Report from Workshop on 'Flexible methods for ecosystem service mapping and assessing'

Held at the Centre for Environmental Management, University of Nottingham

14th and 15th April 2016

Milestone 21

15 June 2016

Marion Potschin (UNOTT), Luke Brander (VU), Benjamin Burkhard (CAU); and Davide Geneletti (UNITN); Roy Haines-Young (UNOTT), Fernando Santos Martín (UAM), Petteri Vihervaara (SYKE)

with further contribution from the additional break out group chairs:
Mihai Adamescu (UB), Erling Andersen (UCPH), Mario Balzan (MCAST), Steven Broekx (VITO),), Bálint Czúcz (MTA ÖK), Ville Karvinen (SYKE), Iliyana Kuzmova (Pensoft), Inge Liekens (VITO), Sandra Luque (IRSTEA), Cristina Marta Pedroso (IST), and Stoyan Nedkov (NIGGG BAS), Pieter van Beukering (VU)

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Acknowledgements:

A lot of work and anticipation from all workshop participants went into this Workshop (see full participants list in appendix A2). We also thank the chairs of the individual break out group for their support during the workshop as well as contributing to the individual session reports led by the session chairs.

Suggested Citation:

Potschin, M.; Brander, L.; Burkhard, B.; Geneletti, D.; Haines-Young, R.; Santos Martín, F. and P. Vihervaara (2016): Flexible methods for ecosystem service mapping and assessing (1st version): Workshop Report. ESMERALDA Milestone 21, 50 pp. EU Horizon 2020 ESMERALDA Project, Grant Agreement No. 642007.

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1. Introduction and Aim of the workshop

ESMERALDA aims at supporting European countries in fulfilling their duties in the frame of the EU Biodiversity Strategy Target 2 Action 5 “Mapping and Assessment of Ecosystems and their Services” (MAES). In the second project phase, ESMERALDA develops a first version of flexible methods for mapping and assessing ecosystem services. The outcomes of a systematic methods review will be presented to the project partners and selected member state stakeholders during the following phases of ESMERALDA. We will look at all kinds of currently available methods in terms of biophysical, social and economic applications, but also start looking into their integration. The final aim is to develop a *flexible* set of methodologies that will serve as a tool for all EU member states. We will then also move on to look at the needs of individual states according to their characteristics in terms of geographical regions, biomes, available case studies, spatial and temporal scales, and selected policy themes such as nature conservation, urban and spatial planning, agriculture and forestry.

This Workshop is about methods for mapping and assessing ES. We are now starting from a quantification and mapping point of view, being aware that both are embedded in a larger framework that is "integrated assessment". As part of ESMERALDA WP4, we are currently outlining a clearer conceptual framework for what "integrative ES assessment" actually consists of and where the mapping of ES fits within it.

At the workshop we use the results of our available methods reports together with the results of the methods review that is currently carried out under WP3 (Tasks 3.1-3.5). The workshop provides an opportunity to:

1. Develop a common understanding within ESMERALDA on methods for mapping and assessing ecosystem services;
2. Assign methods to “tiers” through the discussion of specific applications;
3. Identify the relationships between ES, scales and specific methods; and
4. Identify potential linkages among methods, including those from different domains (biophysical, social, and economic).

The results of these discussions at the workshop will be used to select methods that are to be applied and tested in the ESMERALDA case studies (WP5). The final aim is to get an overview of available methods, their strengths and weaknesses and potential application for ES mapping and assessment.

We plan the actual integration of all methods into a holistic **Flexible Methodology for Ecosystem Service Mapping and Assessment** to take place at a later stage, but we keep that in mind already now and work toward it.

2. Reports from the individual Sessions

2.1 Ecosystem services and their quantification

By Roy Haines-Young (UNOTT) with Mario Balzan (MCAST), Benjamin Burkhard (CAU), Bálint Czúcz (MTA ÖK) and Fernando Santos Martín (UAM)

Session Background

The quantification of ecosystem services, whether for biophysical, social or economic purposes, depends on common definitions of what these services are. In this session we will look at the Common International Classification of Ecosystem Services (CICES) and the way it can be used to help identify what is potentially being 'quantified'. The issue is especially important in that experience suggests that often 'ecosystem service flows' cannot be measured directly, but instead characterised by using proxies that give insights into the capacity of ecosystems to supply services, or the demand for, or use of, services by people. CICES provides a framework that can be used to capture different sorts of metrics and better understand how they relate to each other in an 'integrated assessment'.

Slides from the introduction presentation are on ESMERALDA Intranet (http://esmeralda-project.eu/library.php).

The Aim of the session was to:

- Review the strengths and weaknesses of CICES as a framework for quantifying ecosystem services.
- Identify the kinds of metric that can be used to quantify the supply and demand for different kinds of service.

Outline of session

1. Taking stock of CICES V4.3 as a framework for quantifying ecosystem services (30 minutes).
2. Questions and discussion (15 minutes).
3. Briefing on breakout group session (5 minutes).
4. Breakout groups (40 minutes):
    a. Each group member will present their experience in relation to quantifying one or two specific ecosystem services in their case study.
    b. The group will discuss how the service relates to the CICES framework and whether the metric used quantifies the service directly or uses some proxy measure.
    c. For each of the services discussed the group suggests a suite of measures that can be used to characterise both the capacity of ecosystems to supply that service and the demand of use of it by society.
5. Plenary discussion (after lunch) during which the groups share their views on using CICES as a framework for quantifying ecosystem services (30 minutes).

Results:

The feedback provided by the break-out groups focussed on the role and contribution of CICES to mapping and assessment, and the issues that arise in its application. The points made clearly provide

evidence that can be used in developing both guidelines for the application of the current version of CICES, and points that might be considered in any future revision.

Role and contribution of CICES to mapping and assessment

It was generally agreed that, taken together, the cascade model and CICES provide a framework for 'quantifying' and 'qualifying' ecosystem services. Quantification is clearly a pre-requisite for developing metrics or indicators that can be used both for mapping and ecosystem accounting. The contribution in terms of 'qualification' was emphasised in order to highlight the fact that the cascade and the classification itself provide a set of concepts and descriptors that can be used to engage stakeholders in discussions about ecosystem services. It was noted and accepted that while CICES is not the only 'entry-point' for mapping and assessment, it can provide a way of making comparisons and cross-references.

To help people use CICES it was suggested that links to 'real indicators' were needed; the exercise undertaken in the break-out session indeed identified a number of examples that could be used in this context. It was suggested, however, that while most of these examples were at the class level, it may be useful to also provide examples of how metrics and indicators could be constructed at the division and group level. Such examples could be used to illustrate how these upper levels in the classification can be used to define more aggregated types of metric that can also be used in mapping and assessment work. The need for better guidance and examples was highlighted though an example involving the use of CICES to classify 'purification'. Experience suggests that the category is too complex to be assessed at the class level, and that perhaps mapping needed to be done using more aggregated metrics for representing categories at the group or division level. It was also recognised, however, that for some applications further flexibility could also be highlighted by showing how sub-classes could be added below the class level to better take account of local issues.

It was recommended that guidance should be developed to better communicate flexibility for applications, for example by providing a wider range of names for services at the class level so that the classification can be adapted to local needs. CICES might also be translated into other languages, and in this context resources might need to be found to harmonise the translated names and descriptors. The need to tailor CICES so that it can better be used to assess the variety of ES associated with both terrestrial and marine ecosystems was also considered. It was suggested, for example, that customised versions could be developed for specific habitats/ecosystems (e.g. urban) or more general set of 'biophysical classes'.

While it was acknowledged that CICES can help users simplify the complexity around defining and measuring ecosystem services, it was also pointed out that understanding the supply and demand side is not always 'linear', and can become complex when you have to incorporate all the cascade components into the assessment. In terms of helping people pursue 'an ecosystem approach' it was argued that this might limit its use if we really are aiming to provide information for decision making; a particular issue identified was to ensure that there was consistency between legal and administrative requirements and measures at different levels of the cascade.

Further complexity in the application of CICES was noted because some felt that certain CICES categories were "inherently inseparable", such as 'timber' and 'fuelwood', or mediation at the 'species' and 'ecosystem' level. Other difficulties were identified around those services that are simply 'closely related' such as 'honey' and 'pollination', or where one service was provided by a number of species (i.e. multiple ecological 'structures', in terms of the cascade model). The extent to which the issue of the level of 'human input' needed to be considered when defining an ecosystem

service was also discussed using the example of where ecological pest control was used, but based on an introduced species.

Participants felt that either better guidance on how to handle these issues was needed or the structure of the classification might need to be modified. Other complexities that also needed to be considered were those relating to how to handle temporal fluctuations in ES, related say to timber provision and flood control at different levels of the cascade; it was suggested that some of these difficulties might be resolved by clarifying how the capacity to supply a service and the actual provision relate to each other, and what these two characteristics mean in terms of developing metrics for assessment purposes.

The discussion noted a number of other issues that might be addressed in providing guidance for those using CICES in the context of ESMERALDA. The difficulties of classifying cultural ecosystem services at the division, group and class levels were suggested as especially problematic. Help where proxies (such as species abundance) are used as indicator for ES (or habitat quality) might also be needed so that people have sufficient ecological information to be able apply or interpret metrics appropriately.

The extent to which the need to assess ecosystem services as bundles posed particular problems for CICES was considered, and some felt that the "cross linkages" between some of the services in CICES was not covered particularly well. The example given was the cultural dimension of some provisioning services such as hunting or collecting wild plant food. These kinds of situation, it was pointed out, open up the danger of 'double counting' especially where the distinction between services and benefits is not sufficiently well taken into account. This was illustrated by reference to the case of marine ecosystems that provide nursery habitats, a regulating service, but also food as a provisioning service through fish stocks. A further example was that of mapping ecosystems services associated with forests, where there was an overlap between timber provisioning and the regulation of climate through carbon sequestration.

Further considerations

The breakout sessions generated a number of examples that can be used to illustrate how metrics can be used to characterise the different cascade elements, either to show how proxy measures at the function or structure and process level relate to a service, or to show how a suite of measures that can be used to make a more robust assessment of status and trends. This material will be used both as an input into the guidelines being developed for CICES and as an input into the development of the more comprehensive 'library of CICES-consistent indicators' that is being developed as part of ESMERALDA Milestone 20, and discussed further in D4.1.

Reference/further reading:

Potschin, M. and R. Haines-Young (2016): Report on Workshop on "Customising CICES across member states". Milestone 19 of ESMERALDA (download at: http://www.esmeralda-project.eu/documents/)

For further information, please contact:

Roy Haines-Young (University of Nottingham), Email: Roy.Haines-Young@Nottingham.ac.uk

2.2 Biophysical methods for mapping and assessing ecosystem services

By Petteri Vihervaara (SYKE) with Mario Balzan (MCAST), Bálint Czúcz (MTA ÖK), Sandra Luque (IRSTEA), Stoyan Nedkov (NIGGG BAS) and Ville Karvinen (SYKE)

Session Background

Biophysical methods for *mapping* ecosystem services are used to quantify ecosystems' capacity to deliver ecosystem services (also referred to "supply") and the amount of harvested yield of such capacity for human benefit (also referred to "use" or "demand"). Biophysical measures are closely related to social and economic mapping methods, and they form the basis for natural capital accounting. Methods are numerous due to varying features of different ecosystem services but before they can be applied, indicators and/or proxies for quantification are needed. Tiered approach (suggested to be developed in Esmeralda and discussed in the workshop) could be, for instance: Tier 1 of simple matrix methods (expert judgments for land cover data), Tier 2 of statistics and modelled results added to Tier 1, and Tier 3 of sophisticated models that could operate in varying spatial and temporal dimensions. In the OpenNESS project, for example, 25 potential models or methods were identified of which six were selected for use in the case studies of the project. These six models were Spreadsheet-type methods, ESTIMAP, Bayesian Belief Networks, State and Transition Models, QUICKScan, and InVEST.

