and Society, 10 (2) URL: http://www.ecologyandsociety.org/vol10/iss2/art14/

Petursdottir, T., Aradottir, A. L. and Benediktsson, K. (2012) An evaluation of the short-term progress of restoration combining ecological assessment and public perception. Restoration Ecology 21, 75-85.

Plieninger, T., C. Bieling, B. Ohnesorge, H. Schaich, C. Schleyer, and F. Wolff. (2013). Exploring futures of ecosystem services in cultural landscapes through participatory scenario development in the Swabian Alb, Germany. Ecology and Society 18(3): 39. http://dx.doi.org/10.5751/ES-05802-180339.

Potschin, M. and R. Haines-Young. (2011). Ecosystem Services: Exploring a geographical perspective. Progress in Physical Geography 35(5): 575-594.

Potschin-Young, M. et al. (2018). Multifunctional assessment methods and the role of map analyse - Using an Integrated Ecosystem Service Assessment Framework. Deliverable D4.7 (draft) EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

Priess, J., Hauck, J. (2015). Scenario building and its application. In: Potschin, M. and K. Jax (eds): OpenNESS Ecosystem Service Reference Book. EC FP7 Grant Agreement no. 308428. Available via: www.openness-project.eu/library/reference-book.

Punch, K. F. (2013) Introduction to social research: Quantitative and qualitative approaches. Sage.

Raymond, C.M., Kenter, J.O., Plieninger, T., Turner, N.J., Alexander, K.A. (2014). Comparing instrumental and deliberative paradigms underpinning the assessment of social values for cultural ESs. Ecol. Econ. 107, 145-156.

Richards, D. R., and D. A. Friess. (2015). A rapid indicator of cultural ecosystem service usage at a fine spatial scale: Content analysis of social media photographs. Ecological Indicators 53:187–195.

Rodríguez, L.C., Pascual, U., Niemeyer, H.M. (2006). Local identification and valuation of ecosystem goods and services from Opuntia scrublands of Ayacucho, Peru. Ecological Economics, 57(1): 30–44.

Sandifer, P.A., Sutton-Grier, A.E., Ward, B.P. (2015) Exploring connections among nature, biodiversity, ecosystem services and human health and well-being: Opportunities to enhance health and biodiversity conservation. Ecosystem Services 12: 1-15.

Santos-Martín F, Martín-López B, García-Llorente M, Aguado M, Benayas J, Montes C. (2013) Unraveling the relationships between ecosystems and human wellbeing in Spain. PLoS ONE 8(9): e73249. DOI:10.1371/journal.pone.0073249

Santos-Martín F., Eszter Kelemen, Marina García-Llorente, Sander Jacobs, Elisa Oteros-Rozas, David N. Barton, Ignacio Palomo, Violeta Hevia, Berta Martín-López (2017). Socio-cultural valuation approaches. Mapping Ecosystem Services, Edited by Benjamin Burkhard, Joachim Maes, 03/2017: chapter 4.2.: pages 104-114; Pensoft.

Satterfield, T. (2001). In Search of Value Literacy: Suggestions for the Elicitation of Environmental Values. Environmental Values 10(3): 331–359.

Schoemaker, P.J.H. (1995). Scenario planning - A tool for strategic thinking. Sloan Management Review, 36, 25-40.

Scholte S.S.K., van Teeffelen A.J.A., Verburg P.H., (2015). Integrating socio-cultural perspectives into ecosystem service valuation: a review of concepts and methods. Ecological Economics 114, 67–78.

Swedeen P. (2006). Post-normal science in practice: a Q study of the potential for sustainable forestry in Washington State, USA. Ecol Econ 57:190–208

Teddlie, C., and Tashakkori, A. (Eds.). (2009). Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioral sciences. Sage Publications Inc.

Tenerelli, P., U. Demšar, and S. Luque. (2016). Crowdsourcing indicators for cultural ecosystem services: a geographically weighted approach for mountain landscapes. Ecological Indicators 64:237-248. http://dx.doi.org/10.1016/j.ecolind.2015.12.042

Turnley, J.G., Kaplowitz, M.D., Loucks, O.L., McGee, B.L., Dietz, T. (2008) Sociocultural valuation of ecological resources. In: Stahl, R.G.Jr., Kapustka, W.R.M.Jr., Bruins, R.J.F. (eds): Valuation of Ecological Resources: Integration of Ecology and Socioeconomics in Environmental Decision Making. CRC Press.

van Zanten B., Derek B. Van Berkel, Ross K. Meentemeyer, Jordan W. Smith, Koen F. Tieskens and Peter H. Verburg. Continental-scale quantification of landscape values using social media data. (2016). PNAS 113 (46) 12974-12979. https://doi.org/10.1073/pnas.1614158113.

Vihervaara P, Rönkä, M, Walls M. (2010). Trends in ecosystem service research: early steps and current drivers. Ambio 39, 314–324.

Vihervaara, P., Mononen, L., Nedkov S., Viinikka, A., et al. (2018). Biophysical mapping and assessment methods for ecosystem services. Deliverable D3.4 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

Willemen, L., A. J. Cottam, E. G. Drakou, and N. D. Burgess. (2015). Using Social Media to Measure the Contribution of Red List Species to the Nature-Based Tourism Potential of African Protected Areas. PloS One, 10(6), e0129785.

Wilson, M.A., Howarth, R.B. (2002). Discourse-based valuation of ecosystem services: establishing fair outcomes through group deliberation. Ecological Economics, 41(3): 431–443.

Zander, K. K., S. T. Garnett, and A. Straton. (2010). Trade-offs between development, culture and conservation - Willingness to pay for tropical river management among urban Australians. Journal of Environmental Management 91:2519-2528.

Zulian, G., Stange, E., Woods, H., Carvalho, L., Dick, J et al. (2017). Practical application of spatial ecosystem service models to aid decision support. Ecosystem Services.