Report illustrating the application of the final methods in policy and decision-making

Deliverable D5.3

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Enhancing ecosystem services mapping for policy and decision making

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1. Introduction

1.1. Background information

The ESMERALDA project ultimately 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). The ESMERALDA project will ultimately deliver a "flexible methodology" for mapping and assessment of ecosystem services (ES), based on a tiered approach and on the integration of different dimensions (e.g. biophysical, economic and social). This methodology consists of various methods for developing high quality and consistent information on the condition of ecosystems and their services in EU Member States. Particularly, the methodology will help to select the most appropriate (combination of) methods to perform mapping and assessment of ES under specific conditions (e.g., data and time requirements, expertise and experience, scale of application), and for specific contexts (e.g., geographical area and biome) and purposes (e.g., policy questions, themes and sectors).

Within the ESMERALDA project, WP5 has the overall goal of "testing the proposed methods to map and assess ES to ensure that they meet users' requirements for all relevant themes, spatial scales and geographical contexts" (see DoA). Testing is here to be intended as a process of refinement of the ESMERALDA flexible methodology that was being simultaneously developed in WP 3 and WP 4, as well as with input from WP 2 and other work packages (see Figure 1.1). Operationally, testing is conducted through a series of workshops with the ESMERALDA consortium partners and stakeholders, focusing on a set of case studies that are representative of specific conditions, contexts and purposes (for more information on selection of case studies see Deliverable 5.1 and Milestone Report 27). The testing workshops represent important moments in which the whole consortium could be updated about developments and discuss specific methodological issues as per the DoA. A first set of three workshops served to test the first version of the ESMERALDA flexible methodology (see Deliverable 5.2) while a second set of two workshops focused on the final version of the methods, as reported in this Deliverable.

Finally, an additional objective of the ESMERALDA workshops is to contribute to build stakeholders' capacity in understanding the variety of existing methods for ES mapping and assessment, and the results that can be expected from their application. Thus, the workshops provide an important opportunity to involve stakeholders, and to collect their feedback on the proposed ESMERALDA flexible methodology.

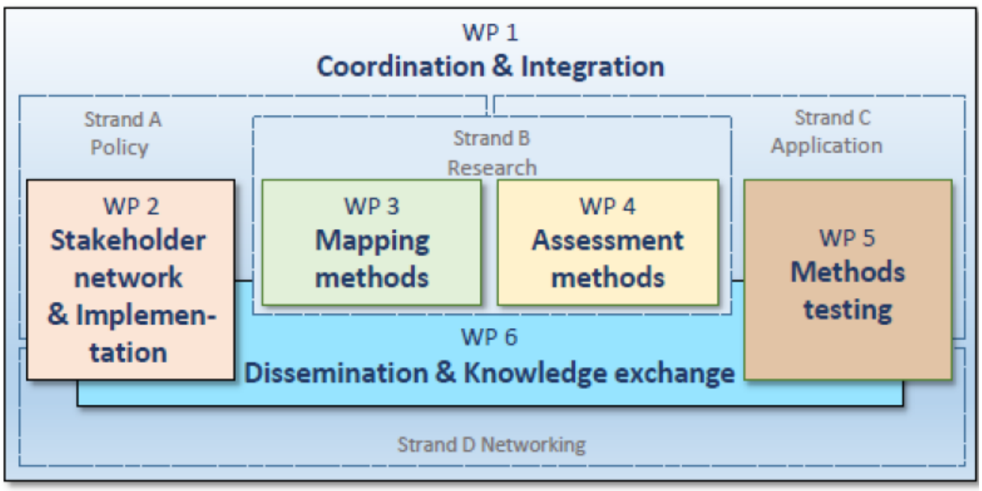


Figure 1.1: ESMERALDA project structure

1.2. ESMERALDA Case studies for testing the final methods

1.2.1. Overview of selected case studies

As reported in detail in Deliverable 5.1 and Milestone Report 27, in total, fourteen real-life case studies were selected to test the different versions of the ESMERALDA flexible methodology for ES mapping and assessment (see Figure 1.2). Of these, nine case studies were used to test the first version in Workshops III, IV, and V (see Deliverable 5.2), while the remaining five case studies served to illustrate applications of the final version of the ESMERALDA methods in policy- and decision making in Workshops VII and VIII.

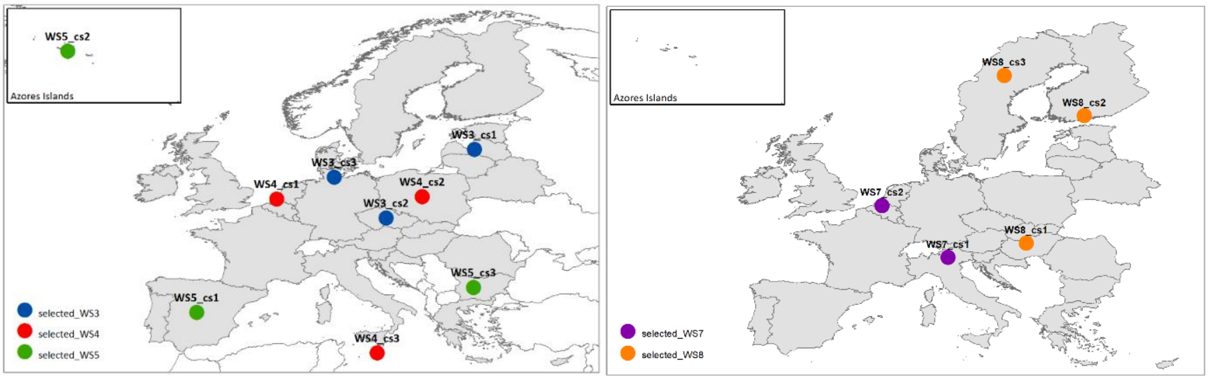


Figure 1.2: Map of the case studies selected for ESMERALDA Workshops 3, 4, and 5 (left) and 7 and 8 (right).

Table 1.1 shows an overview of the case studies. The selected sample, in the whole, covers different geographical regions, types of biomes (at country level), spatial scales, themes, and ecosystem types.

Table 1.1: Overview of the fourteen case studies selected five ESMERALDA methods' testing workshops.

	BIONES	_4	_5	_6	_8	_11	_12	SCALE	_local	_sub-national	_national	THEMES	_nature conservation	_climate, water and energy	_marine policy	_natural risk	_urban/spatial planning	_green infrastructures	_agriculture and forestry	_business, industry and tourism	_health	_MAES	ECOSYSTEMS	_urban	_cropland	_grassland	_woodland and forests	_heathland and shrub	_sparsely vegetated land	_wetlands	_rivers and lakes	_marine inlets and transitional waters	_coastal	_shelf	_open ocean
FIRST SET																																			
_WS3_cs1_LV		√									√				√					√													√		
_WS3_cs2_CZ		√	√								√											√		√	√	√	√			√	√				
_WS3_cs3_DE		√	√						√													√			√	√	√				√				
_WS4_cs1_NL		√							√							√									√					√	√		√		
_WS4_cs2_PL		√	√							√	√			√			√	√	√	√				√	√	√	√			√	√				
_WS4_cs3_ML							√			√	√											√			√			√	√			√	√		
_WS5_cs1_ES		√					√				√											√		√	√	√	√	√	√	√	√	√	√		
_WS5_cs2_PT							√			√			√					√									√								
_WS5_cs3_BG		√			√		√		√				√				√	√	√	√				√		√	√	√							
SECOND SET																																			
_WS7_cs1_IT		√	√				√		√					√			√	√			√			√											
_WS7_cs2_BE		√							√								√	√						√											
_WS8_cs1_HU		√							√				√	√				√	√	√					√	√	√			√	√				
_WS8_cs2_FI		√		√		√			√								√	√						√	√		√				√				
_WS8_cs3_SE		√		√		√				√			√					√	√	√							√	√	√	√					

During the workshops, for each case study, two or three ES and related methods for mapping and assessment were selected for discussing specific issues (e.g. relating to different components of the MAES process) involving the case study stakeholders and other ESMERALDA consortium members. An overview of the ES and related methods in the five case studies used to test the final methods is shown in Table 1.2.

Table 1.2: Overview of the ES and related methods for mapping and assessment selected for discussing specific issues to test the final version of the ESMERALDA methods [1]

	Italy	Belgium	Hungary	Finland	Sweden
	_WS7_cs1	_WS7_cs2	_WS8_cs1	_WS8_cs2	_WS8_cs3
Title	ES mapping and assessment for urban planning in Trento	Mapping green infrastructures and their ES in Antwerp	Fostering pro-biodiversity business in the Bukk National Park	Green infrastructure and urban planning in the City of Järvenpää	ES mapping and assessment in the Vindelälven-Juhtatdahka river valley, northern Sweden
MAES status	Stage 2	Stage 1	Stage 2	Stage 1	Stage 2
Scale	Local	Local	Local	Local	Sub-national
ES 1	Microclimate (and regional) regulation (2.3.5.2)	Filtration/(sequestration/storage/)accumulation by ecosystems (Capture of fine particles) (2.1.2.1)	Animals reared to provide nutrition, fibres and other materials (CICES classes 1.1.3.1 and 1.1.3.2 according to version 5.1)	Educational (3.1.2.2)	Reared animals and their outputs (CICES classes 1.1.1.2)
Method 1	Process-based models	Value (benefit) transfer		Participatory GIS	
ES 2	Physical use of landscapes in different environmental settings (Recreation) (3.1.1.2)	Physical and intellectual interactions with environmental settings (recreation, availability of green infrastructure) (3.1.1.2)	Touristic attractiveness of nature (CICES classes 3.1.1.1, 3.1.1.2 and 3.1.2.4 according to version 5.1)	Integration of GI and ES for infill development	Experiential (physical) use of plants, animals and landscapes (CICES classes 3.1.1.1 and 3.1.1.2)
Method 2	ESTIMAP recreation model	Value (benefit) transfer		Integrated modelling framework (Spatial Multi-criteria Decision Analysis)	
Coordinator	Davide Geneletti, Chiara Cortinovis, Linda Zardo, Blal Adem Esmail (UNITN)	David Vačkář (UVGZ)	Ildikó Arany (MTA ÖK), Tamas Kallay (REC),	Leena Kopperoinen, Arto Viinikka (SYKE)	Johan Svensson (SLU), Hannah Östergård, Ola Inghe (SEPA)
Stakeholders	Giovanna Ulrici (Comune di Trento) Tiziano Brunialti (Comune di Trento) Claudia Alzetta (Comune di Padova) Bruno Zanon (University of Trento)	Gommers Iris (City of Antwerp)	András Schmotzer (Bükk National Park Directorate)	Eira Linko, (Planning Officer at Dept. of Architecture & Planning, City of Järvenpää) Kaisa Saarikorpi, (Councillor at the City of Järvenpää)	Göran Jonsson (Ran Sami Community) Jim Persson, (Ran Sami Community)

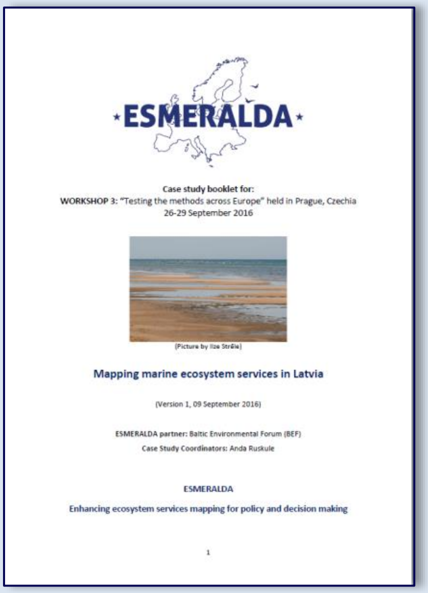
1.2.2. Case Study Booklets and Method Application Cards

Drafted during the preparatory phase by the case study coordinators, Case study Booklets represent important support material used during the ESMERALDA workshops. They illustrate the process of ES mapping and assessment in the case studies, with information about the study area, main policy question

[1] This table is based on the original information used at the time of each workshop, and might have been modified over the course of ESMERALDA project.

and theme addressed, ecosystem types and conditions, mapping and assessment of ES, and finally, about the use and integration of the results (see Box 1.1). The Case Study Booklets are presented in full as an annex to this document.

1) **Case study factsheet and study area description**
2) **Main policy question and theme**
   a) Objectives of ES mapping and assessment
   b) Role of stakeholders
3) **Ecosystem Types and Conditions**
   a) Identification and mapping of ecosystem type(s)
   b) Assessment of ecosystem conditions
4) **Mapping and assessment of ES**
   a) Identification of ES
   b) Applied biophysical methods
   c) Applied socio cultural methods
   d) Applied economic methods
5) **Use & integration of ES mapping & assessment results**
   a) Addressing the policy question
   b) Results communication and dissemination
6) **References & Annexes**


ESMERALDA

Case study booklet for:
WORKSHOP 3: "Testing the methods across Europe" held in Prague, Czechia
26-29 September 2016

(Picture by Ilze Strēle)

Mapping marine ecosystem services in Latvia

(Version 1, 09 September 2016)

ESMERALDA partner: Baltic Environmental Forum (BEF)
Case Study Coordinators: Anda Ruskule

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Enhancing ecosystem services mapping for policy and decision making

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Box 1.1. Content of the booklets illustrating ES mapping and assessment in the ESMERALDA case studies

Method Application Cards are another key support material used during workshops, drafted during the preparatory phase with the involvement the case study coordinators and other ESMERALDA partners acting as supporting experts. The Method Application Cards synthesize the main characteristic of the applied methods in terms of their data, and resources requirement, links and dependency on other methods, collaboration level needed, and spatial scale of application, among others. The Methods Application Cards, which also form a building block of the ESMERALDA flexible methodology, were made available to participants, discussed during the workshops and eventually updated afterwards.

1.3. Content and structure of this report

Deliverable 5.3 "*Report illustrating the application of the final methods in policy and decision-making*" relates to work carried out in "*Task 5.3: Testing the final methods in policy and decision-making*". This is the task in which a second set of five real-world case studies were selected (see Milestone Report 27), hence were used to illustrate how the proposed final version of the methods for ES mapping and assessment may be used to inform policy and decision-making processes (DoA). Task 5.3 is in fact a follow up of "*Task 5.2: Testing the methods across Europe and across themes",* reported in Deliverable 5.2., in which a first set of nine real-world case studies were selected to test and refine the first version of the ESMERALDA methodology then underdevelopment mainly in WP 3, WP 4, an WP 2 (see Figure 1.1).

Similar to Task 5.2, operationally, Task 5.3 was carried out by conducting two workshops with the ESMERALDA consortium partners and stakeholders to illustrate how the final version of the flexible methodology could be applied in policy- and decision making. Specifically, the first workshop focused on urban planning as an illustrative decision making process, while the second workshop looked more at applicability of the methods by citizens and businesses. In each workshop, participants had the opportunity to first receive an update on the latest developments, and then discuss specific topics through the real-world case studies. Noteworthy, Task 5.3 also included activities of stakeholders' involvement and training, also based on the analysis of gaps in ES mapping and assessment in EU Member States carried out in WP 2 (see e.g. Deliverable 2.2).

Specifically, the five real-life case studies selected to investigate specific issues relating to the application of the final ESMERALDA methods for ES mapping and assessment in policy and decision-making are:

- **Workshop VII** "Testing the final methods in policy- and decision-making (I)", 22-25th January 2018, Trento, Italy (MS28)
    - **Italian case study**: *ES mapping and assessment for urban planning in Trento, Italy*
    - **Belgian case study**: *Mapping green infrastructures and their services in Antwerp, Belgium.*

- **Workshop VIII** "Testing the final methods in policy- and decision-making (II)", 19-22nd March 2018, Eger, Hungary (MS29)
    - **Hungarian case study**: *ES mapping and assessment for developing pro-biodiversity businesses in the Bükk National Park, Hungary*
    - **Finnish case study**: *Green infrastructure and urban planning in the City of Järvenpää, Finland.*
    - **Swedish case study**: *ES mapping and assessment in the Vindelälven-Juhtatdahka river valley, northern Sweden*

This Deliverable report provides, for each workshop, three types of outcomes:

- **Case study-related results** that provide evidence-base to illustrate the application of the final methods in policy and decision-making (**Sections 2.2** and **3.2)**.
- **Methods-related results** dealing with efforts to finalize the different ESMERALDA products and Deliverables, with the active involvement of all participants (**Sections 2.3** and **3.3**).
- **Stakeholders-related results** focusing on activities for building capacity of stakeholder in understanding the variety of existing methods, and the results that can be expected from their application. (**Sections 2.32.4** and **3.4**).

The following sections are designed to be read and consulted independently in combination of the Case Study Booklets reported as an Annex

2. WS 7 "Testing the final methods in policy and decision-making (I)" (MS 28)

2.1. Aim and structure of WS 7

Held in Trento (Italy), in January 2018, this Workshop aimed at illustrating in real-world case studies the application of the final version of the ESMERALDA final methods in policy- and decision-making. Thus, it continued the work of testing of the first version of the ESMERALDA flexible methodology conducted in the Workshops held in Prague (WS3, September 2016), WS4 Amsterdam (WS4, January 2017), and Madrid (WS5, May 2017), building also on the revisions and feedback from stakeholders collected at the Plovdiv Workshop (WS6, October 2017). The WS 7 participants included ESMERALDA project partners and stakeholders directly involved in the case studies (Figure 2.1). The former were actively involved in coordinating the activity towards achieving the final ESMERALDA Deliverables. The latter shared their experience with the case study, and provided feedback on the different ESMERALDA products.

Figure 2.1. ESMERALDA Workshop 7 in Trento, Participants Group Picture (By Pensoft)

Content wise, WS 7 included three types of sessions: (i) Case studies-related, (ii) Methods finalization-related, and (iii) Stakeholder involvement and training-related session.

Case study-related sessions: WS 7 focused on two cases studies from Italy (Trento) and Belgium (Antwerp) to analyse how ES mapping and assessment can support different phases of urban planning as an illustrative and relevant decision-making process. The case studies were analysed considering the main components of the MAES process shown in Figure 2.2, based on the structure of the "Final Guidance documentation" that was developed during and after the WS 6 in Plovdiv, Bulgaria. (For more on the "Final Guidance Documentation" refer to sections 2.3.2 and **Errore. L'origine riferimento non è stata trovata.** of this report). In particular, the discussion served to identify the main challenges and respective solutions that emerged in the case study applications also based on input from the stakeholders.

Ultimately, the discussion provided useful insights about the needs and requirements arising from the application of ES mapping and assessment to support urban planning - as illustrative decision-making process - and about their implications for the final version of the ESMERALDA flexible methodology.

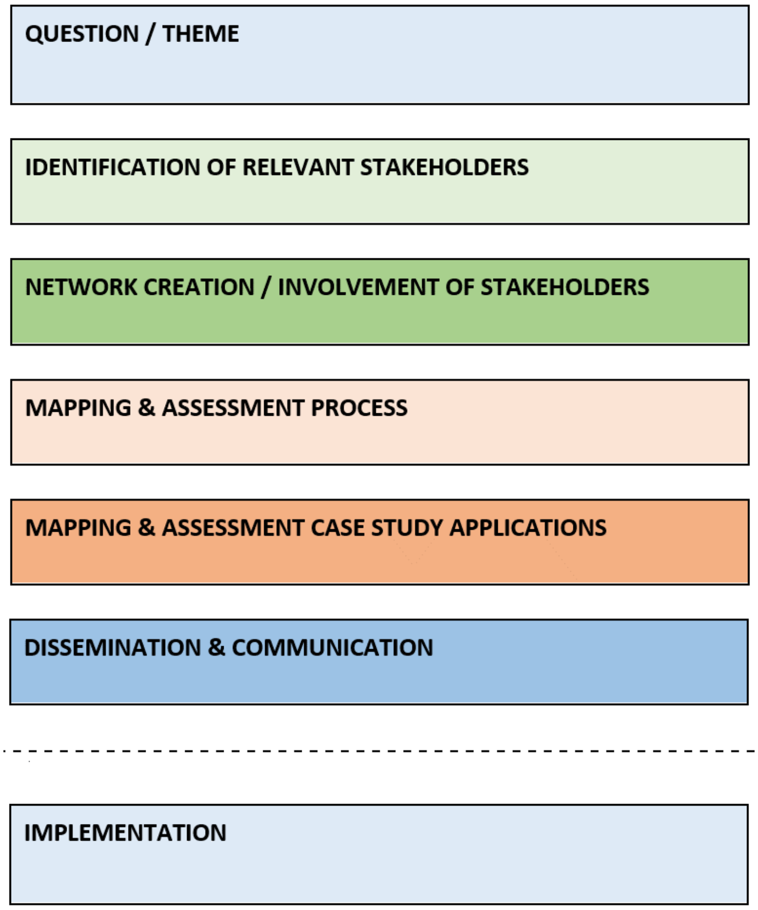


Figure 2.2. Components of the Mapping and Assessment process according to the proposed structure of the ESMERALDA Final GUIDANCE DOCUMENTATION (Version 17.11.2017). (Refer to report of WS 6 in Plovdiv, Bulgaria)

More specifically, for the selected case studies of Trento and Antwerp, the discussions addressed the components of the MAES process related to: (1) “Identification of relevant stakeholders” and “Network creation/Involvement of stakeholders”, (2) “Mapping and assessment”, and (3) “Dissemination & Communication”, and “Implementation”. This allowed exploring the spectrum of needs and requirements - from the more strategic to the more technical stages - that determine usefulness/effectiveness of ES mapping and assessment in informing/supporting policy/decision-making processes. Ultimately, this gave the opportunity to “test” different aspects of the final version of the ESMERALDA flexible methodology.

Given the focus on urban planning as an illustrative and relevant decision-making process, in WS 7, reference was made to a generalized planning process consisting of five main phases, namely: *objectives*; *analysis*; *decision*; *implementation*; and *administration* (see Figure *2.3*). Accordingly, the two case studies were considered to be representative of the phases of *Analysis* (Antwerp) and *Decision* (Trento), allowing to investigate how these two key phases of the planning process could benefit from an application of ES mapping assessment as per the ESMERALDA flexible methodology. (For more details of the MAES process in the case studies refer to the Booklets in the Annex).

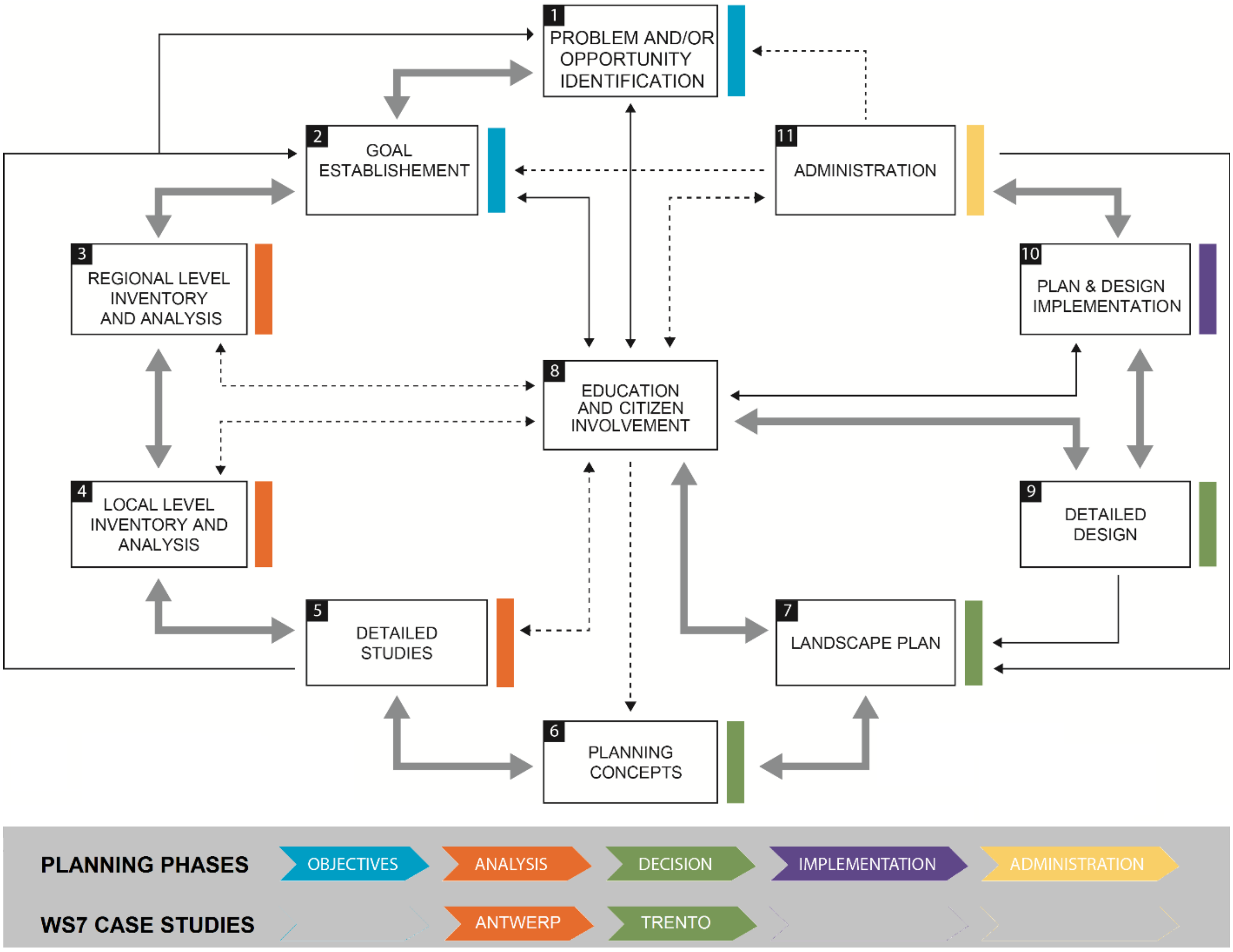


Figure 2.3: Ecological planning model (Source: Steiner, 2000) and the Antwerp and Trento case studies to investigate the analysis and decision phases.

Methods finalization-related sessions: these sessions served to coordinating the activities of the Consortium Partner towards achieving the final ESMERALDA Deliverables. They consisted of a plenary discussion addressing the issues of how structure and technically implement the "Final Guidance Documentation". This plenary was then followed by breakout discussions on the different ESMERALDA Deliverables and on the individual "blocks" of the Final Guidance Documentation and their links to relevant Deliverables.

Stakeholder involvement and training-related sessions: in WS 7, the activities aiming to contribute to stakeholders capacity building stakeholders' capacity in understanding the variety of existing methods for ES mapping and assessment, and the results that can be expected from their application were included throughout the entire workshop. Among others, the stakeholders were exposed to the ESMERALDA approach; hence, during the breakout discussions they had an opportunity to provide their feedback. Additional activities included a science-communication event and a field excursion to the *Arte Sella: the contemporary mountain.*

In the remainder of this section, we report the main results of the three types of sessions.

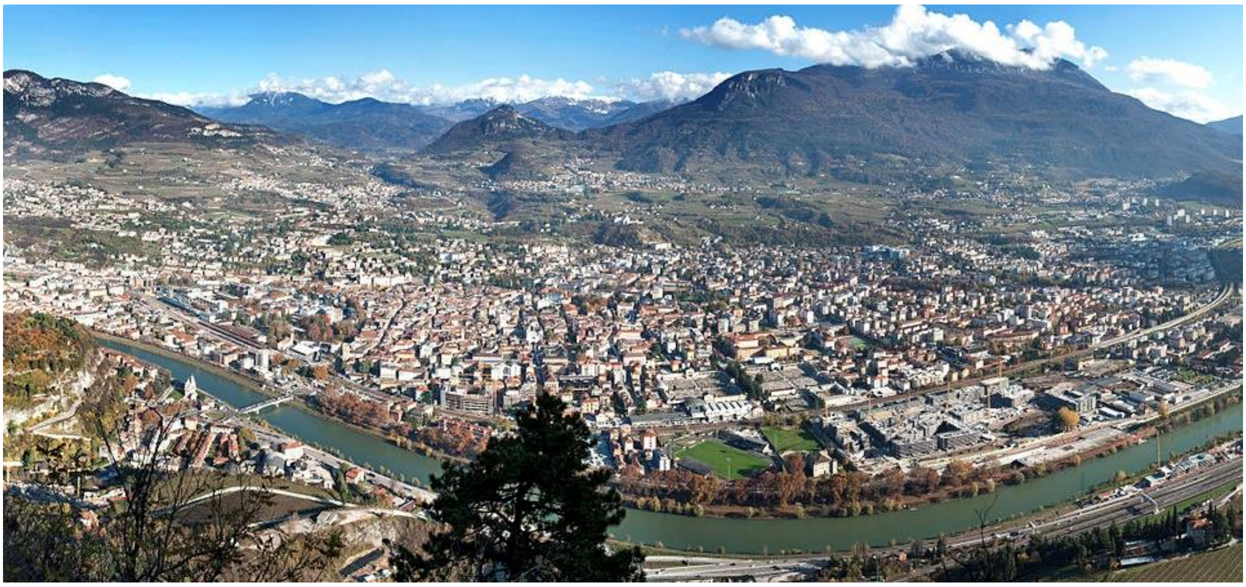
2.2. ESMERALDA case studies related results

2.2.1. Italian case study: ES mapping and assessment for urban planning in Trento (Italy)

Introducing the Trento case study

Located in Northern Italy, Trento is the capital of the Autonomous Province of Trento (Trentino), with a population of around 117,300 inhabitants. The case study represents an application of ES mapping and assessment to a real-life planning decision, and is an example of how it could support the drafting of a new urban plan. As illustrated in detail in the Case Study Booklet in Annex, this specific ES mapping and assessment exercise developed from a scientific research interested in testing methods for ES mapping and assessment on Trento. The research was the occasion to put in contact the PLANES research group at the University of Trento with relevant municipal departments, and to initiate a collaborative discussion.

In particular, the analysis considered the re-greening of 13 brownfields and was aimed at assessing the interventions based on the ES benefits produced. Two ES of key importance for the city, namely microclimate regulation (specifically the cooling effect of vegetation) and recreation, were assessed using the method described by Zardo et al. (2017) and a purposely-adjusted version of the ESTIMAP-recreation model (Zulian et al., 2013), respectively. A spatially-explicit comparison of the 13 scenarios with the current condition allowed quantifying the expected variation in the ES supply and identifying the expected beneficiaries, including specific vulnerable groups for the two ES. The data were combined through a multicriteria analysis illustrating how intervention priorities vary depending on the relative importance assigned to the ES and to the different categories of beneficiaries.



Discussing "Network creation & Involvement of stakeholders" in the Trento case study

How the ES mapping and assessment process in the Trento case study evolved from a mainly scientific endeavour to a formalized collaboration with the city administration, ultimately, contributing to the new Trento urban plan is shown in Figure 2.4

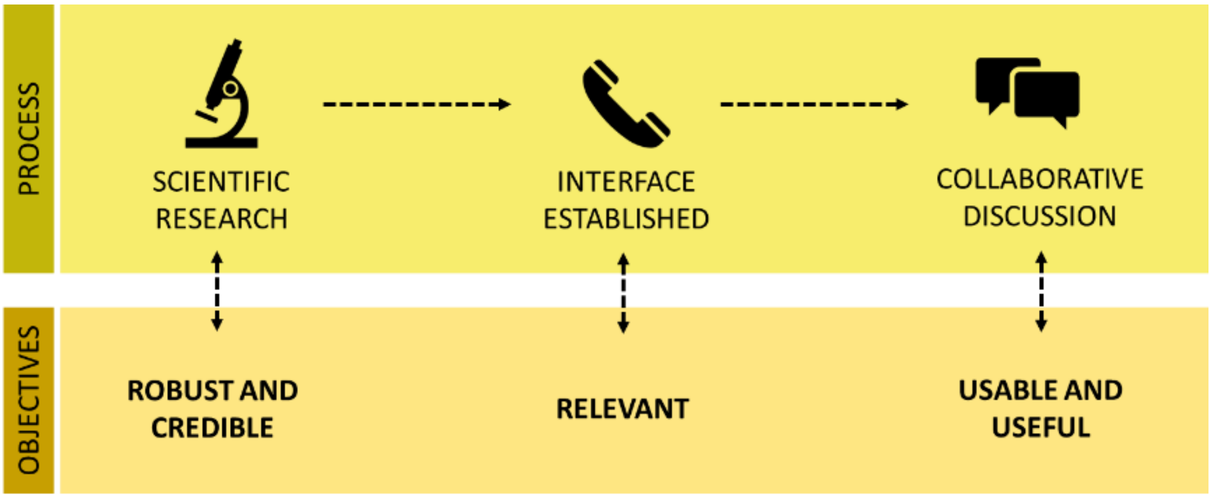
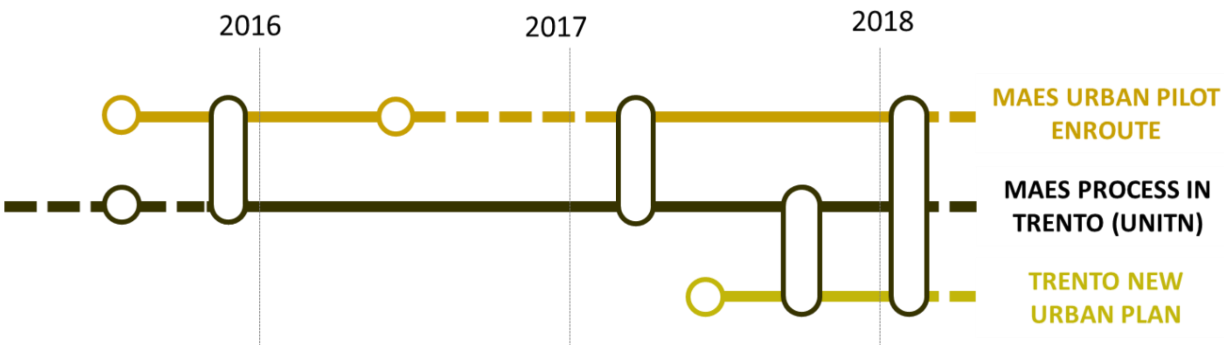


Figure 2.4: An overview of the evolution of the MAES exercise and of its objectives in the Trento case study.

Key stages of this ES mapping and assessment exercise are illustrated in Figure 2.5. Accordingly, the process had initially been concerned mainly about producing results that were robust and credible for scientific publication (see e.g. Geneletti et al. 2016; Zardo et al 2017). Yet, the need for context-specific data (e.g. urban green, population socio-economic data) triggered an interface with the city administration, and this created an important opportunity to show the relevance of the ES mapping and assessment results to meet some of the needs of the administration (e.g. management of its urban parks). This collaboration benefited from a following involvement of both the city and University of Trento in the **MAES Urban Pilot** with opportunities for networking with other EU cities. Later on, the establishment of the **Trento city-lab** was formalized as a requirement for the participation to the **ENROUTE Project** (https://oppla.eu/enroute), whose activities are still ongoing. Finally, the updating of the Trento urban plan, which started in mid-2017 with a formal involvement of the University of Trento, presents a window of opportunity to test usefulness and usability of the ES mapping and assessment results.



I	II	III	IV	V
Scientific research in UNITN + Trento city administration as data provider	MAES Urban pilot (JRC) Networking with other EU cities	ENROUTE Trento city-lab: formal involvement of the city administration	The new Trento urban plan Providing scientific support	Future opportunities…

Figure 2.5: Key stages of the MAES exercise in the Trento Case study that started in mid-2015.

Key points from the discussion

- From the administration perspective, a pragmatic approach is adopted in the interface with scientists (e.g. provide data and receive meaningful results);
- Silo-thinking of different municipal department hinders exchange and efficient use of data. Thus, understanding the internal (highly regulated) procedures of the administration is a pre-requisite to be able to make use of new (MAES) knowledge/results;
- A key element of success of the (scientifically-driven) Trento case study is its contribution to triggering cooperation among different departments of the administration that deal with green areas. As a result, an informal and cross-departmental "working group" was created during the process;
- ES mapping and assessment results bear great potential to communicate the importance of green areas and raise awareness of policy-makers and citizens. Sound baseline analysis together with simple representation of results can help engage stakeholders. However, it is essential to use updated spatial data, including context-specific information and users perception, in order to increase relevance of the MAES results;
- Eliciting abstract preferences may not be enough: involvement of local expert could allow testing the ES models on known examples of green areas in the city;
- Land property (e.g. public vs. private ownership of brownfields) is an issue for planners;
- "Empty area are full of ES": a change in paradigm for planners that consider productive only built up spaces. In fact, the ES approach can trigger innovation in urban planning practice also based on the analysis of demand (e.g. consider temporary uses of empty areas related to the ES they provide). Yet, there are ddifficulties in the selection of indicators that can be included in the plans regulations.
- Networking as a good strategy to empower marginal interests (make them visible), such as those associated to the recreational use of peri-urban space (as opposed, for example, to those associated to agricultural uses).

Discussing the "Mapping & Assessment" in the Trento case studies

The discussion started with an input presentation on the relationships between the ES mapping and assessment and information needs of urban planning and green area management (see Figure 2.6). Key issues were highlighted such as the scale and resolution of the ES mapping and assessment analysis, and the availability of data to characterize the supply and demand of ES in urban areas. This was followed by a more detailed presentation of the method applied to map the cooling effect of urban green areas in Trento (for more details on the method refer to the Case Study Booklet or Zardo et al. 2017). Among others, as shown in Figure 2.7, for ES mapping and assessment to be informative about issues of distributional equity, it was highlighted that due consideration should be given to aspects related to the supply, access, and demand.