Biophysical methods for *assessing* ecosystem services should help assess the level of sustainable use, and provide this information to support decision-making. The assessment of ecosystem services needs to consider both the condition of the ecosystem (structure and function) and empirical (and also historical) levels of sustainable use.

Slides from the introduction presentation are on ESMERALDA Intranet (http://esmeralda-project.eu/library.php).

Aim of the session was to:

- Develop a common understanding within ESMERALDA on biophysical methods for mapping and assessing ecosystem services, in particular:
    - a clear understanding what is meant by biophysical methods and goals of mapping and assessment,
    - how they differ from social and economic methods and goals.
- Assign biophysical methods to "tiers" through discussions of selected biophysical mapping and assessment case studies.

Outline of the session:

1. Introductory presentation on biophysical methods for mapping and assessing ecosystem services, including indicator approach (based on OpenNESS report and selected articles) – 20 minutes
2. Questions and clarifications – 10 minutes
3. Breakout group instructions – 5 minutes

4. Breakout groups – 70 minutes
    a. Break into groups. Each group was be led by a partner in Task 3.4 *(SYKE, UAM, VU, UNOTT, UNITN, BEF, CAU, CVGZ, NIGGG BAS, IRSTEA, MCAST, SEPA, MTA OK)*.
    b. The breakout group leader was briefly presenting a case study (preferably one they have conducted themselves) that uses biophysical mapping (preferably covering all different tiers) and assessment methods. No ppt but a 1-page print out of a key figure or map was also ok. Also participants could present their experiences from their own case studies.
    c. Group discussion on each of the methods used regarding: selection of indicators/proxies, type of method, reasons for selection, how the method combines supply and demand, strengths and weaknesses, the "tier" of the method

5. Summary and final discussion (all groups together) – 15 minutes. Breakout group leaders were drafting a brief summary of the discussions with a focus on the allocation of different methods to tiers (to be synthesised after the workshop)

Results:

The themes of session 2 for biophysical methods were discussed in five breakout groups. As an output, examples of various methods that were used in case studies were listed and discussed. A synthesis of the results from the breakout groups revealed possibilities and challenges that need to be considered further in the Esmeralda project, especially in relation to the case studies (WP5) and assessment (WP4).

At first, challenges related to used data and methods were highlighted. Accuracy of data may vary a lot between areas (MSs). Sometimes expert judgement is used, sometimes direct field or remotely sensed measurements, sometimes extrapolations based on models and the combination of the first ones, and sometimes for proxies. This has obvious influence also on the accuracy of the mapping exercise. How to deal with this was a question that was risen in several breakout groups. Also the spatial and temporal extent of the data was thought to affect the categorization of certain cases under the different tiers. The role of abiotic data was discussed, because it is an integral part of many distribution models, for instance, and it can be sometimes also a proxy for special vegetation and thus a proxy for associated ecosystem services. It was also noted that data availability varies a lot which can influence to the mapping results that are achievable.

Secondly, unifying vocabulary and interpretation what is meant, for instance, by model, method, technique, tool, software, approach etc. The list of 'methods' is inconsistent: there are elementary approaches and more complex methods and complex tools (consisting of several methods given in the same list) – clarification of this is important for the ESMERALDA project.

Thirdly, evaluation of the quality and accuracy of the used data, methods and models is challenging because different ecosystem services need very different techniques. Also the environmental variability may affect the results. Complexity using more than one type of method to quantify and map certain ecosystem services might end up to significantly different outcomes. How to take into account this variation and uncertainty resulting from the use of different methods is a question that should be considered again at the next workshop on case studies.

Fourthly, allocating the used data, methods and models under the 3-tiered classification system was seen as difficult. More or less every case study has elements that can be assigned to different tiers. And actually, the whole workflow (or process, or methodology) from data collection to analysis using different methods and models could be different under each tier. An example of this is species distribution modelling followed by MCA (aggregation). This might also reflect for instance the required expertise or time-allocation to the mapping and assessment under each tier.

Finally, visualisation and communication were seen as important aspects of ecosystem service mapping. Particularly, good and informative maps are crucial tools for decision makers while at the same time they have to show the uncertainties included in them. Different scales of different ecosystem services is a challenge if maps would be used to assess trade-offs and to solve conflicts. Also transferring knowledge and models to decision-making, and their implementation in land use planning, for instance, were noted as key challenges. A challenge of integrating biophysical maps to social and economic aspects still remains.

Further considerations

Based on the discussions and outcome of the breakout groups, at least the following issues need further consideration:

1) Data quality – how different data can be appointed to certain tiers? Data is also a prerequisite of several models.
2) Differentiation of methods, models, tools, software etc. – this was an obvious challenge which has to be elaborated further and discussed also during the case studies.
3) Selection of the best and the most relevant models – there are differences in models and selecting the best option is challenging.
4) Workflow – a synonym for methodology? It was noted that many models are interlinked to each other, and sometimes the models are combined in bundles having elements from different tiers. Thus selection of one tier might be irrelevant, and attention should be used to define e.g. workflows and the data, computation and time as needed resources affecting to differences of the "tiers".

References

EU FP7 OpenNESS project Deliverable 3.2, P.A. Harrison, and R.W. Dunford (Eds.) (2015): Preliminary guidelines describing the set of methods for mapping and modelling ecosystem service supply and their application in the WP5 case studies. European Commission FP7, 2015.

Maes, J., Teller, A., Erhard, M., Murphy, P., Paracchini, M.L., Barredo, J.I., Grizzetti, B., Cardoso, A., Somma, F., Petersen, J.E. and Meiner, A. (2014): Mapping and assessment of ecosystems and their services indicators for ecosystem assessments under action 5 of the EU biodiversity strategy to 2020: 2nd report-final, February 2014. Available at: http://biodiversity.europa.eu/maes

For further information, please contact:

Petteri Vihervaara (SYKE), Email: petteri.vihervaara@ymparisto.fi

2.3 Socio-cultural methods for mapping and assessing ecosystem services

By Fernando Santos Martín (UAM) with Mihai Adamescu (UB), Erling Andersen (UCPH), Mario Balzan (MCAST), Benjamin Burkhard (CAU) and Inge Liekens (VITO)

Background

Socio-cultural methods are defined as an umbrella term for those approaches that aim to analyse human preferences towards ecosystem services in non-monetary units. Under this umbrella, terms such as 'psycho-cultural valuation', 'social valuation', 'deliberative valuation', 'qualitative valuation' and 'subjective assessment' represent mapping and assessment approaches that aim to uncover individual and collective values and perceptions of ecosystem services without relying on biophysical data and monetary metrics.

There are multiple approaches to uncover socio-cultural values of ecosystem services depending on data availability and the purpose of the valuation. In this session, we have identified the most common methods that have been used by ESMERALDA partners in their previous work.

Slides from the introduction presentation are in the ESMERALDA Intranet (http://esmeralda-project.eu/library.php).

The aim of the session was to:

- develop a common understanding within ESMERALDA on social-cultural methods for mapping and assessing ecosystem services;
- assign social-cultural methods to "tiers" through discussion of case studies;
- identify the potential relationships between ES, scales and specific methods; and,
- identify potential uses of social-cultural methods for decision-making processes.

Outline of the session:

1. Introductory presentation on social-cultural methods for mapping and assessing ecosystem services (based on D4.3) – 15 minutes (Tobias Plieninger via Skype)
2. Questions and clarifications – 10 minutes
3. Breakout group instructions – 10 minutes
4. Breakout groups – 75 minutes
    a. Break into groups of 8-10 participants.
    b. Each member briefly presents a case study (preferably one they have conducted themselves) that uses socio-cultural mapping and assessment methods.
    c. Group discussion on each of the methods used regarding: type of method, reasons for selection, how the method combines (biophysical) supply with (economic) demand, strengths and weaknesses, the "tier" of the method
    d. Description and discussion of additional case studies as volunteered by other participants in each breakout group

e. Each group drafts a brief summary of the discussions with a focus on the allocation of different methods to tiers and the ES selected (to be synthesised after the workshop)

Results:

Discussion among ESMERALDA partners about their experience with socio-cultural methods revealed that there is a broad range of options to map and assess ecosystem services. Some examples of the most commonly used socio-cultural methods were: Preference assessment; Time-use assessment; Photo-elicitation surveys; Narrative assessment; Participatory mapping and assessment of ecosystem services (PGIS); Scenario planning; Deliberative assessment. Social assessment methods include quantitative and qualitative research techniques (i.e. surveys, interviews), participatory and deliberative tools (focus groups, citizens juries, participatory or rapid rural appraisal (PRA/RRA), Delphi panels, etc.), as well as methods of expressing preferences in quantifiable terms (i.e. preference assessment, time use studies). Some studies also consider the spatial representation of ES (i.e. Participatory Public GIS).

Due to this large heterogeneity, the ESMERALDA project developed a classification of the methods used by each partner regarding: type of method, reasons for selection, ecosystem services mapped or assessed, ecosystems included, and level of complexity based on the "tier" classification. At the end of the breakout session, 26 examples from different countries of the EU used socio-cultural methods, suggesting that there is a significant expertise on socio-cultural methods but that these are not necessarily framed as ES mapping and assessment methods (e.g. stakeholder involvement, conflict resolution). Some important issues that came out from the discussion are:

- Socio-cultural methods have a strong link to economic valuation. In some of the case-studies social methods were identified as a precursor of economic valuation in an integrated assessment (e.g. through a preference assessment).
- An overlap between methods was also identified (e.g. preference and deliberative assessment). Therefore some partners proposed that some methods may be used in combination (e.g. normative assessment and preferences).
- Some methods that were not included in the list provided are: (1) Virtual reality (as part of preference assessment); (2) Use of social media and apps to rank landscape or identify 'happiness' level in that landscape (still can be a preference assessment); (3) Real time monitoring (e.g. heartbeat of cyclist to measure how stressed they are in specific crossings); (4) WEB scrapping (Flicker, twitter, facebook); (5) Citizen science (needs to go beyond counting species).
- The "tiers" definitions given to classify the methods were difficult to apply for socio-cultural methods, which indicates a substantial difficulty in placing case-studies in cohorts that are based on categories used for biophysical methods. For example in Tier 1: relatively simple methods such as expert knowledge indicator in the context of socio-cultural methods could be considered as a Tier 2 or 3.
- Borders between approaches are blurry (e.g. direct observation by people, citizen science). For each of the methods there is a need for examples, including a list of who is using the methods.
- One advantage of using socio-cultural methods is that these capture the different perceptions of ecosystems and their services, according to specific use or non-use of that ecosystem/service. However this brings also a level of complexity, therefore a practical guide to selecting methods according to the resources required.
- Social assessment methods can be based on large samples and can cover different spatial scales. Assessment methods that claim to be representative for a population are based on large samples and require multivariate analysis to explain values if the population is heterogeneous. However, a number of socio-cultural methods are small-sample approaches aiming at describing specific actor and place-based values. These might be particularly important for local scale planning for the delivery of key ecosystem services (e.g. green infrastructure for recreational purposes or run-off reduction).

Further considerations

This initial discussion about socio-cultural methods is a 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 approach is to contribute to the mainstreaming of socio-cultural methods into all levels of decision-making (policies, plans, programmes and projects), as well as economic accounting and reporting. Therefore, we plan a set of new actions in the following months that will help to achieve these objectives.

1. Provide a more detailed list of social assessment methods and models that have been used in different studies in Europe and can help in the implementation of Action 5 of the EU Biodiversity Strategy.
2. Analyse further social assessment methods that were used in relation to a set of individual variables (i.e. study dimension, scales, ecosystems or ecosystem services).
3. Identify possible methodological or thematic gaps in how social assessment methods are being used in scientific and policy environments and look for potential solutions on how to overcome them.
4. Present all these results as base line information to the ESMERALDA partners to trigger the process of developing the flexible methodology for mapping and assessment activities.

References

Santos-Martín F. and Martin-López B. (2016). *Social mapping and assessment methods and applications*. Deliverable D4.3 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007. Download at: http://www.esmeralda-project.eu/documents/5

For further information, please contact:

Fernando Santos Martín (fernando.santo.martin@uam.es)

2.4 Economic methods for mapping and assessing ecosystem services

By: Luke Brander (VU) with Cristina Marta Pedroso (IST), Inge Liekens (VITO), Pieter van Beukering (VU) and Steven Broekx (VITO)

Background

Economic methods for *mapping* ecosystem services are used to quantify the human welfare derived from the use of ecosystem services and how such values vary across space. Methods include revealed preference, stated preference, cost-based and value transfer approaches. Economic methods for *assessing* ecosystem services are frameworks for structuring information to support decision-making, and include cost-benefit analysis, multi-criteria analysis, cost-effectiveness analysis, and ecosystem service accounting.

Slides from the introduction presentations are available from the ESMERALDA intranet (http://esmeralda-project.eu/library.php).

Aim of the session was to:

- Develop a common understanding within ESMERALDA on economic methods for mapping and assessing ecosystem services
- Assign economic methods to "tiers" through discussions of economic mapping and assessment case studies

Outline of the session:

1. Introductory presentation on economic methods for mapping and assessing ecosystem services (based on D3.2 and D4.2) – 25 minutes
2. Questions and clarifications – 10 minutes
3. Breakout group instructions – 10 minutes
4. Breakout groups – 75 minutes
    a. Break into groups of 5-8 participants. Each group is led by one partner in WP3.3 or WP4.2.
    b. The breakout group leader presented a case study that uses economic mapping and assessment methods.
    c. Group discussion on each of the economic methods used regarding: type of method, reasons for selection, strengths and weaknesses, the "tier" of the method; and if/how the case study combined results from biophysical, social and economic methods.
    d. Fill-in the prepared matrix to summarise the case study and discussion.
    e. Description and discussion of additional case studies volunteered by other participants in each breakout group

Results:

The discussions among ESMERALDA partners in the breakout groups revealed experience with a wide range of economic valuation methods including: hedonic pricing, travel costs, production functions, damage cost avoided, replacement costs, market prices, choice experiments, contingent valuation, and value transfers. The discussions mainly focussed on the use of economic valuation methods rather than assessment methods; the only assessment method to be discussed was an application of multi-criteria analysis. A number of other methods that are not conventionally considered as economic mapping or assessment methods were also discussed, including deliberative methods, distribution of photographs, and the use of capacity matrices. Specific software and models that have been applied in the context of economic mapping and assessment include InVEST, ESTIMAP, and QuickScan.

Across the breakout groups it was generally observed that there is relatively limited experience and expertise among ESMERALDA partners in the application of economic mapping and assessment methods. Mistrust of economic valuation results was expressed. The discussions provided an opportunity for clarification of different valuation approaches.

The need for strong(er) links between biophysical, socio-cultural and economic methods is seen as a key area for future development. All economic mapping and assessment applications fundamentally rely on a sound understanding of the underlying biophysical processes that determine the provision of ecosystem services. It is widely recognised, however, that gaps between disciplines persist leading many economic assessments to be based on simplistic bio-physical models and assumptions. The combination of “Tier 3” economic methods with “Tier 1” bio-physical methods is not uncommon (and vice versa). There is a need for integrated research designs that better combine ecological and economic modelling. Moreover, the alternative policy scenarios that are developed in ecosystem service assessments need to be both bio-physically and socio-culturally sound.

The appeal and utility of economic valuation to decision makers was identified. Economic value is seen as an important variable to generate public interest and engage the private sector. Trade-off analyses based on economic valuation is desirable and welcomed by decision makers. The acceptance of economic value estimates by stakeholders is somewhat complicated, however, since methods that are often preferred by researchers (e.g. stated preference methods) are seen as unconvincing by stakeholders. Conversely, methods that are viewed as theoretically flawed by researchers (e.g. replacement costs) have an intuitive appeal to some stakeholders.

There is a need to communicate the uncertainties associated with the use of different economic valuation methods. Acceptable levels of uncertainty are determined by the purpose of the assessment. The use of valuation results to generate public awareness can arguably use more uncertain information than the determination of payment levels or damage compensation. Given the wide use of value transfer methods (usually simple unit values), it is necessary to understand the potentially high uncertainties associated with this approach. Also for the use of stated preference valuation methods, results should be validated using standard checks (e.g. distance decay effects, income constraints).

There is need for more guidance on how to select appropriate economic methods for mapping and assessment of ecosystem services. Practical guidance should include information on the effort, costs, data, time and expertise required to deliver economic assessments (together with the associated uncertainties). For example, the use of production function approaches to value ecosystem inputs into marketed products are widely advocated but are practically challenging due to data requirements. The use of “tiers” to communicate this information requires more general definitions and it may be challenging to represent different requirements in such aggregated terms. It is also the case that the level of detail with which a method is applied determines the tier to which it is allocated (i.e. individual methods could be assigned to any tier depending on the level of sophistication with which they are applied). In addition to guidance on economic methods, there is

also a need for guidance on how to find relevant experts. The Ecosystem Services Partnership (ESP) website might be a useful resource for this.

Further considerations

Based on the discussions within the breakout groups, the following issues require further consideration in developing ESMERALDA guidance on integrated mapping and assessment methods:

- Next steps need to explore strengthening the links between bio-physical and economic assessment. This is a frequently identified, but unresolved, challenge. Linkages between socio-cultural and economic assessment also need to be explored but this appears to be less challenging.
- Methods for communicating uncertainties need to be developed. Ideally this should be a common approach that applies to bio-physical, economic and socio-cultural methods.
- The ESMERALDA guidance should be practical and explain how to select between the array of available methods. The use of tiers helps to frame this but might also narrow the amount of information given to practitioners.

References

Brander, L.M. and van Beukering P. (2016). *Economic mapping methods for ecosystem services*. Deliverable D3.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

Brander, L.M. and van Beukering, P. (2016). *Economic assessment methods and applications*. Deliverable D4.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007. http://esmeralda-project.eu/documents/1/

For further information, please contact:

Luke Brander (lukebrander@gmail.com)

3. Results

The aim of ESMERALDA is "*to deliver a 'flexible methodology' that can simultaneously provide innovative building blocks for pan-European, national and regional ES mapping and assessment*" (DoA, p6). To achieve this overall aim, ESMERALDA has developed several objectives. Objective number 5 (DoA, page 8) is

"*to develop ES mapping and assessment methods so that they are flexible enough to be applied in all EU members states, including the outermost regions, marine areas and specific biomes*."

Therefore the Nottingham Workshop attempted to gain an overview of what methods, models and tools are currently being applied in case studies undertaken by ESMERALDA partners and what the advantages, disadvantages, problems and reach of the applications are.

To record the body of expertise available in the consortium the "Nottingham Workshop Preparation Group"[1] developed a matrix structure prior to the workshop. To capture the expertise in a manageable way it was decided that each session should have a maximum of five break out groups to identify and discuss methods used, and that the 'break out chairs' would report on the case study examples in a 'matrix' that when complete would give a systematic overview of the material. The picture, below shows one matrix as it was filled in by one of the break out groups.

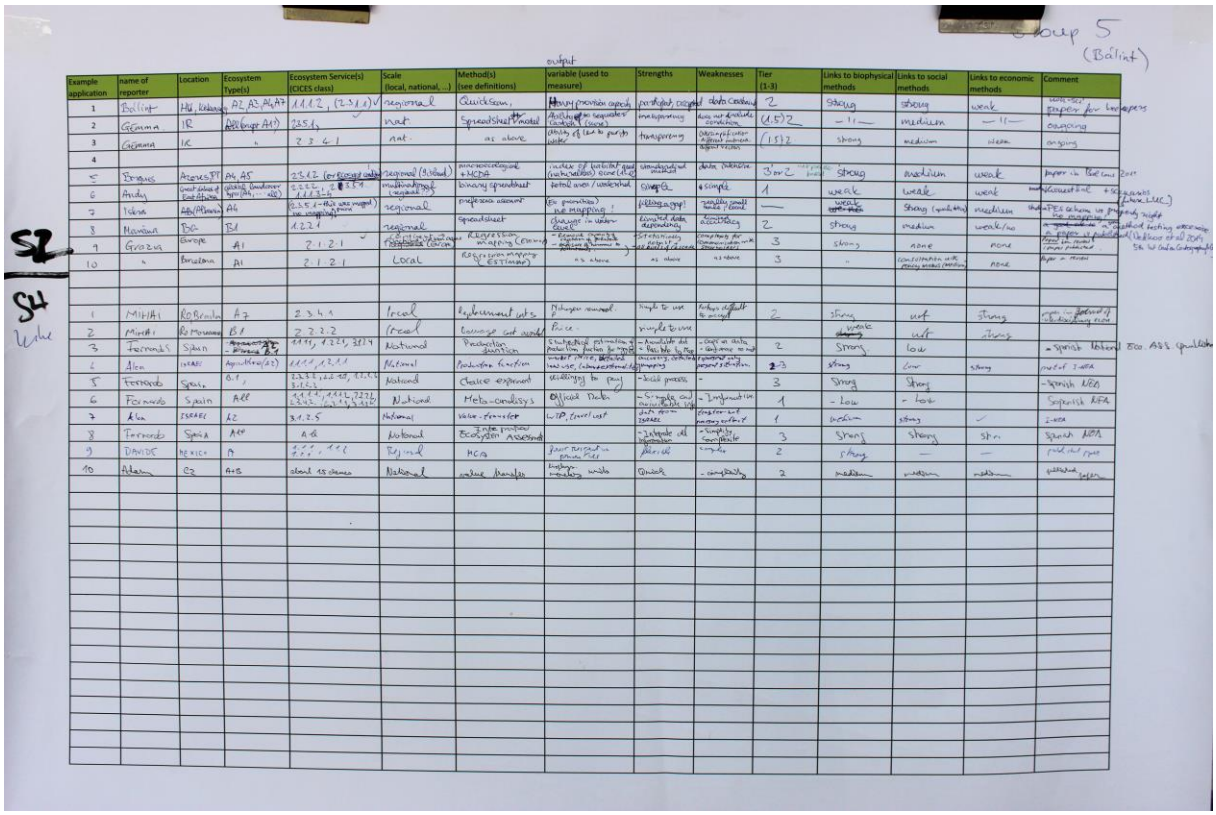


Plate I: An example of methods reported by a break out group.

[1] Luke Brander (VU, economic methods task leader), Benjamin Burkhard (CAU, ESMERALDA coordinator), Roy Haines-Young (UNOTT, CICES champion and assessment task co-leader), Davide Geneletti (UNITN WP5 lead and testing workshop coordinator). Marion Potschin (WP4 leader and workshop lead) Fernando Santos Martin (UAM, WP3 elder and social methods task leader and Nottingham workshop lead), Petteri Vihervaara (SYKE, biophysical methods lead)

In the matrix ESMERALDA Partners were asked to use one line per method (potentially multiple lines per case study that applies multiple methods) and fill in the columns describing the following characteristics (see appendix 4 for definitions and coding):

- Example application
- Name of reporter
- Location
- Ecosystem Type(s) (see Appendix 4 for coding)
- Ecosystem Service(s) (CICES class) (see Appendix 3 for coding)
- Scale (local, national, …) → See Appendix 3 for definitions
- Method(s) → see Appendix 4 for definitions)
- Variable (used to measure ES)
- Strength of method
- Weakness of method
- Tier 1-3
- Links to biophysical methods
- Links to social methods
- Links to economic methods
- Comments

Using the matrix, over 150 examples of methods by ESMERALDA partners attending the Nottingham workshop were collected. In the discussion on the second day (session 5) it became obvious that there is far more material that time allowed to complete the matrix during the workshop. It was also felt that additional information would be beneficial, such as

- Email of Contact person
- Short information of case study
- Link or source of case study

It was felt that some topics covered in the columns of the matrix were not entirely clear and needed some further explanation, e.g. scale of application – what if a method was applied at several scales, etc. To capture all this information and have more time to record the full information it was decided to set up a 'Google Document'. This could be used to take stock before the next workshop in September, but left it as a 'live document' during the life time of ESMERALDA. In further discussion in the 'Nottingham Workshop Preparation Group' it was also decided for simplicity reasons to delete the columns "strengths" and "weakness" form the Google Document and include that information within the column "Comments".