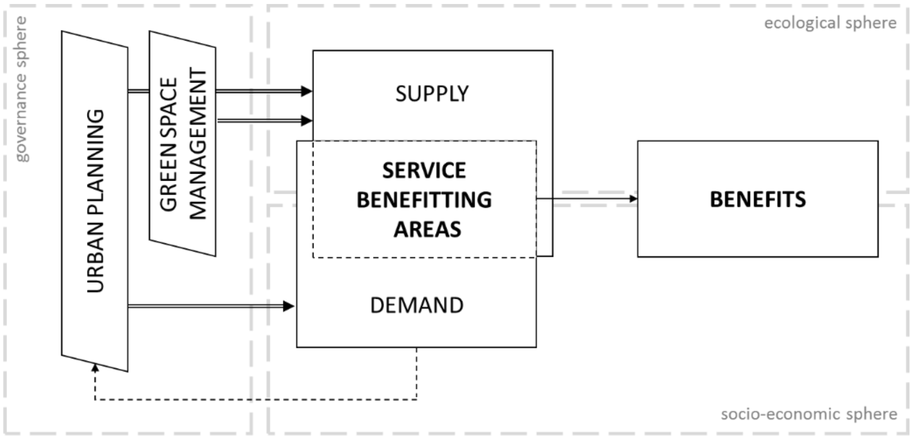


Figure 2.6: Integrating ES in urban planning: effects of planning decisions on ES and related benefits

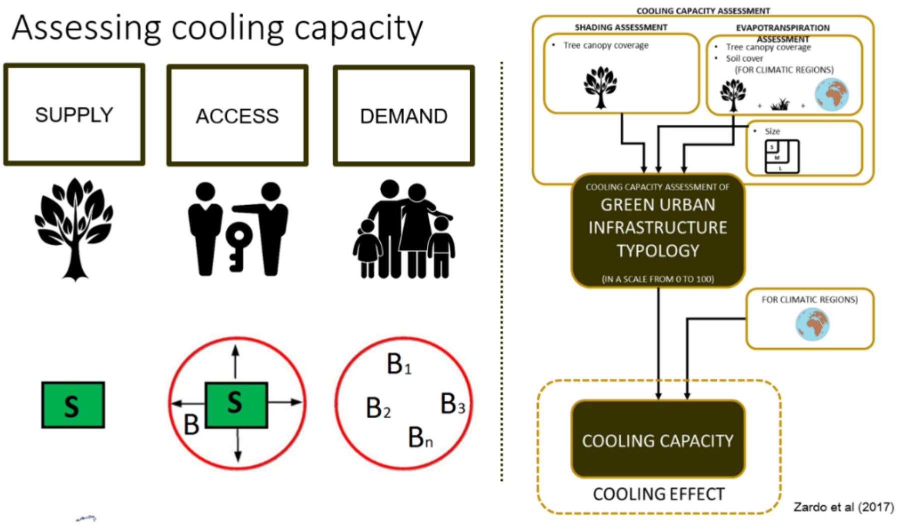


Figure 2.7: Rationale and main steps of the method for mapping and assessing cooling capacity of green areas

Key points from the discussion

- It is important to consider that the performance of planning decisions depends on our ability to design new green spaces, which are different from other traditional typologies of infrastructure, and to manage the existing ones. Findings from research on urban ES can be used the change the way in which planning officers (and the public) see green areas;
- Green infrastructures should be considered as important component of the built environment. In this regard, budget limitation and resource constraints (after 2007), resulted in a change in the activities of the Trento city administration: "we changed the way we look at our activities because the challenges are changing";
- A key challenge is how to balance a research oriented with a planning oriented approach : e.g. how to move from the mapping results to the more operational administrative tools;
- In terms of data availability, data about green space quality (as opposed to quantity and distribution) seems to be mostly lacking. From a research perspective, it is still challenging to use data about quality

to fine-tune ES models. Sometimes, data in itself is not issue (already there, technology etc..) in many case they are not connected- to give them a meaning and use them in an operational setting;

- Ok to have good (biophysical) methods for ES mapping and assessment, but who has the vision of where you want to go. To this end, bottom-up initiatives based in neighbourhood communities (e.g. Riga) – citizen-science – can be a valid approach for defining visions. Similarly, social and health targets are a good starting point for defining "where we want to go";
- There are detailed economic studies on the preference of people (problem in upscaling and mapping) – missing link between the biophysical and economic approaches;
- The importance of a regular update of the baseline data to allow for monitoring ES provision and follow up the implementation of the plan. Moreover, census data doesn't capture the perception and actual use of the services (we know where people live but not where they spend their time);
- The benefits from regulating service are easier to communicate (this area is cooler) than those of cultural services that can be quite subjective.

Discussing "Dissemination & Communication, and Implementation" in the Trento case study

The breakout started with a presentation of an illustrative application of how the ES mapping and assessment results could be combined, considering different stakeholders perspectives, to answer to a specific question relating to the re-development of 13 brownfields in the city of Trento.

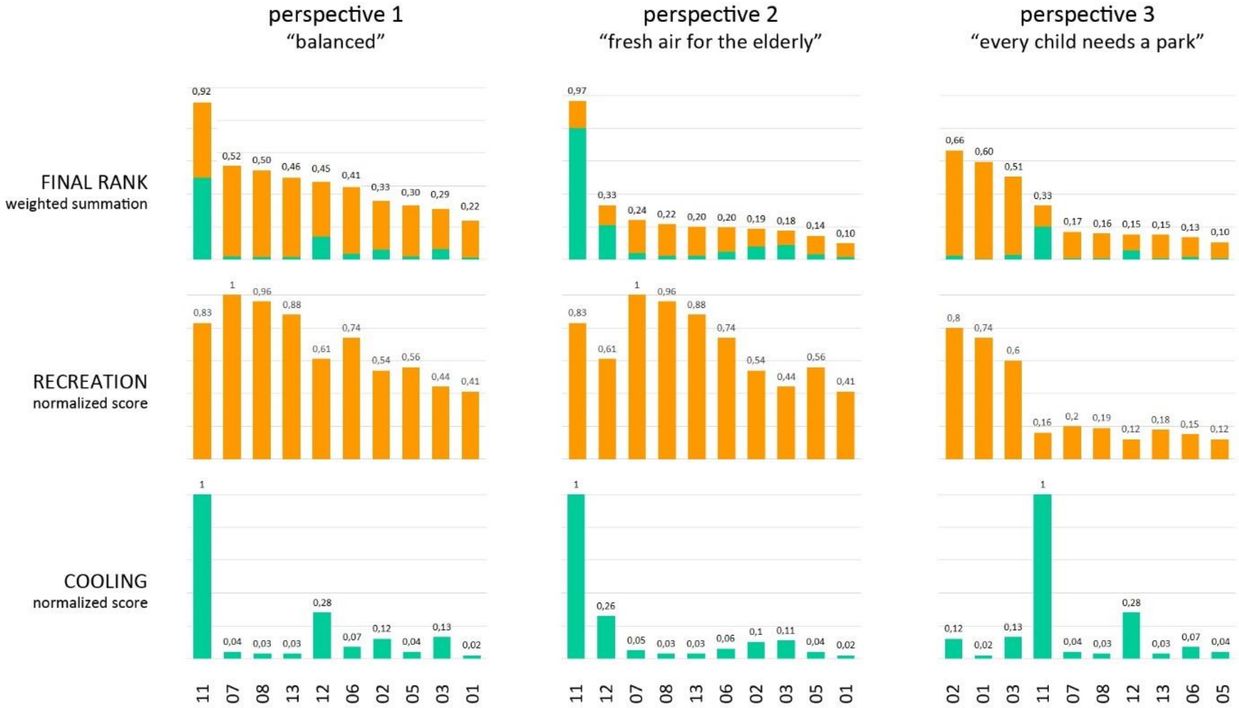


Figure 2.8: Multi-criteria assessment – multiple ranking (e.g. of scenarios to re-greening brownfields) as result of multiple perspectives.

Key points from the discussion

- Critical factor for the "implementability" of the results is the possibility to update the data used as input in the models (e.g., biophysical, economic, but also people preferences data) throughout the implementation of the plan.

- Outcomes of ES mapping and assessment models should become a standard for urban planning process, just as many other data set (e.g., hydrological risk) are commonly accepted as key reference documents during planning;

- The results of ES assessment should allow to compare (and choose from) different design solutions, related to the size/characteristics/location of green space, but also to the distribution of the key beneficiaries of green space.

Summary of the discussion points from the Trento case study

"Network creation and Involvement of stakeholders"

- Curiosity and interest by the city administration, but constant need to understand how to use outcome at a very small scale (frequent mismatch between typical modelling scale and planning needs. Testing of the outcome needed).
- Network creation: the stakeholders' survey about green space helped to establish a sort of new "working group" (within the administration).
- Creating a network helps to give "weight" and visibility to issues not associated to strong interest.
- The process is contributing to establish a "long-term relationship with science".
- But a gap still exists between our MAES indicators and policy questions.

Mapping & Assessment" in the case study

- Outputs are useful to change the way in which planning department looks at the urban space;
- Can contribute to enhance the ability to design new/better green spaces, not necessarily associated to a "demand" (demand can be created by the supply, e.g. of bike lanes in Trento).
- Data availability is not necessarily the central issue, rather data sharing/access by different departments/offices.
- In terms of data: information about green urban infrastructure quality is more critical than quantity.
- In terms of use of the results: often it is biased towards creating new green space, as opposed than better managing the existing one.

"Dissemination & Communication" and "Implementation"

- Key issue: linking people preferences with biophysical data (often the two are collected using different "reference systems").
- Regulating services might be easier to communicate than cultural services!
- For recreation services, biophysical info on green spaces is at least as important as info on how it is equipped, whether it is perceived as safe, etc...
- A general positive view on the possibility that data on ES become a standard baseline data to support planning processes.

2.2.2. Belgian case study: Mapping green infrastructures and their ES in Antwerp (Belgium)

Introducing the Antwerp case study

Antwerp is the second largest city in Belgium. It has 517 000 inhabitants and a surface of 204.5 km². The city is a mix of a highly urbanized central area, with a clear shortage of available green space, some larger important conservation areas at the borders of the city, and an industrial harbour area. The tidal river Scheldt and neighbouring wetlands are also important ecosystems. The city has the ambition to become greener. To his end, a masterplan on green and blue infrastructure was developed, focusing on five "park-regions". The master plan includes large-scale restoration projects and small-scale initiatives such as garden streets, green facades and urban farming. Beside this citywide strategic plan, nine local green plans at district level and one for the harbour area are currently under development or planned.

The MAES process started from a policy questions of the City of Antwerp: to **inform** about blue-green measures and (the effect on) environmental challenges; to **inspire** the design process; to **quantify** impact on a specific site; to **compare and combine** measures; to **stimulate** the dialogue between stakeholders; and finally to **integrate** blue-green infrastructure and challenges in the planning process. Mapping and assessing the impacts of green infrastructure will help to achieve this.

Thus, VITO together with the stakeholders within the city of Antwerp developed the ***Antwerp Greentool***, which contains different ES maps and integrated assessment tools (see https://groentool.antwerpen.be/). The tool calculates the impact of green-blue measures in a certain location based on pressure maps and impact effect of the green-blue measure. The first are created with process based models. The impact calculation is based on expert-based scoring tables. It also gives a lot of information about the ES that a specific type of green-blue measure delivers. The tool can be applied to benchmark sites owned by city authorities, support management plans and can be made mandatory for urban development plans to ensure that spatial planners take into account environmental challenges and liveability.

Discussing "Network creation & Involvement of stakeholders" in the Antwerp case study

How the stakeholders were involved?

The process of creating the Antwerp Greentool involved a large number of stakeholders within the City administration of Antwerp. At the start of the project a user requirement analysis was performed. This was done with a survey and several workshops with different administrations of the city of Antwerp (*what* *are their needs, how would they like to use the maps, tool, what type of data do they have, need…*). Based on the results of this step a functional design was developed: *how will the tool work?* These mock ups were again discussed with the end-users of the tool. Then the tool was built. It was an iterative prototyping process, meaning that the tool went through different feedback loops and adapted on the way. This process led to a slightly different tool than was imagined by the administration but one that is very useful. It answers the questions the city has.

Do you think the process also created a more permanent network?

"Sustainable city" is a more general theme through the city departments. But there is not always a good link, communication between departments. Because of the process of building the Greentool the relations strengthen. It is now much easier to contact each other with questions than it was before. The conclusion was that the research question is best linked to a policy question from the start and to involve stakeholders in the whole process. It was maybe even better to involve the different city administrations earlier: also involving them when writing the tender.

The discussion about the involvement of the end-users was followed by a request for ideas on how to involve also citizens in the use of the tool or data improvement of the tool. Many examples were given such as Growapp.

Discussing the "Mapping & Assessment" in the Antwerp case studies

The discussion started with the supporting expert's presentation on a method of spatial analysis to identify urban green and grey infrastructure types. This was followed by an introduction to the different steps of the Antwerp Greentool and the methodology behind it. An expert-based scoring table is applied to map the impact of measures (tier 1). This is combined with outcomes from process-based models for assessing pressures (tier 3 for noise, urban heat island effect, air quality, risk for pluvial flooding; tier 1 for recreation) to identify interesting locations for green infrastructure (see Figure *2.9*).

Impact calculation:

*impact_measures = pressure * (impact_score measure – impact_score existing situation)*

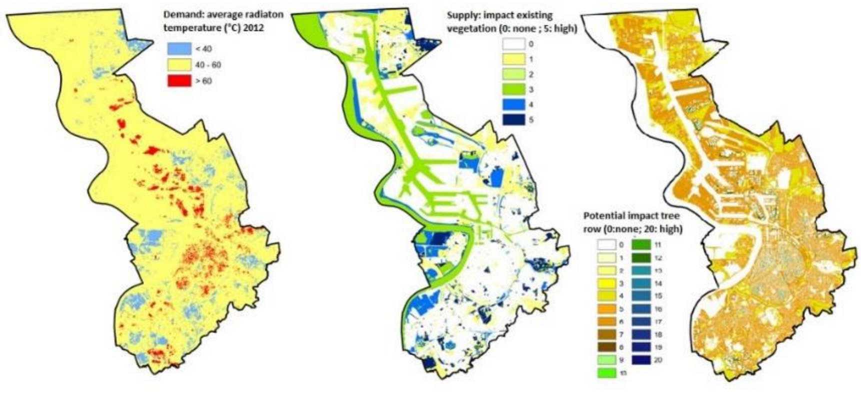


Figure 2.9: ES maps for heat stress in Antwerp. Supply from existing vegetation and water is scored from none (0) to maximal (5). Based on a heat map of the city and population densities the demand is mapped leading to zones with varying degrees of impact vegetation. Taking into account the current supply and demand, the potential for green measures is calculated, and scored from no potential (0) to maximal potential (20).

Key points for discussion

- Identification of the green measures
  - Maps are 1 dimensional. What about e.g. green on facades of buildings?
  - Scale-issues: which scale is refined enough?
  - Information of private gardens is often missing in data layers although very important for biodiversity and ecosystem services in cities.
- Issues concerning indicators and pressure maps
  - Often indicators are chosen based on expert knowledge and available data.
  - Missing topics?
- Issues concerning impact
  - Census data don't capture the perception and actual use of the services (e.g. we know where people live but not where they spend their time);
  - Spatial extent of the impact: is this important?
  - We now used impact scores per measure: but how to combine measures. Impact is not necessary 1+1=2. Could be less, could be more.
  - Not only the quantity of the green but also the quality and species: Is it important? How do you include this in the models?

Discussing "Dissemination & Communication, and Implementation" in the Antwerp case study

Though it was not how the tool was anticipated, the city of Antwerp is pleased with the end result. The tool has been presented in several occasions including: (a) Planning project greening public space "Groenplaats"; (b) C-creation of climate robust neighborhood Sint-Andries; (c) Identifying public buildings for greening based on impact these measures have; and (d) Permit for parking on front garden.

Figure 2.10. An example of how the impact scores for several pressures can be compared against the present situation or against different measures.

Summary of the discussion points from the Antwerp case study

"Network creation and Involvement of stakeholders"

- Stakeholder involvement in this iterative prototyping process was well performed.
- Involvement of citizens with the tool is unclear but citizen science experiments could be very useful to gather missing information + quality check on the used maps.
- Network creation: Process made the network of the different city departments stronger. It made the communication easier. Get down some barriers to contact each other.
- ESMERALDA Online tool: stakeholder would not use the tool as you have to go through too much literature BUT of interest for the researchers answering the policy questions. It would be interesting that you could also do a search on policy questions

Mapping & Assessment" in the case study

- No one best method: depends strongly on the policy question how detailed, which layers to use…
- Based on the questions we had, it was clear that other researchers struggle with similar issues in mapping ecosystem services and especially mapping green. Some interesting suggestions were done on refining the green types and chosen indicators.
- Include more water related measures to make the tool even more relevant for climate change adaptation.

"Dissemination & Communication" and "Implementation"

- Communication
    - Need of 'champions' (persons with influence within administration, neighbourhood..) to push/pull to get action (=use the tool)
    - Co-creation is important although it takes a lot of time and effort.
    - Choose the message depending on the stakeholder's issues; reasons why they should invest in green
    - Engagement of children within the research (serious gaming) => education of the parents

- Implementation
    - The tool was used for several projects in Antwerp.

2.3. ESMERALDA methods finalization

2.3.1. Update on ESMERALDA status and progress

As the first session of WS 7, it served to update the participants about the development of the project; in particular, the case study stakeholders were introduced to the ESMERALDA general approach. The project coordinator, provided and overview of the ESMERALDA state and progress to the WS 7 participants, which consisted of representatives from 25 EU Member States plus Switzerland (33 out of 38 ESMERALDA Consortium partners – See Milestone Report 28) and stakeholders from the case studies of Trento and Antwerp. An outline the objectives and targets of the project alongside of the individual project phases was provided (see Figure *2.11*).

1st phase: Identification of relevant **stakeholders** and stocktaking, collecting and linking **existing approaches** for ES mapping and assessment, creating links to existing **related projects** and **databases**;

2nd phase: Development of the **multi-tiered ES mapping and assessment methodology**;

3rd phase: **Testing** the developed methodology in representative thematic and biome-oriented **Workshops** and **Case studies** across EU member states;

4th phase: Feedbacks from ESMERALDA stakeholders and other relevant user groups, **methodology improvement**;

5th phase: Producing **tailored and flexible solutions** for ES mapping and assessment for policy and decision making;

6th phase: Safeguarding the **implementation** of project results in the context of the BD Strategy and Horizon 2020, including strategies for long-term implementation beyond ESMERALDA

Figure 2.11: Overview ESMERALDA working phases (ESMERALDA DoA, 2017)

The overall target of the ESMERALDA project is the development of a flexible methodology for ES mapping and assessment, through a stepwise approach. During WS 7, the development of the "Final Guidance Documentation" (based on various ESMERALDA Deliverables, and the "ESMERALDA Online Tool") was at the core of three sessions. Among others, finding appropriate, and catchy names for these ESMERALDA products was acknowledged as a key task. Furthermore, an overview of the status of individual work packages was provided, to outline achieved results and highlight remaining tasks. It was recalled that, the next steps in the ESMERALDA project include further method testing in case studies, writing Deliverable reports, writing scientific articles (e.g. for Special Issue in One Ecosystem), working on the "Online tool", networking, developing the "Final Guidance Documentation' for MAES in EU member states, developing long term strategies for the ESMERALDA products, and finalising periodic reporting II 2018.

Three key upcoming events are:

- ESMERALDA Workshop VIII in Eger (Hungary) 19-22 March 2018 - Testing the final methods for application by business and citizens.
- ESMERALDA Project Conference and Final Project Meeting in Brussels (Belgium) 12-13 June 2018.
- ESP Europe Conference in San Sebastian (Spain) 15-19 October 2018 - Session on MAES/ESMERALDA.

2.3.2. Implementation of the ESMERALDA Final Guidance Documentation

Discussing the general structure of the Final Guidance Documentation

The intended structure of the ESMERALDA "Final Guidance Documentation" was presented, highlighting its conceptual foundation and potential technical implementation issues. This served to discuss contents and implementation of the Final Guidance Documentation: e.g. future of the tool, finding an appropriate, 'catchy' name. The session contributed to building a shared understanding of what the Final Guidance Documentation could be, and to paving the way for deeper discussions in the breakout sessions.

	INTRODUCTION CHAPTER A figure and texts showing the whole MAES process (e.g. 2 pages), D1.4 ESMERALDA Glossary	
	QUESTION / THEME (Why do we do this)	- BD strategy – Target 2 · Policy questions, ·Business questions, - Society questions
D2.1	**IDENTIFICATION OF RELEVANT STAKEHOLDERS**	· Scientists, policy makers, business people · Stakeholders
D1.7 D2.2, D2.3, D2.5	**NETWORK CREATION / INVOLVEMENT OF STAKEHOLDERS**	· Stakeholder support groups - Links to country fact sheets on BISE · Provide reference to the material on how to create a network
D1.4 D2.4 D3.1, D3.2, D3.3, D3.4 D4.1, D4.4 D5.4	**MAPPING & ASSESSMENT PROCESS** (scientific process: quantify/map) *- Main block of the guidance -*	Methods → link to online TOOL ESMERALDA case studies for testing and integration (best practice), method cards, case study fact sheets · Data needs, data processing etc. · Data/methods uncertainties / reliability · Link to ESMERALDA Glossary
D5.1,D5.2	**MAPPING & ASSESSMENT CASE STUDY APPLICATIONS**	- ESMERALDA case studies for testing and integration - Link to case studies in online TOOL
D2.1, D2.2 D2.4, D2.5 D6.2, D6.3,D6.4	**DISSEMINATION & COMMUNICATION**	· Science-policy-interface · Policy, business, society questions · Interoperability (BISE, ESP, OPPLA; ...)
D1.7 D5.3, D5.4 D6.2	**IMPLEMENTATION** Recommendations on how to implement MAES in EU member states	To be done basically outside ESMERALDA · Case studies with implementation examples · Gaps and recommendations identified in Riga

Figure 2.12: Intended structure of the ESMERALDA Final Guidance Documentation and potential links to ESMERALDA Deliverables and other products.

In particular, Figure *2.12* presents the intended structure of the ESMERALDA Final Guidance Documentation and potential links to ESMERALDA Deliverables and products and further suggestions for contents. This Final Guidance Documentation will be made available online and open access. The ambition is to provide an easy-to-access online interface with links to all relevant ESMERALDA products (such as reports, country and case study fact sheets, Methods Application Cards etc.) which will support the users with regard to the MAES implementation in their country or region. The Final Guidance Documentation will include detailed descriptions of MAES implementation, related methods and their application as well as further background information for MAES. In the future, this online interface can be integrated in a concise report (pdf with hyperlinks to ESMERALDA products; perhaps also as MAES report). Finding an appropriate, and catchy name remains an open challenge.

Concerning the technical implementation of the Final Guidance Documentation, a prototype design in the form of a website was presented. In principle, all users will get the chance to enter the "content material" from seven different entry points, corresponding to the main blocks in Figure *2.12*. Thus, all available information and material will be organized thematically. Each block can have up to three different hierarchal levels (see Figure *2.13* for an example). Operationally, for each of the main 'blocks' sub-webpages will be developed, and will contain further information on the block and will include links to associated material (e.g. ESMERALDA Deliverables and products).

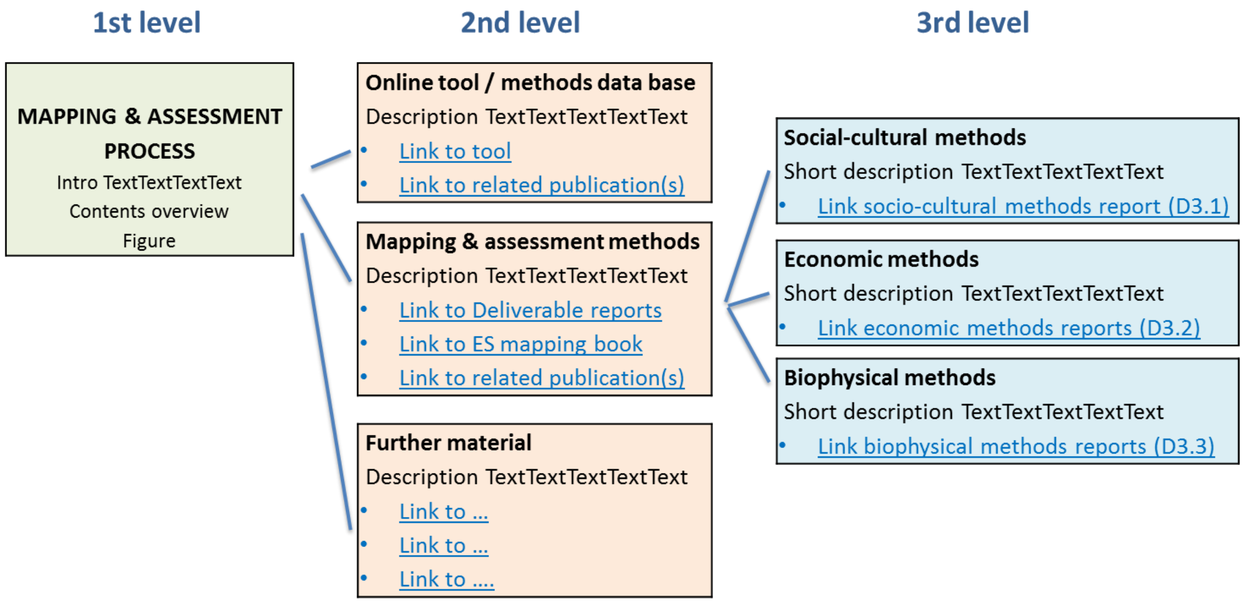


Figure 2.13: Example structure of the block "Mapping & Assessment Process" with 3 hierarchical web-page levels.

Two key aspects to bear in mind are related to copyright and size of included data and material. It is essential that all visuals and images in the report are copyright-free or have the licence for publishing. Users should avoid storing large databases or the like on the website, as server capacities are limited. Given there are already several platforms with similar thematic background, the aim is to rather integrate the ESMERALDA products (e.g. ESMERALDA database and Final Guidance Documentation) in one 'place', and to provide links to the existing platforms (e.g. ESP; BISE; OPPLA).

Discussing the main "blocks" of the Final Guidance Documentation

The main "blocks" of the Final Guidance Documentation were discussed in six breakout groups, exploring the links with relevant Deliverables. After extensive discussions, each group elaborated the structure and content of the 'block' (each corresponding to a webpage) of the Final Guidance Documentation. An overview of the structure of the 'block' (including relevant ESMERALDA Deliverables and products and corresponding allocation of tasks). Most of all, during the session and afterwards, it was possible to assign tasks and timelines to partners for providing their contributions. (For more details on the discussion points and decision refer to the Milestone Report 28).

In general, it was agreed that the general outline of the webpages should be send to Pensoft so they can prepare corresponding templates. A prototype will be created and presented at the next ESMERALDA Workshop in Eger in March 2018.

2.3.3. Discussing the ESMERALDA online Tool

This breakout discussion started with a demonstration of the “ESMERALDA Online Tool” to identify appropriate methods for the two selected ES in each case study (see Table 1.2). As not all participants had seen the online tool the session started with a quick overview of the tool and a description of what data was gathered in the runtime of the project and how it is made accessible so far (see *Figure 2.14* for an example). For the demonstration the case study parameters from the booklet (e.g. scale of assessment, ecosystem services assessed) where selected to show that the literature and appropriate methods show up. Hence, it was shown how the search can be modified to either broaden or narrow the results. http://database.esmeralda-project.eu/#/home

Figure 2.14: Examples of Screenshots of the ESMERALDA Online Tool

The following discussion with the participants of the session was to determine how to make the tool more accessible to end users and how to integrate it with other ESMERALDA products, as at that time it offers access to the literature / methods database on an advanced level. Both the breakouts involving the Trento and Antwerp case studies had similar results and stakeholders in both sessions had similar requests, comments and remarks. The conclusion of both sessions was, that the tool is at this time of limited use for stakeholders / decision makers as the search results is scientific literature and they’d have to go through it, but more of interest for researchers that are looking into finding applications of methods. To get a better entry point to the data it would be interesting to categorize and link the data to policy questions and make them accessible via a short question / answer path. A similar wish was made in linking the methods to tiers. That would open another entry point that is more focused on finding applicable methods for resources available to the user.

2.3.4. Discussing the final ESMERALDA Deliverables

The main outcome here was the engagement people with specific tasks to finalize Deliverables, ensuring coherence between Deliverables. Integration of all ESMERALDA Deliverables within the Final Guidance Documentation was also a topic. Thus, this session served to give an update on the progress of the specific

Deliverables, together with possible publications. Following is the list of the Deliverables that were actually discussed. (For a more detailed report of the discussion refer to the Milestone Report 28).

- **Deliverable 2.4**: Establishment of an operational on-line database and support mechanisms for EU Member States authorities
- **Deliverable 2.5**: Business plan to sustain network beyond ESMERALDA
- **Deliverable 3.1 (and 4.3)**: Social mapping and assessment methods (M36)
- **Deliverable 3.2 (and 4.2):** Economic mapping and assessment methods (M36)
- **Deliverable 3.3:** Biophysical mapping methods (M39)
- **Deliverable 3.4**: Flexible methodology – guidance on linking between biophysical, social and economic methods (M42).
- **Deliverable 4.1**: Report on the use of CICES to identify and characterize the biophysical, social and monetary dimensions of ES assessments. (M42)
- **Milestone 22 represented major part of Deliverable 4.7**: Integrated Ecosystem Assessment
- **Deliverable 5.3**: Report illustrating the application of the final methods in policy and decision-making. (M39).
- **Deliverable 5.4**: Guidelines & recommendations to support the application of the final methods by policy and decision makers and business and public sectors. (M42).

2.4. Stakeholder involvement and training

2.4.1. Science communication event and field excursion

As part of the stakeholders' involvement, a science-communication event was organized, involving the several key stakeholders from the City of Trento together with WS 7 participants. This unique artistic event within the ESMERALDA project was entitled "**W O R T H W H A T? When do values enter the liminal space between what is measurable and what not?**" Designed by the young artists Nadja Grasselli and Federico Robol, it consisted of a scenic reading followed by a discussion about how to construct a dramaturgy and how this can help disseminate their message to reach wider sections of the population.

Finally, to experience the local ES first hand, the WS 7 participants went of a filed excursion to the *Arte Sella: the contemporary mountain.* This is a is a unique creative process, which in a journey of thirty years has seen various meetings of an artistic nature, different inspirations and sensitivities accumulated from a desire to continue a dialogue between nature and the natural world (Link).

2.5. Overview of the method testing and finalization process in WS 7

Overall, WS 7 was well-perceived by the participants given that substantial progress was made with respect to the three board objectives related to: (i) the case study testing of the final methods, (ii) the finalization of the methods, and (iii) the involvement and training of stakeholders.

Testing of the final methods was carried out by illustrating how ES mapping and assessment can support different phases of urban planning - as an illustrative and relevant decision-making process – through two cases studies from Italy (Trento) and Belgium (Antwerp). The discussions focused on the components of the MAES process dealing with “Identification of relevant stakeholders” and “Network creation/Involvement of stakeholders”, “Mapping and assessment”, and “Dissemination & Communication”, and “Implementation”.

Methods finalization was achieved by coordinating the activities of the Consortium Partner towards achieving the final ESMERALDA Deliverables. Both plenary discussion and breakout discussions served define the structure of content of different ESMERALDA products, including the “Final Guidance Documentation” and the numerous final project Deliverables.

Stakeholder involvement and training-related activities were included throughout the entire workshop, including the science-communication event and the field excursion. Among others, the stakeholders were exposed to the ESMERALDA approach, had the chance to receive further clarifications while actively participating in the discussions. , and took part in.

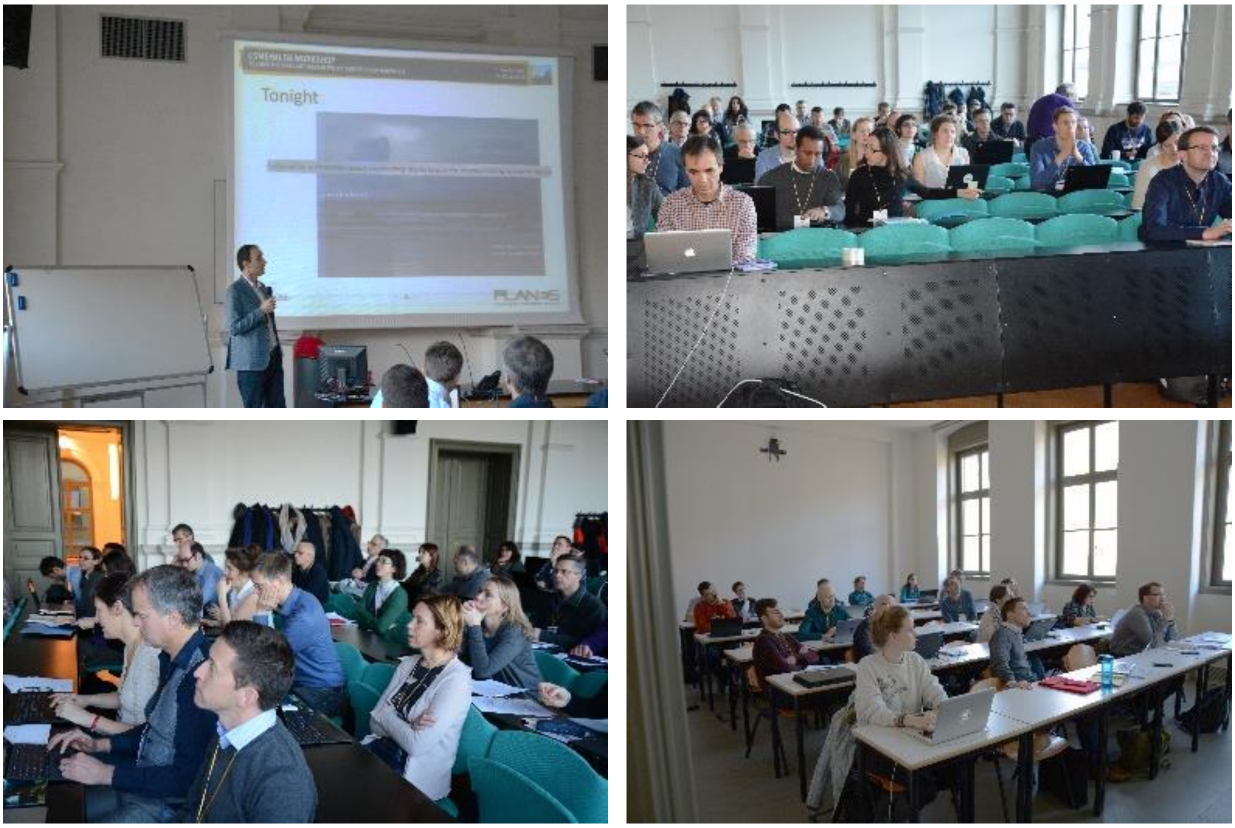


Figure 2.15: Workshop VII in Trento, Italy – Picture from sessions (By Pensoft)

3. WS 8 "Testing the final methods in policy and decision-making (II)" (MS 29)

3.1. Aim and structure of WS 8

Held in Eger (Hungary), in March 2018, this Workshop is a further testing of the final version of the ESMERALDA flexible methodology in policy- and decision-making in real-world case studies. With similar content as WS 7, to ensure a larger variety of policy- and decision-making processes, WS 8 focused mainly of applications by businesses and citizens. It continued the work of testing the first version of the flexible methodology conducted during the Workshops held in Prague (WS3, September 2016), WS4 Amsterdam (WS4, January 2017), and Madrid (WS5, May 2017), building also on the revisions and feedback from stakeholders collected at the Plovdiv Workshop (WS6, October 2017). Again, the WS 8 participants included ESMERALDA project partners and stakeholders directly involved in the case studies (Figure 3.1). The former were actively involved in coordinating the activity towards achieving the final ESMERALDA Deliverables. The latter shared their experience with the case study, and provided feedback on the different ESMERALDA products. To this end, in WS 8, a stakeholders' panel discussion was held aiming at exploring how to move from current practices to novel and more effective approaches in engaging citizens and business as well as communicating and implementing ES mapping and assessment results.

Figure 3.1. ESMERALDA Workshop 8 in Eger, Hungary, Participants Group Picture (By Pensoft)

Content wise, again WS 8 included three types of sessions: (i) Case studies-related, (ii) Methods finalization-related, and (iii) Stakeholder involvement and training-related session.

Case study-related sessions: WS 8 focused on the application of the methods for ES mapping and assessment by business and citizens, considering case studies from Hungary, Finland, and Sweden. Particularly, the case study from Hungary was about local developing pro-biodiversity businesses, also involving several other sectors, through the socio-economic evaluation of ES and development of action plans. The case study from Finland had a strong citizen participation component and links with the business sector. Finally, the one from Sweden involved reindeer husbandry planning aiming to integrate natural and cultural values in territorial planning.

Similar to what was done in WS 7, the case studies were analysed according to the main components of the MAES process already discussed in the previous section (see Figure 2.2). For each case study, the breakout discussions addressed the components of the MAES process related to: (1) “Identification of relevant stakeholders” and “Network creation/Involvement of stakeholders” and (2) “Dissemination & Communication”, and “Implementation”. These were considered to be the two most relevant components of the MAES process to analyse, also given the focus of WS 8 on the application of the final methods by businesses and citizens. The discussions served to identify the main challenges and respective solutions that emerged during the case study applications, also based on input from the stakeholders. Ultimately, the case study-based discussions provided useful insights about the needs and requirements arising from the application of MAES to support decisions by businesses and citizens and about their implications for the ESMERALDA flexible methodology (e.g. structure of the Final Guidance Documentation, Integrated Ecosystem Assessment framework, and Online Tool).

Methods finalization-related sessions: again these sessions served to coordinating the activities of the Consortium Partner towards achieving the final ESMERALDA Deliverables and other additional products like the “Final Guidance Documentation”. Operationally, this was achieved through a plenary discussion on the structure and template of the Final Guidance Documentation, followed by updates and discussion on the ESMERALDA “Online tool” and Glossary. Finally, two breakout discussions addressed the preparation of the final ESMERALDA project Deliverables.

Stakeholder involvement and training-related sessions: as in all the ESMERALDA Workshops, the activities aiming to contribute to building stakeholders' capacity in understanding the variety of existing methods for ES mapping and assessment, and the results that can be expected from their application were included throughout the entire Workshop. To this end, the stakeholders were first exposed to the ESMERALDA approach; hence, during the breakout discussions they had an opportunity receive further clarifications and to provide their feedback. In addition, in WS 8, one of the sessions was entirely dedicated to a stakeholders’ panel discussion with the objective of exploring how to move from current practices to novel and more effective approaches in engaging citizens and business as well as communicating and implementing ES mapping and assessment results. Further activities included a keynote speech focusing on the experience of the Land Degradation Neutrality Fund, launched by the UNCCD in September 2017 together with several partners from the public and private sector. Finally, a field excursion to *Bükk National Park* allowed the stakeholders and project partners to experience first-hand the ES form the Hungarian case study area.

In the remainder of this section, we report the main results of the three types of sessions.

3.2. ESMERALDA case studies related results

3.2.1. Hungarian case study: Fostering pro-biodiversity business in the Bükk National Park (Hungary)

Introducing the Hungarian case study

The Bükk National Park - a part of the Northern Mountain Range of Hungary – was established in 1977 and covers 43 thousand ha. It is mainly managed and utilized as forest (94%) and to a smaller extent, grassland, meadow and pasture (3.4%). Almost 98% of the national park is state owned, with two forestry companies as managing organizations, and the remaining area is managed by the Bükk National Park Directorate. The subject of the case study, however, is the wider local socio-ecological system containing low-intensity areas of settlements, arable lands, grasslands, vineyards and orchards adjacent to the National Park territory, reflecting the significance of these land uses and the opportunities they offered to involve business and citizens.

The case study is part of the project 'Ecosystem services of karst protected areas – driving force of local sustainable development (Eco Karst), funded by the EU Territorial Cooperation Programme to promote the opportunity to use the natural heritage of protected areas as an economic development factor. The project aims to support local development based on the raised awareness and sustainable management of karst ecosystems across the Danube region, including the Bükk National Park in Hungary. Accordingly, ecosystem types are mapped, ES identified, assessed and, where applicable, economically valued and spatially visualized. The results of ES assessment will be a basic resource for the discussion on increasing pro-biodiversity business opportunities.