It was decided that the matrix would be completed by: a) the Nottingham workshop participants; and b) later further ESMERALDA colleagues can be found via the following link: https://docs.google.com/spreadsheets/d/1IdmqQ78M2__PElrfmJZfXJkjn015L6AXwCGppuqUzSE/edit?usp=sharing

With the aim to encourage ESMERALDA partners to participate in this collaborative action, an email text and accompanying explanation on how to fill in the matrix that was sent to the workshop participants can be found in Appendix 5.

A further objective of ESMERALDA is to achieve an overview of the expertise available in the consortium on methods and where are the gaps. To illustrate this, the first attempt to create such a draft matrix was presented during session 5 of the Nottingham workshop (see Plate II):

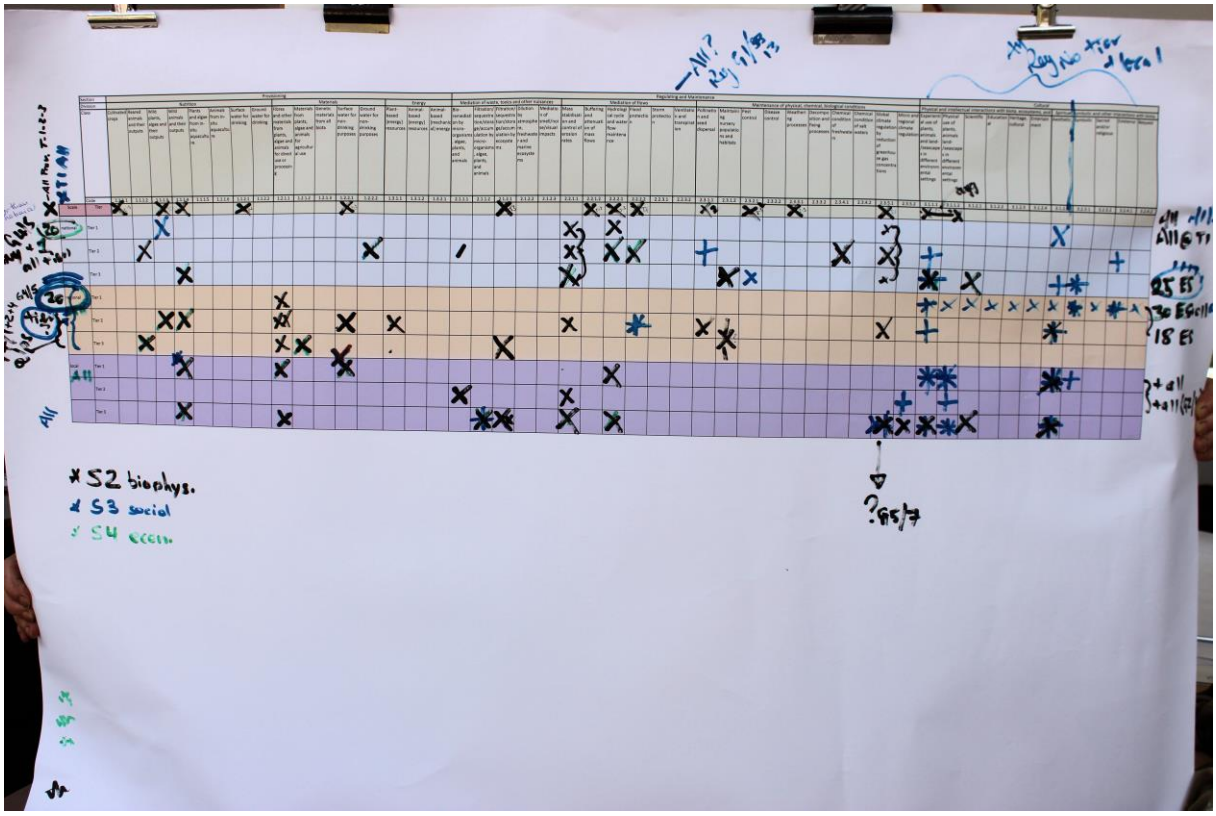


Plate II: Overview of reported methods during the Nottingham Workshop (legend: top green line = CICES classes first as name then as code. The following lines are scale and Tiers per scale: blue = national; orange = regional and lower violet = local. Each scale divided into three lines for Tier 1 top, Tier 2 = middle and Tier 3 = bottom line per scale.

When discussing the construction of this matrix, it was clear, that:

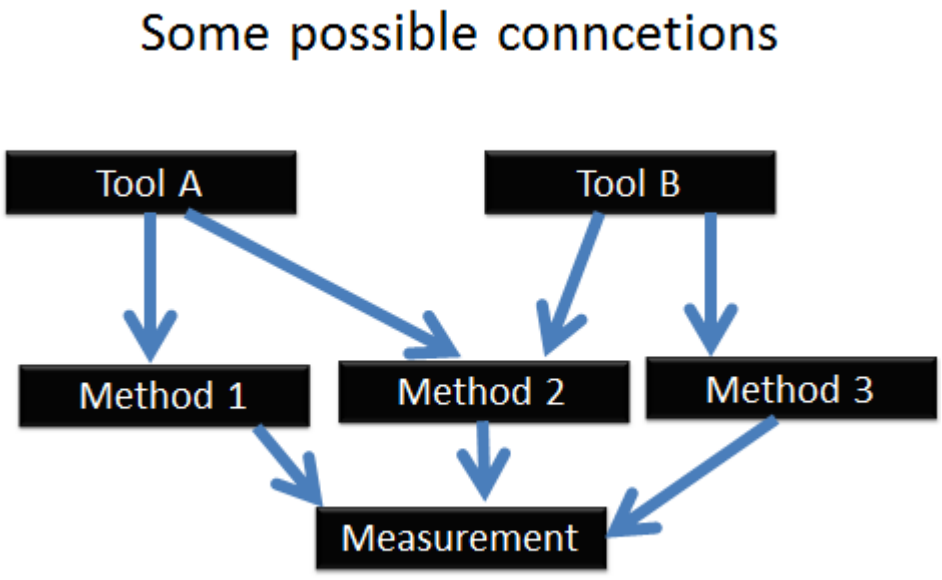
- A 'European scale' or cross national scale needed to be added;
- Potentially different colours were needed for the different method classes, e.g. bio-physical, social and economic;
- Many entries referred to several, many or all ecosystem services classes (numbers and entries on the left and right hand margin).

This matrix (Plate II) will need to be updated on the base of the Google Document, this will be done within WP3 (Fernando Santos Martin together with Luke Brander and Petteri Vihervaara).

4. Discussion and conclusions

At the end of the two days' workshop it was agreed that we gained a very good overview of expertise on methods, tools and models etc. that are available through the ESMERALDA consortium. However, it was also apparent that more clarification was needed:

- It became clear that we need to think more about what a "**flexible methodology**" means. It is one methodology we are aiming for, or several? Which part(s) is/are need to be flexible?
- The terminology between methodology, methods, tools etc. needs clarification. During Session 5 of the workshop the following definitions were suggested, however the Nottingham Workshop Preparation Groups need to discuss and finalise those discussion for the next workshop in September :
    - **Methodology:** a body of methods, rules, and postulates employed by a discipline **:** a particular procedure or set of procedures;
    - **Tool**: a hardware or software device or conceptual framework used to implement a method, e.g. MSS, InVest or BBN or "economic toolkit";
    - **Method**: is a way of structuring information or data, e.g. Natural Capital Index, NDVI;
    - **Model**, e.g. SWAT, LUCI, SHETRAN (hydrological model); and,
    - **Measurement**: the result of applying a method in a form of a quantitative or qualitative variable, e.g. (2t/ha)*year (t/ha/yr), high/low.
- While it was felt that it was not necessary for the workshop in Nottingham to distinguish from the outset what was a method, tool or model, it was suggested during the final discussion that greater clarity was needed and that the different elements might be linked in a hierarchical structure. The following graph was discussed during the session to help to see the linkage.



In terms of the kinds of additional information needed, regarding **scale** it was noted that we need to consider:

- We keep the original scale definitions (as in the Appendix 4), but need to add the pan-European scale
- A 'x' in the matrix means an example/experience collected, not the only place where it can be used/apply.
- Definition on each term (check Tim Pg. paper)
- Data – on which scale collected (also for use to up- or downscale)

- Regarding '**Tiers'** the following recommendations were made:
  - No comparison possible with literature (Tiers are not always given).
  - Easy to apply the current Tiers definition to biophysical – it was more difficult for the social-cultural and economic methods.
  - Do Tiers for social methods need to be developed separately? [The assumption from the Worksop Preparation Core Group is that we need to develop the definitions for the tier approach further, so that all three method groups fit under it, rather than developing separate ones for each method group]we will try to develop tier definitions under each methods category]
  - Need to get back to people and ask what they meant by putting Tier assignments in the way they did (→ develop a legend).
  - It was decided that for the filling in the matrix till the next workshop that we should keep the Tier approach and a further developed approach will be presented and discussed in Prague.
- Regarding **terminology** to was suggested to
  - Clarify terminology around tools, methods and measurements.
  - Need to clarify position of 'data collection' and direct measurements.
  - Circulate definitions for comment.
  - Take account of integration across the three domains.
- The following next steps were agreed on during the discussion session (5):
  - Collate information on single spreadsheet by going back to originators, using Google Docs.
  - Add comment field to link to CS descriptions generated by WP3/5 or publication etc.

5. Next Workshops

5.1 Background

The next series of three workshops (WS 3, 4 and 5) has the objective of testing the first version of the methodology for mapping and assessment of ecosystem services. Testing will enable the refinement of the methods, and the final development of guidelines to support users in the application of the methods to deliver under Action 5 of the EU Biodiversity Strategy. Each workshop will analyse three different case studies, addressing a different set of topics, as follows:

- Workshop 3: Testing the methods across Europe, Czech Republic, SEPTEMBER 2016
- Workshop 4: Testing the methods across THEMES, The Netherlands, JANUARY 2017
- Workshop 5: Testing the methods across BIOMES and REGIONS, Spain, APRIL 2017

In order to identify the case studies, an online survey was filled by ESMERALDA partners in November-December 2015. A total of 32 case study proposals were collected, of which 13 was selected for the workshops. The remaining case studies may be developed independently by ESMERALDA partners, and included in deliverables and guidelines. Figure 1 shows the nine case studies selected for testing the first version of the ESMERALDA methods.

Table ***1*** present some more details for the three case studies to be used in Workshop 3.