Discussing "Network creation & Involvement of stakeholders" in the Trento case study

The discussion started with a presentation of the *stakeholder network analysis in the Bükk case study.* Within the project 'Eco Karst', assessment of ES, development of local action plans and the facilitation of pro-biodiversity businesses are directly related to stakeholder involvement. To involve a big enough group of local people with diverse backgrounds, economic status, expertise and experience, an initial systematic network analysis was carried out. Method of the analysis and interpretation of the resulting network included the following steps: (i) create preliminary stakeholder list based on existing database; (ii) identify the 6 most relevant groups of stakeholders based on two dimensions of their relation to ES (dependence and influence); (iii) Carry out online and personal survey of local stakeholders asking: "*Who do you talk to regularly about issues related to Bükk NP from the XY sector? Please list up to 5 names or organizations*."; (iv) apply the graphic network-layout designer software Gephi on the survey answers; and (v) Analyse the results and interpret patterns, e.g. Bridge people (betweenness centrality), Authorities / Trusted people (in-degree), Hubs (out-degree), as shown in Figure 3.2.

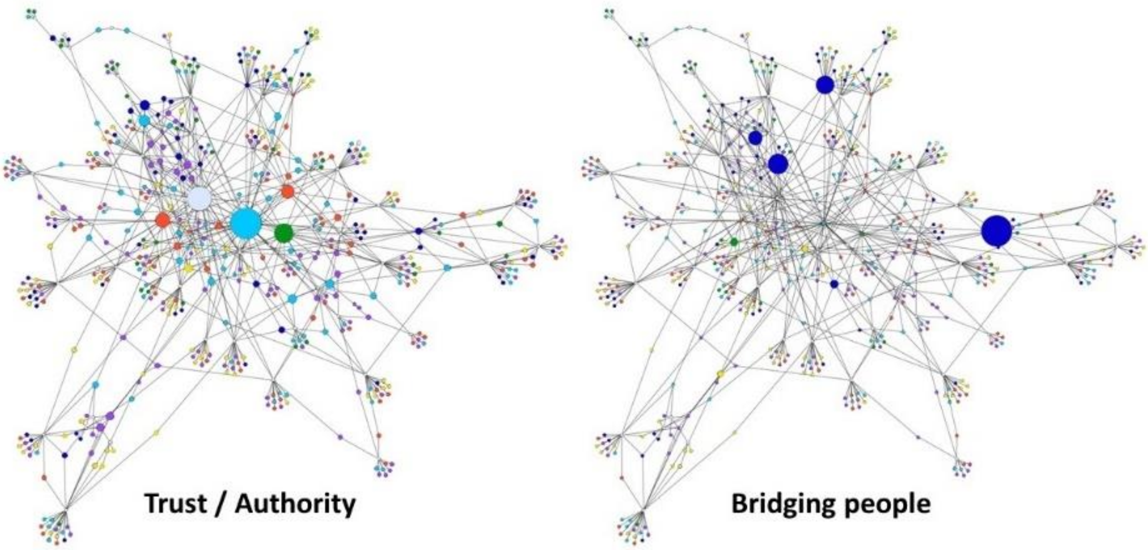


Figure 3.2. Graphic layout of the social network in Bükk based on online survey of stakeholders. Nodes represent people or organizations, edges represent communication.

Main points of discussion

Some practical ideas for social network analysis are:

- You can mix people with institutions both in survey and analysis.
- In the graphic network it is advisable to use specific colour nodes to show activity-groups.
- When processing data, it is suggested to filter results to see group-relations or highlight the more influential people.

Potential pitfalls mentioned during the discussion:

- Willingness (trust) to respond may be low, but it can be overcome with communication and personal trust – in such case personal recording (e.g. by rangers) is more efficient.
- This method does not tolerate typos, spell checking is necessary before data processing.
- People representing institutions are often restricted in what they can answer.
- It is hard to estimate the right sample size. Some expertise is needed for the network analysis (but other social science methods such as focus groups also need experience).

Some conclusions:

- Social network analysis might add significant new knowledge to the current group of people usually contacted by the nature conservation authority of a protected area. Therefore such analysis is a preliminary task before the real involvement of stakeholders.
- There might be mismatch between the most dominant land use in terms of area and the most significant stakeholder groups in terms of social network: in Bükk, forests have the biggest area coverage with no settlements and only two big companies in charge, while grassland are relatively small in area, however due to their complex land management and marketing activities animal keepers turned out to be the bridging people between sectors.
- Results of social network analysis can already indicate further opportunities targeted by the project, e.g. in the Bükk case animal keepers are likely interested in pro-biodiversity business opportunities and national park products certification.
- During the survey it is advisable to ask whether the respondent is willing to participate in later phases of the project, e.g. in workshops.
- Personal data needs to be protected, names never shown in public presentations.
- There are sometimes similar project activities in the same area, which do not cooperate or use the results of each other: e.g. recently there had been a similar social network analysis carried out by Bucharest University colleagues in another Eco Karst pilot area in Romania (Apuseni NP). Better synergy between projects could bring more efficient results.

Discussing "Dissemination & Communication, and Implementation" in the Trento case study

The Eco Karst project specifically builds on the opportunity to use the natural heritage of protected areas as an economic development factor. Thus, ecosystem types are mapped, ES identified, assessed and, where applicable, economically valuated and spatially visualized. The results of ES assessment will then be a basic resource for the discussion on increasing pro-biodiversity business (PBB) opportunities within local small and medium-size entrepreneurs. Involving various public and private actors into capacity building, networking and know-how transfer, local PBB action plan will be developed by participatory approach. Thus, the project aims to contribute to a better balance between nature conservation and local entrepreneurship.

For the discussion, the following two specific policy questions (selected from the list of ESMERALDA policy questions) were raised in the case study:

(i) How can the data & knowledge gained through MAES be used by local planners (…)?

(ii) (…) Are there measures planned to overcome the potential bias of ESs perceived as another business opportunity to "Harvest from nature" without sustainable management?

To be able to map ES capacities and use the results for stakeholder communication, there is a need to better define the concept of sustainable ES capacity. In our understanding, sustainable ES capacity means on one hand, the highest yield or use level that does not negatively affect the future supply of the ES (Hein et al. 2016[2]), on the other, a yield or management that does not negatively affect the ecosystem condition underlying the service supply. To ensure that, ecosystem condition (in most cases, biodiversity) indicators are applied and potential trade-off between provisioning ES and biodiversity are analyzed. For the same considerations, in protected areas use of certain ES is often restricted with legal or institutional tools. When mapping ES capacity, such restrictions were applied as an additional spatial layer on the biophysical capacity map, the logic of that is shown in Figure 3.3. This, in addition to considering trade-offs, helps avoid misinterpretation of ES capacities as potential exploitation of marketable goods on protected areas.

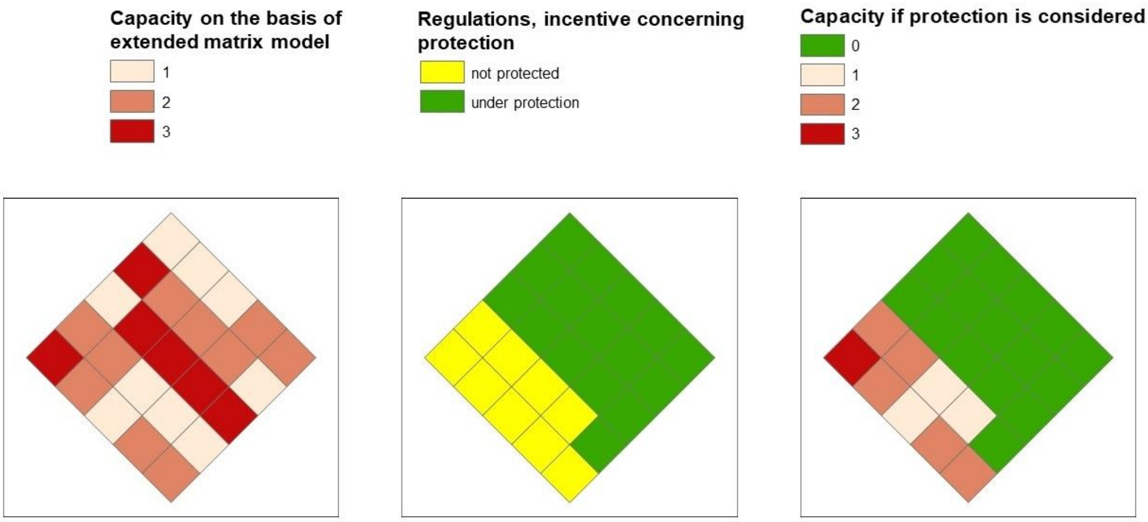


Figure 3.3. Incorporation of regulative restrictions of ES use into ES capacity maps in the Eco Karst project.

Main points of discussion and conclusion

How to implement the results to address question related to businesses and citizens.

Communication to stakeholders is a process of social learning: the aim is to help people with contrasting interest have better understanding of multiple aspects in the end.

- Such processes often offer opportunity to raise awareness of the real value of nature and to resolve existing conflicts between sectors.
- It is key to understand that local people are extremely important to protect local natural capital, e.g. in the Bükk case, protection of karstic water depends on the locals, while it is used by 1 million people in a much wider area.
- Time scale matters: focus should be shifted from short to long term interests.
- Spatial scale also matters: according to the experiences of several projects carried out by the Bucharest University, provisioning and cultural services were more valued at local level while regulating were more valued at higher levels (regional, national).
- When planning business opportunities, legal constraints have to be considered: land ownership and land management regulations often create restrictions for potential new businesses.

[2] Hein L, Bagstad K, Edens B, Obst C, de Jong R, Lesschen JP (2016) Defining Ecosystem Assets for Natural Capital Accounting. PLoS ONE 11(11): e0164460. https://doi.org/10.1371/journal.pone.0164460

"Dos and Don'ts" on how to communicate and disseminate the results:

- Most important message for stakeholders is not the details of models and maps but the actual exercise of thinking together and aiming for a common understanding of the value of ecosystem services and sustainability.
- To help systemic understanding, create some sort of aggregated ES map.
- Focus on trade-offs and show the interlinkages between ecosystem conditions, ES, nature conservation and different human activities and policies affecting them. If possible, analyse ES trade-offs and synergies in a structured way, e.g. use a matrix with all ES against all ES.
- Aim at ES optimization.
- Use simple language: they will not understand technical terms.
- Find the bridge people to multiply the effect of your message and reach other sectors too.
- Fine tune your approach and method in each particular situation to get better understood.
- Don't go with your ready solution to the stakeholders but listen to them and make them think – then translate and interpret their ideas. This will help to create sense of ownership and local support.
- Help stakeholders interpret the maps, let them understand the interlinkages. On the other hand, don't overestimate the message of the map – it's visualization of a lot of assumptions.
- If legal regulations are incorporated in the maps, communicate that clearly.
- Not just the good examples worth sharing but the obstacles too!

Summary of the discussion points from the Hungarian case study

- Network analysis of people and institution is a crucial step to identify key stakeholders, and only then can the real involvement start. This is useful to uncover additional key actors and reach a much larger group. Actually, the results could be a surprise: the key actors are not necessarily those form the institutions that are thought to be most influential sector (e.g. animal keepers and not foresters).
- Importance of building trust also by addressing key stakeholders that act as 'Bridge People' to reach larger group of people. Creating ownership is crucial; before asking you should take care of the persons to explain the scope of the project. From the early stages, try to find the issue that will make them want to cooperate.
- In terms of, communication and implementation, having identified the stakeholders and produced the relevant ES maps, how to communicate the results is essential. To motivate stakeholders' involvement it's important to understand their needs: e.g. identified a couple of challenges, ownership issues are a key barrier to implementation but could also create opportunities.
- More than the details of the maps, their communication was far more important. Thinking with the stakeholders, listening to them and not going with ready solutions but actually listening to them (in their language). Focus on the systemic thinking that the specific trade-offs.
- Given more case studies apply the same methods, perhaps in slightly differently, there is potential for learning from each other experience. Importance of sharing not only good example but also mistakes.

3.2.2. Finnish case study: Green infrastructure and urban planning in the City of Järvenpää (Finland)

Introducing the Finnish case study

The City of Järvenpää is a compact city with tight boundaries and population around 42,000 inhabitants that makes it fourth densely populated city in Finland. The city has an expected population growth of over 10 % by the year 2030, leading to an exceptionally strong need for infill development to provide housing for new inhabitants. The city's interest was to find the tools and criteria for valuing the sites excluded from construction (i.e. green infrastructure) so that future urban planning could compress up and intensify the urban structure without losing the most valuable features of the GI. The objective of this study was to evaluate the green infrastructure in the city by mapping and assessing the supply and demand of the most important ES and assess the connectivity on green infrastructure. In the case study, mapping and assessment was done in three phases concentrating to the questions of: 1) *how the provision of ES related benefits provided by the green infrastructure were distributed in the area*; 2) *how and where the citizens use these benefits* and; 3) *how the ecological processes providing these services were connected*. The citizen role was considered by arranging workshop, via online questionnaire and sending survey to schools and kindergartens to map their perceptions related to cultural ecosystem services.

Discussing "Network creation & Involvement of stakeholders" in the Finnish case study

The breakout started with a description of the case study, with focus on "Network creation and involvement of stakeholders and citizens". Specifically, the needs and requirements for ES mapping and assessment in the city were the topic of this session, with strong methodological focus on experiences and challenges related to the identification and involvement of relevant stakeholders during the process.

In the city of Jarvenpää, a population growth of up to 2,5% per year creates a strong need for housing development, growing upwards instead of extending outside (see Case Study Booklet). Hence, tools and criteria are needed for valuing ES in the city planning. The Järvenpää project aimed to map and assess supply of ES and the spatial distribution of ES demand. Moreover, a spatial MCDA was tested for engagement of practitioners to find the most potential infill development sites and enhance the integration of urban greenspaces and residential infill development. Thus, 12 ES have been assessed, with strong focus on cultural ES (5/12). First, green and blue infrastructure was spatially extracted using multiple GIS-data layers together with aerial images and knowledge of the local planners. The GreenFrame method was applied (semi quantitative, matrix based method) to map the potential provision of. At this stage, the stakeholders were the local planners. The co-operation between researchers and planners started at the very beginning of the process by identifying relevant ES to be mapped and reviewing and compiling the relevant background information and spatial data from the national and city archives.

Main points of discussion and conclusions

Stakeholder and citizen involvement required in planning.

According to the Finnish Land Use & Building Act urban planning must be prepared in interaction with such persons and bodies on whose circumstances or benefits the plan may have substantial impact. The authority preparing plans must publicize planning information so that those concerned are able to follow and influence the planning process (see: Finnish Land use and building act 132/1999, amendment 222/2003 included). This is rather a consolidated approach throughout the EU, although there are some variations. In Norway, for example, such a procedure mainly refers to buildings, but at city level such involvement is rare. Some processes might require consultation in case of technical and political disagreements, but nature of the process is different. Similarly, in Latvia, public hearings are compulsory, but mainly refer to the first draft, where stakeholder’s comments can be left in written form. Thereafter, public meetings are held, good practice means to allow for participation in early stages, including citizens and stakeholders, especially for big planning projects. Participation becomes most active phase in the final public hearing though.

Some of the clarification questions included:

(i) *How is substantial impact in the planning defined?* Means that it is included in all zoning/planning processes. In zoning especially it is required.

(ii) *What is the main reason for population growth in the city?* Are expectations of people who move outside of Helsinki, but commute, included? Traditionally there is lot of detached houses, but there is a change happening, building high up to meet the housing demand. This does not match all citizens’ ideas, as small scale used to be traditional.

(iii) *Who is a stakeholder?* Here, commuter’s opinions are limited; rather, citizens have been included as they experience the city differently. Virtual surveys have been included in the research too.

How has citizen participation been established in the planning process?

Several sources of input were gathered to establish citizen participation in the planning process. Especially, PGIS tools were used to evaluate spatial distribution of cultural ES via workshop, surveys and online questionnaires. PGIS helped to identify ES hotspots on a map. The **Workshop** consisted out of two sessions, held in congress hall. Open invitation advertised by city webpages, big marketing. Collecting all the data on perceptions and placing the values for the individual services. How important are the different areas? Where do citizens get the benefits, by pointing these out on a map? **Schools and kindergartens** received maps via mail to point out areas used for educational purposes, including a few questions. Goal was to differentiate between actual and desired use of city areas. **Online survey** was used to map cultural ES. Online mapping tool gave 377 responses e.g. on areas with high recreational values, beautiful scenery, green areas to be preserved. However, people find it difficult to draw polygon shape areas – here sometimes point size pins are easier.

In the citizen workshop the attendance rate was low – only 8 participants attended. Survey to schools and kindergartens had 36 % answer rate which is actually quite good. According to Survey Monkey statistics 20-30 % answer rate is generally quite good. Also Geographical coverage was good and survey was easy and quick to carry-out. Nowadays, electric tools such as mobile apps and online questionnaires are preferred and Järvenpää has good experiences related to these. After data collection, a hot spot maps of cultural ES was conducted by integrating all the PGIS results together.

Stakeholder involvement during the integration of the ES mapping and assessment results

Following, the spatial mapping & assessment (supply & demand) results were integrated applying a Spatial Multi-criteria Decision Analysis (SMCDA) to test the engagement of practitioners and to enhance the integration of urban greenspaces and residential infill development (see presentation & case Study Booklet). This was mostly scientific driven exercise. The practitioners saw the method & results as logical and a good representation of their city's values from the perspective of green infrastructure. The decision tree was seen useful tool to structure the factors having impact to the infill development. The practitioners saw much potential in the method to improve infill development planning. The resulting maps were considered to be a useful way to communicate with the decision-makers.

But how to minimize the risk of polarizing green and built up areas? Therefore, triangulation of methods (mapping the provision of ES, surveys, SMCDA) were conducted. Also, one of the project purpose was to make planning & decision-making transparent and understandable, by highlighting areas providing multiple ES and areas preferred by citizens and stakeholders.

This methods are transferrable to other cities. For example, Helsinki, as most big cities, requires information concerning land use in great detail, hence applying a similar SMCDA would be feasible. The University of Helsinki, for example, has carried out habitat research using Zonation, which provides added, detailed information of the biodiversity hot spots in the area. However, many of the high-level methods can be very time and resource-intensive that can be difficult to integrate to master planning schedule.

Discussing "Dissemination & Communication, and Implementation" in the Antwerp case study

In the case of the city of Järvenpää, results of the ES mapping and assessment were disseminated and communicated during various events linked to green infrastructure.

Main points of discussion and conclusion

- Easier to communicate to people that have experience with the concepts. Not many people are used to work with map based data and a strong focus on green.
- Limited evidence that Stakeholders from other city departments used the data and maps as factual information. Potential is high, but people are always busy, thus if it is not a simple readymade tool, people might not use it.
- Politicians (according to stakeholder present) know that there is such a study related to the master plan, much good information and ideas, hence it could be good that politicians access it, but need a clear summary, and maps with names, simplifying the information.

Examples in Communicating ES studies in other Member States:

- Finland: the concept of biodiversity seems a bit negatively connoted, thus people do not like to work with it. ES as such might be vague, but when it is properly explained, it is a suitable conceptual framework to explain the meaning of Ecosystem Services to the public. However, in communication, recreational and ecological values are framed as such.
- Belgium: the ES concept connects people from different disciplines, e.g. farmers and biologists, by finding shared values, and shared narratives. However, often without explicitly framing it as ecosystem services.
- Poland still faces challenges with planning as there are no master plans but rather regional plans on smaller scale. Hence, assessing ES becomes difficult as the holistic focus is not needed. Here, more input from government would be needed, as current efforts are restricted on research. Poland thus follows the international agreements to map and assess ES for biggest cities within 10 months.

Enhancing discussion/communication between researchers and city stakeholders:

Presence of researchers in meetings/workshops could be an asset: this is not happening often yet. At the moment, consultants take over most of spatial planning projects. Therefore, a format where consultants, researchers and spatial planning organization collaborate could enhance communication.

A comprehensive summary of results (not more than four pages) for policy makers and governmental actors is needed. This is something they may have time to read. For spatial planning in Järvenpää, communication went well during all stages, also the international attention that Järvenpää receives with this invitation to ESMERALDA shows that communication was successful.

Collaboration is crucial as joint methods are needed, where ES are selected together with stakeholders, not to forget any important ES. Here, researchers need to be involved in the process. However, sometimes, researchers tend to complicate things.

Don’t simplify the problem, but communicate it simply.

Summary of the discussion points from the Antwerp case study

- From the stakeholder point of view, their involvement should start at the very beginning (e.g. in the first stage, the stakeholders were the planner; so we started working with them from the beginning cooperating all the time).
- Regarding citizen involvement, different participation methods should be applied to reach different segments of the society, e.g. citizen workshop, online tool to gar, traditional survey for kindergartens and schools.
- It is difficult to involve people - only eight people out of 40.000 inhabitants - with online tool, much more people but you target only part of the population. We still need all kinds of approaches to involve different types of people who can provide different input. For example, in the case study it was found that ecological connectivity is more important for the citizens than for the city planners and sectoral departments.
- In terms of implementation, it is difficult to engage stakeholders when there is no actual decision-making going on. Even if there is interest in the outputs, there is not enough time to focus on them. Thus, the importance of having a summary of the research results: one map and a very short summary - clear message - not simple message but simple communication.
- A concrete suggestion is: Don't simplify the problem keep the problem as it is but try to communicate it simple.
- Finally, the case study was a collaborative process between researches and planners interacting regularly, which turned out to be very beneficial way of working for both sides.

3.2.3. Swedish case study: ES mapping & assessment in the Vindelälven-Juhtatdahka valley (Sweden)

Introducing the Swedish case study

The Vindelälven-Juhtatdahka river valley stretches about 450 km from the Scandinavian mountain range watershed divide to the Gulf of Bothnia marine coast. The river is the southernmost one out of four national rivers in Sweden. Before railways and roads were developed starting in the late 1800s, the river was the main historical southeast to northwest infrastructure for humans and as the natural ecological spread and migration route for species and habitat types. In particular, the annual migration of reindeers from the mountains to the coast and back – the backbone of the traditional Sami reindeer husbandry – marks the significant value of the river. The river valley includes territories used by seven Sami communities and is within the land of Sápmi, which encompasses indigenous peoples in northern Sweden, Norway, Finland and Northwest Russia. The area is rich in forest, minerals and other natural resources and rich in nature conservation values. Cultural influence dates 8,000 years back. The Vindelälven-Juhtatdahka river valley area is, formally, in the candidacy process for becoming a member reserve in the UNESCO Man and Biosphere Program. The mapping and assessment of ES has been put in the context of planning and implementing sustainable development across a large-scale biotic transition that display a magnitude of economic, ecological and socio-cultural gradients and that it representative for northern Sweden. Here, the foci are on ES associated with forest habitats, forest management and forests in a landscape context, and with the indigenous Sami culture reindeer husbandry.

A short clip from the film on reindeer breeding in Swedish Lapland is available on YouTube at the following link: https://youtu.be/1IYB3FD7eFM

Discussing "Network creation & Involvement of stakeholders" in the Swedish case study

This breakout started with an input presentation about the case study by Johan Svensson (SLU) and Ola Inghe (SEPA). The following paragraphs present summarises some key information discussed in the session, while detailed information can be found in the case study booklet.

One background of the case study is the application of the investigation area to the UNESCO MAB program. Accordingly, the mapping and assessment of ES took place in the context of planning and implementing sustainable development in the investigation area. In the case study, the focus was on reindeer husbandry in the Vindelälven-Juhtatdahka river valley, considering the Sami culture of reindeer husbandry, forest habitat, forest management and forest in a landscape context (see Case Study Booklet). Particularly, the reindeer was analysed in its different aspects: provisioning (e.g. meat, antlers, skin/fur, bones, and milk), regulating and maintenance (i.e. grazing, trampling, and bark scraping), cultural (i.e. physical intellectual, spiritual and symbolic interactions, and Sami cultural identity).

Basic information on the investigation area (Vindelälven-Juhtatdahka river valley)

The study area, which has an extension of 13.300 km², ranges from coastal boreal to high alpine. It includes the River *Vindelälven:* fourth National River, in Sweden, that is without hydropower plants. It is a forest dominated landscape of which 32% is also protected area (mainly forest area in the mountains) with high biodiversity values. Forest industry is dominating the landscape, with forests owned by the State (39%), private companies (34%), and private household owners (32 %). In particular, managed forests are predominant resulting in the prevalence of middle age forests while natural forests are generally fragmented. In addition, a key challenge is the rising of marine coastline (response to the missing glacier load after the last glacial period). Besides forestry together with some small-scale farming, the study area is the home range for Sami people (and reindeer husbandry). In Sweden Sami are exclusively authorized to herd reindeers. Reindeer herds move every year from the coast to the mountain and back. The herding rights include the right to graze the reindeers everywhere in the areas of the Sami community (regardless of the ownership and management of the land). Finally, the study area includes the City of Umeå, which is the biggest city in Norrland (one of the three traditional lands of Sweden).

Main points of discussion and conclusions

The participants discussed the case study with its coordinators and stakeholders Jim Persson and Göran Jonsson, both reindeer herders from a Sami Community. The main outcomes are summarised in the following section.

Stakeholder involvement

Overall, the stakeholders involved in the process for UNESCO MAB application were more than 50 different organisation, including state regional and local authorities, Sami communities, NGOs, Fishing, Wildlife, and Forestry. In particular, the forestry sector is very important and dominating stakeholders; on the other hand, the Sami communities represent a minority group whose interests and needs are often not heard or somehow neglected.

In its initial stage, the stakeholder involvement for the application for UNESCO MAB started in fact as a top-down process dominated by the manager of application. This process, however, did not succeed in achieving the desired outcomes. After a year, the process was restarted (with a new manager) and redesigned as a more bottom-up process. Among other aspects, the process incorporated socio-cultural data, i.e. the reindeer herders mapped the reindeers grazing ranges and their transition routes. Interestingly, this socio-cultural information from reindeer farmers could be confirmed by systematically collected, and long-term data from scientific research on the socio-ecological challenges in the areas, such as the studies on the decrease of forest floor lichen described hereafter.

Identified trade-offs in the investigation area

In study area key trade-offs exist between reindeer husbandry, transportation, tourism, forestry and mining. From the reindeer husbandry perspective, several key challenges arise from the forest management. Among others, a major challenge is related to availability of lichen, which is a key resource for reindeers: it is their feed in winter. The reindeers need open, old forests (dominated by Scots Pine) where they can find feed and rest, rather than mid-aged forests that offer less feed for reindeers. Studies carried out have shown that forest floor lichen (important feed for reindeers) cover in forests have decreased by 70% in 50 years. There is not enough grazing sites for reindeers, with additional costs in terms of artificial feeding, and transportation needed. In fact, there is a need of active forest management with thinning to keep the forest open for reindeers. However, current forest management (mainly by private forest companies in the low lands, these are the winter grazing areas for the reindeers) consists of cutting down, soil scarification, planting Norway spruce or Scots pine, which produce little lichen.

Indeed, a key aspect here is the fact that the Sami have the right to graze reindeers on the land – but the management is by the land-owner. Thus, when a forest company plans a clear cutting of a forest, there is a mandatory process involving the local Sami community. These regulations, however, do not apply to private forest owners. In addition, the accessibility to land for natural long-range reindeer migration is limited due to natural (e.g. steeps) and man-caused barriers (e.g. railways, highways, cities). Generally, the magnitude of different land uses, e.g. forestry, wind mills, mines, built infrastructure, in combination with natural disturbances such as predators, creates a difficult situation, which becomes even further difficult with climate change.

From a sustainability perspective, perhaps the most crucial aspect is the role that reindeer husbandry has had in shaping the entire landscape for several millennia. It is important in fact there is a strong spatial coupling whereby the decrease of winter grazing areas in the lower parts would cause changes also the biodiversity rich mountain regions – because of the change in the reindeer population. This is an example of the need for integrated investigations on the landscape scale to understand land change dynamics.

Discussing "Dissemination & Communication, and Implementation" in the Swedish case study

The break out started with the presentation by the case study coordinator of an article published the 8th March 2018 in the local newspaper *Västerbottens-Kuriren*. It was a response to an article against the candidacy for UNESCO MAB that appeared a month earlier. Interestingly, the response article was signed by 30 persons from 26 organisations, including regional and local authorities, tourism, nature conservation, academy, forest companies, Sami communities etc. Content wise, the articles addressed all the burning issues. Starting from the title, it refers to the UNESCO MAB as an "elevator" for the nature and the local people. Following, it emphasized that there will be no land-use restrictions and recognise that there will be sustainable initiative and business development for the future. Actually, the river valley could be a "beacon" for other areas with similar premises. Indeed, a key aspect is the fact that the authors comprise representatives of large and small businesses, society and service, protected areas, recreation areas, tourism as well as strong and internationally recognised researcher institutes. In turn, this was possible as a result of the long process of stakeholder involvement with more than 160 different meetings with the local people and organizations. By including engaged stakeholder, the process has in fact succeeded in establishing an arena for long-term sustainable development.

Interestingly, the emphasis of the project remains on "Juhtatdahka" –reindeer husbandry – as a rather unique living example of a sustainable land use for sustainable societies. The term Ecosystem Services was used in the communication. Its ultimate goal is to "empower" the area by supporting, maintaining and developing the specific natural and cultural values. An example of this is the expanding tourism industry, with tourists that look for "qualities of life" through amenity values. Potentially, the tourism industry can expand without negative impact on the Sami culture and reindeer husbandry land use. *But it's a challenge.*

Main points of discussion and conclusion

With the direct anchorage with the County Administrative Board of Västerbotten and the Municipality Boards involved in the UNESCO-MAB-process, the outcomes of the ES mapping and assessment process will contribute to regional and local ES understanding and use as input data in territorial planning. Yet, for exploring and solving the conflict risks and elucidating integration and synergy opportunities among reindeer husbandry and other land uses, appropriate ES mapping and assessment will be needed for stakeholder-informed and sustainable operational landscape planning. At a national level, the case study is particularly valuable in terms of continuing building of know-how on ES applications with the Swedish EPA research and communication programs.

At an international level, the UNESCO MAB format offers indeed an excellent platform. Through the MAB-program and the following steps towards formal reserve membership for the Vindelälven-Juhtatdahka site, the specific case study can push forward the inclusion of ES-applications as key ingredients in the global MAB-network with the SDG and Agenda 2030 as the main framework. Yet, ES mapping and assessment of natural and cultural values of the Scandinavian mountain and northern boreal forest landscape, in particular, those associated with the Sami culture and reindeer husbandry, still has some steps to take – but it is a promising route to explore.

The case study is a good example on the integration of different methods, scales and stakeholders. Key barriers were due to pressure from different and new land users – tradeoffs. While key aspects contributing to the success of the process include the co-creation of maps and the fact that stakeholders were compensated for their work. For co-creation, for example, the path to the assessment was discussed and agreed upon form the start, resulting in the strategic decision to focus on reindeer husbandry.

Summary of the discussion points from the Swedish case study

- Part of the UNESCO MAB initiative, the case study covers a large area with multiple interests but the focus was on reindeer husbandry reflecting the local traditions and values. The UNESCO MAB process has being going on for several years, with more than 160 public meetings. It started as a top-down process but with little success, so it started all over again with a more bottom-up and participatory fashion. I think the failure at the beginning was kind of the cause for the success later on.
- The process included several stakeholders from different sectors of the society in addition to benefitting from several ongoing projects in the areas.
- The use of the ES concept with focus on reindeer husbandry was crucial for the success of the process. It in fact takes place over a large area, involving multiple sector and actor; and ES approach can help address situation of trade-offs and potential conflicts through appropriate landscape planning.
- Importance of having long-term scientific data to be combined with local profile of ES having a strong participation component, for example, in scenario analysis - *what happens if we chose this direction?*

3.3. ESMERALDA methods finalization

3.3.1. Update on ESMERALDA status and progress

The main outcome of the Session was that the Workshop participants were updated about the development of the project. In particular, the stakeholders were introduced to the ESMERALDA general approach. After a brief introduction by the host, the project coordinator, provided and overview of the ESMERALDA state and progress to the Workshop participants, which consisted of representatives from 22 EU Member States plus representatives from Norway and Israel (See Milestone Report 29) and stakeholders from the Hungarian, Finnish, and Swedish case studies. An outline the objectives and targets of the project alongside of the individual project phases was provided (see Figure *2.11* from previous section).

Key points of the presentation included the fact that WS 8 is the last ESMERALDA working meeting, before the final conference in Brussels (12-13 June 2018). Moreover, it was highlighted that WS 8 was focused on the application of the ESMERALDA flexible methodology by business and citizens. In terms of method finalization, an open task from WS 7 is related to 'How to name the different ESMERALDA products. Finally, it was recalled that the rich experience of the ESMERALDA Consortium has the potential to make an important and substantial contribution to the development of a Guidance on Ecosystem services implementation by the European Commission DG ENV.

3.3.2. ESMERALDA Final Guidance Documentation

The template of the "Final Guidance Documentation" as well as example of its online version (accessible via the provisional address: http://esmeraldaguidance.devtest.science/) were presented to the WS 8 participants. The main points of discussion and decisions include the fact information to fill into the website should be delivered to the responsible person for the whole page by the **end of April** (see Milestone Report). Finally, given most of the pages will require visuals, every partner submitting visuals should **make sure they are copyright free**.

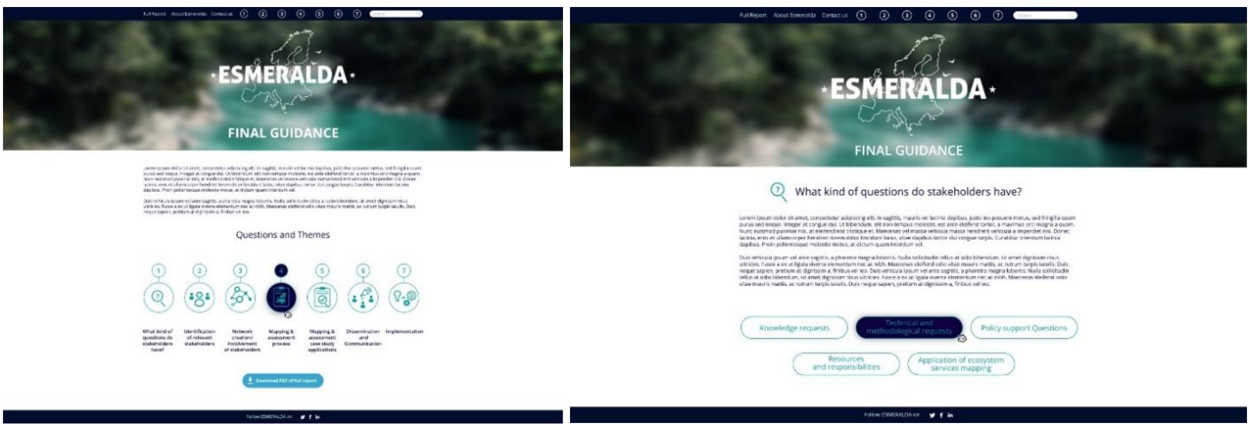


Figure 3.4. Illustrative screenshots of the Online Final Guidance Documentation

3.3.3. ESMERLADA Online Tool

The discussion started with an update about the development of the ESMERALDA Online Tool. Specifically, it was recalled that methods and applications have been collected, based on the online questionnaire and compiled excel sheet. The rationale behind the "Online Tool" is thus to connect methods with studies and/or science and grey literature. This has been achieved by the structuring the querying logic thorough a number of filters.

The latest version of the database is accessible via the provisional address is http://database.esmeralda-project.eu/#/home. The database has undergone many changes since the first version. There has been discussion how to organize/explore the database in the last months. Now the database entries are also classified in terms of policy questions, ETH Zurich colleagues are doing the same re-structuring in terms of tiers. This should be ready by the end of the **March 2018** in order to have it ready for Brussels.

Regarding the database user experience, it is possible for users to choose to look for literature or methods, and then select information through the filters. There are many extra filters that can be added to the query, this however could be overwhelming for the user. Therefore, and alternative way to access information is through the Case Study Booklets, which can be classified via a set of structured information on scale, domain, ecosystems assessed, etc. All this information can be translated into a database query with precompiled filters so the tool finds similar cases/literature. One of the new filters ready for use is **policy questions**.

In conclusion, the key aspect that need to be addressed before the Final Conference in Brussels include (i) finding an appropriate name for the database, (ii) integrating tier level, and (iii) polishing the User Interface to improve accessibility.

Main points of discussion and decisions

- While we cannot guarantee the possibility to incorporate a new data in the future (this depends on where the database will be stored), it is still possible to add new data now.
- A decision must be taken on where the tool will be allocated for the afterlife of the project. Which community could host it? Several options available: ESP, OPPLA, BISE…
- As ESMERALDA started off with using CICES version 4.3 (most recent one available at the time of writing DoA) all entries of the database were references to version 4.3. While since January 2018 a new updated CICES version 5.1 is available (see www.CICES.eu) it was agreed to keep the ESMERALDA online database referenced to version 4.3 and to provide clear information for user that need to apply other versions, e.g. the translation link.
- Presently, the links among the different ESMERALDA products are not so clear: we need clearer links between the method documentation, the booklets and the methods databases.
- Regarding the method application cards, Stoyan Nedkov (NIGGG-BAS) agreed to coordinate the update of the application cards, including the translation form the old to the new methods.

3.3.4. ESMERALDA Glossary

The glossary was constructed based on OpenNESS, which was the results of a two-year consultation process. In ESMERALDA, the glossary has been expanded by adding more terms related to mapping. Yet, the glossary still needs to be updated also based on the experience we all have in our own areas. If a specific term is used in the Deliverables, the authors should make sure the definition is included in the glossary. If there are doubts about different understandings of a definition, this should be discussed with Marion. All terms used should be in accordance with the content of the glossary. If there are discrepancies about the terms in the glossary, it is still possible to fill questionnaire in survey monkey, being clear about the reasons for overwriting existing terms and be ready to discuss it with the coordinator Marion Potschin-Young (FABIS). In conclusion, it was pointed out that new set of terms from the methods compendium has been added to the final glossary (40 terms). Moreover, there is a glossary out form the ETC/BD with focus on ecosystem condition. This glossary should be checked against the ESMERALDA, to see if there is something what we are missing. The updated glossary will be submitted as Del. 1.5 in April 2018.

Main points of discussion and decisions

- Within ESMERALDA, the aim is to create one of the most comprehensive glossaries in the ES community. Actually, there are already many projects using the glossary ESMERALDA; so perhaps publishing should be considered as an option (e.g. turning the glossary into a data paper).
- Regarding definition coming from the IPBES, it was agreed to include the 5-6 most important terms into the glossary and clarify how we are using them in ESMERALDA. Generally, when a new definition is added to the glossary, authors should point out the source giving credit to the original definition.

3.3.5. Discussing the final ESMERALDA Deliverables

Similar to what was done in WS 8, the main outcome here was the engagement people with specific tasks to finalize the different ESMERALDA Deliverables, ensuring coherence between them. Thus, this session served to give an update on the progress of the specific Deliverables, together with possible publications. While a more detailed account of the main discussion points and decisions is reported in the Milestone Report 29, following is the list of the discussed Deliverables:

- **Deliverable 4.8**: Integrated Ecosystem Assessment (IEA). (M42)
- **Deliverable 5.4**: Guidelines & recommendations to support the application of the final methods by policy and decision makers and business and public sectors. (M42).

3.4. Stakeholder involvement and training

3.4.1. Stakeholder panel discussion - Engaging citizens & business

The panel discussion was aimed at exploring how to move from current practices to novel and more effective approaches in engaging citizens and business as well as communicating and implementing ES mapping and assessment results. Specifically, the session explored how to improve the role of stakeholders and citizens in planning & decision making related to ES; how to improve and engage the business sector towards ES mapping & assessment and responsible use of its results; how to improve the communication between stakeholders, citizens, researchers, politicians, planners and businesses.

The panel discussion involved the stakeholders from Hungarian, Finnish, and Swedish case studies as well as a stakeholders from the ETH Zurich. The ESMERALDA community was interested in learning about the practical experience-based knowledge from stakeholders about the engagement of citizens and businesses. The discussion could potentially target a wide range of policy domains and sectors including: nature conservation, climate, water and energy, marine policy, natural risk, urban and spatial planning, green infrastructure, agriculture and forestry, business, industry and tourism, and health.

Figure 3.5. Stakeholder panel during the ESMERALDA WS 8 in Eger, Hungary.

The discussion was divided into three blocks focusing on stakeholder in general, on citizens, and on businesses. For each block, the panel members were presented with a list of potential questions they could answer with reference to the themes policy domains and sectors presented above.

Stakeholders in general

According to the panel, relevant stakeholders are those involved in the land uses where potential investment is taking place. Thus, they depend on the context and on the scale of the landscape/ extent of the area. Different users as farmers or businesses, which make use of the resources should be considered as well as local communities and authorities. However, it is not just the question who is involved from the policy perspective but it is very important to find a common ground and to find ways that are acceptable to everyone. It was found important that the scientists should not just come and claim to conduct a study, rather the stakeholders should get a say in the study itself. All of this was found relevant for example for the policy sectors natural risk, nature conservation and agriculture and forestry. However, the panel members agree that these aspects always need to be specific to the context.

Among others, the stakeholders from the Swedish case study pointed out that some issues need to be addressed globally, which makes it very difficult to identify stakeholders. This is the case of climate change, which is having significant impacts on their lives and reindeer husbandry. They emphasized that many actors and stakeholders need to be involved. Similarly, at a national level, they acknowledged the importance and the challenges of involving several stakeholders given that they travel long distances together with their grazing reindeers a lot of different areas and thus different stakeholders are involved.

The stakeholder from the Hungarian case study explained that the state of the national park depends on forestry management, local tourism activity and nature conservation thus including authorities, business and citizens. Foresters do their regular work with regard to their regulations and planning, usually the old fashioned way (e.g. clear cutting). Thus, the main challenge is rising awareness and promoting a mind change towards sustainability. However, as their current practices are sustainable according to the Hungarian law, this is a difficult task (the ECO KARST project may help).

The stakeholder from the Finnish case study also mentioned the issue with the "***old***" fashioned way. The stress lied on the "old" and referred to the age and respective mind-set of a great share of the policy makers. In conclusion, the panel agreed upon the fact that "we are still a minority" and, unfortunately, several mainstream policies and economic development initiatives still take place at the expense of our planet and natural resources.

Citizens

As citizens we all have important power to make decisions on what to buy (as consumer). This decision provides vote and data. In countries where choices are given to consumers, the consumer can decide sustainable. Learning from knowledge that we already collected in the past is crucial. Today, also thanks to the modern technology, almost everything is feasible including living in harmony with nature. An encouraging aspect is that the civil society, at least in the EU context, is increasingly quite liberal, modern and environmental thinking.

To have opinion of many people, not only few, is crucial and necessary step. The local knowledge is very valuable, e.g. about traditions which regard to animal keeping. Therefore, many local people from the villages should be involved, collecting local information on land use. This kind of stakeholder involvement usually works better via personal communication, no online doodle or questionnaire. Of course, this is very time consuming. In this regard, an interesting example was shared by the stakeholders from the Swedish case study. Back in 2011, as reindeer farmer, he started to identify important areas for grazing. He then consulted other members of the community and together they marked the important areas, drawing in maps and writing down conclusions on their findings. These maps indicated their vision of the priorities for the different land/land usages. The maps were further refined with the use of GPS technology, and as a result more people started to listen and hear their voice.

Businesses

The experience shared by the stakeholders form the Swedish case study is indeed a good example of the relation between ES and businesses. Around 20 years ago, working with reindeers brought a good income. Today, it is very hard to make money from reindeers. Another important aspect, which is closely connected with the economic stand, is the health in their communities, which live from and with reindeer husbandry. A very bad and alarming development can be seen with regard to the health of the reindeer hunters. The number of suicides is higher than average and increasing.

In the Hungarian case study area, most business belong to the state. There are several small or medium sized business around. However just very few belong to the private sector. An exception is the management of the grasslands. Contracts exists between the authorities and small local business with regard to grazing and haymaking. As the society is dependent on work places and thus industry, one always needs to make compromises between these interests and green structures. Finally, it was pointed out that it is not very useful to generally think of businesses as separate entities on their own. Businesses are rather the response to our demand as consumers, promoting sustainable business through sustainable choices.

3.4.2. Perspective on using MAES in the private sector

The aim here was to expose the stakeholders and Partners to potential applications of ES mapping and assessment in decision-making involving businesses and citizens. Specifically, based on the experience of the "**Land Degradation Neutrality Fund**" launched by the UNCCD, the keynote speech By Simone Quatrini (ETH Zurich) served to explore both the decision-making needs of the private sector and the potential that the MAES process has to address these needs. What follows is the abstract of the keynote speech.

Unlocking finance for sustainable development: the Land Degradation Neutrality Fund

Over the past two years, the international community adopted a number of important policy frameworks that laid the foundations for an inclusive green economy that acknowledges the value of ecosystem services, protects natural resources and promotes a sustainable future, such as the 2030 Sustainable Development Goals (SDG) Agenda. Without finance, all these objectives and commitments will remain on paper. While the public sector can cover part of the finance gap, the largest investment is expected to come from the private sector. Yet, the global financial system is not effectively channelling private sector investments towards sustainable development. Essentially, this is due to the lack of instruments to mitigate risks and uncertainty, and lack of appropriate investment vehicles. One particularly underexploited instrument is a form of public-private partnerships called blended finance. The recently launched Land Degradation Neutrality Fund (LDN Fund) is a rare example of blended finance vehicles specifically anchored to a SDG target. The talk provided an overview of the key characteristics of this innovative financial instrument, including the role of ES in the fund's environmental and social standards. It illustrated the underlying theory of change and challenges ahead.

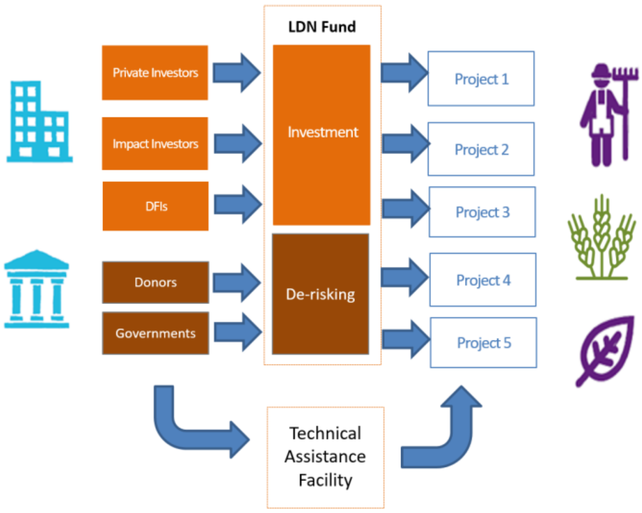


Figure 3.6: Architecture of the Land Degradation Neutrality Fund (Source: Morova, 2018)

3.4.3. Field excursion to the case study in Bükk National Park

Finally, to experience the local ES first hand, the WS 8 participants went on a filed excursion to the Bükk National Park. The national park is protected since 1976, to safeguard the rich fauna and flora, as well as geological and cultural heritage of the area. Important geological features of Bükk include various karst formations within its limestone mountains - particularly caves (once inhabited by pre-historic people), swallow-holes, and ravines. In the morning, the Workshop participants visited the **woody pasture of Cserépfalu**, a target area of the Hungarian case study. The participants visited **Répáshuta** in the heart of the national park as well as hiked from the village to see neighbouring protected areas and the Balla cave.

3.5. Overview of the method testing and finalization process in WS 8

WS 8 continued the work of testing making substantial progress towards the three main ESMERALDA project objectives related to: (i) the case study testing of the final methods, (ii) the finalization of the methods, and (iii) the involvement and training of stakeholders.

Here, testing of the final methods focused on the application of the final methods by businesses and citizens. Thus, three case studies from Hungary, Finland, and Sweden were analysed with respect to the two most relevant components of the MAES process, namely: (1) “Identification of relevant stakeholders” and “Network creation/Involvement of stakeholders”, and (2) “Dissemination & Communication”, and “Implementation”.

Methods finalization was achieved by coordinating the activities of the Consortium Partner towards achieving the final ESMERALDA Deliverables. The discussions served define the structure of content of different ESMERALDA products, including the “Final Guidance Documentation”, the “Online Tool”, and the ESMERALDA Glossary, in addition to the final project Deliverables.

Again, stakeholder involvement and training-related activities were included throughout the entire WS 8, including a field excursion to one of the case study areas. Among others, the stakeholders were exposed to the ESMERALDA approach, had the chance to receive further clarifications while actively participating in the discussions. Furthermore, in WS 8, an entire session was dedicated to a stakeholders’ panel discussion.

Figure 3.7: Workshop VIII in Eger, Hungary – Picture from sessions (By Pensoft)

4. Concluding remarks

Deliverable 5.3 reports the main results of two workshops conducted with the ESMERALDA consortium partners and stakeholders to test the final version of the flexible methodology for ES mapping and assessment. The last two workshops built on the efforts achieved in previous round of workshops for testing the first version of the methods as well as the different activities mainly in WP 3 and WP 4, where the different ESMERALDA products were being developed (e.g. Final Guidance Documentation, Online Tool, Integrated Ecosystem Assessment Framework, and Glossary). In each workshop, participants had the opportunity to first receive an update on the latest developments, and then discuss specific topics through a set of case studies. Furthermore, the two workshops contributed to stakeholders' involvement and training, adding to the more specific efforts of WP 2. In terms of content, each workshop generally consisted of three parts. A first part related to the case studies, a second part dealing with the finalization of the ESMERALDA flexible methodology itself, and a third part aimed at contributing to building capacity of stakeholder in understanding the variety of existing ES mapping and assessment methods, and the results that can be expected from their application.

4.1. ESMERALDA case studies related results

The two main outcomes here are the Case Study Booklets and Method Cards. The former illustrates the process of ES mapping and assessment in the nine ESMERALDA case studies, and thus providing a set of good working examples of ES mapping and assessment in real-life, covering different conditions across Europe, across themes, and for specific biomes and regions, as per the DoA (see Appendix: Case Study Booklets). The Method Cards synthesize, for a selected set of ES in the case studies, the main characteristic of the applied methods in terms of their data, and resources requirement, links and dependency on other methods, collaboration level needed, and spatial scale of application, among others. Both the Case Study Booklets and Methods Cards, which form the building blocks of the ESMERALDA flexible methodology, are integrated by the results of the specific discussion on specific aspects that took place during the workshops; for more on this see sections 3.2, 4.2 and 5.2.

4.2. ESMERALDA methods refinement

Concerning the refinement of the final methods of ES mapping and assessment, a key feature was the collaborative, and iterative nature of the process, which involved the whole consortium. Generally, the work progressed tentatively under three main streams: i) building the Final Guidance Documentation, ii) developing the ESMERALDA Online Tool, and iii) finalizing the ESMERALDA Glossary and other Deliverables, among others.

With respect to the first stream, an initial structure of the Final Guidance Documentation was defined in WS 6 in Plovdiv, highlighting the links with the different project Deliverables (see WS 6 Report). In WS 7 in Trento, the structure was finalized, hence, the discussion shifted to the contents and technical implementation of the Final Guidance Documentation (see section 2.3.2). In WS 8, a template of the "Final Guidance Documentation" as well as a prototype of its online version were presented and discussed (see section 3.3.4). As the next step all partners will provide information to fill into the website, including visuals that should necessarily be copyright free (see Milestone Report 29).

The second work stream is directly related to the efforts of collection and classification of methods for ES mapping and assessment carried out mainly in WP 3 and WP 4 in which, initially, two method databases were built based on the entries of studies from the ESMERALDA Consortium members ("Google document") and on a comprehensive review of scientific literature ("Matrix"). The rationale behind the "Online Tool" is thus to connect methods with studies and/or science and grey literature. This has been achieved by first merging the two databases, hence by structuring a querying logic thorough a number of filters (e.g. policy questions, case studies etc.). The latest version of the database is accessible via the provisional address is http://database.esmeralda-project.eu/#/home. (For more details refer to sections 2.3.3 and 3.3.3).

The third stream focused on finalizing the ESMERALDA Glossary and the remaining project Deliverables. Specifically, under the guidance of the work package leaders, the ESMERALDA Consortium partners are actively engaging in preparing the deliverables. For more on this see sections 2.3.4 and 3.3.5.

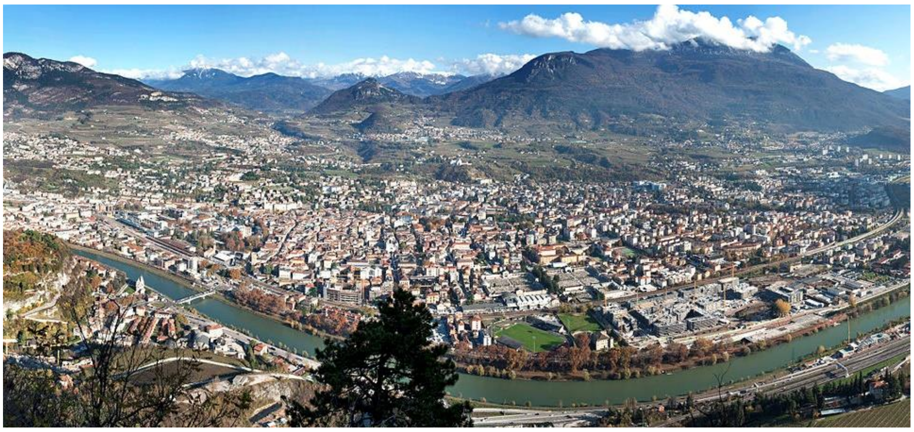
4.3. Stakeholder involvement and training

Contribute to build stakeholders' capacity in understanding the variety of existing methods for ES mapping and assessment, and the results that can be expected from their application is an additional objective of the ESMERALDA workshops. To this end, all case study stakeholders were trained about the general ESMERALDA approach as well as received clarification during their active participation in the case study discussions. Furthermore, stakeholders had an opportunity have some practical demonstration through field trips: the Arte Sella – Contemporary Mountain (WS 7, Trento) and the Bükk National Park (WS 8, Eger). Finally, besides providing specific input during the case study related sessions, the stakeholders actively participated to all the method development sessions as well. Finally, as reported in sections 2.4 and 3.4, additional sessions were entirely dedicated to collecting input from the case study stakeholders.

Annex to D5.3 - Case Study Booklets

- **Italian case study:** ES mapping and assessment for urban planning in Trento
- **Belgian case study:** Mapping green infrastructures and their ES in Antwerp (Belgium)
- **Hungarian case study:** Fostering pro-biodiversity business in the Bukk National Park (Hungary)
- **Finnish case study:** Green infrastructure and urban planning in the City of Järvenpää (Finland)
- **Swedish case study:** ES mapping & assessment in the Vindelälven-Juhtatdahka river valley (Sweden)

Case study booklet for:
WORKSHOP VII: "Testing the final methods in policy- and decision-making (I)"
held in Trento, Italy, 22-25 January 2018



1. ES mapping and assessment for urban planning in Trento

January 2018

ESMERALDA partner: University of Trento, UNITN

Case Study Coordinators: Davide Geneletti, Chiara Cortinovis, Linda Zardo, Blal Adem Esmail

ESMERALDA

Enhancing ES mapping for policy and decision making

1.1. Case study factsheet and study area description

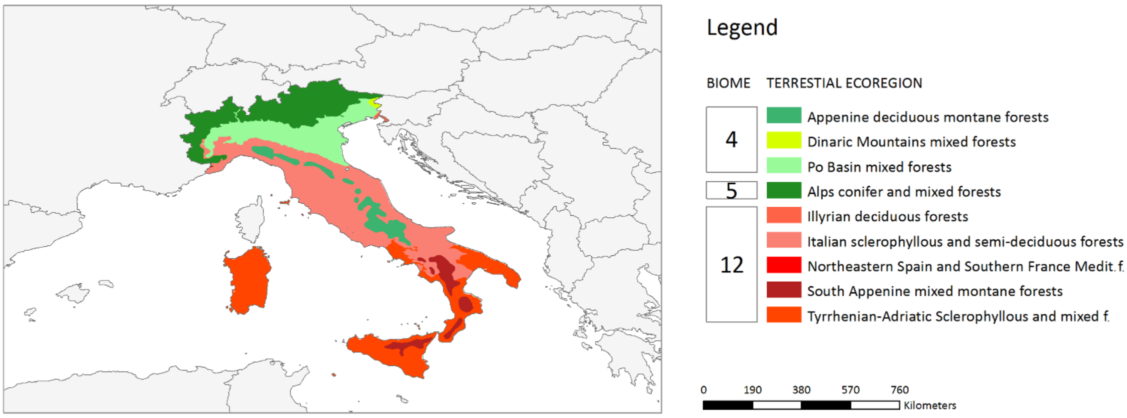
ES mapping and assessment for urban planning in Trento WS7_cs1

NAME AND LOCATION OF STUDY AREA	City of Trento, Trentino Alto Adige, Italy
COUNTRY	Italy

STATUS OF MAES IMPLEMENTATION		
Stage 1	**Stage 2**	Stage 3

BIOMES IN COUNTRY

1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests**
5 Temperate Conifer Forests	6 Boreal Forests/Taiga
8 Temperate Grasslands, Savannas & Shrublands	11 Tundra
12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
14 Mangrove	



SCALE		
national	sub-national	**local**

AREAL EXTENSION: **156 km²**

THEMES

nature conservation	**climate, water and energy**	marine policy	natural risk
urban and spatial planning	**green infrastructures**	agriculture and forestry	business, industry and tourism
health	ES mapping and assessment		

ECOSYSTEM TYPES

urban	cropland	grassland	woodland and forest
heatland and shrub	sparsely vegetated land	wetlands	rivers and lakes
marine inlets and transitional waters	coastal	shelf	open ocean

Study area description

The city of Trento is located in Northern Italy, in the valley of the Adige River, which flows from the Dolomites to the Adriatic Sea. It is the capital of the Autonomous Province of Trento (Trentino), with a population of around 117,300 inhabitants. The city centre is in the valley floor at 194 m above sea level and hosts around 70% of the population. The remaining 30% lives in small villages spread across the surrounding hills and mountains, which rapidly reach the altitude of more than 2000 m. The local economy is driven by the service industry (around 70% of the local companies) as well as by a quite consolidated public-private partnership. Overall, of the total city area (156 km^2), 22% is covered by urban areas, while forests account for one third of the surface. More than 10 km^2 are natural protected areas, including 7 Natura2000 sites and 3 local reserves.

1.2. Main policy question and theme

1.2.1. Objectives of ES mapping and assessment

In its first phases, the present ES mapping and assessment exercise was scientifically-driven; nevertheless, intermediate results have been used to establish an interface with the local administration, and to progressively engage in a shared discussion on urban green infrastructures and ES. Along this process, the study benefitted from the involvement of the city of Trento as a case study in the MAES Urban Pilot (2015-2016) and, later on, in the follow-up project EnRoute (ongoing). From the primary scientific interest of developing and testing credible methods for urban ES mapping and assessment, the aim of the study gradually shifted towards producing relevant knowledge, able to support the local administration in pursuing its objectives of enhancing citizens' wellbeing.

The drafting of the new urban plan, just started in 2017, indeed represents a window of opportunity for the administration to revise and update the strategies regarding urban green infrastructures, as well as an occasion to propose and test the ES approach as a tool to support the planning process. In this context, the scope of an ES mapping and assessment is twofold: first, describing how ES and related benefits produced by urban green infrastructures are currently distributed across the city, and second, supporting the design and assessment of planning actions from an ES perspective.

Among the main challenges for the new urban plan are the redevelopment of brownfields and abandoned areas. Most of them are big urban voids, whose regeneration has been debated for years without finding a proper solution. The actual plan identified 13 brownfields (Figure 1.1), mostly former industrial sites or partially abandoned residential areas, with an extension ranging from 0.5 to 9.9 ha. Due to a mixture of economic, bureaucratical, and technical reasons, the conversion of all of them into new residential or productive areas within the time-frame of the plan is highly unlikely, hence it is possible to hypothesize the conversion of some of them into a (temporary or permanent) green area. Based on their location and dimension, and on the type of intervention proposed, the benefits that could be expected from the intervention are different. The aim of the ES mapping and assessment application was to assess alternative greening scenarios for the redevelopment of brownfields, based on their effects on key urban ES for the city of Trento.

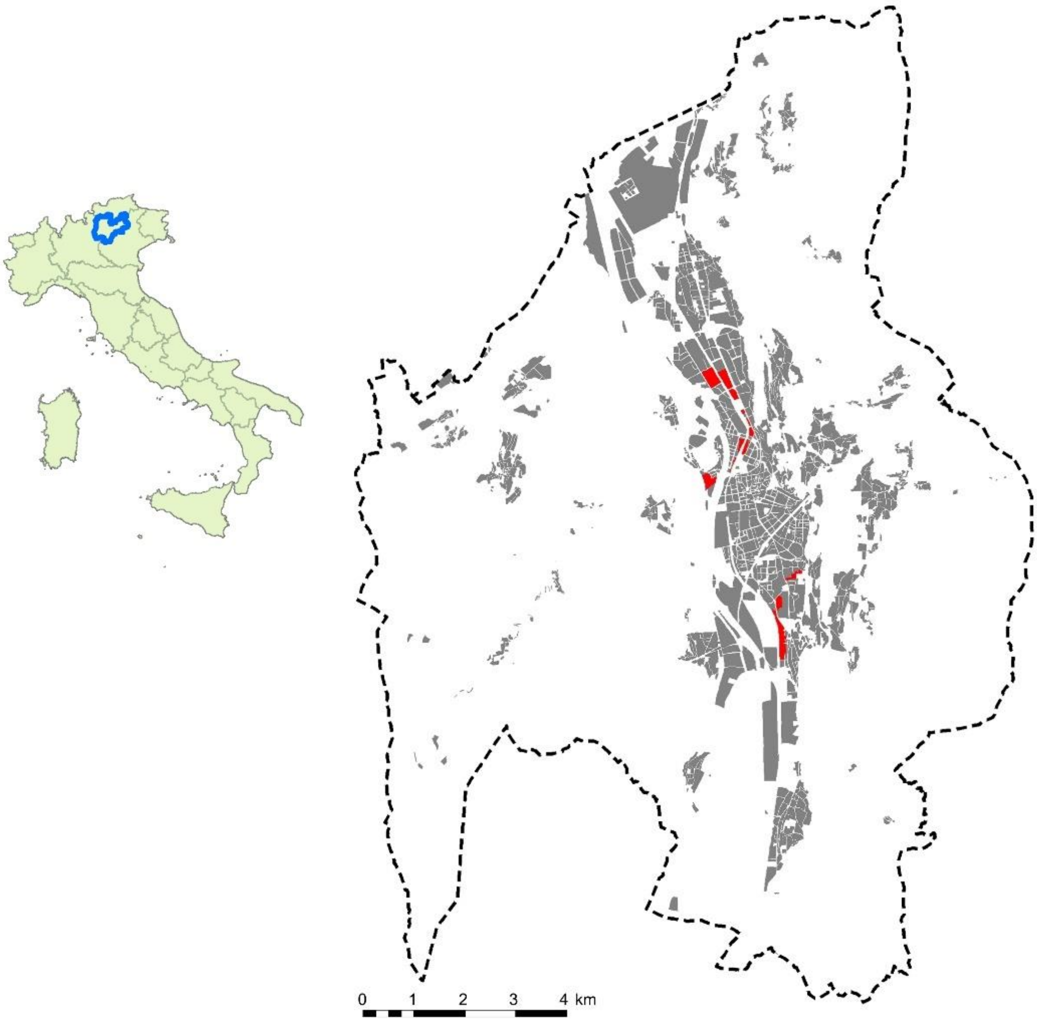


Figure 1.1: Location of the 13 brownfields with respect to the urbanized areas of the city.

1.2.2. Stakeholders and their role

Within the ES mapping and assessment process, key staff from the local administration were involved. In the first phases, the interaction was limited to the provision of baseline data and to preliminary, informal discussions on the most pressing issues to address. Later on, also following the requirements of the EnRoute project, a "city-lab" was established composed of members from the city administration and the University of Trento. The city lab was the opportunity for a closer collaboration, grounded on the discussion of preliminary results and of their usefulness for planning and management purposes. This helped identifying key requirements and needs to enhance the usability of the results (e.g., ways of presenting and summarizing information).

From discussions in the city lab the idea of involving other experts in some steps of the ES mapping and assessment process emerged. Thus, 20 people including officers from several municipal and provincial departments, researchers and academics from the university and other research institutions in the city, and local practitioners were asked to provide their opinion through an on-line questionnaire. Later on, most of them agreed to participate in a follow-up table to discuss and validate the results of the ES mapping and assessment exercise.

1.3. Ecosystem Types and Conditions

1.3.1. Identification and mapping of ecosystem type(s)

Although relatively few data are specifically collected for the purpose of analysing and monitoring urban green infrastructures, the combination of currently available datasets allowed gaining the information necessary for the ES mapping and assessment exercise. The most relevant data were the high-resolution aerial photograph produced in 2015 and the recent land use map purposely-realized by the municipality to provide a base layer for the drafting of the new plan. Other key information was retrieved form the municipal databases of public green areas and public trees. The database of public green areas is a highly detailed mapping of urban green areas managed by the municipality, providing information on all the elements that compose the area (walking and cycling paths, tree and water areas, flowerbeds, etc.) as well as on their use and management. The database of public trees collects valuable information about species, dimensions, ages, and management activities. Detailed data for public green infrastructures from the two databases were integrated with more rough and coarse data about private areas.

1.3.2. Assessing ecosystem conditions

Ecosystem condition, i.e. the effective capacity of an ecosystem to provide services relative to its potential capacity (MA, 2005), was assessed rather indirectly within this case-study. Information about ecosystem conditions relevant for the case study were mostly related to two aspects: the structural analysis of urban green infrastructure components, and their management. More specifically, the structural analysis involved a preliminary assessment of soil cover and tree canopy coverage across the whole study area. Information about management that were collected concern the property of green areas (public vs. private), their opening to the public, and the presence of infrastructures and facilities. This could indeed be considered as first step towards assessing ecosystem condition.

1.4. Mapping and assessment of ES

1.4.1. Identification of ES

The identification of key urban ES was based on the knowledge of the local context and validated though a joint discussion with stakeholders. The selected ES cover pressing environmental issues for the city, as well as priority themes that the plan aims to address. The objective of providing all citizens with equal opportunities for nature-based recreation supported the identification of “Physical use of landscape” as one of the main urban ES. At the same time, the increasing intensity and frequency of heatwaves with growing negative consequences for citizens’ health and wellbeing, particularly in the valley floor, led to the selection of “Micro-climate regulation” as another key urban ES.
Table 3.2 lists the ES selected in the case study, classified using the CICES v4.3 (2013) classification, and the related assessment method categories.

Table 1.1. Overview of the ES and related mapping and assessment methods in the Trento case study

Ecosystem Service selected for mapping and assessment	B	S	E
2.3.5.2. Micro and regional climate regulation	X		
3.1.1.2. Physical use of land- /seascapes in different environmental settings		X	

* ES selected for further discussion during ESMERALDA workshops 7 in Trento;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

1.4.2. ES mapping and assessment: biophysical methods

A biophysical method was applied to map and assess microclimate regulation provided by urban green infrastructures in the valley floor under the present condition and the two redevelopment scenarios hypothesized for each brownfield. The biophysical method moved from the analysis of the structural features of urban green infrastructure to assess their capacity for microclimate regulation.

Mapping of regulating and maintenance services

2.3.5.2. Micro and regional climate regulation
Indicator: *Cooling capacity (classes from A+ to E) (Capacity)*
Indicator: *Cooling effect (classes from A+ to E) (Capacity)*
Indicator: *Total and vulnerable beneficiaries under the different scenarios (Flow)*

A process-based model for assessing the cooling capacity of urban green infrastructure was developed during the study (for a detailed illustration refer to Zardo et al. (2017)). The method is specifically tailored for assessments in urban contexts, and is aimed at supporting a design of new urban green infrastructures that maximize their cooling capacity and effect on the surrounding areas. The method estimates the two main functions involved in cooling, namely shading and evapotranspiration, based on the structural features of urban green infrastructure components (i.e., soil cover, percentage of canopy cover, and dimension of the area). The cooling capacity of each green infrastructure component is assessed in a scale 0-100 and then classified into 6 classes that, depending on the climatic zone (i.e. Atlantic, Continental, and Mediterranean) can be linked to a range of temperature differences between the analysed area and the surrounding.

Given the omnidirectional flow of the ES, the cooling effect perceived in the surroundings is modelled by applying different spatial decay functions depending on the dimension and the shape of the green infrastructure component that provide the service. Thus, it is possible to assess to what extent the presence of urban green infrastructures affects the microclimate of the city. The cooling effect is also classified into 6 classes, from A+ to E.

The model was applied to the current condition and to assess different scenarios of brownfield redevelopment. Two greening scenarios were hypothesized for each site (Figure 1.2). Scenario A simulates the conversion to an urban park (a homogeneous grassy area with tree coverage higher than 80%). Scenario B simulates an intense planting (i.e., high tree coverage) over a mostly sealed surface. The scenarios were compared based on the benefits in terms of enhanced cooling effect experienced by the surrounding residents. By combining the maps of the cooling effect with census tract data and the location of residential buildings, it was possible to count the number of beneficiaries within each class of cooling effect in the different scenarios. The quantification of the beneficiaries was done both by considering the beneficiaries as whole and by identifying the vulnerable groups, i.e. those that are the most sensitive and less adaptive to heat stresses. Following the analyses by Kabisch and Haase (2014) and Kazmierczak (2012), here vulnerable groups included elderly people (above 65 years old), children (under 5 years old), and foreigners.

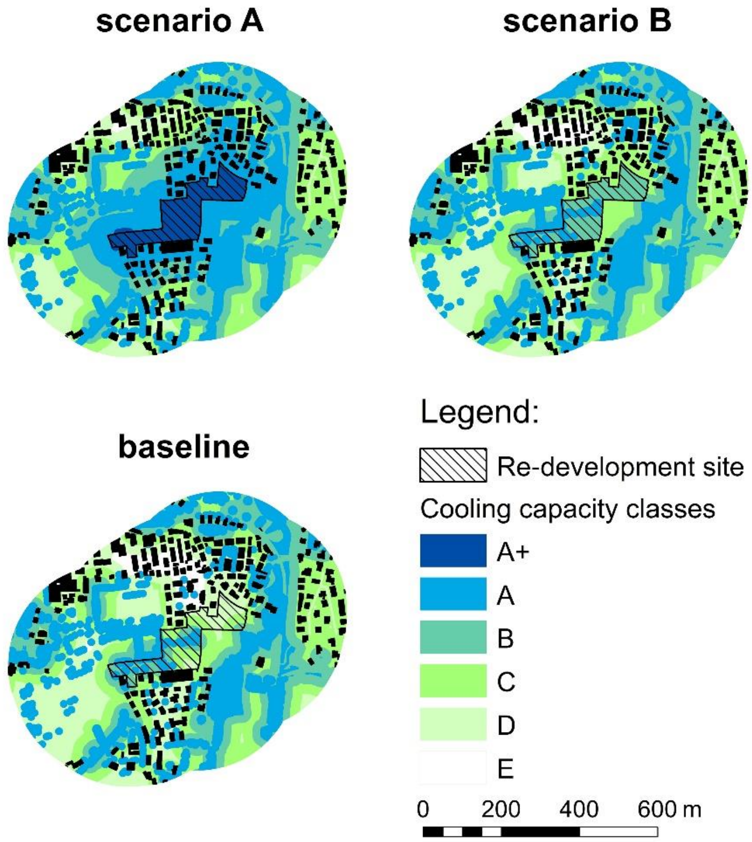


Figure 1.2. Cooling capacity classes modeled for one of the re-development sites (Site 11) in the baseline conditions and under the two transformation scenarios.

1.4.3. ES mapping and assessment: socio-cultural methods

A social method was applied to map and assess the recreation potential and opportunities offered by the green infrastructures in the city. The potential benefits provided by the redevelopment of brownfields into new urban parks were quantified based on a comparison between the present condition and redevelopment scenario. The social method combines data about the presence and characteristics of green infrastructures with information on their use by the citizens, hence the values associated to them.

Mapping of Cultural ES

3.1.1.2 Physical use of land- /seascapes in different environmental settings.
Indicator: *Recreation Potential (normalized score) (Capacity)*
Indicator: *Recreation Opportunity Spectrum (categories) (Capacity)*
Indicator: *Total beneficiaries and beneficiaries in specific age groups under the different scenarios (Flow)*

The ESTIMAP recreation model (Paracchini et al. 2014) was applied to assess the potential and the opportunities for nature-based recreation provided by the urban green infrastructure in Trento. The model, originally developed for EU-wide assessments, it has been already adopted, with case-specific adjustments, in a number of local scale applications (Zulian et al. 2017). The model was considered suitable for the case study due to its capacity of accounting for the whole range of nature-based recreational activities carried out in the city area. The location and the peculiar shape of the settlements determine a high proximity of residential areas to peri- and extra-urban green areas, hence a wider range of opportunities for nature-based recreation compared to other cities. As a result, activities typically carried out in forests and mountain areas (e.g., hiking, mountain-biking, climbing) are common, day-to-day activities for many people in Trento.

The model was used to assess the Recreation Potential and the Recreation Opportunity Spectrum for nature-based recreation in the whole area of the city. The Recreation Potential measures the suitability of green infrastructure to support different activities based on the intrinsic characteristics of the area. The assessment of the Recreation Potential accounts for three groups of thematic information: the presence of relevant and attractive natural features (i.e., mountain peaks, river areas, cascades, etc.), the structural characteristics of urban green areas (i.e., size, presence of vegetation and water, etc.) and the influence of the context (i.e., land use). The elements in the three groups are weighted and then combined in a normalized score.

The assessment of the Recreation Opportunity Spectrum combines the map of the Recreation Potential with information about facilities and infrastructures (Figure 1.3). To allow for an easier assessment, these are divided into two groups: access-related (i.e., road network, cycle paths, bus stops, etc.), and use-related (i.e., picnic areas, playgrounds, mountain tracks, etc.). The elements in the two groups are weighted and summed. The final value is cross-tabulated with the score of the Recreation Potential to identify 9 categories defined by the combination of low, medium, and high Recreation Potential with low, medium, and high availability of infrastructures and facilities.

Spatial data for the assessment were retrieved both from publicly-available datasets owned by the city and the province, and from OpenStreetMap, which allowed the inclusion of information about specific activities (e.g., MTB trails and rock climbing routes). Although these data can be considered quite accurate and reliable, their completeness, hence the full coverage of the area, is uncertain. The weighting phase is the most delicate in the application of the model. In this case, we involved 20 experts including researchers and academics from the university and other research institutions in the city, officers from the municipal and provincial departments with an interest in outdoor recreational activities, and local practitioners, who were invited to fill-in an on-line questionnaire.

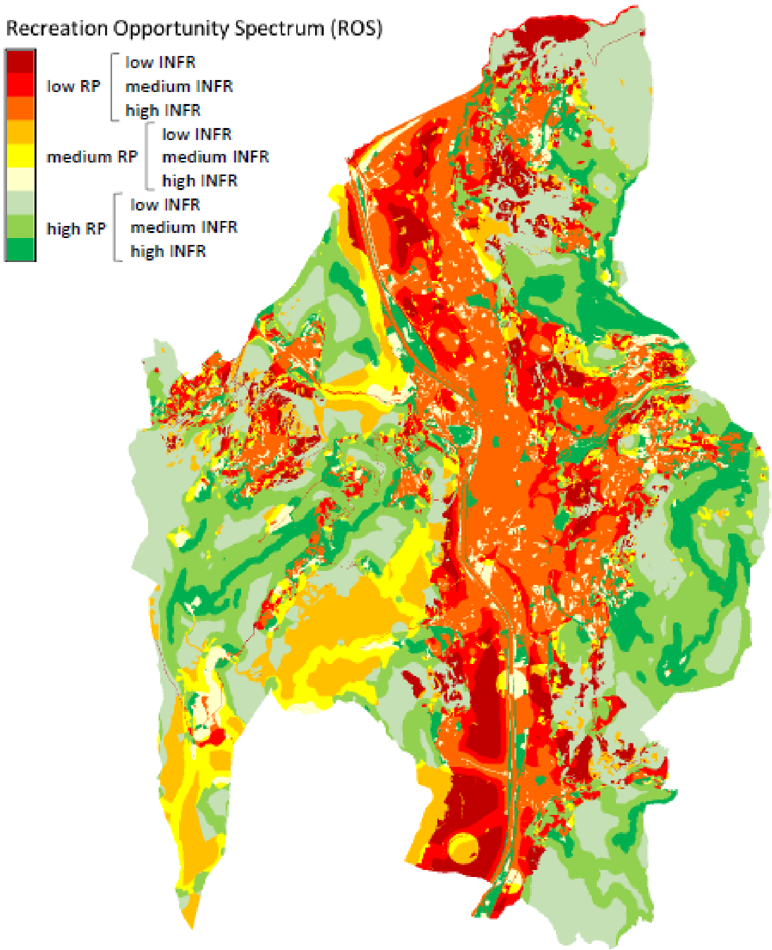


Figure 1.3: Classes of opportunities for recreation based on the recreation potential of the area (RP) and on the availability of infrastructures and facilities (INFR).

The model was applied to analyse the current condition and to assess different scenarios of brownfield redevelopment. In this case, only the conversion of existing brownfields to urban parks (i.e., Scenario A in the assessment of cooling effect) was considered. Current conditions and future scenarios were compared based on the benefits in terms of enhanced opportunities for nature-based recreation. More specifically, a comparison of the number of people living within walking distance from areas with high Recreation Potential and high availability of infrastructures and facilities was used as an indicator. Both the number of beneficiaries as a whole and the number of beneficiaries in specific age groups (i.e., children and elderly people) was considered in the analysis.

1.4.4. ES mapping and assessment: economic methods

Economic methods for mapping and assessment of ES were not used in this study.

1.5. Use and integration of ES mapping and assessment results

1.5.1. Addressing the policy question

The ES mapping and assessment in the case study generated credible and relevant information that can help address the starting policy question on how a green-oriented redevelopment of brownfields could contribute to increase the availability of key ES and related benefits for the citizens of Trento.