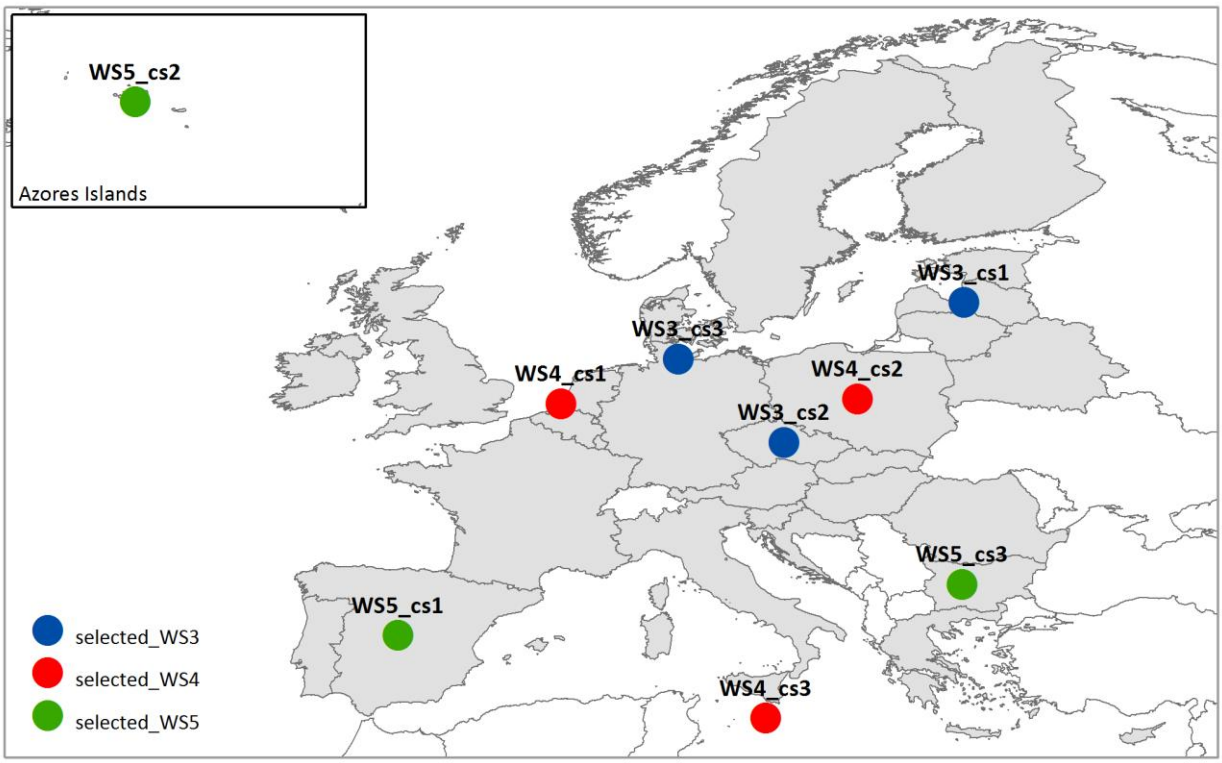


Figure 1: Map of the case studies selected for workshops 3, 4 and 5.

Table 1: Case studies to be used in Workshop 3 in Prague

	NAME	COUNTRY	REGION	BIOME°	STAGE	THEME
WS3-cs1	Mapping marine ecosystem services in Latvia	Latvia	Northern	4	Beginner	Marine policy; Business, Industry and tourism
WS3-cs2	Pilot National Assessment of Ecosystem Services	Czech Republic	Eastern	4, 5	Mid-level	ES mapping and assessment
WS3-cs3	Mapping ES dynamics in agricultural landscapes	Germany	Western	4, 5	Front-runner	ES mapping and assessment

* BIOMES refer to those present in the country in which the case study is located;

5.2 Workshop concept

The workshops will provide feedback for improvement of the first version of the methodology, contributing to the final version of the flexible methodology for ecosystem service mapping and assessment. Feedback will be provided by both project partners and stakeholders. Particularly, feedback will concern the critical aspects that will be identified by the work done in WP 3 and 4, including the following issues:

- The soundness of the mapping and assessment proposed methodology;
- The flexibility of the methodology (can they be used in the variety of contexts, conditions, ecosystems, scales, etc.?) and their potential for "integration";
- The suitability to provide tangible support to different types of policy and decision making processes.

An additional objective of the workshops is to build stakeholders' capacity in understanding the different methods for ES mapping and assessment (and their pros and cons).
Operatively, the workshops will consist of plenaries and breakouts for the three case studies. Breakout groups are expected to have around 15 people. These include people directly involved in the case study (coordinator and team; stakeholders), as well as "other ESMERALDA partners". The latter people will be assigned to one of the three case studies ahead of the workshop, according to their interest, knowledge and needs (they will receive an overview of the three case studies before the workshop, so that they can identify the preferred one, e.g., because deals with countries in the same conditions as their own, or applies similar methods, etc.).
In this way, the "other ESMERALDA partners" will come to the workshop prepared to contribute to the discussion and bring-in their experience with methods/conditions of their interest. They will leave the workshop with better understanding and ideas from other experiences on how to improve/get started with a similar analysis for their own case studies.
All the mapping and assessment analysis needs to be performed ahead of the workshop by the case study coordinators and their team. During the workshop, these analyses will be illustrated and demonstrated (in plenary sessions), and then discussed in detail with both stakeholders and partners (in break-out sessions).

5.3 Dissemination

Pictures were taken during the event to document it and be used for consecutive dissemination activities. Updates were provided via the project's social media – Facebook and Twitter. After the even a dedicated news item was posted to present a summarized report targeted at wider audiences. A video clip was also filmed during the event and published via the project's YouTube Channel to provide a short and engaging summary of the workshop.

Group photo taken during the ESMERALDA Workshop in Nottingham, April 2016; Credit: Pensoft.

Appendices

A1 Programme structure of the workshop

A2 Participants lists

A3 Abstracts of invited Plenary Speakers

A4 Definitions used

A5 Email and instructions to fill in google doc (matrix)

A6 Protocol template

A1 Programme overview

	Wednesday, 13.04.2016	Thursday, 14.04.2016	Friday 15.4.2016	Saturday 16.04.2016
	Arrival day and welcome	Session title	Session title	Excursion
08.30 - 09.00		Registration (A44)		8:30 Bus departure from 'visitor car park' - behind Clive Granger building
09.00 - 09.30		Introduction Session (A41)	Summary from Day 1	
09.30 - 10.00			Session 3: Socio-cultural methods for mapping and assessing ecosystem services	
10.00 - 10.30				
10.30 - 11.00				
11.00 - 11.30		coffee/tea (A44)	Session 4: Economic methods for mapping and assessing ecosystem services	
11.30 - 12.00		Session 1: Ecosystem Service and their quantification	coffee/tea before the break out groups	
12.00 - 12.30				lunch at Calke Abbey
12.30 - 13.00				
13.00 - 13.30	Executive Board Meeting	lunch		Departure 12.45
13.30 - 14.00	Barton In Fabis			13:30 drop off at East Midlands Parkway
14.00 - 14.30	(EB members only)		Summary of the Day Session 5: Matching methods to assessment	continue to University of Nottingham
14.30 - 15.00		Session 2: Biophysical methods for mapping and assessing ecosystem services	purpose and context	
15.00 - 15.30			Plenary Discussion	
15.30 - 16.00		Tea/Coffee	Tea/Coffee	
16.00 - 16.30			Session 6:Introducing the next workshops	
16.30 - 17.00			Close and info on excursion	
17.00 - 17.30		General Assembly (A41)		
17.30-18.00			17:30 Walk into town (optional) ca 18:15 Trip of Jerusalem (oldest pub in England)	
Evening	19:30 Welcome Reception	19:00 Conference Dinner	from 19:30: Dinner at Malt Cross	

A2 Participants List

Total registrations: 50 – first name in alphabetical order

First	Family Name	Affiliation	Abbrev	Email
Adam	Pártl	Global Change Research Institute	CVGZ	partl.a@czechglobe.cz
Alon	Lotan	Tel-Aviv University, ISRAEL	TAU	alon.lotan@hamaarag.org.il
Anda	Rusk	Baltic Environmental Forum - Latvia	BEF-LV	anda.ruskule@bef.lv
Andy	Arnell	United Nations Environment Programme - World Conservation Monitoring Centre	UNEP-WCMC	andy.arnell@hotmail.com
Anja	Uhlenbrok	Christian-Albrechts-Universitaet zu Kiel	CAU	auhlenbrok@ecology.uni-kiel.de
Bálint	Czúcz	Centre for Ecological Research, Hungarian Academy of Sciences	MTA ÖK	czucz.balint@okologia.mta.hu
Benjamin	Burkhard	Christian-Albrechts-Universitaet zu Kiel	CAU	bburkhard@ecology.uni-kiel.de
C. Sylvie	Campagne	Institut national de Recherche en Sciences et Techniques pour l'Environnement et l'Agriculture	IRSTEA	sylvie.campagne@irstea.fr
Chiara	Cortinovis	University of Trento	UNITN	chiara.cortinovis@unitn.it
Constantin	Cazacu	University of Bucharest Research Center in Systems Ecology and Sustainability	UB	constantin.cazacu@gmail.com
Cristina	Marta Pedroso	Instituto Superior Técnico, Universidade de Lisboa	IST-ULisboa	cristina.marta@tecnico.ulisboa.pt
Damian	Łowicki	Adam Mickiewicz University in Poznań	UPOZ	damek@amu.edu.pl
David	Vackar	Global Change Research Institute, The Czech Academy of Sciences	CzechGlobe	vackar.d@czechglobe.cz
Davide	Geneletti	University of Trento	UNITN	davide.geneletti@unitn.it
Diana	Mortimer	Joint Nature Conservation Committee	JNCC	diana.mortimer@jncc.gov.uk
Erling	Andersen	University of Copenhagen	UCPH	eran@ign.ku.dk
Felix	Müller	Christian-Albrechts-Universitaet zu Kiel	CAU	fmueller@ecology.uni-kiel.de
Fernando	Santos Martin	Universidad Autonoma de Madrid	UAM	fernando.santos.martin@uam.es

First	Family Name	Affiliation	Abbrev	Email
Gemma	Weir	National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht	NPWS, DAHG Ireland	gemma.weir@ahg.gov.ie
Graciela	Rusch	Norwegian Institute for Nature Research	NINA	graciela.rusch@nina.no
Grazia	Zulian	Joint Research Centre	JRC	grazia.zulian@jrc.ec.europa.eu
Hannah	Ostergard	Swedish environmental protection agency	SEPA	hannah.ostergard@naturvardsverket.se
Hermann	Klug	Paris-Lodron University of Salzburg	PLUS	hermann.klug@sbg.ac.at
Hilary	Grant	Joint Nature Conservation Committee	JNCC	Hilary.Grant@jncc.gov.uk
Iliyana	Kuzmova	Pensoft Publishers	PENSOFT	pressoffice@pensoft.net
Inge	Liekens	VITO	VITO	inge.liekens@vito.be
Iskra	Konovska	Foundation for Sustainable Development	FSD	iskra.konovska@fsd.nl
Joachim	Maes	Joint Research Centre	JRC	joachim.maes@jrc.ec.europa.eu
Katie	Medcalf	Environment Systems	EnvSys/UK	katie.medaclf@envsys.co.uk
Kristina	Veidemane	Baltic Environmental Forum - Latvia	BEF-LV	kristina.veidemane@bef.lv
Luke	Brander	Institute for Environmental Studies, VU University Amsterdam	IVM-VU	lukebrander@gmail.com
Mario	Balzan	Malta College of Arts, Sciences and Technology	MCAST	mario.balzan@mcast.edu.mt
Marion	Potschin	CEM, University of Nottingham	UNOTT	Marion.Potschin@Nottingham.ac.uk
Mariyana	Nikolova	National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Scienses	NIGGG - BAS	mknikolova@gmail.com
Matej	Simčič	The Institute of the Republic of Slovenia for Nature Conservation	IRSNC	matej.simcic@zrsvn.si
Miguel	Villoslada	Estonian University of Life Sciences	EMÜ	mpecina@emu.ee
Mihai	Adamescu	University of Bucharest Research Center in Systems Ecology and Sustainability	UB	mihaicristian.adamescu@g.unibuc.ro
Paulo	Borges	Azorean Biodiversity Group - Centre for Ecology, Evolution and Environmental Changes	ABG / CE3C	paulo.av.borges@uac.pt
Pavel	Stoev	Pensoft Publishers	PENSOFT	pavel.e.stoev@gmail.com