More specifically, 13 brownfields identified as areas for future re-development were investigated based on their actual and potential provision of two illustrative and crucial ES for the city of Trento: microclimate regulation and recreation. In the case of microclimate regulation, the biophysical analysis was combined with the quantification of the beneficiaries of the cooling effect, considering both the surrounding residents in general and specific vulnerable groups among them. In the case of recreation, the spatially-explicit assessment of the recreation potential and of the opportunities for nature-based recreation based on expert evaluation allowed comparing the current condition with the case of redevelopment of brownfields to new urban parks. The quantification of beneficiaries was done by considering the number of people (total and for specific age groups) with increased availability of areas in the highest class of recreation opportunity within walking distance from home.

From a planning perspective, although each analysis provided useful information, especially on the current needs of the city, the integration of the results of the two mapping and assessment exercises was far more interesting. The integration, carried out in a multicriteria fashion, allowed exploring synergies and trade-offs between the ES in the specific context, considering their combined impact of the potential beneficiaries of the transformation. This beneficiary-based assessment proved to be consistent with the administration objective of increasing the wellbeing of the citizens, hence a useful tool to inform planning decisions.

1.5.2. Dissemination and communication of results

From the academic perspective, results obtained in this case study have been disseminated through scientific publications (e.g. Geneletti et al. (2016); Zardo et al. (2017)), and communications in international and national conferences. Furthermore, the involvement of the city in the MAES Urban Pilot and EnRoute projects was the occasion to communicate and disseminate the results in the respective networks through publications (the MAES report) and project websites (https://oppla.eu/enroute).

Above all, results have been shared with municipal officers responsible for planning and managing urban green infrastructures in the city of Trento, through regular meetings and their direct participation to the project activities. Moreover, the involvement as experts of officers from other municipal and provincial departments and from other institutions with an interest in nature-based recreation provided a table for discussion and paved the way for a more effective policy-science-society interface and for a closer cross-sectoral collaboration.

The continuous interaction along the entire process of mapping and assessment is expected to facilitate the introduction of the results into the ongoing urban planning process.

1.6. References & Annexes

References

Geneletti, D., Zardo, L. & Cortinovis, C., 2016. Promoting nature-based solutions for climate adaptation in cities through impact assessment. *Handbook on Biodiversity and Ecosystem Services in Impact Assessment*, (2009), pp.428–452.

Paracchini, M.L. et al., 2014. Mapping cultural ecosystem services: A framework to assess the potential for outdoor recreation across the EU. *Ecological Indicators*, 45, pp.371–385. Available at: http://dx.doi.org/10.1016/j.ecolind.2014.04.018.

Zardo, L. et al., 2017. Estimating the cooling capacity of green infrastructures to support urban planning. *Ecosystem Services*, 26, pp.225–235. Available at: http://linkinghub.elsevier.com/retrieve/pii/S2212041617301171.

Zulian, G. et al., 2017. Practical application of spatial ecosystem service models to aid decision support. *Ecosystem Services*. Available at: http://www.sciencedirect.com/science/article/pii/S2212041617302358.

Annexes

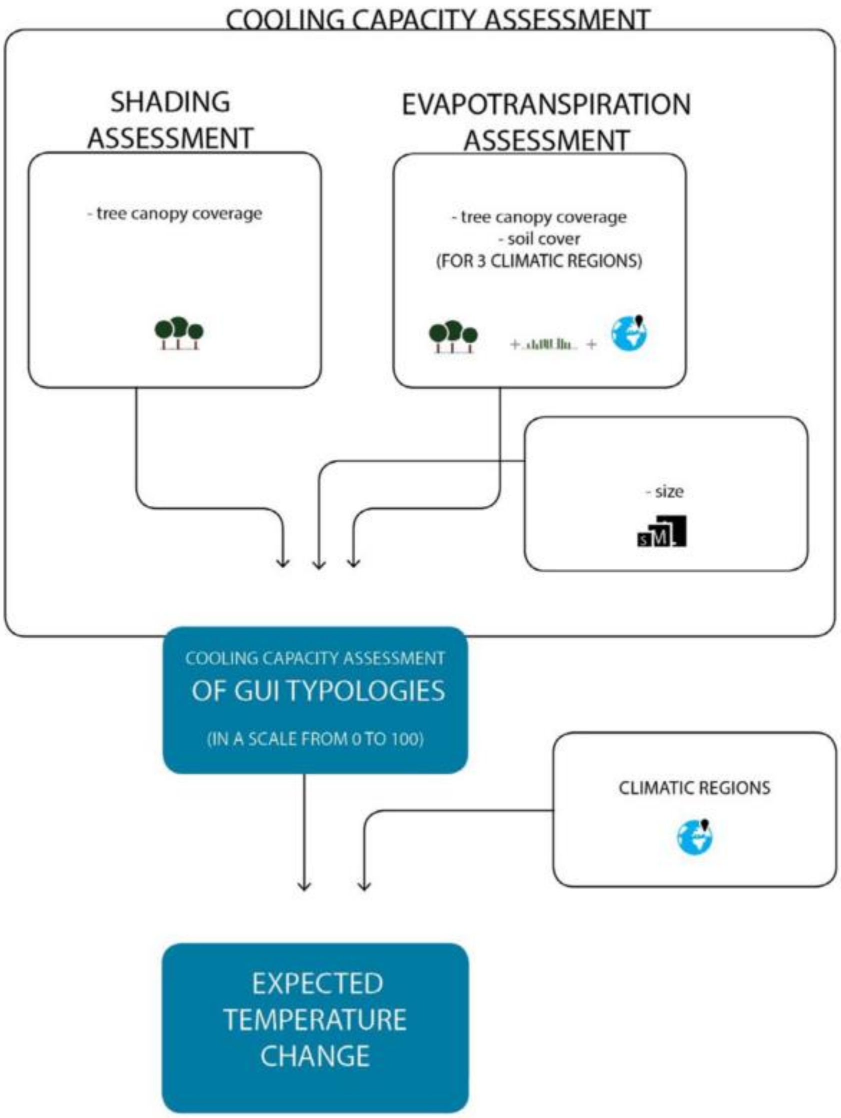


Figure 1.4. An approach for assessing the cooling capacity of green urban areas (Source: Zardo et al. 2017)

METHOD CARD: PROCESS-BASED MODEL Applied to: Micro and regional climate regulation (2.3.5.2)	
CASE STUDY	Trento
SCALE	Local
TYPE	Biophysical
TIER	2/3
DESCRIPTION	
The method is specifically tailored for the assessment of the cooling capacity and cooling effect of urban green infrastructure, in the European context. It estimates the two main functions involved in cooling, namely shading and evapotranspiration, depending on the structural features of urban green infrastructure components (i.e., soil cover, percentage of canopy cover, and dimension of the area). Based on an analysis of the three structural features, each green infrastructure component can be classified into one of the 50 combinations identified by the model. For each combination, the cooling capacity is expressed by a score from 0 to 100. The scores can then be classified into 5 classes, from A to E, which correspond to a range of temperature differences between the analysed area and the surrounding, depending on the climatic zone (i.e. Atlantic, Continental, and Mediterranean). Finally, the cooling effect perceived in the surroundings is modelled by applying different omnidirectional spatial decay functions depending on the dimension and the shape of the green infrastructure component. For a detailed illustration of the method and the scoring tables refer to Zardo et al. (2017).	
1. DATA REQUIREMENT	
Qualitative	• Climatic zone, i.e. Atlantic, Continental, or Mediterranean
Quantitative	• Soil cover map classified into 5 categories (i.e. water, grass, heterogeneous, bare soil, sealed) and dimension of each area of homogenous soil cover. • Percentage of canopy coverage over each area (e.g. based on aerial or satellite images).
2. RESOURCES REQUIREMENT	
Time	• Running the model on a city can take a few days, data preparation may be more demanding
Cost	• The analysis can be run with free GIS software, related paper is open access.
Expertise	• Good GIS skills needed.
Tools & equipment	• GIS software to run the model.
3. LINKS AND DEPENDENCY ON OTHER METHODS	
Biophysical	•
Socio-cultural	• Analysis of the different categories of beneficiaries and levels of demand (e.g. vulnerability to heat stress). • Accessibility analysis.
Economic	• Replacement cost methods (e.g. savings in artificial cooling) • Avoided cost (e.g. health benefits in terms of reduced hospital admissions)
4 COLLABORATION LEVEL	
Researchers own field	•
Researchers other fields	•
Non-academic stakeholders	•
5. SPATIAL SCALE OF APPLICATION[1]	
Local	• Appropriate, the method was specifically developed for urban contexts (in EU).
Regional	• Not applicable.
National	• Not applicable.
Pan European	• Not applicable.
6. EXAMPLES OF POLICY QUESTION	
	• How does green urban infrastructures affect the local microclimate? • Which parts of the city benefit most from the cooling effect of urban green infrastructure? • How to design new areas that maximize the related cooling effect?

METHOD CARD: ESTIMAP Applied to: Physical use of land- /seascapes in different environmental settings (3.1.1.2)	
CASE STUDY	Trento
SCALE	Local
TYPE	Socio-cultural
TIER	2/3
DESCRIPTION	
ESTIMAP (Ecosystem Service Mapping Tool) is a GIS model based approach to spatially quantify ES, developed to support ES policies at a European scale (Zulian et al., 2013b; Zulian *et al.*, 2017). The ESTIMAP models for recreation (Liquete et al., 2016; Paracchini et al., 2014; Zulian et al., 2013b; Zulian *et al.*, 2017) is an Advanced multiple layer LookUp Tables" (Advanced LUT); it measures the capacity of ecosystems to provide nature-based outdoor recreational and leisure opportunities. It consists of three basic sections: (1) The Recreation Potential (RP), which estimates the potential capacity of ecosystems to support nature-based recreation activities based on land suitability for recreation and the natural, infrastructure and water features that influence recreational opportunity provision; (2) The Recreation Opportunity Spectrum map (ROS), which combines a proximity-remoteness concept with the potential supply (RP), and depends on the presence of infrastructure to allow access and profit from the potential opportunities; and (3) The use, or demand, of a service based on an analysis of population or users accessibility. The Recreation Potential is a spatially-explicit indicator ranging from 0 to 1; the Recreation Opportunity Spectrum is also a spatially-explicit indicator classified into nine categories that combine high/medium/low Recreation Potential with high/medium/low level of accessibility.	
1. DATA REQUIREMENT	
Qualitative	• (For local applications) input from local experts and stakeholders to assign weights to the different data used in the model
Quantitative	• Natural features supporting recreation, e.g. for EU application: water elements with related quality, natural protected areas, land uses with related degree of naturalness; • Accessibility parameters, e.g. for EU application: road network and urban areas; • Demand of recreation, e.g. for EU application: population density map; • Other/more detailed data can be used in local applications (e.g. accessibility can be assessed based on the presence of cycle paths, bus stops, parking areas etc.)
2. RESOURCES REQUIREMENT	
Time	• Data preparation and adjustment of the model to include all the elements of interest are the most demanding part.
Cost	• The analysis can be run with free GIS software.
Expertise	• GIS software expertise required for preparing the data. At present, to run the model may require some support from experts at the JRC.
Tools & equipment	• Computer, GIS software
3. LINKS AND DEPENDENCY ON OTHER METHODS	
Biophysical	• No needed
Socio-cultural	• stakeholder and experts consultation to identify local preferences and validate results
Economic	• e.g. travel costs or choice experiment to derive weights
4 COLLABORATION LEVEL	
Researchers own field	• None
Researchers other fields	• Researches from both natural and social sciences with an interest in green areas of in recreational activities can provide useful input
Non-academic stakeholders	• Local experts and stakeholders involved in the management of green areas or with an interest in nature-based recreational activities
5. SPATIAL SCALE OF APPLICATION[1]	
Local	• Yes, the model can be adapted to include locally relevant data (e.g. in Zulian et al. 2017).

Regional	• Yes, the model can be adapted to include locally relevant data (e.g. in Zulian et al. 2017).
National	• Yes. However, the results at the national level can be drawn from the EU level application
Pan European	• Yes. ESTIMAP was developed for this scale
6. EXAMPLES OF POLICY QUESTION	
	• What is the recreational potential of the study area? • Are opportunities for nature-based recreation equally distributed across the study area? • How many citizens have access to an area of high recreation potential close to home?

Case study booklet for:
WORKSHOP VII "Testing the final methods in policy and decision-making" held in Trento, Italy, 22-25 January 2017

Source: groenplan antwerpen www.antwerpen.be

2. Mapping green infrastructures and their ES in Antwerp

January 2018

ESMERALDA partner: Vlaamse Instelling Voor Technologisch Onderzoek N.V. (VITO)

Case Study Coordinators: Liekens Inge & Steven Broekx

ESMERALDA

Enhancing ES mapping for policy and decision making

2.1. Case study factsheet and study area description

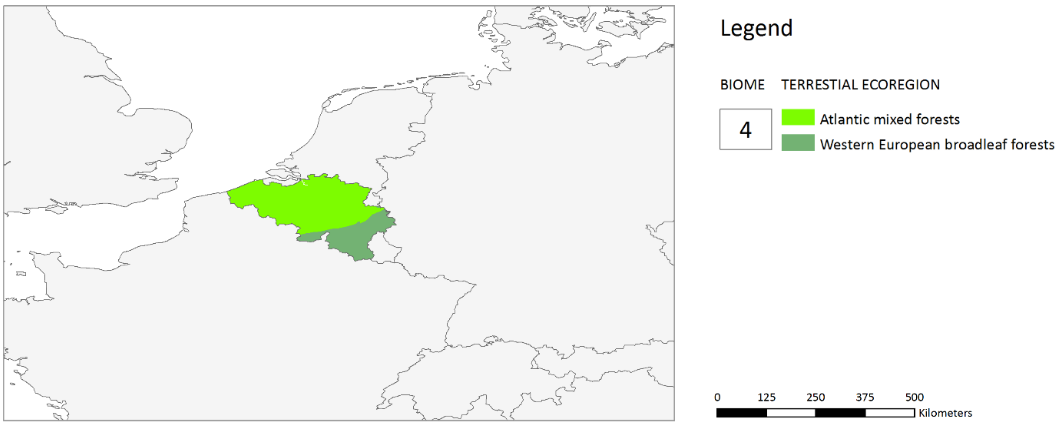
Mapping green infrastructures and their ES in Antwerp

WS7_cs2a

NAME AND LOCATION OF STUDY AREA	City of Antwerp
COUNTRY	Belgium

STATUS OF MAES IMPLEMENTATION	Stage 1	Stage 2	**Stage 3**

BIOMES IN COUNTRY	1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests**
	5 Temperate Conifer Forests	6 Boreal Forests/Taiga
	8 Temperate Grasslands, Savannas & Shrublands	11 Tundra
	12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
	14 Mangrove	



case study outline

SCALE	national	sub-national	**local**
AREAL EXTENSION	**Ca. 200 km²**		

THEMES	nature conservation	climate, water and energy	marine policy	natural risk
	urban and spatial planning	**green infrastructures**	agriculture and forestry	business, industry and tourism
	health	ES mapping and assessment		

ECOSYSTEM TYPES	**urban**	cropland	grassland	woodland and forest
	heatland and shrub	sparsely vegetated land	wetlands	rivers and lakes
	marine inlets and transitional waters	coastal	shelf	open ocean

Study area description

Antwerp is the second largest city in Belgium. It has 517 000 inhabitants and a surface of 204.5 km². The city is a mix of a highly urbanized central area, with a clear shortage of available green space, some larger important conservation areas at the borders of the city, and an industrial harbour area. The tidal river Scheldt, which runs through the city, and neighbouring wetlands are also important ecosystems.

The city has the ambition to become greener (see Figure 2.1). To achieve this purpose, a masterplan on green and blue infrastructure was developed, focusing on five "park-regions". The master plan includes large-scale restoration projects (e.g. *parkspoor Noord*: transform former railway station to urban park; *park groot Schijn*: restore a green-blue corridor and connect a large nature area to the city) and small-scale initiatives such as garden streets, green facades and urban farming. Beside this citywide strategic plan, nine local green plans at district level and one for the harbour area are currently under development or planned.

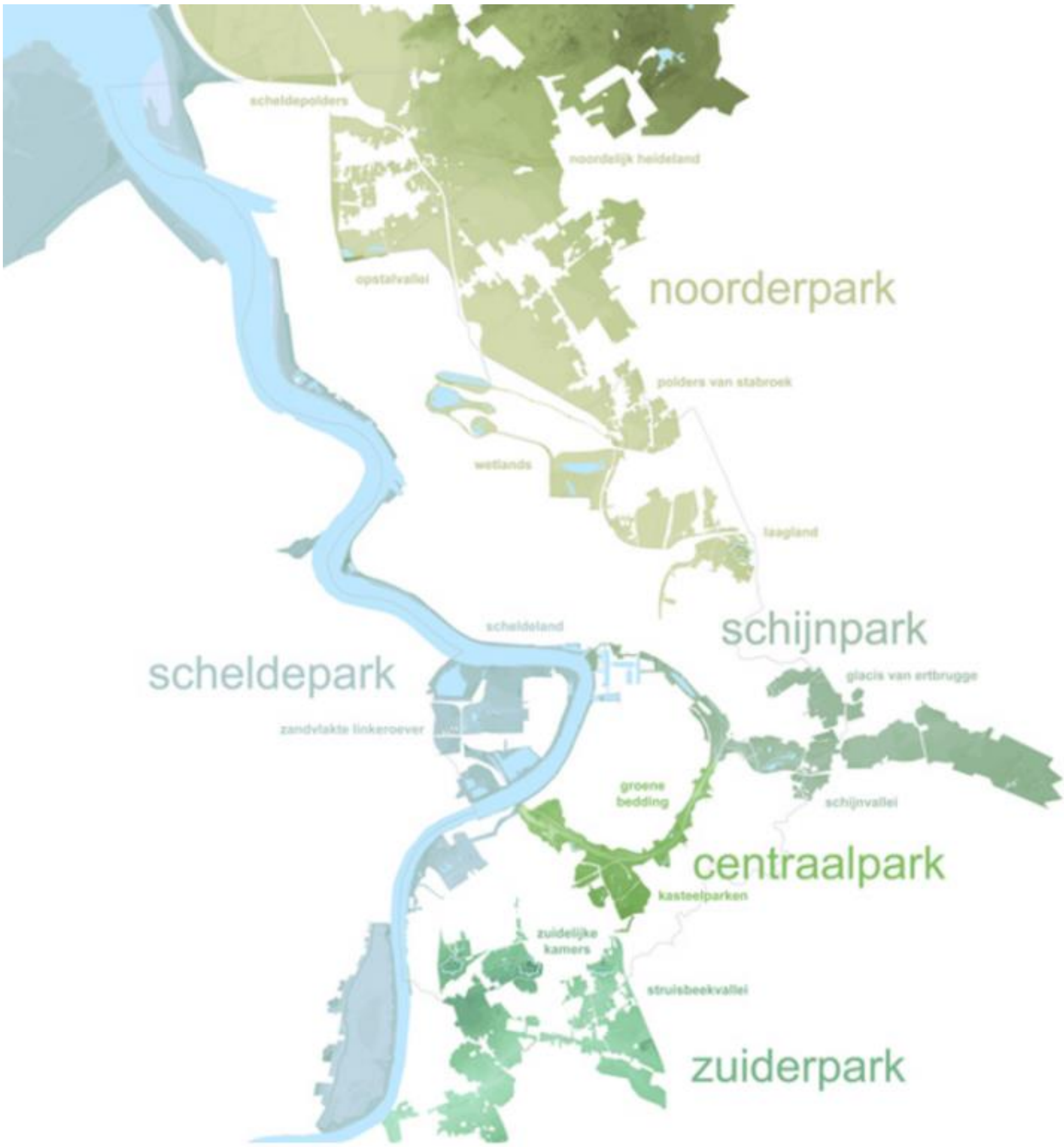


Figure 2.1: Key park regions and corridors in the Antwerp green masterplan

2.2. Main policy question and theme

2.2.1. Objectives of ES mapping and assessment

Establishing win-win situations for different topics simultaneously with green and blue infrastructure is a key ambition of the city and its strategy. Mapping and assessing the impacts of green infrastructure will help to achieve this. For this purpose, the city developed the ***Antwerp Greentool***, which contains different ES maps and integrated assessment tools (see https://groentool.antwerpen.be/). It is only available in Dutch but “gebiedsanalyse” is self-explanatory.

The objective of the *Greentool* is to inspire spatial planners and city officials to take smart and green measures when developing urban locations. For this purpose, it provides different sorts of information:

1) General Insights into the advantages of including vegetation and water bodies in urban developments (literature review). The degree of positive impact of various ‘smart’ measures can be seen on the following environmental factors:
    - Air quality
    - Heat Stress
    - Noise
    - Water management
    - Nature and Biodiversity
    - CO2-capture
    - Recreation
    - …

2) An overview of the existing environmental quality is provided allowing the existing environmental challenges to be identified (pressure maps).
    - The effects of a large database of green and blue measures can be performed for each topic (expert based evaluations).
    - Suggestions of interesting measures to users for locations of their interest
    - The measures are applicable on different scales: street level up to city wide
    - Analysis is based on cartographic information:

3) Maps presenting the impact of possible measures

The tool can be applied to benchmark sites owned by city authorities, support management plans and can be made mandatory for urban development plans to ensure spatial planners take into account environmental challenges and liveability.

The tool is inspirational. The idea is to supply easily available information (it should not take more than 1 hour), to non-expert users.

2.2.2. Role of stakeholders

The development of the tool and all maps was done in close cooperation with the city authorities (department sustainable city, with focus on energy and environment). During the project, other departments such as the biodiversity department and the spatial planning department were consulted. Generally, the tool supports the development of local green plans, which involves the consultation of local citizens.

2.3. Ecosystem Types and Conditions

2.3.1. Identification and mapping of ecosystem type(s)

The major ecosystem type is "Urban". Other important habitats include forests, wetlands and grasslands.

2.3.2. Assessment of ecosystem conditions

Condition indicators:

- Land cover map taking into account a tree inventory and the presence of green roofs (proportions of land use)
- Biodiversity: identification of key protected areas and corridors.

Pressure indicators:

- air quality (yearly average concentrations EC, Nox, PM10, PM2,5 in µg/m³)
- noise hindrance (dB)
- urban heat (radiation temperature during a heat event in °C)
- flood risk pluvial flooding (risk: non critical risks < T 20years; low critical T 20 years; highly critical T 5 years; very critical T 2 years)
- areas with shortage local green (m² of green area per inhabitant)

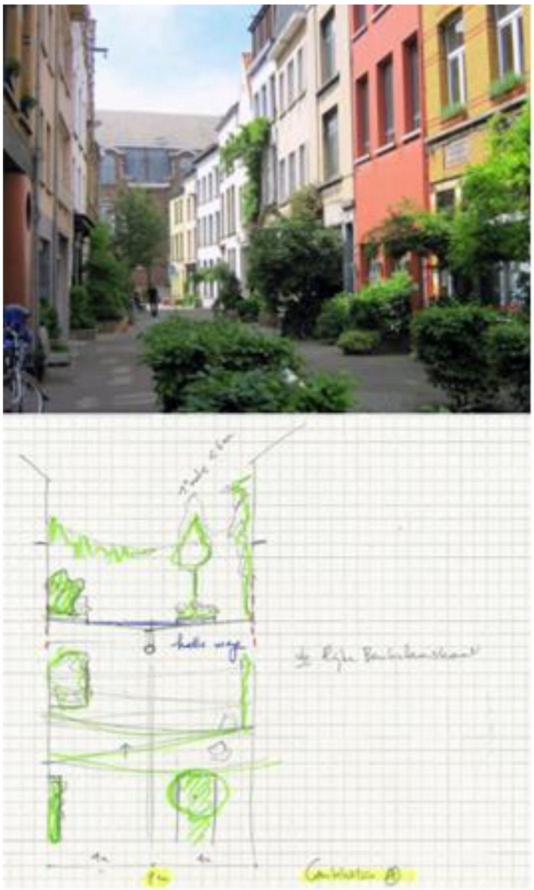
A lot of effort was invested in setting up a suitable typology of urban green infrastructure and developing a map of the current situation (see Table 2.1). This is based on existing morphological classifications of land use maps, green management, green infrastructure (example categories are green roofs intensive, extensive; semi-hardened surface; tree rows; SUDs; grass field; hedges and shrubs; coniferous – broadleaved forest.

Table 2.1: Typology of urban green infrastructure applied for Antwerp

Level 1	**Level 2**	**Level 3**
Green roofs	Extensive Green roofs	
	Semi intensive green roof	
	Intensive green roof	
Pavements	Closed pavements	
	Semi-hardened pavement	
	Open pavements (soil, woodchips, broken fractions)	
Water and Humid Vegetation	Water	
	Humid vegetation	
	Suds	
Open vegetation	Bare soil	
	Flower meadow and herbaceous vegetation	
	Grass field, lawn	
	Heathland	
	Private gardens (low vegetation)	
	Agricultural landuse	Community gardens/kitchen garden
		Other agricultural landuse
Bushes, hedges and wood sides		
Forest	Deciduous forest	Tree height <6m; 6-12m; >12m
	Coniferous forest	Tree height <6m; 6-12m; >12m
	Mixed forest	Tree height <6m; 6-12m; >12m
	Forest edge vegetation	Tree height <6m; 6-12m; >12m
City trees	Deciduous trees	Tree height <6m; 6-12m; >12m
	Coniferous trees	Tree height <6m; 6-12m; >12m
	Mixed trees	Tree height <6m; 6-12m; >12m
	Orchard	
Facades and walls	Green walls	
Build surface		

We also provide 12 inspirational street images from Antwerp or other cities to roughly estimate the impact of combined measures (see examples in Figure 2.2).

Street typology 1: Garden street Antwerp



Street typology 2: Copenhagen water street

Figure 2.2. Examples of inspirational street typology

2.4. Mapping and assessment of ES

2.4.1. Identification of ES

The ES were selected based on expert knowledge and relevance for the city authorities. The following Table 2.2 lists the selected ES, classified using the CICES v4.3 (2013) classification, and related assessment method categories.

Table 2.2. Overview of the ES and related mapping and assessment methods in the Antwerp case study

Ecosystem Service selected for mapping and assessment	B	S	E
2.3.5.1 Global climate regulation by reduction of greenhouse gas concentrations	X		
2.3.5.2 Micro and regional climate regulation	X		
2.1.2.3 Mediation of smell/noise/visual impacts	X		
2.1.2.1 Filtration/sequestration/storage/accumulation by ecosystems*	X		
2.2.2.1 Hydrological cycle and water flow maintenance	X		
3.1.1.2. Physical use of land- /seascapes in different environmental settings*	X		

* ES selected for further discussion during ESMERALDA workshops 7 in Trento;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

2.4.2. ES mapping and assessment: biophysical methods

An expert based scoring table was applied to map the impact of measures (tier 1). This was combined with outcomes from process based models for modelling pressures (tier 3 for noise, urban heat island effect, air quality, risk for pluvial flooding; tier 1 for recreation) to identify interesting locations for green infrastructure.

Impact calculation:

*impact_measures = pressure * (impact_score measure – impact_score existing situation)*

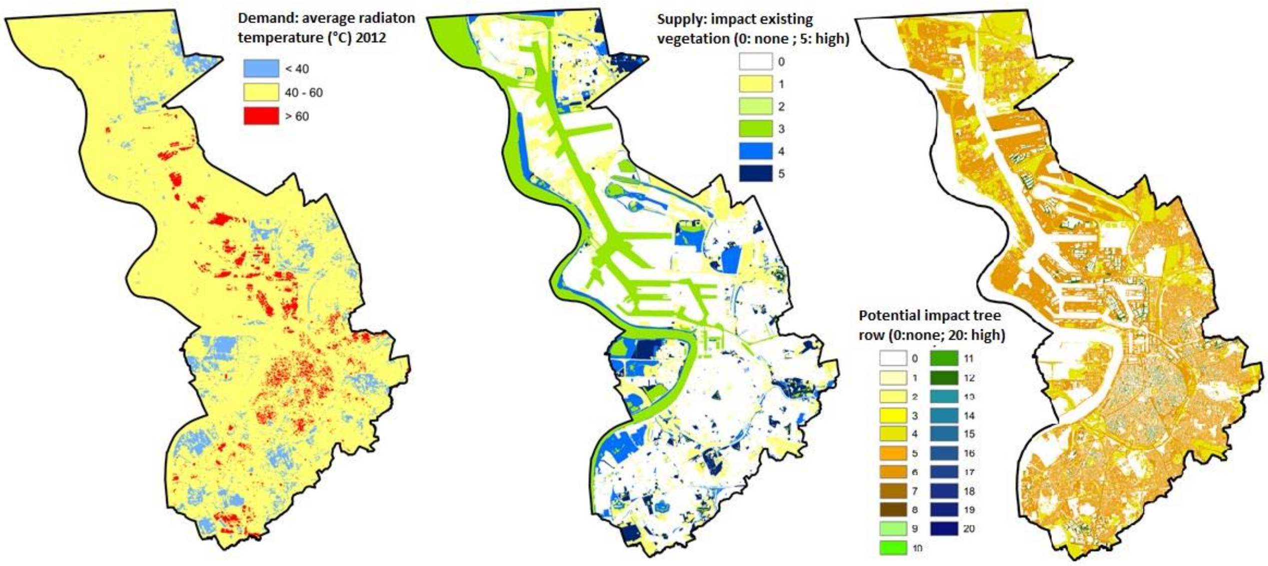


Figure 2.3: ES maps for heat stress in Antwerp. Supply from existing vegetation and water is scored from none (0) to maximal (5). Based on a heat map of the city and population densities the demand is mapped leading to zones with varying degrees of impact vegetation. Taking into account the current supply and demand, the potential for green measures is calculated, and scored from no potential (0) to maximal potential (20).

2.4.3. ES mapping and assessment: socio cultural methods

No socio-cultural mapping and assessment methods were applied

2.4.4. ES mapping and assessment: economic

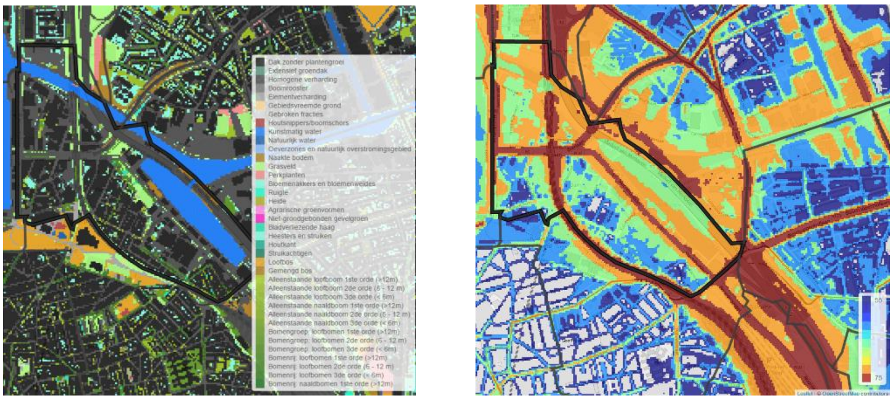
No economic mapping and assessment methods were applied.

2.5. Use and integration of ES mapping and assessment results

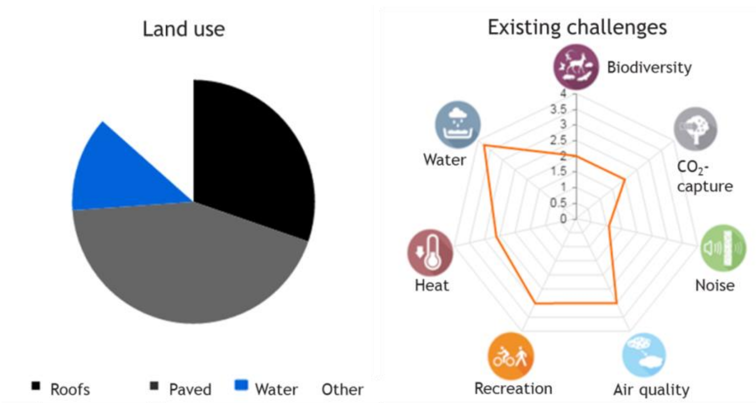
To allow an easy overview on the condition (land use distribution, pressures)**,** the *Greentool* allows users to select an area and get a quick overview (star diagram) of all the pressures. This information, in combination with other data such as the presence of buildings, **street canyons**, open spaces to assess the suitability of the area to implement specific measures, allows to assess the impact of specific types of measures.

2.5.1. Applying the *Greentool*

*Step 1**: Select an urban area in an interactive map: noise map with noise levels in dB and selection of an area (left) and land use - buildings, infrastructure, vegetation, water** etc. **(right).***



Step 2: Analyze current situation for selected area: land use composition - existing pressures



Step 3: Assess the suitability and impact to install specific types of green infrastructure in this area

2.5.2. Methodological challenges

General feedback of users given on the existing methodologies is that a quick feedback on identification of the pressures in the selected area is very relevant and of high added value. Impact calculation of the measures and top five list of most suitable measures could improve.

The general challenge remains on improving the usability of maps and assessments for selecting suitable building blocks for local green plans.

General expert question: Is it sufficiently credible? Yes/no? Where do you see major knowledge gaps and challenges for further improvement? How to bridge the gap with spatial planners?

This general question is split into the following five groups of specific questions found in annex:

- Typology
- Selection of indicators
- Impact calculation
- Integrated assessment
- Communication of results and use

2.6. References

https://groentool.antwerpen.be

https://www.natuurwaardeverkenner.be/

2.7. Annexes

Table 2.3: Biophysical ranges as a baseline for expert based evaluation of impact green infrastructure

Score	Heat stress reduction	Air quality improvement	Noise buffer	kg C seq. per year per m²	Recreation & Amenity
5	-2°C	> 15% improvement local air quality	>=10 dBA	0.79 - 1.18	High visibility and a lot of evidence positive impact on amenity, recreation
4	-1.5°C	> 10%	>=5 en <10 dBA	0.74 - 1.08	High visibility and some evidence positive impact
3	-1°C	> 5%	>=3 en <5 dBA	0.45 - 0.79	Average visibility (low vegetation), some evidence positive impact
2	-0.5°C	> 1%	>=1 en <3 dBA	0.40 - 0.74	Low visibility, some evidence positive impact
1	-0.5 tot 0°C	< 1% improvement	>0 en <1 dBA	0.05 - 0.40	Low visibility, very little evidence positive impact
0	no impact	no improvement	0 dBA	< 0.05	No impact
-1		negative	< 0dBA	n.a.	n.a.

Table 2.4: Impact scores major types green infrastructure elements (expert based)

Green infrastructure element	Heat	Air quality open	Air quality canyon	Air quality buffer	Noise	Carbon seq.	Biodiv esity	Water	Amenity and recreati on
Extensive Green roofs	1	0	0	0	4	1	1	3	0
Semi intensive green roof	2	1	1	1	4	2	2	3	1
Intensive green roof	3	2	2	2	4	3	3	4	1
Closed pavements	0	0	0	0	-1	0	0	0	0
Grass dales	1	0	0	0	2	0	2	2	0
Broken fractions	1	0	0	0	1	0	0	3	0
Wood chips	1	0	0	0	2	0	0	3	0
Water	3	0	0	0	-1	0	4	5	4
Humid vegetation and wetlands	4	0	0	0	1	1	5	4	3
SUDS	2	0	0	0	0	1	3	5	3
Bare soil	1	0	0	0	0	0	1	3	2
Grass field	1	0	0	0	2	1	3	5	3
Flower meadow	1	0	0	0	3	1	5	5	3
Heathland	1	0	0	0	3	1	5	5	3
Agriculture	1	0	0	0	3	1	3	5	3
Green walls	1	1	1	1	3	1	1	1	2
Hedges	2	1	-1	1	3	2	1	4	3
Shrubs	2	1	n.a.	2	2	2	4	5	4
Deciduous forest	5	3	n.a.	5	4	5	4	5	5
Forestedge vegetation	1	1	n.a.	1	2	2	5	5	5
City tree deciduous(>12m)	2	2	-1	2	1	4	4	4	4
City tree deciduous (6 - 12 m)	1	1	-1	2	1	3	4	3	3
City tree deciduous (< 6m)	1	1	-1	2	1	2	3	3	3
Biodiversity friendly building elements	0	0	0	0	0	0	4	0	0

Specific expert questions to be discussed during workshop:

a) Typology of green (land cover map):

Expert questions:

- Do you have suggestions on how we can incorporate tree canopy data and information of private gardens? What are suitable data layers and methodologies?
- How to deal with two-dimensional information? (tree crown versus soil coverage, green walls)
- Scale: what is an appropriate scale for the line of questioning? Is 10x10m sufficiently detailed?

b) Indicator selection

Expert questions:

- Are the applied indicators suitable for the objective of the tool?
- Do you see important topics missing?
- Are the applied indicators good to assess the pressures for the different topics? Do you have alternative suggestions?
- Does including biophysical, social and economic valuation add value to the evidence base for the decision making process? If yes, how and how to approach this?

c) Impact calculation

Large simplification of impact calculation due to lack of knowledge and calculation complexity. Assessment of quantitative impacts of process-based models is not an option (scenarios). Biophysical (e.g. tonnes), social and economic valuation was not expressed as a need by the users.

Expert questions:

- Impact calculation depends heavily on the local pressure in the existing methodology (cell values). Is this problematic? Do you know methodologies to overcome these problems? And do you have good examples? (E.g., distance decay functions)
- Can/should we standardize scores based on the importance of the impact? (e.g. in terms of health)
- Diversity on impact of measures can be large between different species (e.g. tree species). Is credible information available on this? Where can we find this information?
-

d) Prioritization of measures / integrated assessment

The star diagram is used to demonstrate the integrated impact on different topics.

Expert questions:

- What is your feeling about these star diagrams? Does it answer the need of the tool?
- Do you see possible improvements? Do you have inspirational examples?

e) Communication of results and use

The tool is intended to be used on a voluntary basis. As many small projects are happening where it is not feasible to do detailed model calculations/scenario analysis on specific topics, this tool can serve as an explorer to assess small-scale impacts of urban greening. Additionally, it needs to help to identify priority areas on a city scale. Inspiration is an important key word. Not decision.

Target audience: city administrations, consultancies, urban planners, citizen organizations.

Multi-scale application:

- Project level/street level: Design book management of public spaces – can a sustainability check be built in the building code to underpin selection of measures?
- City level: where are the top five locations to install green roofs?
- What is the contribution of projects, specific measures, to sustainable development goals?

Time foreseen for use: the idea is that the user gets feedback within 1 hour.

Expert questions:

- Does the intended use corresponds with the tool set up? Do you see issues?
- Do you see other potential uses to support decision-making?
- Do you have other examples where similar tools are used in a similar context?
- How to improve usability? How to improve the process organization and the inclusion of the tool / maps in this?
- What can we learn from social valuation/participatory techniques in this perspective?