First	Family Name	Affiliation	Abbrev	Email
Petteri	Vihervaara	Finnish Environment Institute	SYKE	petteri.vihervaara@ymparisto.fi
Philip	Roche	Institut national de Recherche en Sciences et Techniques pour l'Environnement et l'Agriculture	IRSTEA	philip.roche@irstea.fr
Pieter	van Beukering	Institute for Environmental Studies, VU University	IVM-VU	pieter.van.beukering@vu.nl
Roy	Haines-Young	CEM, University of Nottingham	UNOTT	Roy.Haines-Young@Nottingham.ac.uk
Sandra	Luque	National Research Institute of Science and Technology for Environment and Agriculture, France	IRSTEA	sandra.luque@irstea.fr
Steffen	Reichel	Paris-Lodron University of Salzburg	PLUS	steffen.reichel@sbg.ac.at
Steven	Broekx	VITO	VITO	steven.broekx@vito.be
Stoyan	Nedkov	National Institute of Geophysics, Geodesy and Geography - Bulgarian Academy of Scienses	NIGGG - BAS	snedkov@abv.bg
Sven-Erik	Rabe	ETH Zurich, Planning of Landscape and Urban Systems	ETH-PLUS	rabes@ethz.ch
Ville	Karvinen	Finnish Environment Institute	SYKE	ville.karvinen@ymparisto.fi
Zbigniew	Szkop	Regional Environmental Center	REC	zszkop@rec.org

A3 Abstracts presentations – introduction session

"Integrated assessment in ESMERALDA"

By

Roy Haines-Young

with

Marion Potschin, Benjamin Burkhard, Fernando Santos-Martín and Joachim Maes

Abstract

How does an '*integrated* assessment' differ from an 'assessment'? What do we mean or seek to emphasise when we describe ecosystem assessments as being *integrated*? In the context of sustaining ecosystem services or biodiversity the need to unify different strands of thinking and action comes about because we have to deal with interactions at the interface between people and nature. We are, for example, often interested in the capacity of ecosystems to provide services and the demands that people have for these outputs. Thus at a *methodological* level we need to integrate the analysis of the biophysical conditions and dynamics of ecosystems with an understanding of how they benefit different groups of people and how they are valued. In designing policy or management interventions, however, we may also need go beyond methodological integration, and consider the casual linkages between different sectors of society. We therefore need conceptually integrated assessments in order to understand how different drivers of change impact on ecosystems, and how changes in the stock or condition of ecosystems have consequences elsewhere. Such holistic thinking is the very essence of the Ecosystem Approach. In developing guidelines for integrated assessment in ESMERALDA we therefore need to show how and where integration is achieved and the role that mapping plays in the integration process. We also need to show how integrated assessment approaches can support the targets of the EU Biodiversity Strategy to 2020.

Pen sketch of yourself

Roy Haines-Young is Emeritus Professor of the University of Nottingham, where he was previously Director of the Centre for Environmental Management in the School of Geography. He has taught and undertaken research in landscape ecology and environmental geography, and taken particular interest in how science is used in a policy and management context. He has been involved in a number of ecosystem assessment projects, has looked at

the role of scenarios and futures thinking in the assessment process, and the way concepts can be operationalised.

References

Ash, N., Bennett, K., Reid, W., et al. (11 authors) (2012):. Assessing Ecosystems, Ecosystem Services, and Human Well-being. In, Ash, N., Blanco, H., Brown, C., et al. (12 authors) (Eds) Ecosystems and human wellbeing a manual for assessment practitioners. Island Press, Washington Island Press, Washington, p. 1-32

Haines-Young, R. (2011): Exploring ecosystem service issues across diverse knowledge domains using Bayesian Belief Networks. *Progress in Physical Geography* 35(5): 681-700.

Haines-Young, R. and M. Potschin (2014): The Ecosystem Approach as a framework for understanding knowledge utilisation. *Environment and Planning C* 32 (2): 301-319.

Haines-Young, R., et al. (2014): UK National Ecosystem Assessment Follow-on. Work Package Report 7: Operationalising scenarios in the UK National Ecosystem Assessment Follow-on, UNEP-WCMC, LWEC, UK. Download at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

Palacios-Agundez, I., Onaindia, M., Potschin, M., Tratalos, J. A., Madariaga, I., & Haines-Young, R. (2015): Relevance for decision making of spatially explicit, participatory scenarios for ecosystem services in an area of a high current demand. *Environmental Science & Policy*, 54, 199-209.

Potschin, M., Haines-Young, R, Fish, R and Turner, K.R (Eds) (2016) *Routledge Handbook of Ecosystem Services*. Routledge, London and New York, 630 pp.

Potschin, M. and R. Haines-Young (2013): Landscape and the place-based analysis of ecosystem services. *Landscape Ecology* 28: 1053-1065

Related project

www.openness-project.eu

http://www.ecosystemassessments.net/

Contact Details:

roy.haines-young@nottingham.ac.uk

UK's contributions to the MAES process

Diana Mortimer

Abstract

This talk will outline the work undertaken in the UK that contributes to Target Two of Action Five under the EU Biodiversity Strategy. The UK National Ecosystem Assessment (UK NEA) took place from 2009 to 2011, with a follow-on project between 2012 and 2014. Both elements involved around 500 natural scientists, economists, social scientists and policy makers. The work provided the first assessment of the benefits that the UK natural environment provides to society and the economy.

England's policy response to the UK NEA was *The Natural Choice: Securing the Value of Nature*. Key elements included;

- Supporting Local Nature Partnerships, to strengthen local action.
- New Nature Improvement Areas across England that seek to improve the nature in areas working in partnership with local organisations.
- The independent Natural Capital Committee, which provides expert, independent advice to Government on the state of England's natural capital.
- Improving public health locally, by making high-quality green space available.

A land use strategy for Scotland was produced, it proposals included

- Assessing how an Ecosystem Approach can be used in decision-making
- Researching the impact of land management on ecosystem processes
- Develop a land-use information hub
- Reducing land-based emissions
- Involving communities in land-use decisions

In Wales an Environment Bill was recently passed. It will use a 'joined-up' approach to manage the country's natural resources. A 'State of Natural Resources' report, highlighting the condition and extent of Wales's natural resources, their ability to respond to pressures and their capacity to adapt to climate change will be frequently published as part of the approach, while a national resources policy will outline the key priorities and opportunities for sustainable management of natural resources in relation to Wales.

Pen sketch

Diana leads JNCC's programme on ecosystem services and natural capital focusing on the integration of ecosystem services and natural capital across JNCC's work areas eg developing the Ecosystem Service Spatial Framework and working on the application natural capital approaches in both the marine and terrestrial environments. Diana is a member the UK Government delegation to IPBES and co-ordinator of the UK IPBES Stakeholder Hub. Diana has also worked with the CBD Secretariat on the implementation of the Ecosystem Approach.

Key JNCC publications

- Report on Realising nature's value in UK business http://jncc.defra.gov.uk/pdf/Report%20558_web.pdf
- Practice note on Realising the value of natural capital to UK businesses in the electricity supply sector - http://jncc.defra.gov.uk/PDF/PN1_Elec_v7.pdf
- Practice note on Realising the value of natural capital to UK businesses in the agriculture, forestry and fisheries sector http://jncc.defra.gov.uk/PDF/PN2_AFF_FINALv6.pdf
- Tool Assessor: http://ecosystemsknowledge.net/resources/tool-assessor
- Spatial framework for assessing evidence needs for operational ecosystem approaches http://jncc.defra.gov.uk/page-6241
- Further development of a spatial framework for mapping ecosystem services - http://jncc.defra.gov.uk/page-6690

Contact Details: Dr Diana Mortimer, JNCC, Monkstone House, City Road, Peterborough, PE1 1JY. Tel 01733 562626, email diana.mortimer@jncc.gov.uk

"The Role of quantification and mapping within integrated assessments"

By Dr Katie Medcalf

Abstract

This talk will cover how quantification is introduced within ecosystem service mapping. It will consider how existing data can be scored and proxies generated to give a scale of high to low for a particular service. The evaluation of data sets and the creation of a database, showing what services can be mapped with what data for the UK, will be explained. Different case studies from projects at a local, to regional, to national scale will be used to illustrate how the quantification can contribute to an integrated assessment.

Publications or project (websites) related to this talk

http://jncc.defra.gov.uk/page-6241
http://jncc.defra.gov.uk/page-6690
http://www.scotborders.gov.uk/info/1220/conservation/964/biodiversity/5
http://www.avonwildlifetrust.org.uk/downloadablemaps

Pen sketch of yourself

Dr Katie Medcalf is Environment Director at Environment Systems, she is a landscape ecologist with over twenty years' experience in delivering successful projects in ecology, environmental policy, agri-environment, GIS and remote sensing and more recently in ecosystem service modelling. She has worked on projects across the UK, in Europe, the Caribbean and the South Atlantic. Katie has been instrumental in the successful development of the Ecosystem Quantification methodology behind the SENCE (Spatial Evidence for Natural Capital Evaluation) methodology and has successfully delivered over ten ecosystem service projects in a range of countries at a variety of scales.

For more information on "SENCE" follow link: http://www.envsys.co.uk/sence/

Contact Details:

Email: katie.medcalf@envsys.co.uk

http://www.envsys.co.uk/

+44 (0)7741008974, +44 (0)1970626688Xxx

A4 Definition of terms essential for the workshop

A4.1 Definitions for ES mapping and assessment approaches as used in ESMERALDA and MAES

Tiered approach for mapping ecosystem services:

Tier 1: **Experts provide** a score of ecosystem services supply or demand for each type of **land cover**. These scores can be used to directly map ES from the land cover map itself. This approach may be suitable for ES that are closely related to land use.

Tier 2: Builds on the Tier 1 approach by incorporating **extra data** to add detail and accuracy. For example, primary data collected in one area can be 'upscaled': linked to land cover data and used over larger scales. Data can also be 'downscaled' when, for example, national timber statistics are disaggregated and used to map provision of this service over more local scales.

Tier 3: The third tier adds another level of detail by incorporating **process-based models**. These models account for the underlying processes, both biological and physical, that affect ES supply.

(Source: Science for Environment Policy (2015): Ecosystem Services and the Environment. In-depth Report 11 produced for the European Commission, DG Environment by the Science Communication Unit, UWE, Bristol[2]:)

The choice of Tiers depends on data and resource availability, mapping purpose and expected accuracy of results. However, Tier 3 does not necessarily deliver more useful results than Tier 1. In an optimum case, all three Tiers are combined in one analysis and the results can be triangulated.

Scales for mapping ES:

Local: the (relatively) smallest spatial scale; comprises points sources, communities, individual farms, ecosystems.

Regional: can consist administrative districts (counties, districts, municipalities), watersheds, 'landscapes'.

National: national state territory (administrative boundary; to be used flexibly as the size of countries differs substantially).

[2] http://ec.europa.eu/environment/integrati

on/research/newsalert/pdf/ecosystem_services_biodiversity_IR11_en.pdf

A4.2 Coding system for CICES classes

CICES V4.3				
Section	Division	Group	Class	Code
1. Provisioning	1. Nutrition	1. Biomass	1. Cultivated crops	1.1.1.1
			2. Reared animals and their outputs	1.1.1.2
			3. Wild plants, algae and their outputs	1.1.1.3
			4. Wild animals and their outputs	1.1.1.4
			5. Plants and algae from in-situ aquaculture	1.1.1.5
			6. Animals from in-situ aquaculture	1.1.1.6
		2. Water	1. Surface water for drinking	1.1.2.1
			2. Ground water for drinking	1.1.2.2
	2. Materials	1. Biomass	1. Fibres and other materials from plants, algae and animals for direct use or processing	1.2.1.1
			2. Materials from plants, algae and animals for agricultural use	1.2.1.2
			3. Genetic materials from all biota	1.2.1.3
		2. Water	1. Surface water for non-drinking purposes	1.2.2.1
			2. Ground water for non-drinking purposes	1.2.2.2
	3. Energy	1. Biomass-based energy sources	1.Plant-based resources	1.3.1.1
			2. Animal-based resources	1.3.1.2
		2. Mechanical energy	1. Animal-based energy	1.3.2.1
2. Regulation & Maintenance	1. Mediation of waste, toxics and other nuisances	1. Mediation by biota	1. Bio-remediation by micro-organisms, algae, plants, and animals	2.1.1.1
			2. Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals	2.1.1.2
		2. Mediation by ecosystems	1. Filtration/sequestration/storage/accumulation by ecosystems	2.1.2.1
			2. Dilution by atmosphere, freshwater and marine ecosystems	2.1.2.2
			3. Mediation of smell/noise/visual impacts	2.1.2.3
	2. Mediation of flows	1. Mass flows	1. Mass stabilisation and control of erosion rates	2.2.1.1
			2. Buffering and attenuation of mass flows	2.2.1.2
		2. Liquid flows	1. Hydrological cycle and water flow maintenance	2.2.2.1
			2. Flood protection	2.2.2.2
		3. Gaseous / air flows	1. Storm protection	2.2.3.1
			2. Ventilation and transpiration	2.2.3.2
	3. Maintenance of physical, chemical, biological conditions	1. Lifecycle maintenance, habitat and gene pool protection	1. Pollination and seed dispersal	2.3.1.1
			2. Maintaining nursery populations and habitats	2.3.1.2
		2. Pest and disease control	1. Pest control	2.3.2.1
			2. Disease control	2.3.2.2
		3. Soil formation and composition	1. Weathering processes	2.3.3.1
			2. Decomposition and fixing processes	2.3.3.2
		4. Water conditions	1. Chemical condition of freshwaters	2.3.4.1
			2. Chemical condition of salt waters	2.3.4.2
		5. Atmospheric composition and climate regulation	1. Global climate regulation by reduction of greenhouse gas concentrations	2.3.5.1
			2. Micro and regional climate regulation	2.3.5.2

Coding system for CICES classes, cont

CICES V4.3				
Section	Division	Group	Class	Code
3. Cultural	1. Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	1. Physical and experiential interactions	1. Experiential use of plants, animals and land-/seascapes in different environmental settings	3.1.1.1
			2. Physical use of land-/seascapes in different environmental settings	3.1.1.2
		2 Intellectual and representative interactions	1. Scientific	3.1.2.1
			2. Educational	3.1.2.2
			3. Heritage, cultural	3.1.2.3
			4. Entertainment	3.1.2.4
			5. Aesthetic	3.1.2.5
	2. Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	3. Spiritual and/or emblematic	1. Symbolic	3.2.3.1
			2. Sacred and/or religious	3.2.3.2
		4. Other cultural outputs	1. Existence	3.2.4.1
			2. Bequest	3.2.4.2

A4.3 Ecosystem types for mapping ES (copied from the first MAES report[3] and coding used in this workshop

A. Terrestrial ecosystems:

A. 1. **Urban ecosystems** are areas where most of the human population lives and it is also a class significantly affecting other ecosystem types. Urban areas represent mainly human habitats but they usually include significant areas for synanthropic species, which are associated with urban habitats. This class includes urban, industrial, commercial, and transport areas, urban green areas, mines, dumping and construction sites.

A. 2. **Cropland** is the main food production area including both intensively managed ecosystems and multifunctional areas supporting many semi- and natural species along with food production (lower intensity management). It includes regularly or recently cultivated agricultural, horticultural and domestic habitats and agro-ecosystems with significant coverage of natural vegetation (agricultural mosaics).

A. 3. **Grassland** covers areas dominated by grassy vegetation (including tall forbs, mosses and lichens) of two kinds – managed pastures and (semi-)natural (extensively managed) grasslands.

A. 4. **Woodland** and forest are areas dominated by woody vegetation of various age or they have succession climax vegetation types on most of the area supporting many ecosystem services.

A. 5. **Heathland** and shrub are areas with vegetation dominated by shrubs or dwarf shrubs. They are mostly secondary ecosystems with unfavourable natural conditions. They include moors, heathland and sclerophyllous vegetation.

A. 6. **Sparsely or unvegetated land** are all unvegetated or sparsely vegetated habitats (naturally unvegetated areas). Often these ecosystems have extreme natural conditions that might support particular species. They include bare rocks, glaciers and dunes, beaches and sand plains.

A. 7. **Inland wetlands** are predominantly water-logged specific plant and animal communities supporting water regulation and peat-related processes. This class includes natural or modified mires, bogs and fens, as well as peat extraction sites.

B. Freshwater ecosystems

B. 1. **Rivers and lakes** which are the permanent freshwater inland surface waters. This class includes water courses and water bodies.

C. Marine ecosystems

C. 1. **Marine inlets and transitional waters** are ecosystems on the land-water interface under the influence of tides and with salinity higher than 0.5 ‰. They include coastal wetlands, lagoons, estuaries and other transitional waters, fjords and sea lochs as well as embayments.

C. 2. The **coastal areas** refer to coastal, shallow, marine systems that experience significant land-based influences. These systems undergo diurnal fluctuations in temperature, salinity and turbidity, and are subject to wave disturbance. Depth is between 50 and 70 m.

C. 3. The **shelf** refers to marine systems away from coastal influence, down to the shelf break. They experience more stable temperature and salinity regimes than coastal.

C. 4. The **open ocean** refers to marine systems beyond the shelf break with very stable temperature and salinity regimes, in particular in the deep seabed. Depth is beyond 200 m.

[3] http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

A4.4 Definitions of methods, models, software etc. as used for the workshop

BIOPHYSICAL "METHODS models, software etc"

Term	Definition as used in Deliverable
1. Spreadsheet methods	Simple methodology that provides a quick output in a spatial explicit manner and can involve different stakeholder/expert perceptions (Tier 1). Can be used in data-scarce areas.
2. ESTIMAP	Assess the supply, demand and flow of different ES at different scales. Simple, easy to understand, spatially-explicit approach that can be tailored to particular case studies.
3. Bayesian Belief Network	A probabilistic graphical model for reasoning under uncertainty, consisting of an acyclic, directed graph describing a set of dependence and independence properties between the variables of the model represented as nodes, and a set of (conditional) probability distributions that quantify the dependence relationship. Adapted from Kjærulff & Madsen (2013)
4. State and Transition Model	Communicate uncertainty about ecosystem potential future scenarios. Diagrammatic, low cost, flexible and suit participatory modelling.
5. QuickScan	Used to assess societal and environmental conditions and evaluate the impacts of potential responses. Participatory approach that can be applied to a selected area, to identify which options would be applicable and what would be the costs and benefits of them.
6. INVEST	Used to do ES trade-off assessment of certain land use or management scenarios. Set of models for mapping and valuing the ecological or economic value of multiple ES at a local to regional scale.
7. Spatial proxy models	We define spatial proxy models as models that relate ES indicators to land cover, abiotic and possibly biotic (although not often used beyond vegetation type) variables by way of calibrated empirical relationships. As such they therefore can provide the most basic form of incorporation of 'biodiversity' effects on ES supply. It is desirable, and in practice most common for such models to be derived from well-known causal relationships between environmental variables.
8. Phenomenological models	Describe qualitative or semi-quantitative relationships between biodiversity components and ES supply, based on an understanding of biological mechanisms underpinning ES supply. They assume a relationship between elements of the landscape – quite often represented by land cover or land use classes – and the provisioning of and/or the demand for ecosystem services. In difference to purely empirical approaches parameters (or a part of the parameters) are not derived from observed data from the location of the model application. Instead parameters are transferred from other studies or meta-analysis.
9. Macro-ecological models	Models that assess ES supply based on the presence (or abundance) of specific components of biodiversity, referred to as Ecosystem Service Providers (ESP) or Service Providing Units (SPU), depending on their geographic distribution. The contribution of e.g. different species or functional groups to the ES of interest is assessed based on specific traits (e.g. trophic guilds) or expert knowledge.

Term	Definition as used in Deliverable
10. Trait-based models	There is increasing evidence for relationships between traits of organisms and ES supply. Trait-based models quantify ES supply based on (statistical) relationships between functional traits of Ecosystem Service Providers (ESP) and ecosystem properties considered either by experts or by stakeholders to support a given ecosystem service.
11. Process-based models	Rely on the explicit representation of ecological and physical processes that determine the functioning of ecosystems. They provide functional means of plant and ecosystem processes that are universal rather than specific to one biome or region. One purpose of such models is to explore the impact of perturbations caused by climatic changes and anthropogenic activity on ecosystems and their biogeochemical feedbacks. Many process-based models allow the net effects of these processes to be estimated for the recent past and for future scenarios. In terms of ecosystem services, these types of models are most widely applied to quantify climate regulation, water supply from catchments, food provision but also in the wider frame of habitat characterisation.

SOCIO-CULTURAL "METHODS models, software etc"

Term	Definition as used in Deliverable
12. Preference assessment	Preference assessment is a direct consultative method to demonstrate the social importance of ecosystem services by analysing social motivations, perceptions, knowledge and associated values of ecosystem services demand or use. Data can be collected through free-listing exercises, ecosystem service ranking, rating or selection mechanisms
13. Time-use assessment	This method estimates the value of ecosystem services by directly asking people how much time they are willing to invest (WTI) for a change in the quantity or quality of a given ecosystem service or conservation plan. Methodological 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
14. Photo-elicitation surveys	Photo-elicitation surveys, although still quantitative by nature, follow a different logic to explore and translate people's visual experiences and perceptions of landscapes related to ecosystem services. Photo elicitation is based on the simple idea of inserting a photograph into a research interview. The difference between interviews using images and text, and interviews using words alone lies in the ways we respond to these two forms of symbolic repres-entation. 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
15. Narrative assessment	Narrative methods differ from the previous three in terms of collecting mainly qualitative data. By using narrative methods (e.g. in-depth and semi structured interviews, observations, voice and video recording of events, artistic expressions), it allow research participants to articulate the plural and heterogeneous values of ecosystem services through their own stories and direct actions (both verbally and visually).
16. Participatory mapping and assessment of ecosystem services (PGIS)	Participatory mapping and assessment of ecosystem services (PGIS) evaluates the spatial distribution of ecosystem services according to the perceptions and knowledge of stakeholders via workshops and/or surveys. PGIS allows for the participation of various stakeholders in the creation of an ES map (e.g. community members, environmental professionals, NGO representatives, decision-makers) 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.
17. Scenario planning	Scenario planning applies various tools and techniques (e.g. individual interviews, brainstorming or visioning exercises in workshops, often complemented with modelling) to develop plausible and internally consistent descriptions of alternative future options. Assumptions about future events or trends are questioned, and uncertainties are made explicit to establish transparent links between changes of ecosystem services and human well-being.
18. Deliberative assessment	Deliberative methods – an umbrella term for various tools and techniques engaging and empowering non-scientist participants – ask stakeholders and citizens to form their preferences for ecosystem services together through an open dialogue. Deliberative methods (e.g. valuation workshops, citizens' juries, photo-voice, etc.) allow for the consideration of ethical beliefs, moral commitments and social norms beyond individual and collective utility, and are often used in combination with other approaches (e.g. mapping or monetary valuation).