METHOD CARD: SPATIAL PROXY METHOD (EXPERT SCORING) Applied to: Filtration, sequestration/storage/accumulation by ecosystems (2.1.2.1)	
CASE STUDY	Antwerp Green tool
SCALE	Local
TYPE	Biophysical
TIER	1
DESCRIPTION	
A list of possible green measures is assembled. Experts are questioned to give a score on the rate (between 0 and 10) a certain green measure supplies a certain ecosystem service (in this example capturing capacity of fine particles by green). This score is combined with pressure maps (air quality PM10 concentrations) based on process based models	
1. DATA REQUIREMENT	
Qualitative	• Score per green measure
Quantitative	
2. RESOURCES REQUIREMENT	
Time	• Low to medium time (survey set up and literature research). Process based model: very high
Cost	• low
Expertise	• Expert survey
Tools & equipment	• /
3. LINKS AND DEPENDENCY ON OTHER METHODS	
Biophysical	• Scores can be linked to biophysical quantification methods (kg of PM10 captured yearly) (multiplication)
Socio-cultural	• Participative approaches: scores can be used in discussions with stakeholders
Economic	• Replacement cost approach or social cost method has been applied in some studies
4 COLLABORATION LEVEL	
Researchers own field	•
Researchers other fields	• Air quality experts working particularly on PM emissions and capturing by green
Non-academic stakeholders	
5. SPATIAL SCALE OF APPLICATION[1]	
Local	• Highly appropriate, but more quantitative methods can be used.
Regional	• Appropriate.
National	• Appropriate.
Pan European	/
6. EXAMPLES OF POLICY QUESTION	
	• Which green measures are best to lower the pressure of bad air quality due to fine particles in the city? • At which location in the city these green measures are best taken? • Where is the demand for capturing fine particles the highest? Where is air quality a severe pressure?

METHOD CARD: SPATIAL PROXY METHOD (EXPERT SCORING) Applied to: Physical and intellectual interactions with environmental settings (availability of green infrastructure) (3.1.1.2)	
CASE STUDY	Antwerp Green tool
SCALE	Local
TYPE	Biophysical
TIER	1
DESCRIPTION	
A list of possible green measures is assembled. Experts are questioned to give a score (between 0 and 10) on the rate a certain green measure supplies a certain ecosystem service. The score for recreation is the average of 3 expert scores for visibility, naturalness of vegetation and attractiveness for recreation. The visibility score for green infrastructures that are less visible from public places (e.g. green roofs) get a low score, whereas big trees that are visible from a longer distance get the highest score. As naturalness is an important element for the attractiveness of green landscapes, more natural vegetation (wetlands) types get a higher score. The score for attractiveness for zero for non-accessible areas (e.g. green roofs), lawns and low vegetation get a middle score whereas vegetation types that were identified in literature as very attractive, such as forests or natural waters get a high score. Also individual trees get a higher score, as they mitigate visual intrusion. It has to be noted that the score does not account for size of the area or scarcity (e.g. important for parks) and population density. These scores were combined with a pressure map on the availability of green space for recreation. This pressure map was created by clustering the available accessible green within 400m of inhabitants using a national land use map (10x10m), green map and tree map of the city of Antwerp. On this map hot spots and cold areas could be detected. This cold areas could be linked to possible measure to lower the shortage of available green for recreation in a certain neighbourhood	
1. DATA REQUIREMENT	
Qualitative	• Score per green measure based on attractiveness
Quantitative	• Available green space within 400m of home location, based on a detailed LU-map (10x10m resolution).
2. RESOURCES REQUIREMENT	
Time	• Low to medium time (survey set up and literature research) • Land use map costs time to set up using with small green elements in cities (resolution).
Cost	• Low to high (depending on available LU data)
Expertise	• Expert surveys (expert score tables for attractiveness green elements) • GIS
Tools & equipment	• GIS
3. LINKS AND DEPENDENCY ON OTHER METHODS	
Biophysical	• Combined scores (multiplication) based on pressure maps showing the available green within 400m of inhabitants and the attractiveness of urban green elements
Socio-cultural	• Participative approaches: scores can be set up based on discussions with stakeholders
Economic	• Travel cost and contingent valuation studies can be used to monetize this ecosystem service.
4 COLLABORATION LEVEL	
Researchers own field	• Expertise in cultural services/recreation
Researchers other fields	• Experts in GIS;
Non-academic stakeholders	• Possible interaction with non-academic stakeholders on accessibility of green in the neighbourhood.
5. SPATIAL SCALE OF APPLICATION[1]	
Local	• Highly appropriate, but the availability can further be translated to number of visits

Regional	• Appropriate.
National	• Appropriate.
Pan European	/
6. EXAMPLES OF POLICY QUESTION	
	• Attractiveness of an area for walking and biking • Shortage of recreation possibilities in comparison with the demand. High recreation pressure on some areas.

Case study booklet for:
WORKSHOP VIII: "Testing the final methods in policy- and decision-making (II): businesses and citizens" held in Eger, Hungary, 19-22 March 2018

3. ES mapping and assessment for developing pro-biodiversity businesses in the Bükk National Park

March 2018

ESMERALDA partner: MTA ÖK

Case Study Coordinators: Ildikó Arany, Béla Kuslits, Tamás Kállay

ESMERALDA

Enhancing ES mapping for policy and decision making

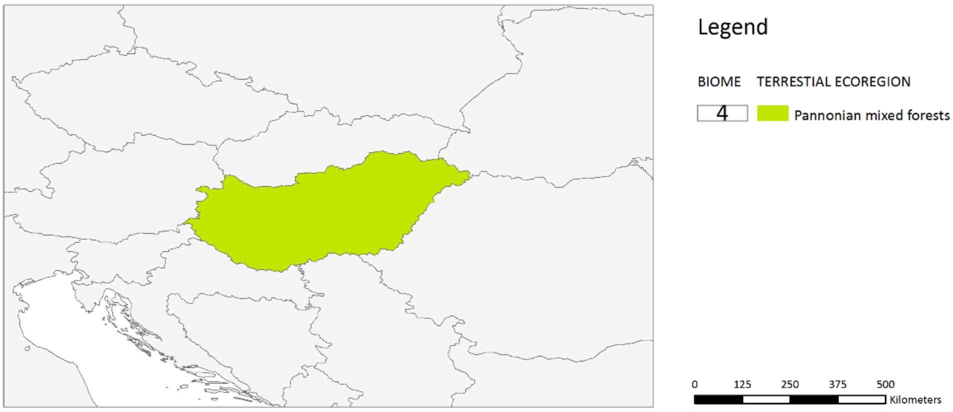
3.1. Case study factsheet and study area description

ES mapping and assessment for developing pro-biodiversity businesses in the Bükk National Park WS8_cs1

NAME AND LOCATION OF STUDY AREA	Bükk National Park, Northern Hungary region, Hungary
COUNTRY	Hungary

STATUS OF MAES IMPLEMENTATION	Stage 1	**Stage 2**	Stage 3

BIOMES IN COUNTRY	1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests**
	5 Temperate Conifer Forests	6 Boreal Forests/Taiga
	8 Temperate Grasslands, Savannas & Shrublands	11 Tundra
	12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
	14 Mangrove	



SCALE	national	sub-national	**local**
AREAL EXTENSION	**432 km²**		

THEMES	**nature conservation**	climate, water and energy	marine policy	natural risk
	urban and spatial planning	green infrastructures	**agriculture and forestry**	**business, industry and tourism**
	health	**ES mapping and assessment**		

ECOSYSTEM TYPES	urban	cropland	**grassland**	**woodland and forest**
	heatland and shrub	sparsely vegetated land	wetlands	rivers and lakes
	marine inlets and transitional waters	coastal	shelf	open ocean

Study area description

Bükk National Park – located in the Bükk Mountains, a part of the Northern Mountain Range of Hungary - was established in 1977 and it covers 43,168.8 hectares. This area is managed and utilized mainly as forest (94.27%) and to a smaller extent, grassland (3.35%, meadow and pasture), while 1.95% is withdrawn from cultivation, 0.42% is arable land, and the remaining 0.01% is vineyards and orchards. Some 97.7% of the national park is state owned, with two forestry companies as managing organizations in charge, while only 2.5% of the area is managed by the Bükk National Park Directorate. However, the subject of our project is the wider local socio-ecological system containing low-intensity areas of settlements, arable lands, grasslands, vineyards and orchards adjacent to the NP territory, reflecting the significance of these land uses and the opportunities offered by them to involve business and citizens (see Figure 3.1).

The Bükk has a great geological diversity including a central karst area with its special features: sumps, caves, deep gorge valleys, lofty rocks. Among others, 45 of its 853 explored caves are strictly protected, including the deepest cave of the country. The karst water treasure in the depth of the mountain is the greatest value of the Bükk, providing more than 1 million people with clear fresh water. As pollution may get into the karst galleries together with the precipitation, karst water is very sensitive. The diversity of geological characteristics, bedrock, soil types, climate and land use allows a great biodiversity of Bükk: it is home to approximately 1500 vascular plants, several endemic fish and invertebrates, high number of bats and diurnal birds of prey as well as large carnivores, to mention a few.

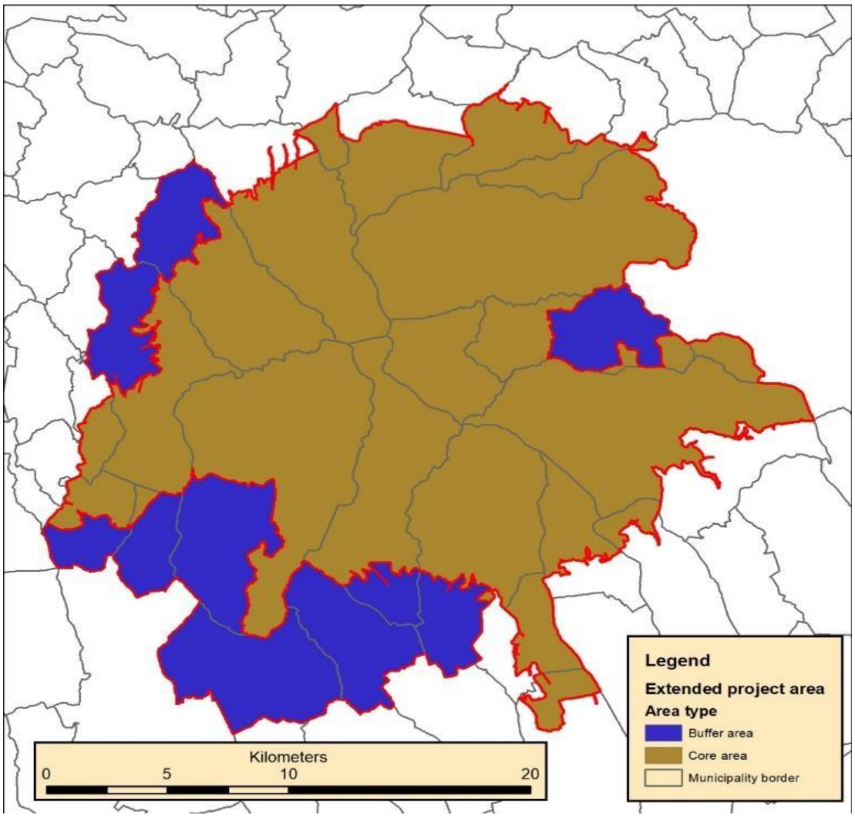


Figure 3.1. Sample map of Bükk National Park by András Schmotzer. Boundaries of the larger focus area represents the whole social-ecological system, and an inclusive core area, with all important spatial information (with special regard to the ecosystem map). The area around the core area is the buffer.

3.2. Main policy question and theme

3.2.1. Objectives of ES mapping and assessment

The project 'Ecosystem services of karst protected areas – driving force of local sustainable development (Eco Karst), funded by the EU Territorial Cooperation Programme, builds on the opportunity to use the natural heritage of protected areas as an economic development factor. The project has started in 2017 and is ongoing until June 2019. It aims to support local development based on the raised awareness and sustainable management of karst ecosystems across the Danube region. The project works with a series of pilot areas including the Bükk National Park in Hungary and combines different disciplines and methods, develops customized methodologies for ES assessment and applies them to the case studies. Ecosystem types are mapped, ES identified, assessed and, where applicable, economically valued and spatially visualized. The results of ES assessment will be a basic resource for the discussion on increasing pro-biodiversity business (PBB) opportunities. Involving various public and private actors into capacity building, networking and know-how transfer, local PBB action plan will be developed by participatory approach. This will contribute to a better balance between nature conservation and local entrepreneurship based on the conservation of biodiversity and awareness on ES. At the time of the compilation of this document, the project is in its first stage, which is why most of the following chapters present concepts, methods or in some cases preliminary results but no final results.

3.2.2. Stakeholders and their role

In general, the Bükk National Park Directorate is a key stakeholders in the region. Its main task is to secure the good state of natural ecosystems, which can provide a wide range of ES. As a non-authority public body they need to cooperate with many regional partners in order to be successful in fulfilling this task. It also authorizes the use of the 'National Park Product' brand for products primarily made from local materials and ingredients. Public awareness-raising, education, introduction of natural values and eco-tourism as well as organization and management of research programmes are also important tasks of BNPD.

More specifically, within the Eco Karst project, assessment of ecosystem services, development of local action plans and the facilitation of pro-biodiversity businesses is directly related to stakeholder involvement. The goal of the process is to involve a big enough group of local people with diverse backgrounds, economic status, expertise and experience. High diversity improves the quality of work significantly, representative selection of stakeholders is important to define goals which are feasible on the longer run. The below steps are followed.

Step 1: Identification of major stakeholder groups and the most important ESs they interact with. This was done by the national park administration, based on their knowledge of the area (Figure 3.2).

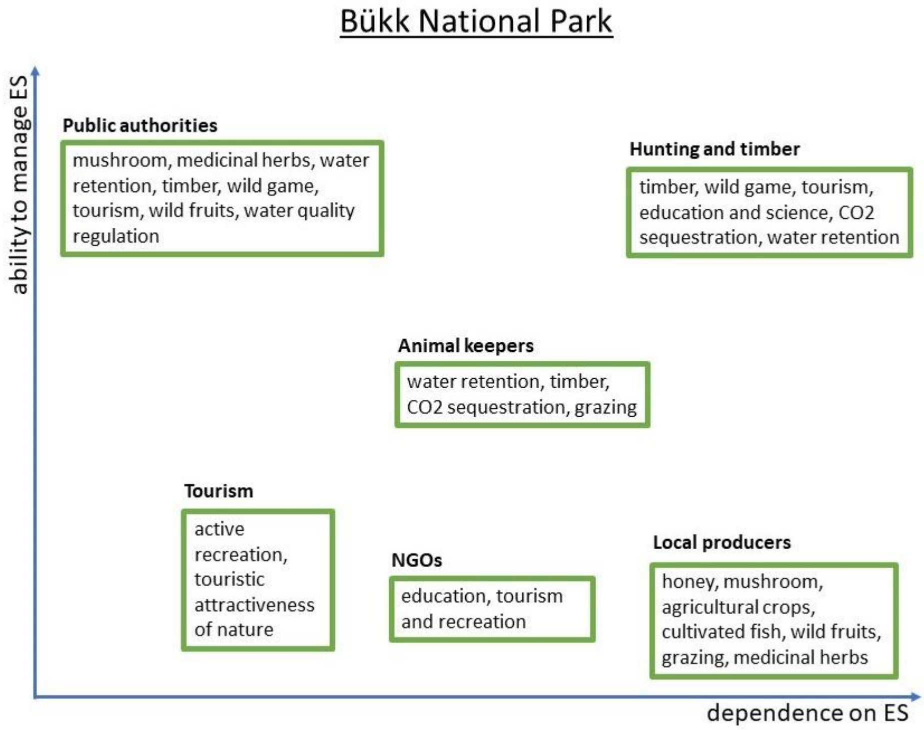


Figure 3.2. Major stakeholder groups of the Bükk NP and the most important ESs they interact with.

Step 2: Stakeholder selection with social network analysis. This method intends to select a relevant sample for larger workshops, where a larger group and the highest possible diversity of views is desirable. The process consists of two main steps: (1) data collection with a simple survey (see questionnaire in Annex 1) and (2) creation of network layout and identification key players among respondents (Figure 3.3). The network layout is drawn by Gephi, which is an open-source network-layout designer software.

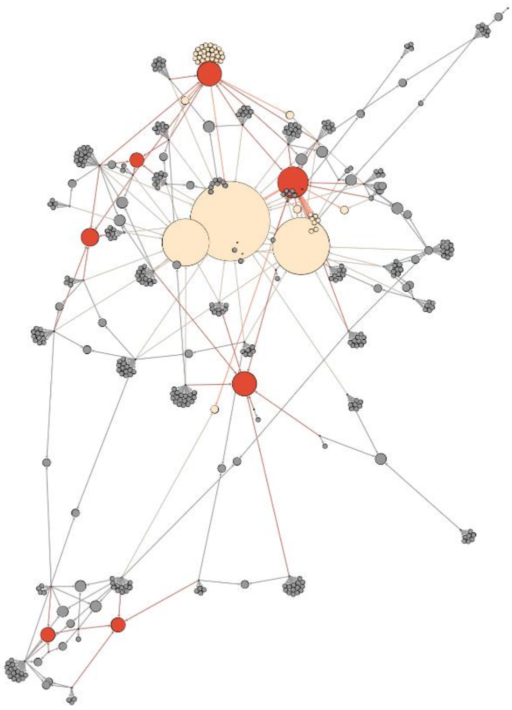


Figure 3.3. First preliminary graph of the social network in Bükk, based on online survey of stakeholders. Nodes represent people or organizations, edges represent communication.

3.3. Ecosystem Types and Conditions

3.3.1. Identification and mapping of ecosystem type(s)

The goal of ecosystem type mapping is to provide the necessary spatial units and basic input for the ES assessment and mapping. The input requirements may differ for the different services and thus the typology and scale of the ecosystem type map needs to be chosen carefully. In this project we use categories of EUNIS level 3. After assembling available information (e.g. existing vegetation/habitat maps) a conversion table was created, where each original class was assigned a EUNIS category. See the conversion workflow in Figure 3.4 and the resulting map in Figure 3.5.

For most ES, further specific customization of the ecosystem type map is necessary. In most cases 'customizing' means a simplification, in order to reduce the number of categories to be considered. It is most easily done by merging some classes. Since in Eco EUNIS is a hierarchical classification, in case of certain ecosystem services we can simply consider using the EUNIS level 2 categorisation of our maps, rather than level 3. But it is also possible to choose other considerations on how to merge the categories according to the ecosystem service we are working with. Technically the simplest way of carrying out this merging of categories is to create a conversion table (old categories → new categories) and join it to the original ecosystem type map layer. This would not necessarily mean a physical merging of habitat patches, only a reclassification added to the attribute table of the map.

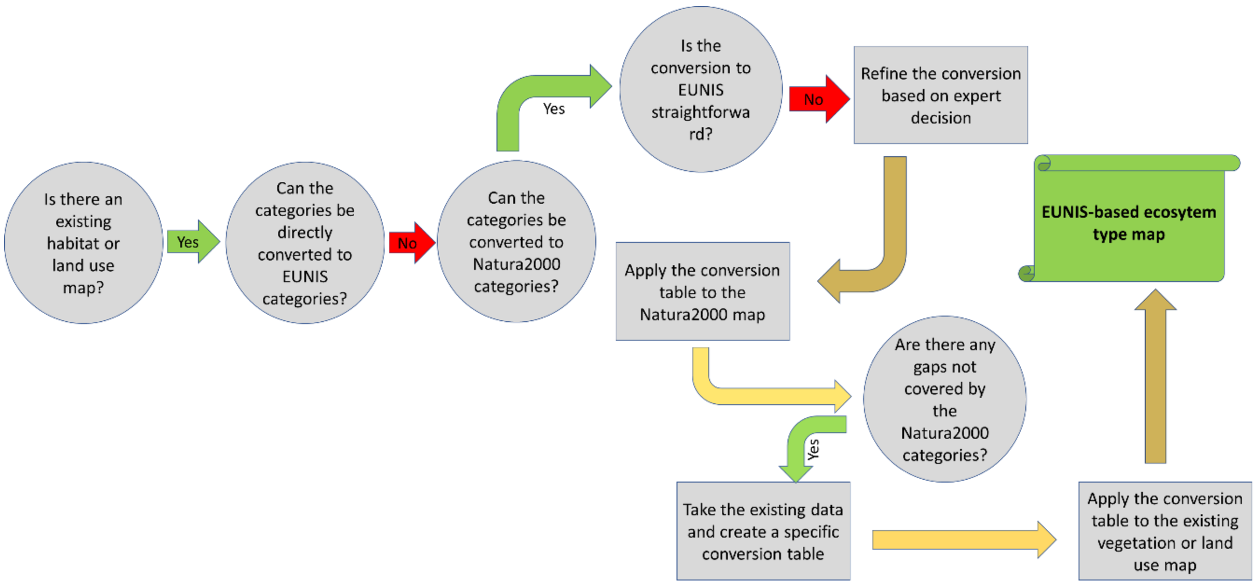


Figure 3.4. Workflow for creating ecosystem type map of the Bükk NP

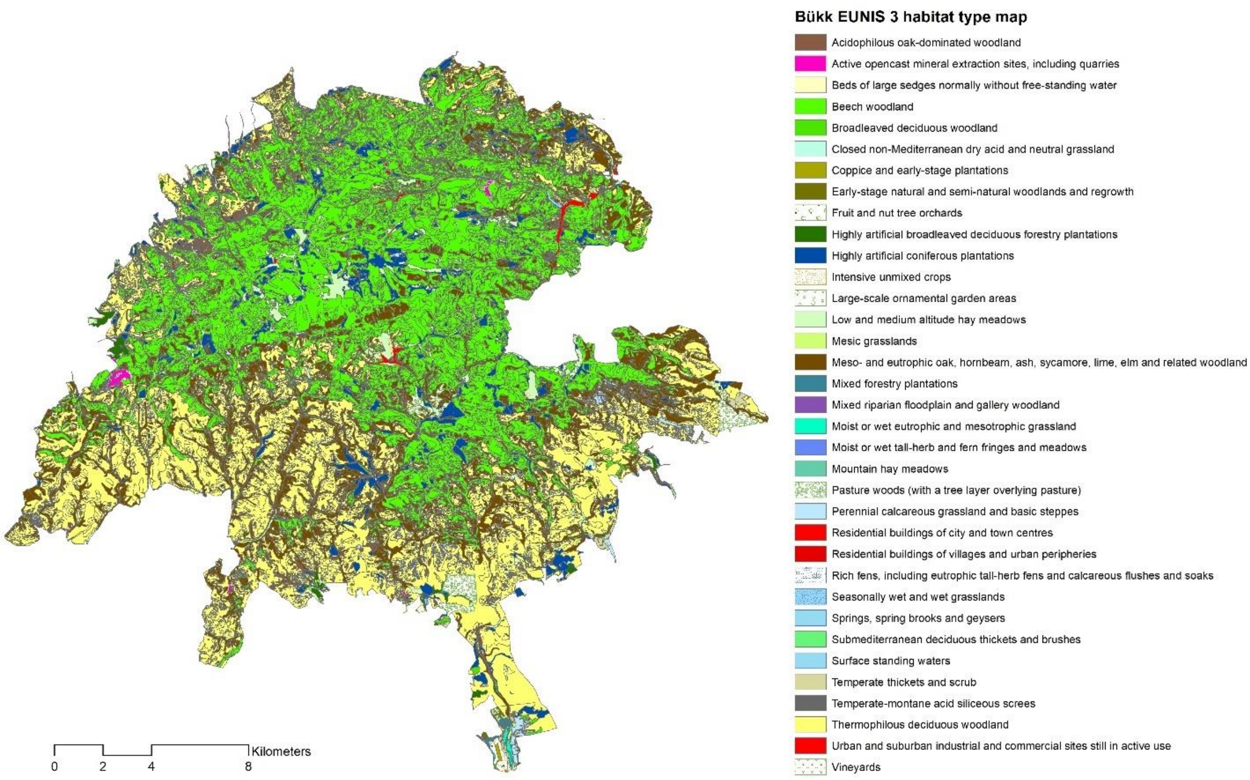


Figure 3.5. EUNIS 3 ecosystem type map of the Bükk National Park.

3.3.2. Assessing ecosystem conditions

A simple model of habitat condition (Figure 3.6) is being developed in the project for mapping ecosystem condition, using naturalness values assigned to ecosystem types and a single modification factor based on the number of protected vascular plant species present in each patch. The method follows the one used in the mapping and evaluation of ecosystem services of Luxembourg by Becerra-Jurado et al. (2015). The naturalness map will be used as input data for the ES maps. The model has the following main components:

- In the first step, all the ecosystem types were assigned a general naturalness value
- In the second step, this categorisation was further refined on the basis of the number of protected species found in each polygon. Modification factors were defined according to the number of protected species present in the polygon: a polygon with 0 or 1 protected species gets 0 as a modification factor, 2-7 species +1 and more than 8 species +2. The scores and the modification values were then added up. In the final step we reclassified the resulting values so that the scale remains 1-5 (in this case values of 6 or 7 were reclassified to 5).

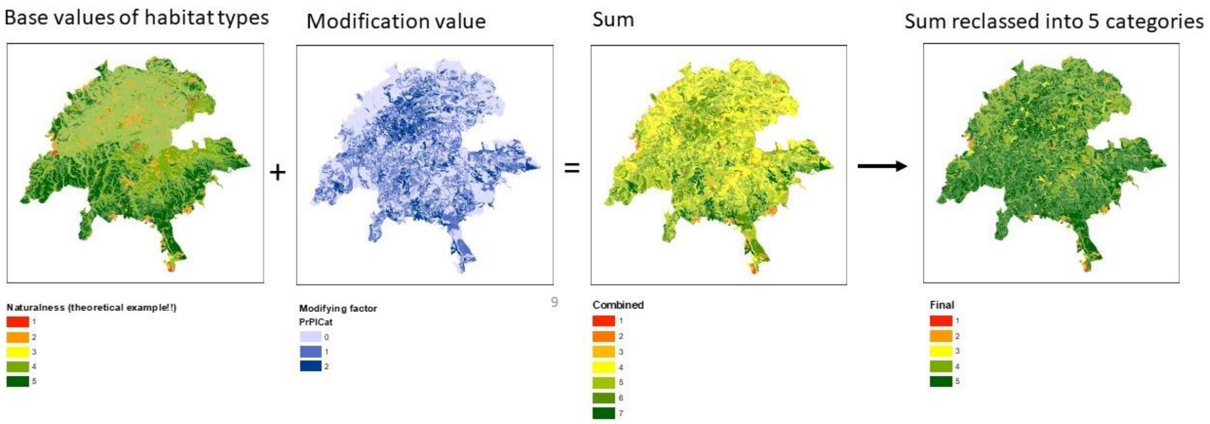


Figure 3.6. Components of habitat condition map of the Bükk National Park.

3.4. Mapping and assessment of ES

3.4.1. Identification of ES

As a first step, semi-structured interviews with experts of the pilot area were carried out to collect preliminary information on the dominant natural characteristics and land use. An initial list of ES was derived corresponding to the Common International Classification for Ecosystem Services (CICES, v5.1, www.cices.eu). This list was slightly customized (some ES split or merged) to a list of 15 ES as subject of prioritization.

To enable a comparable, comprehensive and documented ES prioritization which takes several aspects into consideration, a list of selection criteria was drawn (see Table 3.1). These criteria are listed in the below textbox. The adjusted list of ecosystem services was assessed one by one against the selection criteria, estimating whether a certain ES is relevant or not (scoring 1 or 0) considering each criteria. This resulted in an aggregated score of 'relevance' for each service. Based on these aggregated scores, ES could be ranked according to their relevance in the area.

Table 3.1. Criteria for prioritization and selection of ecosystem services

1. Ecosystem types concerned a. can be linked to specific karst ecosystems b. can be linked to an ecosystem type of large land surface within the pilot area c. can be linked to an ecosystem type of small land surface, but high conservation value
2. Benefits for local people a. provides economic benefit for the local economy (in terms of jobs or GDP) b. provides non-marketed livelihood for local people (e.g. grazing animals for self-sustaining, collecting mushrooms) c. has a high capacity for benefit which is still underutilized, predicting a potential for PBB development
3. Local relevance a. important in the perception of local people e.g. cultural heritage, local customs and events, local identity b. is part of an important local issue in some way, e.g. subject of development plan or land use conflict
4. Relation to other ES a. is inherently bundled with one or more other ES, thus its assessment can indirectly provide information for those too b. is in trade-off with one or more other ES, thus its assessment can indirectly provide information for those too

The following list shows the 7 highest ranked ES selected for mapping and assessment.

1. touristic attractiveness of nature
2. water quality protection (pollutant removal, drinking water quality)
3. timber and firewood provision
4. hay and fodder provision (output of grazing livestock)
5. agricultural crop provision
6. medicinal herbs
7. carbon sequestration and storage

Table 3.2. Overview of the ES and related mapping and assessment methods in Hungary case study

Ecosystem Service selected for mapping and assessment	B	S	E
Agricultural crop			
Hay, fodder / output of grazing livestock			
Timber and firewood			
Medicinal herbs			
Water quality protection (pollutant removal, drinking water quality)			
Carbon sequestration and storage			
Touristic attractiveness of nature			

* ES selected for further discussion during ESMERALDA workshops 8 in Eger, Hungary;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

3.4.2. ES mapping and assessment: biophysical methods

The simplest models are compiled with local experts using the ES **matrix model,** assigning values to certain land use/land cover classes for each ecosystem service. Instead of data, the necessary information is provided directly by experts or stakeholders in the form of synthetic judgements. Local experts assign scores from 1 to 5 to the capacity of specific habitats to provide different services.

In Eco Karst, most of our models are rule-based **extended matrix model**. Besides (or in some cases, instead of) the baseline expert matrix, indicators are calculated using either a statistical model or a set of rules linking the value of the indicator to additional background variables. The variables included in the models are based on expert recommendations or international literature, so that the models take into account additional environmental factors (e.g. the altitude of a given location). Data should be available at the required spatial resolution and they should determine the value of the indicator (at least to a certain degree) or be correlated to it. We design specific workflows to ease the creation and visualization of matrix results using ArcGIS and Excel. In order to avoid repeating processes for similar ES models, and also for better documentation, we create workflows in ArcGIS ModelBuilder. As a final step resulting scores are estimated in terms of physical quantities (e.g. m3 wood/ha/year). A general overview of the model is shown in Figure 3.7.Detailed models for the two ES discussed in the Esmeralda workshop (touristic attractiveness of nature; hay and fodder provision) are in Annex 2 and 3.

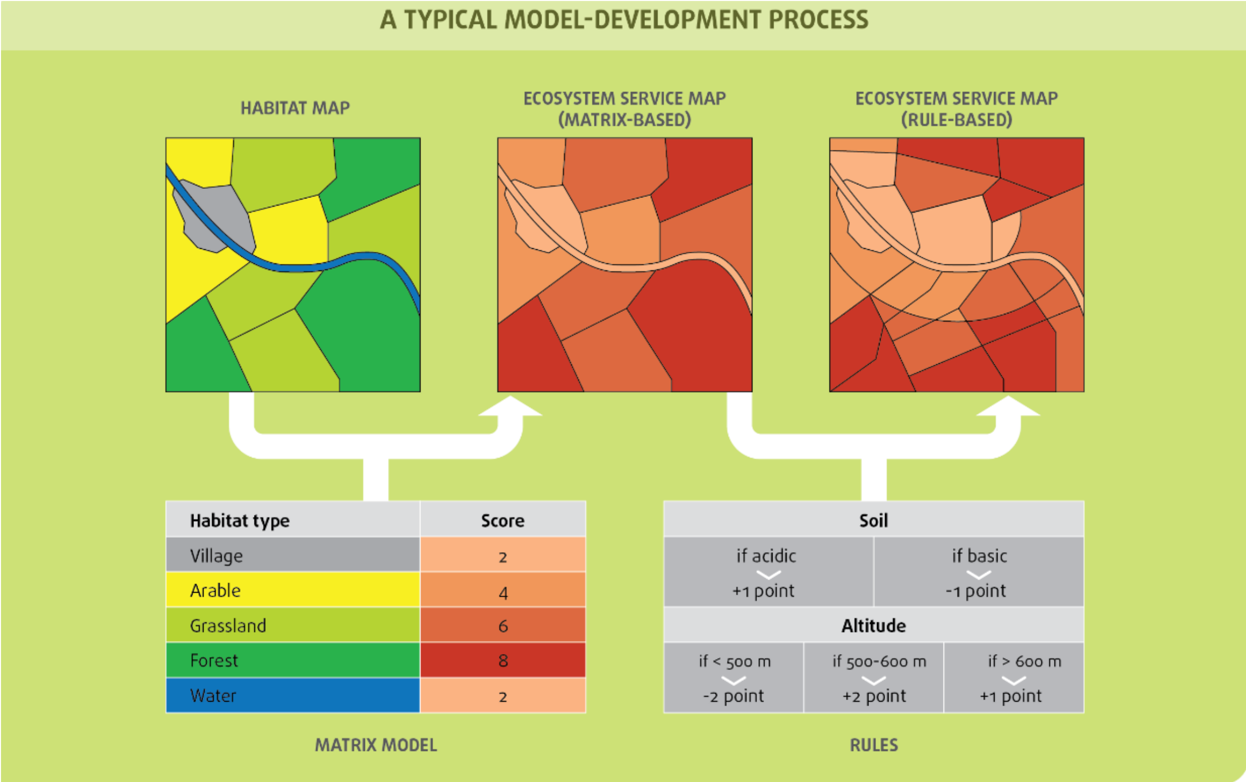


Figure 3.7. ES extended matrix model scheme.

3.4.3. ES mapping and assessment: socio-cultural methods

Socio-economic methods are used at the integration and implementation stage of this project, see 1.5.1.

3.4.4. ES mapping and assessment: economic methods

Within the Eco Karst project the potential and actual use of ecosystem services are compared in order to identify the gap between the two. The economic valuation of ESs is able to quantify the value stemming from the actual use of ESs. For all ES we use market price method, being the most straightforward approach within the scope of this study. However, we are aware that there are certain limitations of such valuation. First, it does not show if the use of ESs is sustainable or not. Second, statistical data is not always available or limited for even provisioning services therefore, other data sources are needed for precise calculation. Third, market prices can be used only for those ESs and only for those amounts that appear in the market (e.g. producing for family consumption or grey economy are excluded). When using economic valuation results in decision making, it is important to reflect on the limitations of the methods.

Final calculations of economic valuation are not available at the time of compiling this document. However, we can share the concept and methods already. In Annex 4, we present 3 potential indicators for the economic valuation of the ES natural forage and fodder. To avoid double counting, only one of these indicators will be selected and calculated.

3.5. Use and integration of ES mapping and assessment results

3.5.1. Addressing the policy question

One of the main objectives of the project is to explore and verify pro-biodiversity business (PBB) potentials and create a local action plan for new PBB development with the active participation of stakeholders, in particular SMEs. A pro-biodiversity business (PBB) is dependent on biodiversity for its core business and through that, business effects contributes to biodiversity conservation. ES maps and valuation provides crucial information to ensure that the resulting action plans are indeed sustainable and support biodiversity. The below path is followed in order to effectively influence business decisions.

1. A gap analysis comparing biodiversity-related businesses in the case study area with international best practice PBB examples from different sectors will explore the current situation and form the basis for identifying new and innovative biodiversity-based business opportunities. Its focus will be on sectors identified as irrelevant, such as forestry, non-timber forest products, agriculture and tourism, and mainly on SMEs which play a key role in the development of PBB. The gap analysis will explore the current situation and allow identifying new and innovative biodiversity-based business opportunities in the pilot karst areas. Methodological approaches and results of previous and ongoing projects on PBB such as the Biodiversity Technical Assistance Unit (BTAU) EU project and the work under the Workstream INNOVATION FOR BIODIVERSITY AND BUSINESS of the EU Business@Biodiversity Platform will be integrated into the design of activities. Further, national business and biodiversity initiatives as well as the CBD Global B+B Platform will provide the latest innovative biodiversity-based business examples.
2. Two workshops will be organized with the relevant business-related stakeholders to verify the feasibility of PBB ideas suggested by the gap analysis, and to examine new business models that use existing ES more sustainably and secure local livelihoods. To enable that, a participatory multi-criteria analysis will be completed, creating the ‘missing link’ between local ES assessments and the PBB action plan. In this analysis, developed based on the impact matrix of Martinez-Alier and his colleagues, alternative scenarios are compared to each other as well as to the present status, such as the single ES maximized (intensive land use), multiple ES optimized (sustainable land use) biodiversity maximized (conservation) and land use change scenario. These theoretical scenarios are compared along a pre-defined set of criteria: biodiversity impact, monetary value of ES and emergent opportunities (including the potential of new PBBs) and challenges, repeated in the aspect of all relevant ES. After completing the assessment for each individual ES, a summary table is compiled allowing the assessment of overall effect, opportunities and trade-offs of the scenarios. When considering opportunities and requirements of local PBB development, results of the above analysis will allow a strategic context at national park level. The business opportunities identified as viable and sustainable will be further screened with regard to potential challenges, needed competences and conditions, like financial requirements, capacity building, market access, incentives, etc. Workshop result will be a refined list of potential PBBs and agreed next steps to analyse the ideas viability.
3. In the second pilot area workshop the realization of identified business opportunities will be discussed and further developed with chambers of commerce, associations, land owners and local communes. This will verify the feasibility of business ideas and motivate all involved actors to support new PBB, remove obstacles and plan the next steps.

3.5.2. Dissemination and communication of results

All participating stakeholders from the pilot areas will at the end of this activity receive a PBB Development Guide. This Guide will inform on factors of success of existing best practice examples (cross-sectoral/ sector specific), relevant steps for developing a PBB, and legal requirements to be considered. The guidance will also be applicable for businesses outside the pilot areas. A ‘Best PBB idea’ title is awarded across the seven pilot areas of the project. Owners of this idea will be given professional help for its realization.

Besides, the project has a strong communication activity targeting a large range of external stakeholders (local authorities, agencies, higher education, research, SMEs and NGOs) and aiming to achieve a change in at least one of the following three characteristics: knowledge, attitude and practice. For that, a number of communication channels are used from scientific publications and conferences to press releases social media, at levels from local to international.

3.6. References & Annexes

3.6.1. References

Mapping Ecosystem types and services:

EUNIS Home: http://eunis.eea.europa.eu/about

PHYSIS Home: http://cb.naturalsciences.be/databases/cb_db_physis_eng.htm

Devillers, P, Devillers-Terschuren J. & Ledant J-P (1991): CORINE biotopes manual. Vol. 2. Habitats of the European Community. Office for Official Publications of the European Communities, Luxembourg.

Devillers P & Devillers-Terschuren J (1996) A classification of Palaearctic habitats. Council of Europe, Strasbourg: Nature and environment, No 78.

EEA (2014): Terrestrial habitat mapping in Europe: an overview. EEA Technical report No 1/2014 (https://www.eea.europa.eu/publications/terrestrial-habitat-mapping-in-europe)

MAES (2013): An analytical framework for ecosystem assessments under Action 5 of the EU Biodiversity Strategy to 2020. Discussion paper (final). http://ec.europa.eu/environment/nature/knowledge/ecosystem_assessment/pdf/MAESWorkingPaper2013.pdf

Maes, J. et al. (2015) Mapping and Assessment of Ecosystems and their Services. Trends in ecosystems and ecosystem services in the European Union between 2000 and 2010. Publications Office of the European Union. http://publications.jrc.ec.europa.eu/repository/bitstream/JRC94889/lbna27143enn.pdf

Moss, D (2008): EUNIS User Guide https://www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification/documentation/eunis-habitat-classification-users-guide-v2.pdf

Stakeholder involvement and implementation:

Borgatti, Stephen P., Martin G. Everett, and Jeffrey C. Johnson. 2018. Analyzing Social Networks. Sage Publishing.

Bodin, Örjan, and Christina Prell. 2011. Social Networks and Natural Resource Management: Uncovering the Social Fabric of Environmental Governance. Cambridge University Press.

Felipe-Lucia, María R., Berta Martín-López, Sandra Lavorel, Luis Berraquero-Díaz, Javier Escalera-Reyes, and Francisco A. Comín. 2015. “Ecosystem Services Flows: Why Stakeholders’ Power Relationships Matter.” PLoS ONE 10 (7): 1–21. doi:10.1371/journal.pone.0132232.

Crona, Beatrice, and Örjan Bodin. 2006. “What You Know Is Who You Know? Communication Patterns Among Resource Users as a Prerequisite for Co-Management.” Ecology and Society 11 (2).

Bodin, Örjan, and Beatrice I. Crona. 2009. “The Role of Social Networks in Natural Resource Governance: What Relational Patterns Make a Difference?” Global Environmental Change 19 (3): 366–74. doi:10.1016/j.gloenvcha.2009.05.002.

Reed, Mark S., Anil Graves, Norman Dandy, Helena Posthumus, Klaus Hubacek, Joe Morris, Christina Prell, Claire H. Quinn, and Lindsay C. Stringer. 2009. “Who’s in and Why? A Typology of Stakeholder Analysis Methods for Natural Resource Management.” Journal of Environmental Management 90 (5): 1933–49. doi:10.1016/j.jenvman.2009.01.001.

Barnaud, Cecile, and Annemarie Van Paassen. 2013. “Equity, Power Games, and Legitimacy: Dilemmas of Participatory Natural Resource Management.” Ecology and Society 18 (2): 21.

Martinez-Alier, Joan, Giuseppe Munda, and John O’Neill. 1998. ‘Weak Comparability of Values as a Foundation for Ecological Economics’. Ecological Economics 26 (3): 277–286.

3.6.2. Annexes

Annex 1. Social Network Survey questionnaire

Social Network Survey questionnaire

The following information will be used to understand how people communicate within/around the area of Bükk National Park about the use of natural resources. After processing the data, it will be treated ***anonymous****, no personal answer will be shared with anyone outside the project team. The results will only be published or presented in a form where no respondent can be identified.*

Your name:

Your organization:

Your settlement:

Your occupation:

Do you communicate with any institutional player on natural resources usage in the Bükk National Park? Please list up to 5 institutions:

Name	Organization	Settlement	Occupation

Do you communicate with anyone from animal keepers on natural resources usage in the Bükk National Park? Please list up to 5 names:

Name	Organization	Settlement	Occupation

The above table is repeated in the questionnaire 4 more times referring to the following sectors: hunting and forestry, NGOs, local producers, tourism.

Annex 2. Detailed model of the ES hay and fodder provision

Natural forage and fodder (hay)

Definition: Potential forage supply provided by the ecosystems through mowing or grazing. Cultivated or marketed roughage and grain feed are not included while grazing on fallow land and stubble as well as plants spontaneously occurring on waysides and banks are included in this service.

Workflow

➢ **Data pre-processing:**
- define categories of soil fertility based on the soil types of the soil map
- create grazing pressure categories for pastures based on land use data (e.g. livestock number)

➢ **organize a mini-workshop with 2-4 local farmers to set up the ES model:**
- create a customized **ecosystem type map** optimized for hay provision (merge some habitat types and potentially divide others)
- **score** hay provision capacity along a relative scale (1-5) for the customized **ecosystem types**

➢ **Rules** according to expert judgement, identify rules **modifying the scores**:
- elevation (example: >500 m: +0.5 score)
- soil fertility (example: low soil fertility: -0.5 high soil fertility: +0.5)
- biodiversity (example: lower tertile scores: -0.5 upper tertile scores: +0.5)
- grazing intensity (example: high: -0.5 very high: -1)
- slope steepness (example: steep (11-27°): -0.5 very steep (>27°): -1)

fix the scale: transform scores into fodder units (FU) which serves as a basis for transforming capacity scores into benefit volumes (e.g. hay, sheep/mutton, cattle/beef, milk) /ha/yr

➢ **Create draft map**
based on the established model

➢ **Calibrate** and if necessary, fine-tune the yield potentials calculated by the model with literature data / statistical data / additional expert consultation

➢ **Validate** the draft map on the stakeholder workshop
if needed, modify the scores and rules according to the suggestions of validation

➢ **Create final map**

Potential pitfalls

Separate scoring for pasture and meadow might be reasonable in some cases. Uncertainties of the results might be high due to the uncertainties of the input maps (habitats and soil), the transformation to fodder units, and the ambiguities in the fodder unit approach itself.

Input data *

- ecosystem type map
- biodiversity (condition indicator prepared for all pilots)
- grazing intensity (based on land use data in sites dominated by grazing, in pilots where overgrazing or abandonement of pastures is an issue)
- soil fertility (based on soil type)
- elevation (digital elevation model)
- steepness (digital elevation model)

** consult with experts which are needed*

Expert involvement

individual consultations:
data pre-processing phase:
- identification of soil fertility categories of soil types (individual soil expert)
- identification of grazing pressure categories (individual agriculture expert)

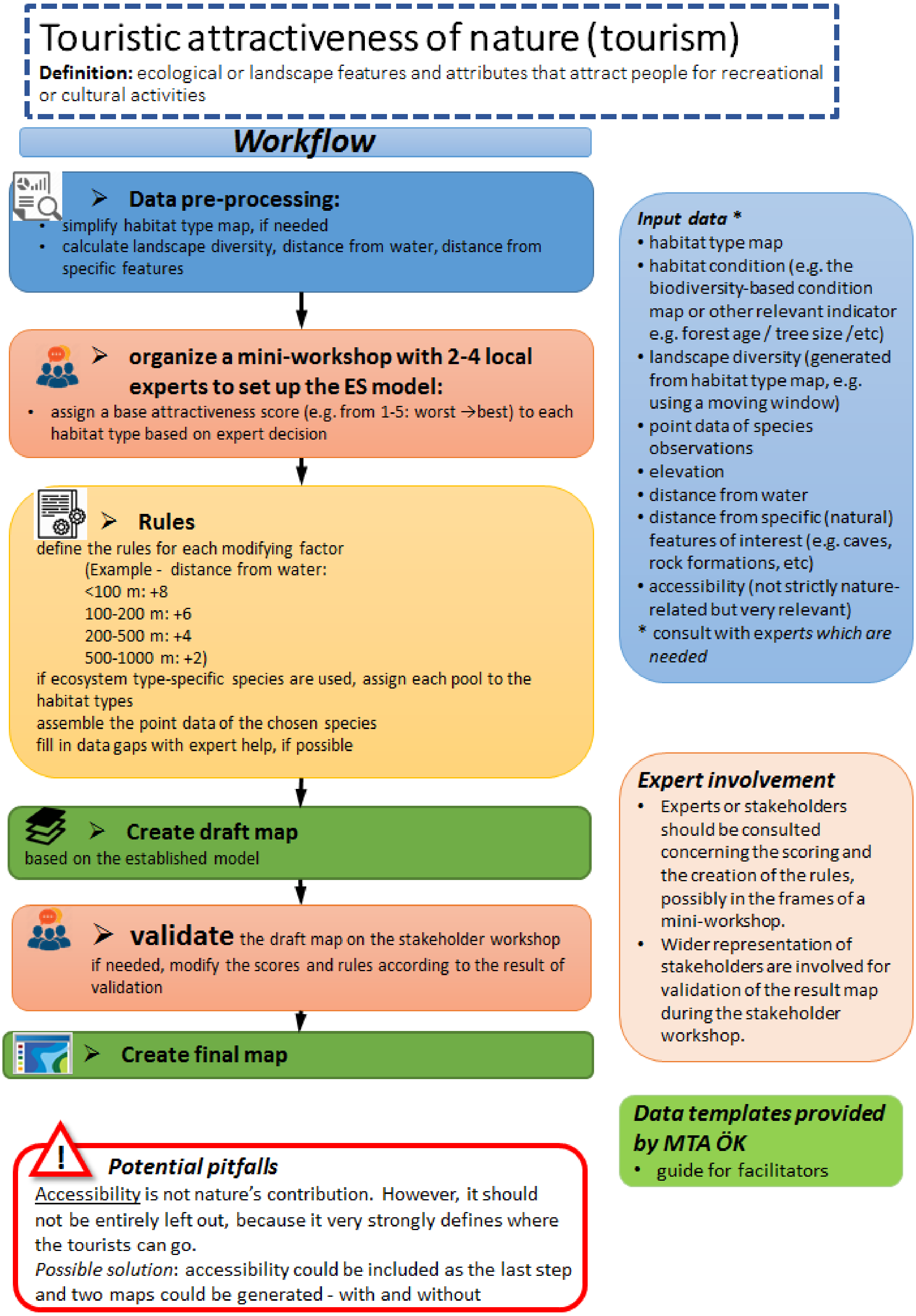
calibration phase:
- farming expert (preferentially the participant of the mini-workshop) to calibrate and fine-tune the yield potentials calculated by the model

mini-workshop with local farmers (persons selected according to their experience and overview of the whole area):
- establish the ES model
- wider representation of stakeholders for validation of the result map

Data templates provided by MTA ÖK

- definition of input data classes and categories and necessary location accuracy
- xls template

Annex 3. Detailed model of the ES touristic attractiveness of nature



Annex 4. Economic valuation options of the ES hay and fodder provision

INDICATOR 1: ECONOMIC VALUE OF FODDER/FORAGE	INDICATOR 2: ECONOMIC VALUE OF THE MEAT OF GRAZED ANIMALS	INDICATOR 3: ECONOMIC VALUE OF THE MILK OF GRAZED ANIMALS
COMPONENTS OF THE INDICATOR		
- fodder produced in the area (by type) (kg),	- annual meat production in the area (by type) (kg)	- annual milk production in the area (by type) (l),
- annual sale of fodder (by type) (kg),	- annual number of live animals sold by type (kg)	- annual sale of milk (by type) (l),
- price of fodder sold (by type) (local currency, Euro)	- annual sale of meat (by type) (kg)	- producer/consumer price of milk sold (local currency, Euro)
	- annual sale of live animals by type (kg)	
	- producer/consumer price of meat sold (local currency, Euro)	
DATA COLLECTION		
- local or regional statistical data,	- local or regional statistical data,	- local or regional statistical data,
- data from farmers and professional associations,	- data from meat or animal-breeder associations,	- data from milk associations,
- data of local markets	- data of local markets	- data of local markets
CALCULATION		
OPTION 1:	OPTION 1: If animals are sold in producer market (in larger quantities, without further processing):	OPTION 1: If milk is sold in producer market (in larger quantities, without further processing):
Revenue from fodder production = quantity of fodder (kg/year) * **producer price** (local currency/kg, annual average).	Annual revenue from meat production from animal grazing= quantity of meat (kg/year) * **producer price** (local currency/kg, annual average).	Annual revenue from milk production = quantity of milk (l/year) * **producer price** (local currency/kg, annual average).
cost of fodder production = quantity of fodder (kg/year) * estimated value unit cost (EUR/kg) of fodder production estimated by the producers	Annual cost of meat production = quantity of meat (kg/year) * estimated unit cost (EUR/kg) of meat production estimated by the farmers/animal breeders	Annual cost of milk production = quantity of milk (l/year) * estimated unit cost (EUR/l) of milk production estimated by the milk producers
Economic value of fodder = revenue - cost.	Annual economic value of meat = annual Revenue – annual cost.	Annual economic value of milk = annual revenue – annual cost.
	OPTION 2: If meat is sold in consumer market (smaller quantities, individually packaged, sold by kilograms)	OPTION 2: If milk is sold in consumer market (smaller quantities, individually packaged)
	Annual revenue from meat production from animal grazing= quantity of meat (kg/year) * **consumer price** (local currency/kg, annual average).	Revenue from milk production = quantity of milk (l/year) * **consumer price** (local currency/kg, annual average).
	Annual cost of meat production = quantity of meat (kg/year) * estimated unit cost (EUR/kg) of meat production estimated by the farmers/animal breeders	cost of milk production = quantity of milk (l/year) * (estimated value) the unit cost (EUR/l) of milk production estimated by the milk producers
	Annual economic value of meat = annual revenue – annual cost.	Economic value of milk = revenue - cost.

Case study booklet for:
WORKSHOP VIII: "Testing the final methods in policy- and decision-making (II)"
held in Eger, Hungary, 19-22 March 2018

4. Green infrastructure and urban planning in the City of Järvenpää

March 2018

ESMERALDA partner: Finnish Environment Institute, SYKE

Case Study Coordinators: Arto Viinikka, SYKE; Leena Kopperoinen, SYKE

ESMERALDA

Enhancing ES mapping for policy and decision making

4.1. Case study factsheet and study area description

Mapping green infrastructures and their ES in Järvenpää

WS8_cs2a

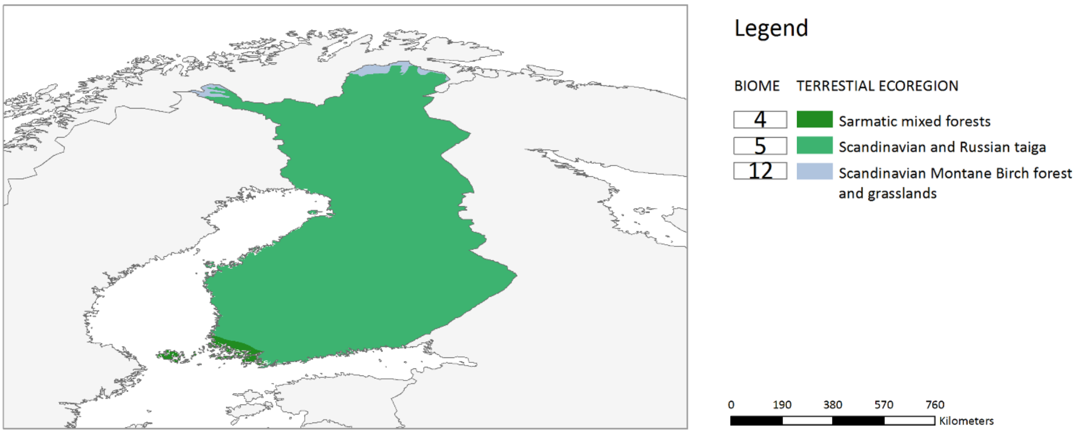
NAME AND LOCATION OF STUDY AREA	City of Järvenpää
COUNTRY	Finland

STATUS OF MAES IMPLEMENTATION

Stage 1	Stage 2	**Stage 3** (highlighted)

BIOMES IN COUNTRY

1 Tropical & Subtropical Moist Broadleaf Forests	**4 Temperate Broadleaf & Mixed Forests** (highlighted)
5 Temperate Conifer Forests	**6 Boreal Forests/Taiga** (highlighted)
8 Temperate Grasslands, Savannas & Shrublands	**11 Tundra** (highlighted)
12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
14 Mangrove	



case study outline

SCALE	national	sub-national	**local** (highlighted)	
AREAL EXTENSION	**Ca. 40 km²** (highlighted)			

THEMES

nature conservation	climate, water and energy	marine policy	natural risk
urban and spatial planning (highlighted)	**green infrastructures** (highlighted)	agriculture and forestry	business, industry and tourism
health	ES mapping and assessment		

ECOSYSTEM TYPES

urban (highlighted)	**cropland** (highlighted)	grassland	**woodland and forest** (highlighted)
heatland and shrub	sparsely vegetated land	wetlands	**rivers and lakes** (highlighted)
marine inlets and transitional waters	coastal	shelf	open ocean

Study area description

The City of Järvenpää is a compact city (40 km2) with tight boundaries and population around 42,000 inhabitants that makes it fourth densely populated city in Finland. It is located in Uusimaa region, Southern Finland surrounded by three municipalities (Figure 4.1).

4.2. Main policy question and theme

4.2.1. Objectives of ES mapping and assessment

The city of Järvenpää has an expected population growth of over 10 % by the year 2030. As a result, there is an exceptionally strong need for infill development to provide housing for new inhabitants as the master plan already covers the whole city and the neighbouring municipalities prevent the city to grow outside. Infill development and the fragmentation of the existing landscape structure require a more accurate assessment and development of the GI. The city's interest was to find the tools and criteria for valuing the sites excluded from construction (i.e. GI) so that future urban planning could compress up and intensify the urban structure without losing the most valuable features of the GI.

The objective of this study was to evaluate the green infrastructure in the city by mapping and assessing the supply and demand of the most important ecosystem services (ES) and assess the connectivity on green infrastructure (GI). In the first phase of ES mapping and assessment, the perspective was policy driven aiming to support the city planners for sustainable development on natural values and ES provided by green and blue areas while simultaneously identifying land for future construction. Mapping and assessment was done in three phases concentrating to the questions of: 1) how the provision of ES related benefits provided by the green infrastructure were distributed in the area; 2) how and where the citizens use these benefits and; 3) how the ecological processes providing these services were connected.

According to the Finnish Land use and building act plans urban planning must be prepared in interaction with such persons and bodies on whose circumstances or benefits the plan may have substantial impact. The authority preparing plans must publicize planning information so that those concerned are able to follow and influence the planning process (see: Finnish Land use and building act 132/1999, amendment 222/2003 included). The citizen role was considered by arranging workshop, via online questionnaire and sending survey to schools and kindergartens to map their perceptions related to cultural ecosystem services.

This real-life planning example provided also a good opportunity to test the spatial multi-criteria analysis (SMCA) for engagement of practitioners in enhanced integration of urban greenspaces and residential infill development. The results from the first phase were used as input data for this scientific driven method testing. Here the focus was especially in the interaction and the underlying processes behind stakeholder role during planning process that can support the future planning.

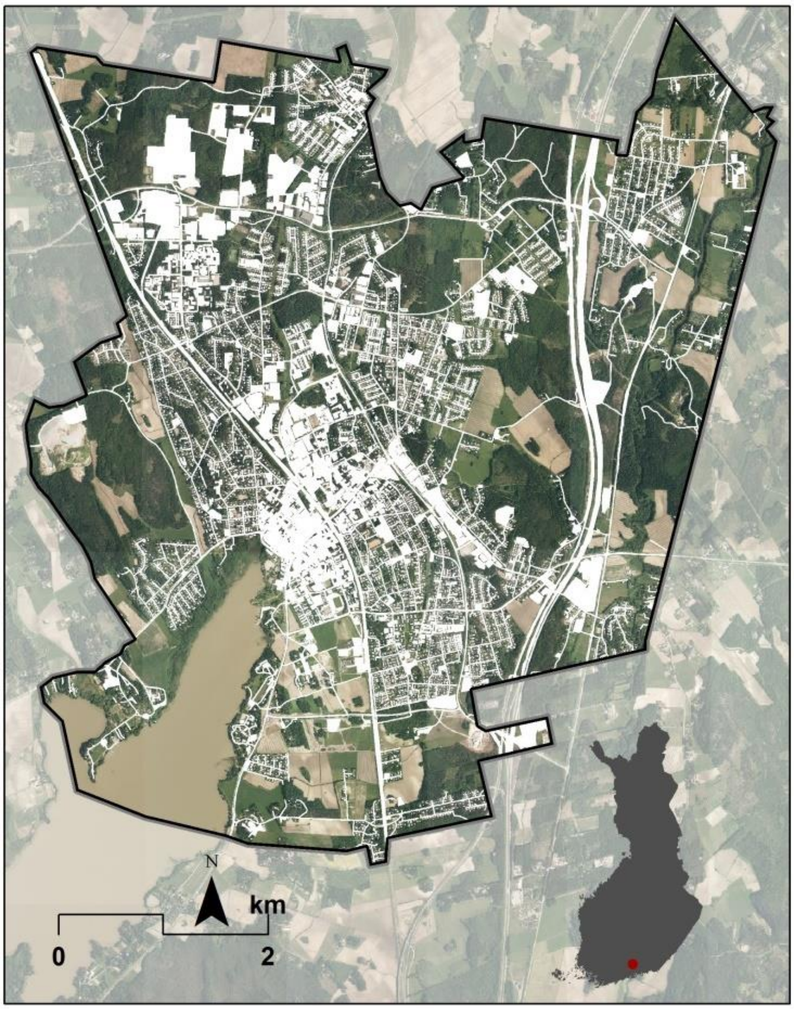


Figure 4.1. Location of the study area with impervious areas presented on white.

4.2.2. Stakeholders and their role

Within the first phase of mapping and assessment process the main stakeholders were local planners. The co-operation between researchers and planners started at the very beginning of the process by identifying relevant ES to be mapped and reviewing the relevant background information and spatial data from the national and city archives. Especially, the local knowledge with spatial data provided by the planners were valuable enabling the spatially explicit mapping exercise.

Citizens were involved in the planning process by providing their perceptions and values related to cultural ecosystem services. This was done during workshop that was twofold: first, participants were asked to give subjective value of the most important cultural ES in area. After that, the respondents were asked to place those areas on a map.

In the second phase, with respect to the SMCDA the city planners invited a total of nine experts to the workshops from the different sectors including: master planning (3), town planning (1), health and welfare (1), children and youth services (1), maintenance of green areas (1), forestry (1) and environment sector (1). Experts were essential part of the process as they provided input on the criteria and weighting of the criteria to find most optimal sites for infill development.

4.3. Ecosystem Types and Conditions

4.3.1. Identification and mapping of ecosystem type(s)

Starting point for this mapping and assessment exercise was the identification and extraction of green and blue areas with sufficient spatial accuracy required for planning purposes. Aim was to create a typology of green infrastructure (e.g. Cvejić et al. 2015). To capture the most detailed features in the study area, we used the combination of currently available multiple different datasets that were complemented with digitization using temporally accurate high resolution aerial images with 0.5 m resolution. A key dataset was city owned local biotope data including areas of uniform environmental conditions that was used as a baseline for the delineation. As a complementary we used multiple datasets such as aerial images and environmental features from Finnish National Land Survey database.

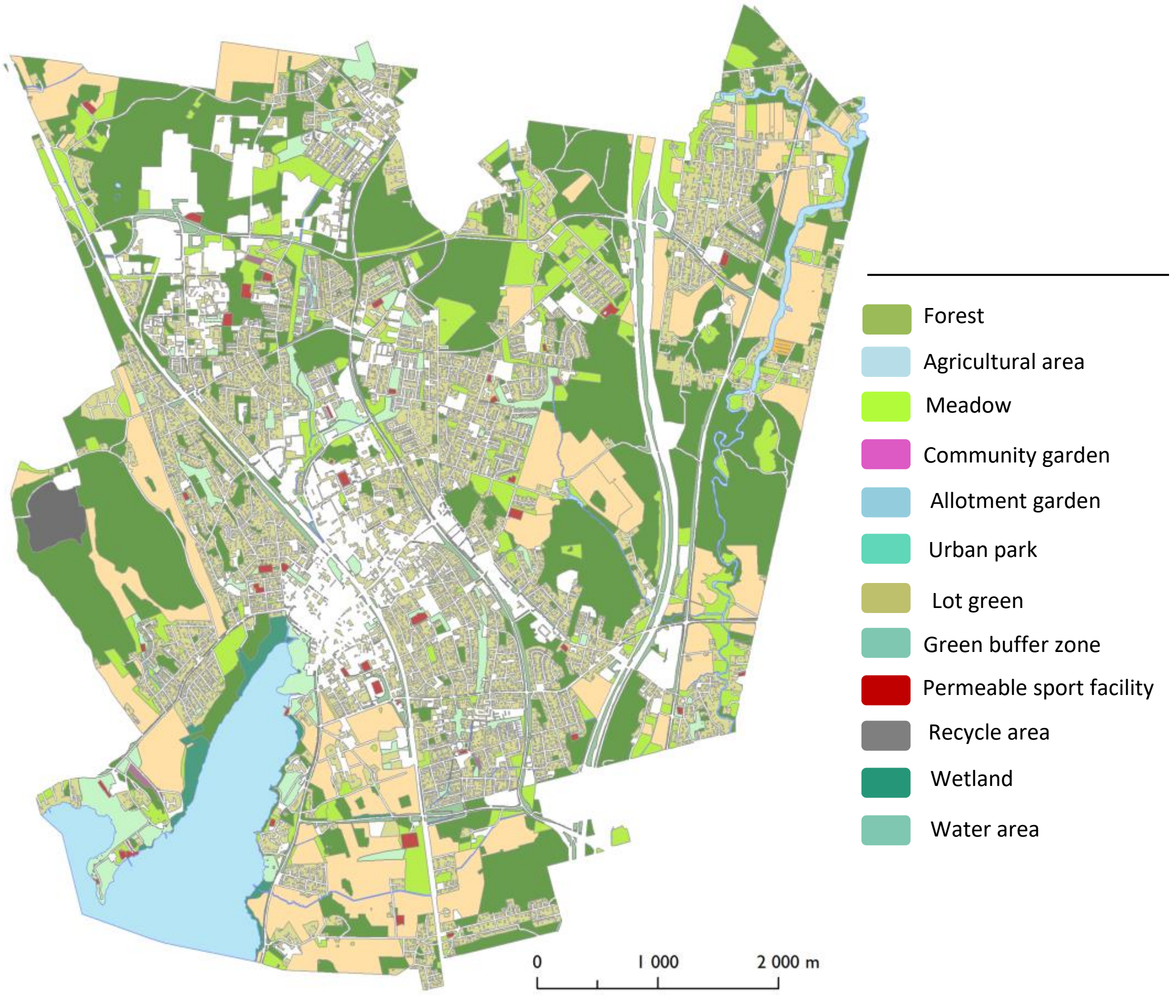


Figure 4.2. Järvenpää GI typology.

The green typology was a prerequisite for the mapping and assessment, but it was also a result being the most accurate digital representation of the prevailing land cover in the area (Figure 4.2). This provided a possibility for the land use planners to have more accurate overview of the city green and blue areas to support planning and the importance, for example, of the private gardens to provide of multiple ES and maintain connectivity could be pointed out.

4.3.2. Assessing ecosystem conditions

Direct ecosystem condition assessment was not included in this study. However, ecosystem condition is directly linked to ecosystem relative service provision potential that was assessed in this study. Information about ecosystem conditions relevant for the case study were mostly related to structural analysis of urban green infrastructure components (e.g. connectivity) that is essential for the ecosystem sustainability and service provision.

1.4 Mapping and assessment of ES

4.3.3. Identification of ES

For the identification of relevant ES, we used the knowledge from previous mapping and assessment studies that were validated though a joint discussion with city planners. The objective of maintaining good opportunities for urban recreation and other cultural values supported the selection of all cultural ES according to CICES 4.3 to be mapped whereas provisioning and regulating and maintenance services consisted only the most relevant services in the area. Table 4.1 includes the selected ES for the case study classified using the CICES v4.3 (2013) and the related assessment method categories where B = Biophysical, S = socio-cultural. Original CICES 4.3 was slightly modified by combining categories to fit better to the city needs. Economic assessment was not conducted in this study.

Table 4.1. Overview of the ES and related mapping and assessment methods in the city of Järvenpää

Ecosystem Service selected for mapping and assessment	B	S	E
1.1.1.1 Cultivated crops	X		
1.1.1.3 Wild plants, animals and their outputs + 1.1.1.4 Wild animals and their outputs	X		
1.1.2.2 Ground water for drinking	X		
2.2.2.1 Hydrological cycle and water flow maintenance + 2.2.2.2 Flood protection	X		
2.3.1.1 Pollination and seed dispersal	X		
2.3.1.2 Maintaining nursery populations and habitats	X		
2.3.5.2 Micro and regional climate regulation	X		
3.1.1.1 Experiential use of plants, animals and land-/seascapes in different environmental settings + 3.1.1.2 Physical use of plants, animals land-/seascapes in different environmental	X	X	
3.1.2.1 Scientific + 3.1.2.2 Educational	X	X	
3.1.2.5 aesthetic + 3.1.2.3 Cultural heritage	X	X	
3.2.3.1 Symbolic + 3.2.3.2 Sacred and/or religious	X	X	
3.2.3.2 Existence + 3.2.4.2 Bequest values	X	X	

* ES selected for further discussion during ESMERALDA workshops 8 in Eger, Hungary;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

4.3.4. ES mapping and assessment: biophysical methods

Total of three different biophysical methods were used to mapping and assessment. Spatial proxy method was applied to all ES listed in Table 4.2. The structural (potential) connectivity of GI was assessed using connectivity models and spatial multi criteria analysis was used to integration of urban greenspaces and residential infill development.

Mapping of provisioning, regulating and maintenance and cultural services

The potential provision of selected ES was assessed using Green Frame (GF) method that belongs to spatial proxy models (Kopperoinen et al.2014). GF is especially tailored for supporting planning processes due to its flexibility, transparency and operational possibilities. It provides an overview of the potential provision of ES in relative scale using spatial data and expert opinions. Analyses can be conducted in a short amount of time, which is usually a requirement in the planning process. In addition to expert opinions, the method uses quantitative data when available, usually from provisioning services such as timber volume (m^3) or ground water yield (m^3).

The method uses multiple different datasets that were combined to themes and scored by the experts (Table 4.2). We utilized the results from the scoring workshop from previous year used to mapping and assessment of ES in Uusimaa region as these were transferrable to local context. The scoring system for assessing the effect of each theme on the prerequisites for the provision potential of each ES group was:

3	2	1	0	-1	-2	-3
Very favourable	Favourable	Slightly favourable	No effect or neutral effect	Slightly harmful	Harmful	Very harmful

Table 4.2. Expert scoring applied into data themes

	Cultivated crops	Wild plants, animals and their outputs	Ground water for drinking	Hydrological cycle and water flow maintenance	Pollination and seed dispersal	Maintaining nursery populations and habitats	Micro and regional climate regulations	Recreation	Education	Aesthetic and cultural heriotage	Symbolic, Sacred and/or religious	Existence and bequest
Conseravtion areas	0	2	2	3	2	3	2,5	3	3	2	3	3
Valuable landscapes	3	1,5	1	1	2	2	1	2	2	3	2	2
Cultural heritage sites of built environments	2	1	0	1	2	1	1	3	1,5	3	2	2
Traditional biotopes	2	2	0	1	3	3	1	2	2	3	2	3
Areas of valuable environment according to Finnish forest act	0	2	1,5	2	2	3	1	2	3	2	2	3
Bogs	0	2	2	3	1	3	2	2	3	2	3	3
Important bird areas	0	1	0	1	1	3	1	2	3	2	2	3
Ground water formation areas	0	1	3	3	1	1	1	1	1	1	1	2
Agriculture areas with high nature values	3	1	0	1	2	2	1	2	2	2	2	2
Ecological condition of surface waters	0	2	3	2	0	3	0	3	3	2	2	3
Recreation areas	1	2	1	1	1	1	1	3	2	2	2	2

Respondents were advised to give a score of 0 if they saw no connection between the theme and the provision potential of the ES group in question. Scoring was also done to the Finnish national Corine Land Cover data to avoid empty areas in the mapping results. Although it is possible to map all the ES separately, the method reveals areas providing the multiple benefits (i.e. ES bundles) which are essential for comprehensive assessment of GI (Figure 4.3).

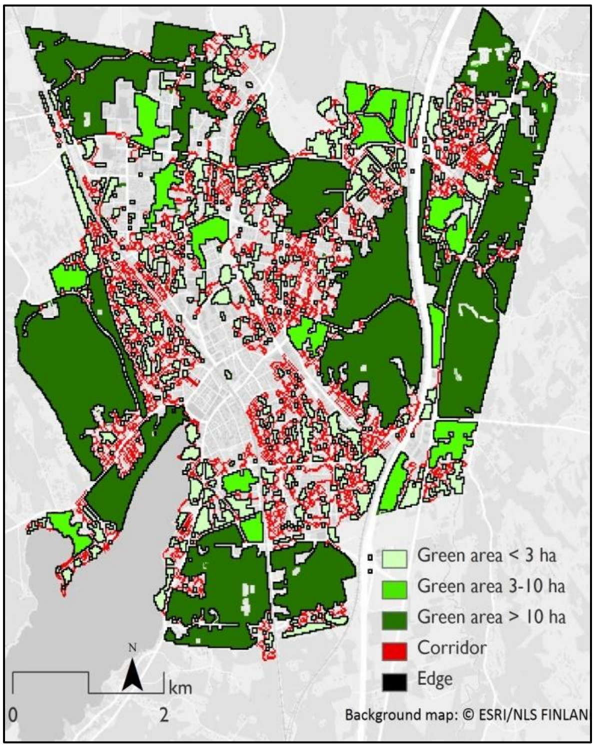
Figure 4.3. Provision of cultural ecosystem services in Järvenpää

Connectivity analyses

We used ecological connectivity models to evaluate the structural degree to which the GI facilitates potential movement of different ecological processes. Connectivity promotes the provision potential of many ES as connectivity is fundamentally linked to the ecological processes providing these services. In Järvenpää, assessment was conducted using two different approaches. Firstly, we applied Morphological

Spatial Pattern Analysis (MSPA) that classified the green patches based to geometry, area and edge size (Vogt et al. 2007) (Figure 4.5).

Secondly, we used graph theory based Matrix Green and Conefor software's (Saura & Pascual-Hortal 2007) to quantify the theoretical importance of habitat to maintain the overall connectivity (Figure 4.4). Information of the attributes such as land cover and ES of GI were not included into the connectivity analyses, but rather all the GI habitats were handled equally.



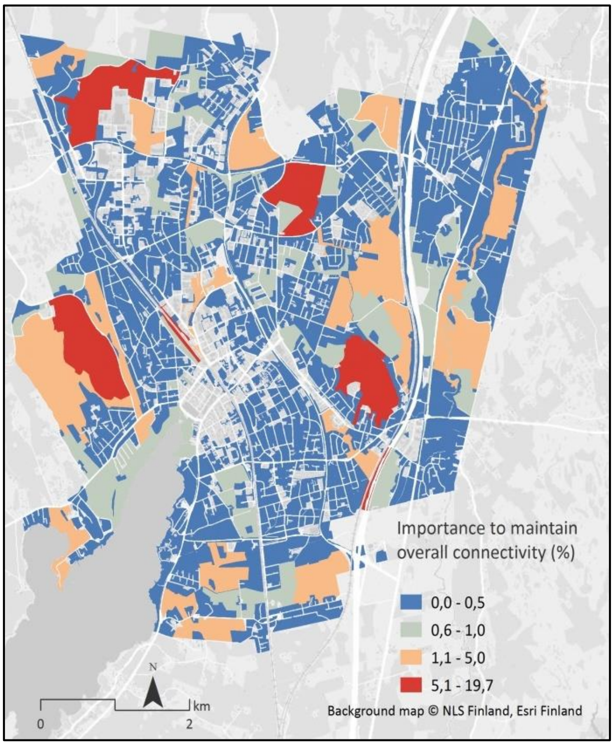


Figure 4.4. Structural connectivity of GI in Järvenpää.

Spatial Multi-Criteria Analysis

We tested the spatial multi-criteria analysis (SMCA) for engagement of practitioners aiming to enhance the integration of urban greenspaces and residential infill development. We applied a GIS-based Multi-Attribute Value Theory (MAVT) approach, which is a widely-used technique for supporting the decision making especially in the environmental field and urban planning (Ferretti and Comino, 2015, Huang et al., 2011).

Using the spatial assessment results from the ecosystem services and connectivity analyses integrated to the existing spatial knowledge of construction costs, transportation, accessibility to daily services and environmental nuisances and disturbance researchers drafted the initial version of the decision tree (Annex 1). The decision tree including the objectives and criteria was further discussed and altered on-the-fly according to the joint discussion based to the participant's expert knowledge on various sectors. Later, the stakeholders scored the criteria that were integrated to the spatial datasets to present the results on a map (Figure 4.5). Stakeholders participate in a follow-up table to discuss and validate the results of the ES mapping and assessment exercise.

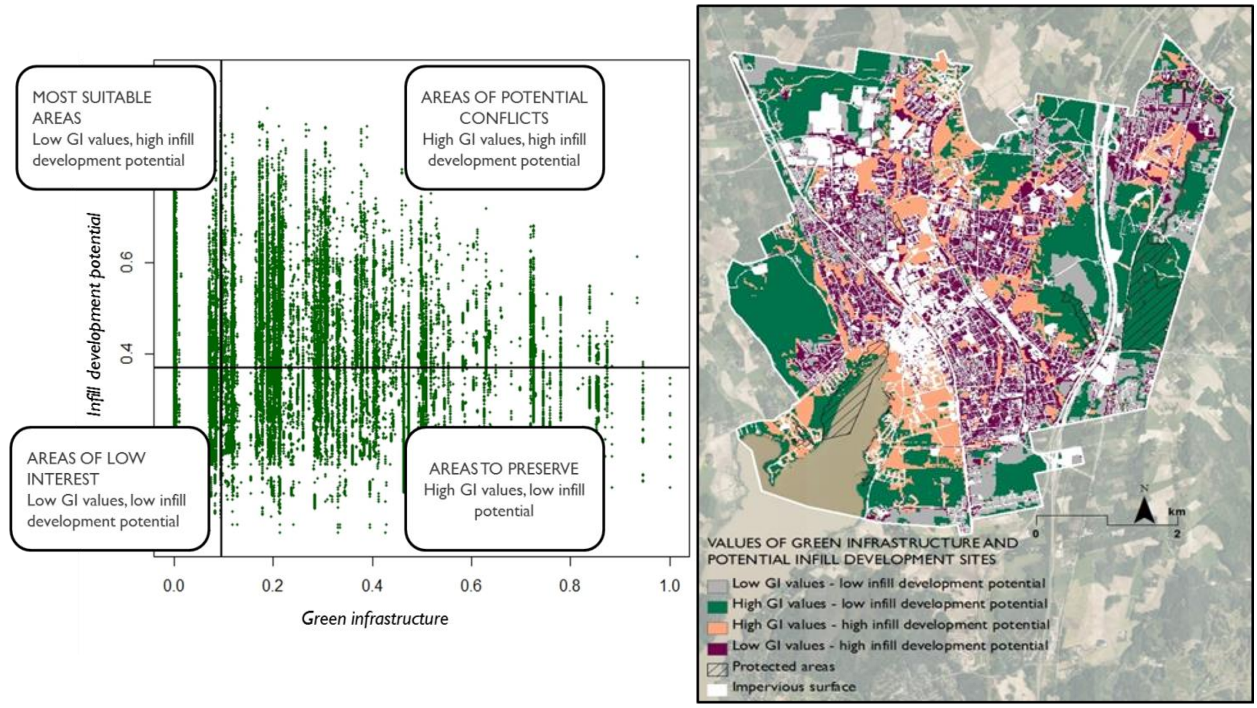


Figure 4.5. Normalized stakeholder median scores for each dataset pixels (left). Output map representing potential infill sites based to (right).

4.3.5. ES mapping and assessment: socio-cultural methods

We used Participatory GIS to evaluates the spatial distribution of cultural ES (mainly) according to the perceptions and knowledge of citizens via workshop, surveys and online questionnaire (Figure 4.6). Citizen workshop was a twofold. In the first session participants scored green and blue areas according to the importance to provide ecosystem services (see: Annex 2). Method was highly subjective capturing respondent personal opinions. In the second phase, participants marked areas providing ES on a map.