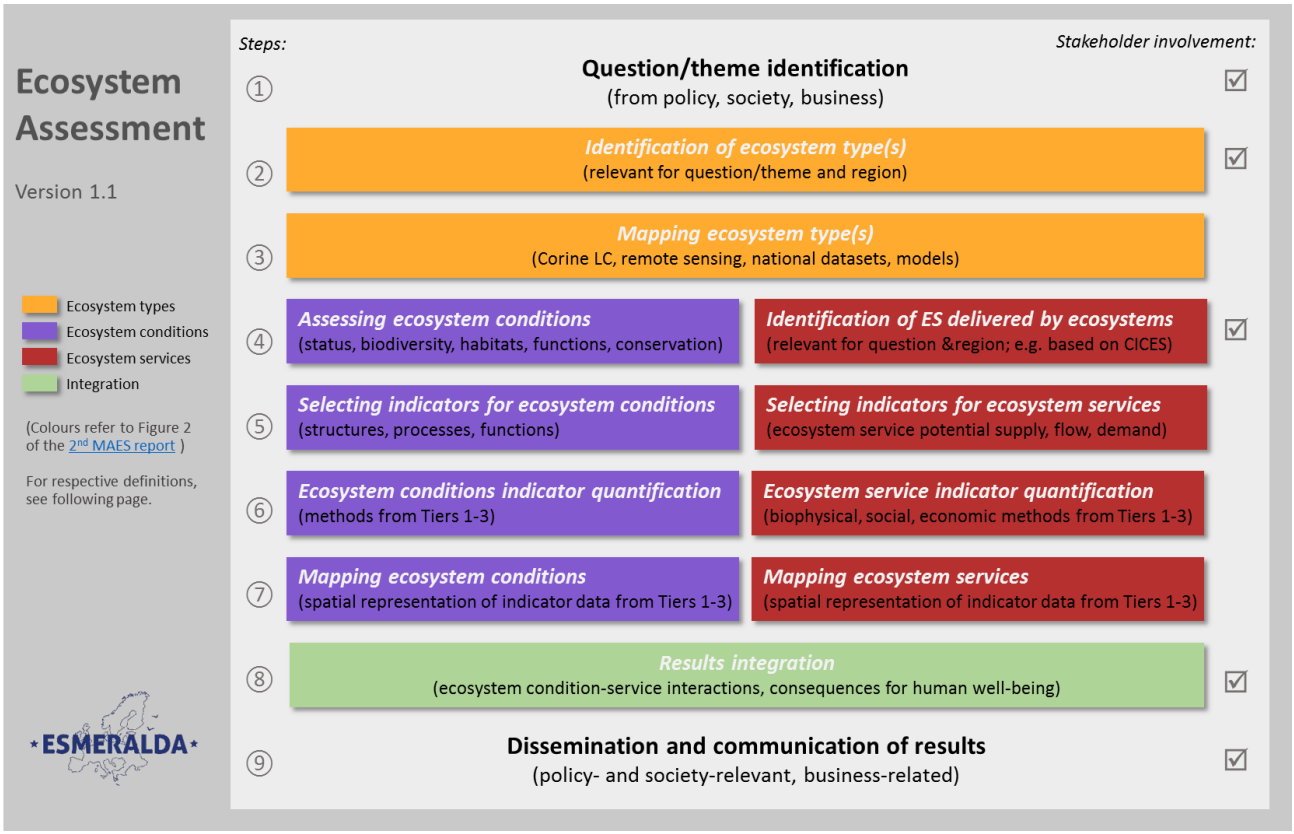
Term	Definition as used in Deliverable
19. Q-Methodology	Q-methodology has been used as a research tool in a wide variety of disciplines. The methodology is particularly useful when researchers wish to understand and describe the variety of subjective viewpoints on an issue. The name "Q" comes from the form of factor analysis that is used to analyse the data. Normal factor analysis, called "R method," involves finding correlations between variables (say, height and age) across a sample of subjects. Q, on the other hand, looks for correlations between subjects across a sample of variables. 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. It is sometimes said that Q factor analysis is R factor analysis with the data table turned sideways. While helpful as a heuristic for understanding Q, this explanation may be misleading, as most Q methodologists argue that for mathematical reasons no one data matrix would be suitable for analysis with both Q and R.
20. SOlVES	A GIS Application for Assessing, Mapping, and Quantifying the Social Values of Ecosystem Services. It integrated with the Maxent maximum entropy modelling software to generate more complete social-value maps and to produce robust models describing the relationship between social value intensity and explanatory environmental variables. Maxent also more readily permits the transfer of social-value models to physically and socially similar areas where primary survey data are not available. Due to its flexible design, SolVES 3.0 users are able to define their own social values and public uses, model any number and type of environmental variables, optionally weight mapped survey data, and modify the spatial resolution of analysis. SolVES provides an improved public-domain tool for decision makers and researchers to evaluate the social value of ecosystems and to facilitate discussions among diverse stakeholders regarding the trade-offs among different ecosystem services in a variety of physical and social contexts, ranging from forest and rangeland to coastal and marine.

ECONOMIC "METHODS models, software etc"

Term	Definition as used in Deliverable
21. Public pricing	Is used for ES for which there are public expenditures. Public expenditure or monetary incentives (taxes/subsidies) for ES as an indicator of value.
22. Defensive expenditure	Is used for ES for which marketed substitutes are available Expenditure on marketed goods that can substitute for ES. Limitations: No direct link to preferences of beneficiaries
23. Replacement cost	Estimate the cost of replacing an ES with a man-made service. Some of the limitations: no direct relation to ES benefits. Over-estimates value if society is not prepared to pay for man-made replacement. Under-estimates value if man-made replacement does not provide all of the benefits of the original ecosystem.
24. Restoration cost	Estimate cost of restoring degraded ecosystems to ensure provision of ES. Any ES that can be provided by restored ecosystems.
25. Damage cost avoided	Estimate damage avoided due to ecosystem service. Ecosystems that provide storm or flood protection to houses or other assets.
26. Net factor income	Revenue from sales of environment-related good minus cost of other inputs. Ecosystems that provide an input in the production of a marketed good.
27. Production function	Statistical estimation of production function for a marketed good including an ES input. Ecosystems that provide an input in the production of a marketed good
28. Hedonic pricing	Estimate influence of environmental characteristics on price of marketed goods. Environmental characteristics that vary across goods (usually houses)
29. Travel cost	Economic valuation techniques that use observed costs to travel to a destination to derive demand functions for that destination.
30. Contingent valuation	Stated preference-based economic valuation technique based on a survey of how much respondents would be willing to pay for specified benefits
31. Choice modelling	A method of valuing goods and services based on their attributes. It is a stated preference technique whereby respondents trade-off different levels of the attributes with payments to reveal the value of changes in the attributes.
32. Group / participatory valuation	Ask groups of stakeholders to state their willingness to pay for an ES through group discussion
33. Value transfer	is the use of research results from existing primary studies at one or more sites or policy contexts ("study sites") to predict welfare estimates or related information for other sites or policy contexts ("policy sites"). Value transfer is also known as benefit transfer but since the values that are transferred may be costs as well as benefits, the term value transfer is more generally applicable.
34. Cost-effectiveness analysis (CEA)	Analysis to identify the least cost option that meets a particular goal (MA)
35. Cost-benefit analysis (CBA)	A technique designed to determine the economic feasibility of a project or plan by quantifying its economic costs and benefits.(MA)
35. Multi-criteria analysis (MCA)	is an applicable assessment method in the situation that the relevant criteria (costs and benefits) to the decision cannot be expressed in monetised values, but can only be expressed in other units or in qualitative terms (i.e. impacts can be ranked in order of importance

Term	Definition as used in Deliverable
36. Ecosystem service accounting	The process of organising information about natural capital stocks and ecosystem service flows, so that the contributions that ecosystems make to human well-being can be understood by decision makers and any changes tracked over time. Accounts can be organised in either physical or monetary terms
37. Corporate ecosystem service review	is a structured methodology that helps private sector decision-makers to develop strategies to manage business risks and opportunities arising from their company's dependence and impact on ecosystems.

A4.5 Mapping as part of an assessment – concept used for the Nottingham workshop



Definitions

- **Assessment**: 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. Predominantly scientific evidence is translated into information that is understandable for policy and decision making, e.g. through maps, indicators, narratives and graphs.
- **Integrated assessment**: integrates data and information on biophysical ecosystem components with socio-economic system components and the societal and policy contexts in which they are embedded. Links between ecosystem condition, habitat quality and biodiversity, and how they affect the ability of ecosystems to deliver ecosystem services, and then evaluating the consequences for human well-being are assessed.
- **Ecosystem condition/state**: A description of the structure or functioning of an ecosystem according to some predefined criteria. Relates to the capacity of an ecosystem to yield services.
- **Ecosystem (service) mapping**: spatial delineation of ecosystems as well as their conditions and the services they supply through the spatial integration of a wide range of data sets. The different mapping approaches and techniques are embedded in the integrated and consistent assessment framework.

Definitions inspired by ESMERALDA DoA (2015); ESMERALDA Glossary (D1.4); EEA (2016); Maes et al. (2016)

A5 Email text and instructions to Workshop participants (01.06.16)

Dear Nottingham Workshop participants,

We have now been able to create the matrix as started at the ESMERALDA Workshop on flexible methods (version 1) in Nottingham and Sylvie has kindly turned it into a google document, see link: https://docs.google.com/spreadsheets/d/1IdmqQ78M2__PElrfmJZfXJkjn015L6AXwCGppuqUzSE/edit?usp=sharing

We would now kindly ask you to

- fill in your examples again and on the base of the improved "legend"
- and add to the additional columns as discussed (link to case study, contact, a bit of information etc.).
- We would also like to ask you to send us the PDF of any publication (either scientific or grey literature) where this information can be found, so we can include them in our database. (primary to Fernando Santos at fernando.santos.martin@uam.es and cc Marion in
- I have only put in your first names and the name of the location. Please correct/add to your name as you want to be (officially) addressed.
- For each method you want to refer to (or if there are differences in using the methods per ecosystem type etc., please do use a new line)
- The entries are split according to how they were made during the Sessions 2-4 (different excel sheets). However if you (now based on the experience of the whole workshop) feel they should go somewhere else (or be also copied into a different domain) you can use this online google document as a normal desktop excel file, e.g.
    - Add lines
    - Copy lines
    - Moves/delete etc.
    - These optional additions/changes refer to lines only. If you want to change the structure of the matrix or have further ides please do not do this o the google doc. You can either add a comment in the discussion option of the google facility or send an email to me (cc Fernando)
- In some places I could not read the hand writing so I do apologize if something is misspelled
- I hope the given information is enough to remember your example – should you have problems send me an email and I will add this particular line – but I did not want to write it all from the outset as indeed we actually collected over 150 examples ….
- You can also add entries at a later time. The cut-off date for this first round of exercise will 20. June 2016. We will then also open it up to all ESMERALDA partners (incl. those not being present at the workshop) but we hope to have solved everything which wasn't clear on the approach by then.
- While we will write up the idea, process and preliminary results of the Nottingham workshop in a milestone report (MS20) we would also like to kindly ask you to inform and introduce or colleagues to the workshop idea and
- please also check the legend (add comments possibly in a different colour)
- send any longer feedback (not easily to be added to the excel spread sheet or improvements for using the google doc etc.) in an email to Marion (cc Fernando) – we will look into this for the next version/workshop

Thanks for the good work – it will be interesting to see how we will be developing this jointly together over the next couple of months and workshops.

Best wishes, Fernando and Marion

A6 Protocol Templates

These protocols will also be handed out during the workshop. They are supposed to help your creating your own partner/case study profile. There is no obligation – just an option. The ESMERALDA workshop coordinator will create a similar protocol for each workshop so

ESMERALDA Workshop II

"Flexible Methods for Ecosystem Service Mapping and Assessment"

(1st version)

13.-16. April 2016, Nottingham, UK

by the end of EMERALAD each/partner/case study will have a personalised booklet.

"Your Partner specific Protocol for the ESMERALDA workshops"

Please use this protocol to reflect on the methods introduced and discussed in the ESMERALDA workshops and create your own personal case study relevant protocol. You will also find attached to this your member state/case study fact sheet which was uploaded onto the ESMERALDA webpage in February 2016. However please note that this information is not set in stone and could/should develop further over the life time of ESMERALDA.

What is the focus of your case study, e.g. assessments?

……

……

What is your understanding of an Integrated Assessment? Do you agree with the one presented in the plenary/background paper? If not, why?

……

……

Session 1: Ecosystem Service and their quantification

What do you make of this session in respect to your own case study? Please fill in the table below during or at the end of the session 1.

what	Pros	Cons	Comments

CICES class			

General thoughts on the session for your member state/case study

……

……

Session 2: Biophysical methods for mapping and assessing ecosystem services

Method	Pros	Cons	Comments
…			

General thoughts on the session for your member state/case study

……

……

Session 3: Socio-cultural methods for mapping and assessing ecosystem services

Method	Pros	Cons	Comments
…			

General thoughts on the session for your member state/case study

……

……

Session 4: Economic methods for mapping and assessing ecosystem services

Method	Pros	Cons	Comments
…			

General thoughts on the session for your member state/case study

……

……

Session 5: Matching methods to assessment purpose and context

Method	Pros	Cons	Comments
…			

General thoughts on the session for your member state/case study

……

……

Session 6: Introducing the next workshops

General thoughts on the session for your member state/case study

……

……

Do I need to prepare something for the next workshop?

……

……