Survey regarding the important educational sites was sent out to schools and kindergartens. In the survey the respondents were asked to mark on a map nature sites, routes or areas that are used for educational purposes. Respondents were also asked to mark areas that they would be willing to use with explanation why it is not possible.

We also utilized the results from the PGIS online survey from 2006 regarding the quality of environment in the area. Survey was not specifically tailored for ecosystem services, but by we were able to modify the results to fit our needs by classifying the answers into ES groups.

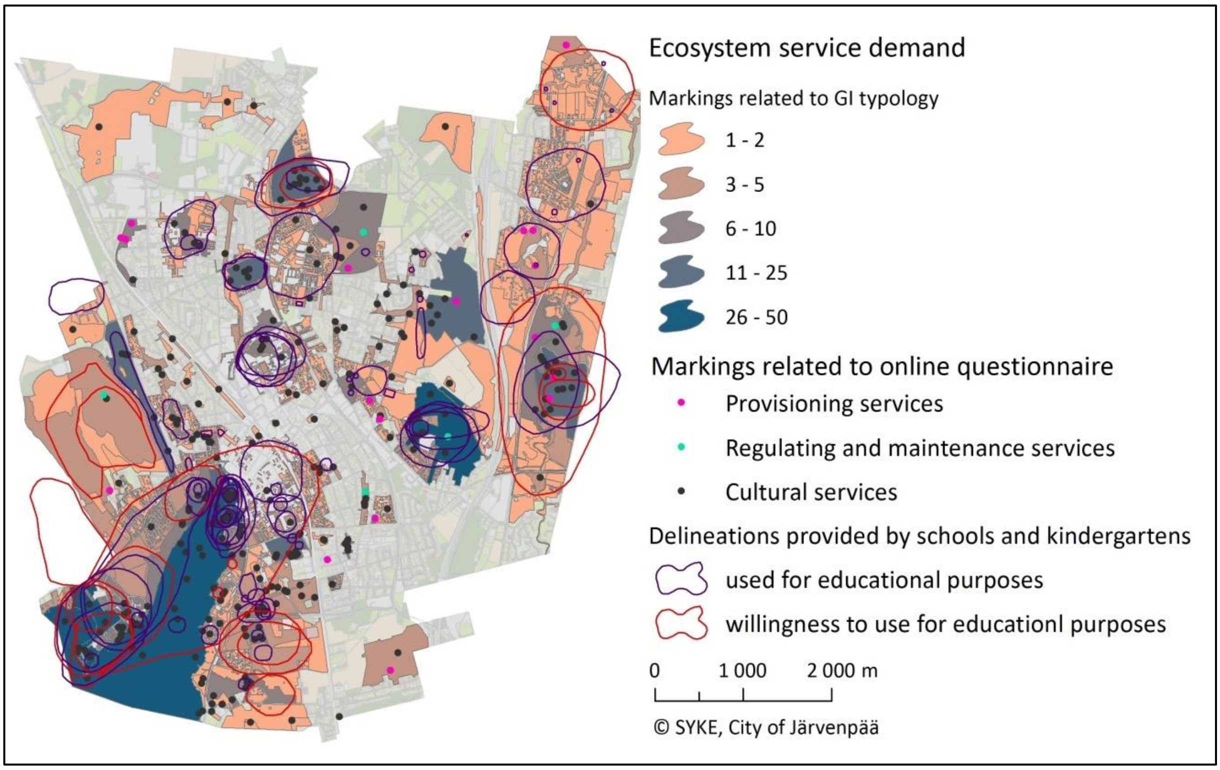


Figure 4.6. Compilation of the cultural ecosystem services demand in Järvenpää

4.3.6. ES mapping and assessment: economic methods

Economic methods for mapping and assessment of ES were not used in this study.

4.4. Use and integration of ES mapping and assessment results

4.4.1. Addressing the policy question

The mapping and assessment of ES in Järvenpää generated important information that helped to address the policy question on the better and more sustainable integration of GI and infill development. From a planning perspective, spatially explicit analysis results provided a way to compare potential ES supply, demand and connectivity between the planned infill development sites. Thus, the construction could be directed to areas not decreasing the quality of green and blue structure in the area.

Although each category of the ES was included, the main focus was in cultural ES. Provision potential combined to citizen preferences and values related to cultural benefits is directly linked to the wellbeing of the citizens, hence a useful tool to inform planning decisions in a way required in the Finnish land use and building act.

The SMCA mapping and assessment exercise allowed better engagement of the practitioners to the planning process. The decision tree was seen useful tool to structure the factors having impact to the infill development and provide a visual way to understand the challenge to weight different factors against each other. It provided also a way to include experts' knowledge and perceptions in equal manners.

4.4.2. Dissemination and communication of results

Communication and collaboration between planners and researcher were ongoing during the process through regular meetings and planners participation to the process. Analysis results including GIS-datasets and report (Kopperoinen et al. 2016 [in Finnish]) have been shared with municipal planners. The involvement of citizens, schools and kindergartens provided a way for a more effective policy-science-society interface and enhanced the knowledge exchange between participants in terms of cultural ES. The continuous collaboration along the entire process of mapping and assessment is expected to facilitate the introduction of the results into the ongoing urban planning process.

From the academic perspective, results obtained in this case study concerning the engagement of practitioners aiming to enhance the integration of urban greenspaces and residential infill development will be disseminated through scientific publications later this year (Tiitu et al. 2018). In addition, case study has been presented in international and various national conferences.

4.5. References & Annexes

4.5.1. References

Cvejić, R., Braquinho, C., Eler, K., Gonzales, P., Haase, D., Hansen, R., Kabisch, N., Lorance Rall, E., Niemela, J., Pauleit, S., Pintar, M., Lafortezza, R., Santos, A., Strohbach, M., Vierikko, K. & Železnikar, Š.

A typology of urban green spaces, ecosystem provisioning services and demands (2015). Report: D3.1. GREEN SURGE project (2013-2017)

Ferretti, V. & Comino, E. 2015. An integrated framework to assess complex cultural and natural heritage systems with Multi-Attribute Value Theory. Journal of Cultural Heritage, 16, 688-697.

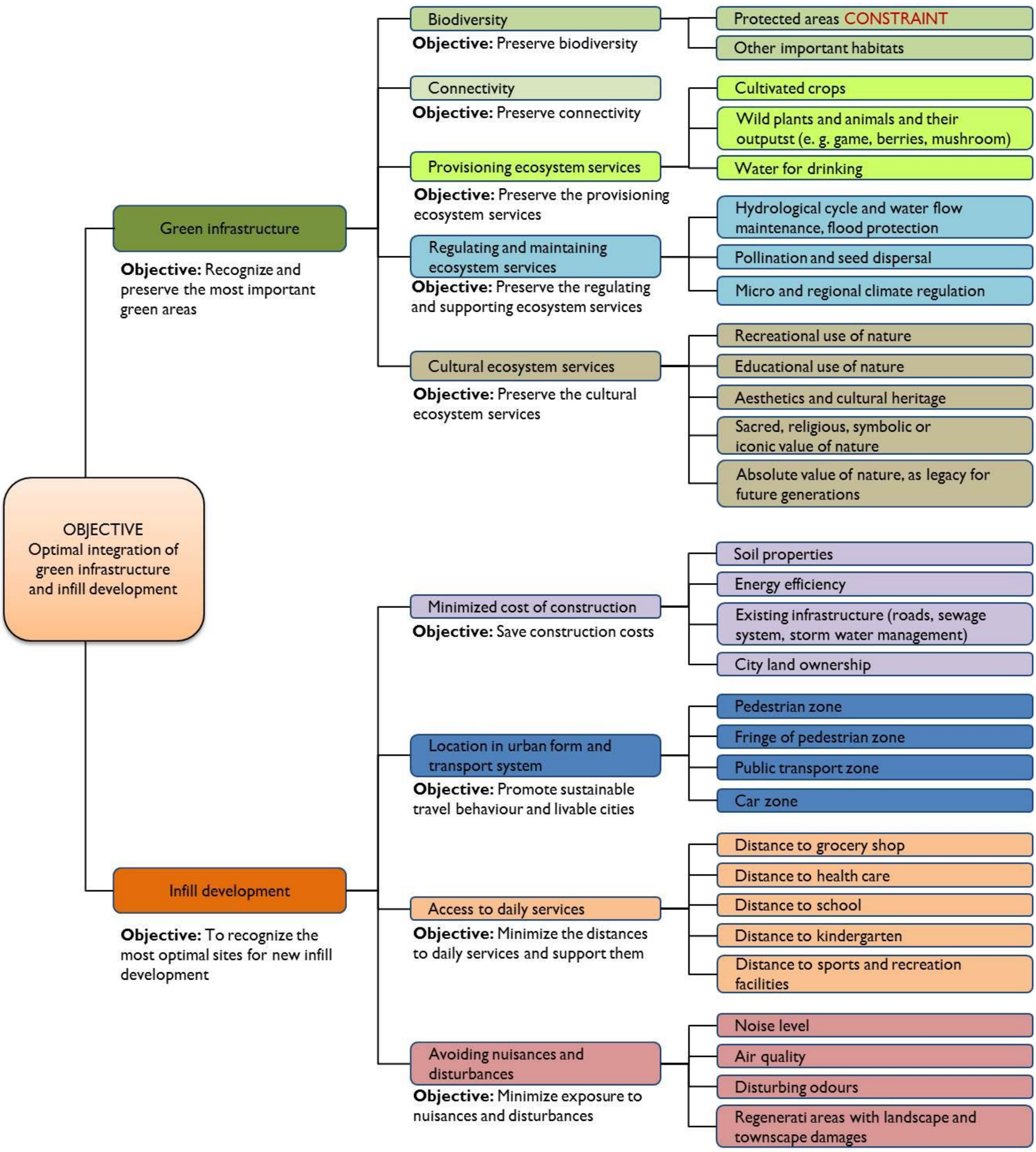
Huang, I. B., Keisler, J. & Linkov, I. 2011. Multi-criteria decision analysis in environmental sciences: Ten years of applications and trends. Science of The Total Environment, 409, 3578-3594.

Kopperoinen, L., Tiitu, M., Viinikka, A., Itkonen, P. (2016). Järvenpään viherrakenteen arvot ja hyödyt. [Values and benefits of green and blue areas in Järvenpää]. Järvenpään kaupunki ja Suomen ympäristökeskus, Järvenpää. [City of Järvenpää and Finnish Environment Insitute] 102 s.

Saura, S. & L. Pascual-Hortal. 2007. A new habitat availability index to integrate connectivity in landscape conservation planning: comparison with existing indices and application to a case study. Landscape and Urban Planning 83 (2-3): 91-103

Vogt, P., Riitters, K. H., Iwanowski, M., Estreguil, C., Kozak, J. & Soille, P. 2007. Mapping landscape corridors. *Ecological Indicators* 7: 481-488

4.5.2. Annexes



Structure of the decision tree including objectives and criteria for the integration of green infrastructure (GI) and infill development.

	Forest	Agricultural area	Meadow	Community garden	Allotment garden	Urban park	Lot	Green buffer zone	Wetland	Lake	River	Stream
Recreation	2	0.8	1.4	0.8	0.6	1.9	1.9	1.3	1.3	2	1.8	1.1
Education	1.9	1.3	1.9	1	1	1.5	1.5	1.4	1.6	1.8	1.8	1.5
Aesthetic and cultural values	1.9	1.3	1.9	1.1	1.3	1.8	1.8	1.5	1.6	2	1.9	1.8
Artistic representation of nature	1.9	1.4	1.6	0.6	0.7	1.7	1.4	1.1	1.4	1.7	1.7	1.6
Symbolic meaning of nature	1.7	1	1.4	0.7	0.4	1.7	1.6	0.7	0.8	1.7	1.4	1.3
Spiritual values of nature	2	0.9	1.3	0.7	0.4	1.6	1.6	0.7	1	1.9	1.6	1.3
Sacred and/or religious	1.7	0.7	1.1	0.1	0.3	1	1	0.6	0.9	1.3	1.3	0.9
Existence and bequest	1.7	1	1.1	0.8	0.7	1.6	1.3	0.7	1.7	2	2	1.6
Cultivated crops	1.6	0.9	1.1	1	0.8	0.6	1.8	0.9	1.3	1	0.9	0.6
Micro and regional climate regulations	1.9	0.7	1	0.6	0.9	1.9	1.7	1.4	1.3	1.9	1.4	1.1

Importance of green and blue areas as a provider of ecosystem services based to the respondents median scores from citizen workshop. Scale was from 0 to 2 (0= not important, 1= important, 2= very important).

Case study booklet for:
WORKSHOP VIII: "Testing the final methods in policy- and decision-making (II)"
held in Eger, Hungary, March 19-22, 2018

5. ES mapping and assessment in the Vindelälven-Juhtatdahka river valley, northern Sweden

March 2018

ESMERALDA partner: Swedish Environmental Protection Agency

Case Study Coordinators: Johan Svensson [1)], Hannah Östergård [2)], Ola Inghe [2)]

1) Swedish University of Agricultural Sciences; 2) Swedish Environmental Protection Agency

ESMERALDA

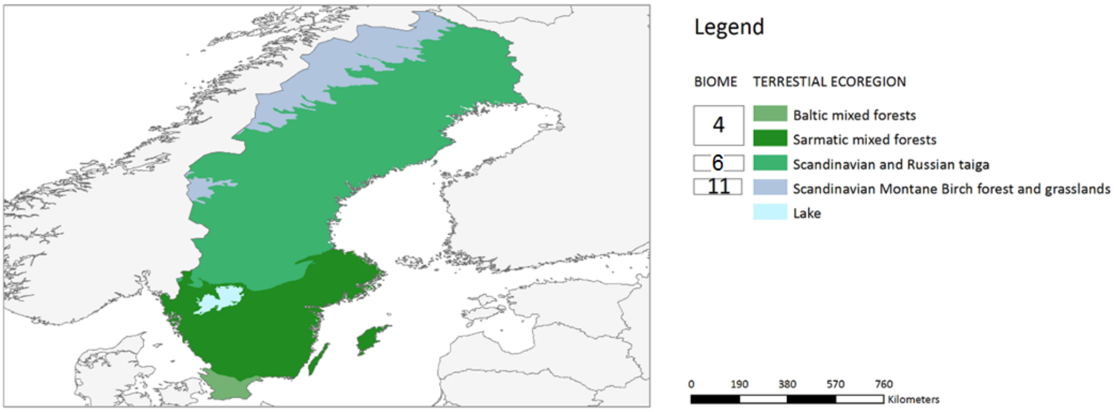
Enhancing ES mapping for policy and decision making

5.1. Case study factsheet and study area description

ES mapping and assessment in the Vindelälven-Juhtatdahka river valley WS8_cs3

NAME AND LOCATION OF STUDY AREA	Vindelälven-Juhtatdahka river valley, northern Sweden		
COUNTRY	Sweden		
STATUS OF MAES IMPLEMENTATION	Stage 1	Stage 2	Stage 3

BIOMES IN COUNTRY	1 Tropical & Subtropical Moist Broadleaf Forests	4 Temperate Broadleaf & Mixed Forests
	5 Temperate Conifer Forests	6 Boreal Forests/Taiga
	8 Temperate Grasslands, Savannas & Shrublands	11 Tundra
	12 Mediterranean Forests, Woodlands & Scrub	13 Deserts and Xeric Shrublands
	14 Mangrove	



SCALE	national	sub-national	local
AREAL EXTENSION	13,300 km²		

THEMES	nature conservation	climate, water and energy	marine policy	natural risk
	urban and spatial planning	green infrastructures	agriculture and forestry	business, industry and tourism
	health	ES mapping and assessment		
ECOSYSTEM TYPES	urban	cropland	grassland	woodland and forest
	heatland and shrub	sparsely vegetated land	wetlands	rivers and lakes
	marine inlets and transitional waters	coastal	shelf	open ocean

Study area description

The Vindelälven-Juhtatdahka river valley stretches about 450 km from a highest point of 1,641 m in the Scandinavian mountain range watershed divide to the Gulf of Bothnia marine coast. "Älv" translates to river in Swedish and "Juhtatdahka" translates to migration route in local Sami language. The river is the southernmost one out of four national rivers in Sweden, i.e. it has not been developed for hydropower. The river valley includes the contributory Laisälven mountain river that merge in the mountain foothills area, and the lower part of Umeälven river into which Vindelälven merge about 40 km from its mouth in the Umeåälven Ramsar and Natura 2000 delta. "Juhtatdahka" – migration route – refers specifically to the traditional use of the river and valley for movement and transport by boats and on ice and snow. Before railways and roads were developed starting in the late 1800s, the river was the main historical southeast to northwest infrastructure for humans and also as the natural ecological spread and migration route for species and habitat types. In particular, the annual migration of reindeers from the mountains to the coast and back – the backbone of the traditional Sami reindeer husbandry – marks the significant value of the river. The river valley includes territories used by seven Sami communities and is within the land of Sapmi, which encompasses indigenous peoples in northern Sweden, Norway, Finland and Northwest Russia. The area is rich in forest, minerals and other natural resources and rich in nature conservation values; in total 32% is protected including the 550,000 ha Vindelfjällen Nature Reserve which is one of the largest reserves in Europe. Cultural influence dates 8,000 years back. The Sami culture have enriched the natural values through a very long-term traditional and sustainable land use, alongside with rural settlers and small-scale farming.

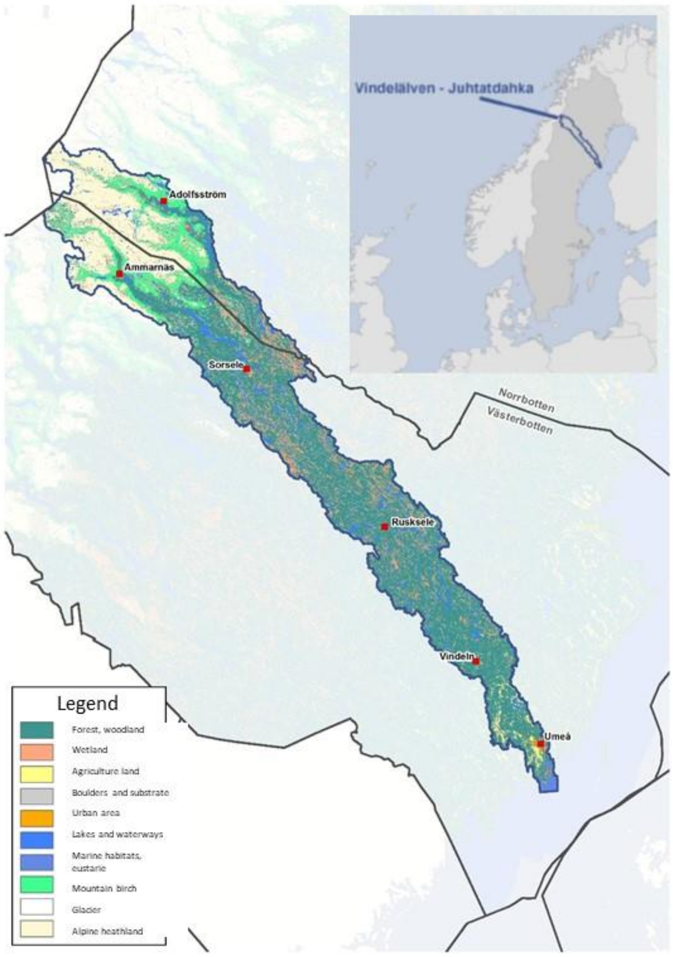


Figure 5.1. Location and cover types in the Vindelälven-Juhtatdahka river valley. Area (Latitude/Longitude) coordinates: Northernmost point 65.56483/15.56046, southernmost point 63.61657/20.22930, westernmost point 66.25310/15.37727, and easternmost point 63.67642/20. Source: Västerbotten County Administration Board.

Figure 5.2. Cultural influence have enriched the natural values. Photo from Padjelanta, north of the area. Source: NILS-ESS project, SLU

The river valley is an alpine and boreal transition of 13,300 km^2 with a human population of about 110,000, of which the vast majority (93%) in the coastal zone and the city of Umeå. Umeå, the largest city in northern Sweden, host two universities (Umeå University and Swedish University of Agricultural Sciences, Faculty of Forest Sciences) with around 35,000 students and high-profile research in, e.g., natural sciences and indigenous culture. The Vindelälven-Juhtatdahka area supports numerous long-term and project research as well as biophysical monitoring sites. The Vindelälven-Juhtatdahka river valley area is, formally, in the candidacy process for acceptance as a member reserve in the UNESCO Man and Biosphere Program.

5.2. Main policy question and theme

5.2.1. Objectives of ES mapping and assessment

The mapping and assessment of ES has been put in the context of planning and implementing sustainable development across a large-scale biotic transition, that display a magnitude of economic, ecological and socio-cultural gradients and that it representative for northern Sweden. With the overarching incentive of increasing the know-how and capacity for sustainable development following the Sustainable Development Goals and Agenda 2030, the UNESCO MAB program combines natural and social aspects of economy and education for improved human livelihoods and equitable sharing of goods and benefits of natural and managed ecosystems. The MAB-program is an intergovernmental scientific program that aims for establishing a scientific basis for advancing the relationship between people and their environment. Through the program, with the about 670 sites in 120 countries, MAB promotes innovative approaches to environmentally sustainable and socially and culturally appropriate economic development. Accordingly, ES is included as a central axis in the formal UNESCO candidacy process. The ES mapping and assessment theme thus follows the local natural and cultural identity and the premises for developing, supporting and conserving those values. Here, the foci are on ES associated with forest habitats, forest management and forests in a landscape context, and with the indigenous Sami culture reindeer husbandry. The Sami people with reindeer husbandry represents a culture that ultimately is based on services and goods provided by ecosystems and landscapes. In addition, a sustainable reindeer husbandry and vital Sami culture relies on continued access to ecosystem, landscapes and ES across geographical areas that reflect the natural annual and seasonal movement of the reindeer. Since reindeer husbandry occurs simultaneously with other land use – such as forestry – and irrespective of land ownership, the balancing of different and conflicting interest and views on multiple geographical scales requires, amongst others, appropriate ES data for stakeholder-informed operational landscape planning.

5.2.2. Stakeholders and their role

This ES mapping and assessment approach have benefitted from the process of forming and developing the formal UNESCO MAB candidacy for Vindelälven-Juhtatdahka, which was hosted by the County Administrative Board of Västerbotten and the municipalities in the area. This process has included broad and long-term stakeholder involvement and participation to outline strategies for conservation, development and supporting sustainable development. ES are specifically addressed in one of the chapters in the candidacy report. With the focus on Sami people and reindeer husbandry, the final setting of the Vindelälven-Juhtatdahka river valley ESMERALDA ES mapping and assessment report was prepared in dialogue with members of the Ran Sami community and incorporate some of the ES that generically or specifically are related to or generated by reindeer husbandry as a culture and land use in northern Sweden.

5.3. Ecosystem Types and Conditions

5.3.1. Identification and mapping of ecosystem type(s)

The area represents an elongated transition from the coastal boreal to the alpine biome. The bio-climatic zone ranges from hyper-arid to per-humid (climate zone Dfc; Köppen classification system). Forests and woodlands are predominant and cover about 535,100 ha (52%). Other nature types, in decreasing order, are alpine heath (18%), wetlands (12%), mountain birch forest (8%, water bodies (6%), agricultural land (2%), marine habitat (<1%), built areas (<1%), glaciers (<1%), estuary (<1%) and rocky and substrate land (<1%). The Vindelälven-Juhtatdahka landscape contains natural and cultural premises that support a rich pool of provisioning, regulation and maintenance and cultural ES. Furthermore, the watershed scale, from the uppermost divide in the Scandinavian mountain range and the valley hillsides to the mouth in the Gulf of Bothnia, represents a holistic landscape with a continuum of ecosystems and ecological processes. The configuration of alpine environments, alpine tree line forests, forests, woodlands, semi-open to open wetlands, heath, rock and flat rock sites, riparian zones, estuaries and water bodies, follows natural gradients and terrain formation. Land use by forestry, reindeer husbandry, agriculture, etc., have modified and affected the ES pools in both positive and negative ways. The river stretch itself, in particular with respect to its natural condition, provides a range of ecological, economic and socio-cultural premises. The rich natural resources and landscape characteristics support land use and business opportunities. Nature-based tourism is well developed with facilities ranging from internationally recognized downhill skiing resorts to family-driven fishing and wildlife activities. Unique natural features of significant values include a number of endemic species, primary succession on post-glacial rising coastlines (the official rate 8.5 mm uplift per year along the Gulf of Bothina coastline), 20 priority species according to the Habitats directive, 51 priority species according to the Bird Directive, 19 species on the global IUCN priority list, and 488 species on the national red list.

5.3.2. Assessing ecosystem conditions

Ecosystems conditions have been assessed by using public data governed by the County Administration Board and Municipality Boards, statistics in public databases and from sector authorities, expert knowledge by researchers that have experience from the area and by stakeholders, biophysical national monitoring data, and local knowledge with reindeer herders. For the biophysical data the main sources are the Swedish National Forest Inventory (NFI; Fridman et al. 2014) and the National Inventory of Landscapes in Sweden (NILS; Ståhl et al. 2011). Both these program collect a large set of variables that can be used as indicators or other type of ES measures, in particular if combined with wall-to-wall remote sensing-based data (cf. Mononen 2017).

No final indicators for continued assessment and evaluation have been defined at this stage. However, earlier studies by, e.g., Geijzendorffer & Roche (2013), Hansen and Malmeus (2016), Svensson et al. (2016) and Naturvårdsverket (2017) – the two latter in Swedish – indicate substantial ES assessment opportunities in particular with the NILS data. Currently, work is ongoing on testing cultural ES-based amenity value assessment for mountain environment by biophysical NILS variables (Hedblom et al. in prep).

5.4. Mapping and assessment of ES

5.4.1. Identification of ES

In the context of ESMERALDA, the ecosystem mapping and assessment have focused on ES associated with forests, forest management and forests in a landscape context, and with Sami community reindeer husbandry. Forests constitute the predominant land cover (Figure 5.1), and forest industry is a key business in the area as well as regionally and nationally. Forest ecosystems are also key biodiversity entities, alongside with open or semi-open habitats in the forest landscape. Reindeer husbandry represents an indigenous culture and sustainable, traditional land use that substantially contribute to the natural and cultural values of northern Sweden (Figure 5.2). The annual migration of reindeers from the mountain to the coast and back is a distinct feature that, ultimately, require large-distance connectivity and functional green infrastructure across different land cover types, land ownership situations and land used simultaneously for other land use. The mapping and assessment has been prepared for the following ES types:

Table 5.1. Overview of the ES and related mapping and assessment methods in the Northern Sweden case study

Ecosystem Service selected for mapping and assessment	B	S	E
1.1.1.2. Reared animals and their outputs *		X	
1.1.1.3. Wild plants, algae and their outputs	X		
1.2.1.1. Fibres and other materials from plants, algae and animals for direct use and	X		
2.3.1.2. Maintaining nursery populations and habitats	X		
3.1.1.1. Experiential use of plants, animals and landscapes *		X	
3.1.1.2. Physical use of plants, animals and landscapes *	X	X	

* ES selected for further discussion during ESMERALDA workshops 8 in Eger, Hungary;
B = biophysical methods; S = socio-cultural methods; E = economic methods.

5.4.2. ES mapping and assessment: biophysical methods

Biophysical methods were applied to map and assess services associated with natural forest (wild plants, algae and their outputs; 1.1.1.3), wood fibre provisioning (Fibres and other materials from plants, algae and animals for direct use or processing; 1.2.1.1), and valuable forest habitat qualities (Maintaining nursery populations and habitats; 2.3.1.2) and for physical use (Physical use of plants, animals and landscapes; 3.1.1.2). The approach was based on data from the NFI and NILS national monitoring schemes. The Swedish NFI dates back to the 1920s with a fairly consistent outlay since 1983. The NILS-program dates back to 2003. Thus, retrospective analyses of ES can be done, as well as forecasting based on a set or moving 5-year average measure assessed towards, e.g., selected land-use or climate change scenarios.

The NFI monitoring protocol includes a combined permanent and temporary field plot-based sampling of biophysical data with a 5-year sampling rotation. The NFI-based mapping applied here was performed through interpolated Inverse Distance Weighting (IDW) moving window with a 25 km search radius, where an average value was calculated from 20 field sample plots and weighted towards the centred plots. The numerical values presented was based on a moving average on the 2012-2016 sampling period. The NILS monitoring protocol includes a combined field sample plot and aerial photo interpretation within a systematic sample of 1x1 and 5x5 km sampling squares. Twelve field plots, consisting of concentric plots of increasing size for step-wise detail to broader resolution of biophysical data, are systematically placed within the 1x1 km square and sampled on a 5-year rotation. The mapping procedure applied here was a

Species Distribution Model (SDM) that maps presence probability of a selected monitoring variable. The specific model was a Generalized Additive Model (GAM) with auxiliary wall-to-wall land-cover information (Swedish Land Cover map and Lidar data) and data on topography, ground inclination, ground moisture and climate variables (Svensson et al. 2016). The GAM-approach based on NILS-data allows for spatially explicit and high resolution scenario-based mapping of selected variables on multiple scale.

Mapping of provisioning services

1.2.1.1. Fibres and other materials from plants, algae and animals for direct use or processing
Indicators: *Areal extension (ha) of productive forest land and total forest land / Areal extension of forest age class (ha) / total volume wood biomass (m^3) and dry substance (kg) / Areal extension of dominating tree species (ha) / Distribution of forest age classes (%/ha) / Distribution of broadleaf share in coniferous forest (%/ha) / Length (m) and density (m/ha) of ditches in productive forest land.*

Growing forests contribute to wood fibre provisioning and also to regulating and maintenance services such as carbon sequestration. Out of 530,7 kha productive forest land, 23,7 kha are recent clearcuts, 120,7 kha are plant- and young forests, 214,1 kha are mature forests at thinning stage, and 172,3 kha are older, mature forest that according the forestry regulations has reached an allowed clearcutting stage (*Figure 5.3*, left panel). The total volume wood biomass in the area equals about 54 million m^3 for all forest land and 51.5 million m^3 for productive forest land. According to forestry policy, productive forest land is forest land that produces a minimum of 1 m^3 (merchantable) wood per ha and year, and only productive forest land can be used for forest management for economic purposes. The wood biomass in productive forest equals in total 21,786,999 kkg (stems and bark), 7,636,000 kkg (branches and needles) and 10,042,000 kkg (stumps and roots) dry substance. For total forest land, the comparable dry substance equals 42,863,000 kkg which equals 110% compared with productive forest land.

Different tree species provide diversity in and different premises for ES. The pre-dominant tree species in the area is Scots pine on 346,8 kha (65,5% of the productive forest land), followed by Norway spruce on 18,5%, coniferous dominated mixed forest on 15%, mixed coniferous and broadleaf forest on 7%, and broadleaf forest on 5% (3, right panel). While coniferous trees are the main source of wood fibre, also broadleaf trees and forests contribute to the range and pool of provisioning services. Drainage in forest land contribute to the tree growth site capacity and provisioning ES, but has also negative effects such as nutrient loss and physical and chemical conditions in aquatic ecosystems. In total about 55 kha (10.5% of total productive forest land) have a drainage system whereof the majority (49 kha) are in function.

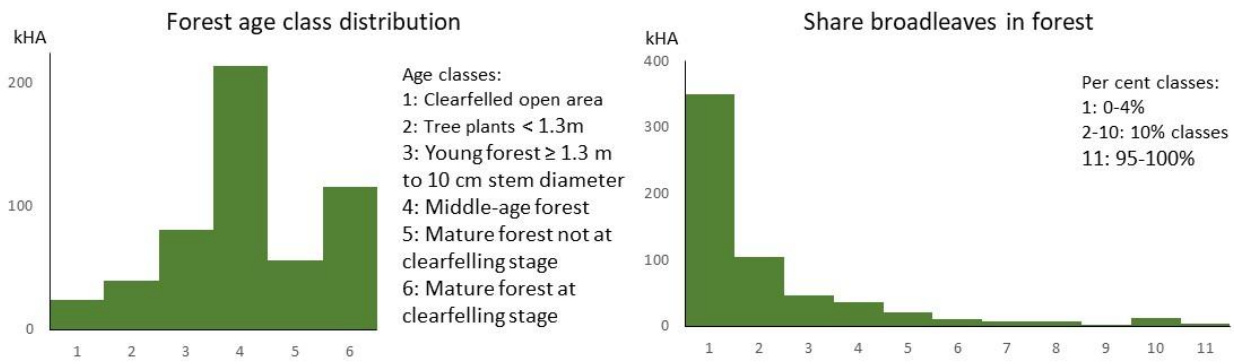


Figure 5.3. Forest age class distribution and the share of broadleaf trees, both on productive forest land. Data source: The Swedish National Forest Inventory for the 2012-2016 5-year monitoring rotation.

Mapping of regulating and maintenance services

2.3.1.2 Maintaining nursery populations and habitats

Indicators: *Areal extension and distribution (ha) of old forest (age ≥140 years) / Areal extension and distribution of old broadleaf-dominated forest (age ≥80 years) / Density (no/ha) of large trees (diameter 0.45 and more at 1.3 m above ground) / Amount (m^3) dead wood / Areal extension and distribution of protected area (ha) / Areal extension and distribution of priority habitats and species (ha) / Numbers and types of formal protection areas.*

Old forests contribute critical biodiversity values and ES, e.g., as core forest areas with intact habitat and ecosystem characteristics, structures and processes and as refuge entities for threatened species (Figure 5.4). The area harbour about 64,000 ha forest older than 140 years, which equals 12% of the productive forest land. Old broadleaf forest, which generally support a higher level of biodiversity and ES pool, cover about 11,000 ha. Large and old trees provide essential niches for biodiversity and also contribute specific amenity, historical and cultural values. There is on average one (0.9) large tree (diameter 0.45 m or more at 1.3 m above ground) per ha in the area. Most of them are Norway spruce or Scots pine and only about 10% are broadleaves. Dead wood provides an important substrate for many species and is generally considered as a key factor for biodiversity. Assessed for productive forest land, the total volume dead wood is about 4,326,000 m^3, equal to 8.2 m^3/ha. The amount dead wood on total forest land is just slightly higher, about 4,702,000 m^3, owing to the fact that low productive forest land by nature often is more open with low volumes of trees.

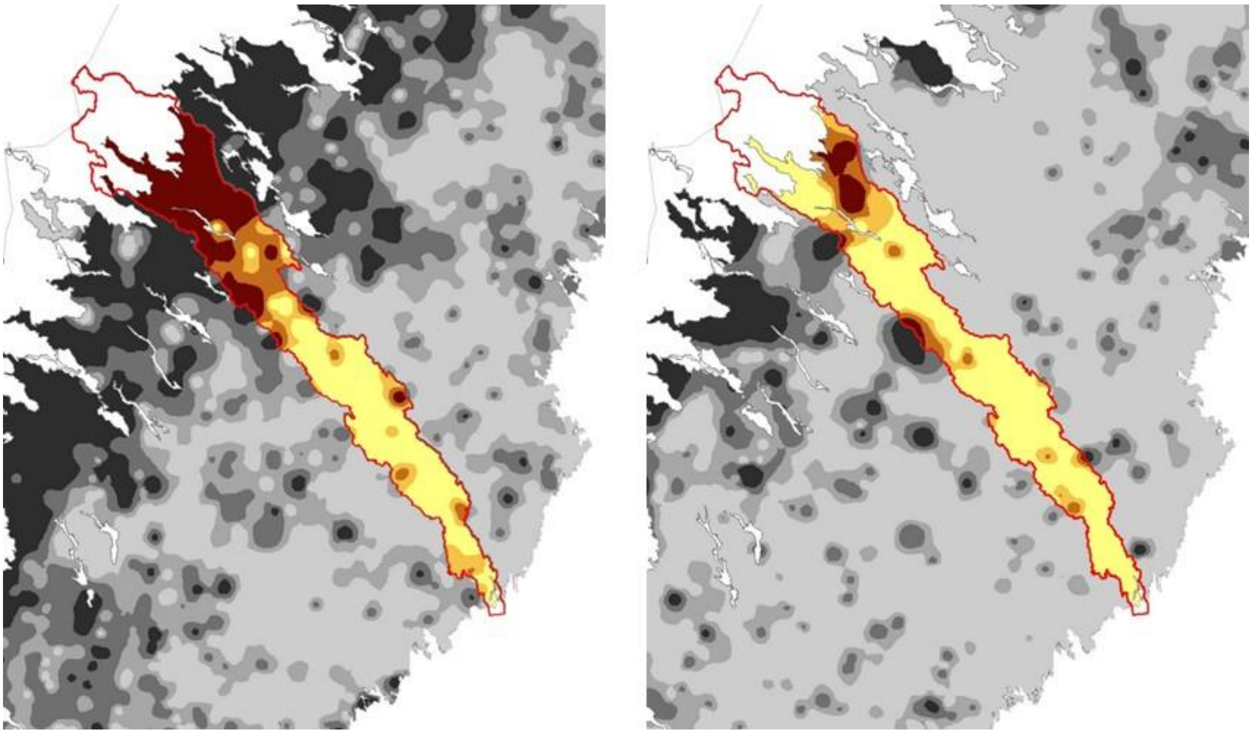


Figure 5.4. Distribution of old forest (age ≥140 years) to the left and old broadleaf forest (i.e. broadleaves at minimum 30% of the basal area and 80 years old) to the right. The map shows the Vindelälven-Juhtatdahka river valley in yellow to red colors and the surrounding areas in grey to black colors. Data: The Swedish National Forest Inventory for the 2012-2016 5-year monitoring rotation. Source: Västerbotten County Administration Board.

Nature conservation in the form of nature reserves and other types of formal protection set aside larger areas and clusters of ecosystems and habitats that have a high degree of ecosystem functionality and biodiversity, and where the functionality can be maintained for a continued pool of provisioning, regulating and maintenance and cultural services. Thereby, mapping of protected areas is indicative for ES mapping. As well, data on identified priority natural and cultural values are indicative for ES assessment. Out of the 13,300 km^2 Vindelälven-Juhtatdahka area, 4,300 km^2 are formally protected and another 230 km^2 voluntary protected – altogether equivalent to about 34% (Figure 5.5). The area encompasses about 90 different nature reserves, including the 550,000 ha Vindelälven mountain reserve, several near-natural forest areas, river rapids, cultural landscapes, estuary and marine habitats, etc. Besides nature reserves, in total 43 formal nature conservation agreements, 120 biotope protection areas, and three Ramsar sites currently are demarcated.

The concept of green infrastructure is developed to secure long-term functionality of ecosystems at multiple spatial scales. Liquete et al. (2015) defined green infrastructure as a strategic and operational planning network of natural and semi-natural areas that specifically are designed to provide and mobilize ecological connectivity, functionality, biodiversity and services in ecosystems. Hence, a functional green infrastructure is a spatiotemporally connected configuration of habitats that sustain ecosystem processes and structures also under ongoing climate change and forest management. A large share of the protected area is located in the alpine region. Recent studies (Svensson et al. in revision) have identified connected boreal forest green infrastructure along the mountain range foothills but also a lack of connectivity in the mountain to coast northwest to southeast gradient.

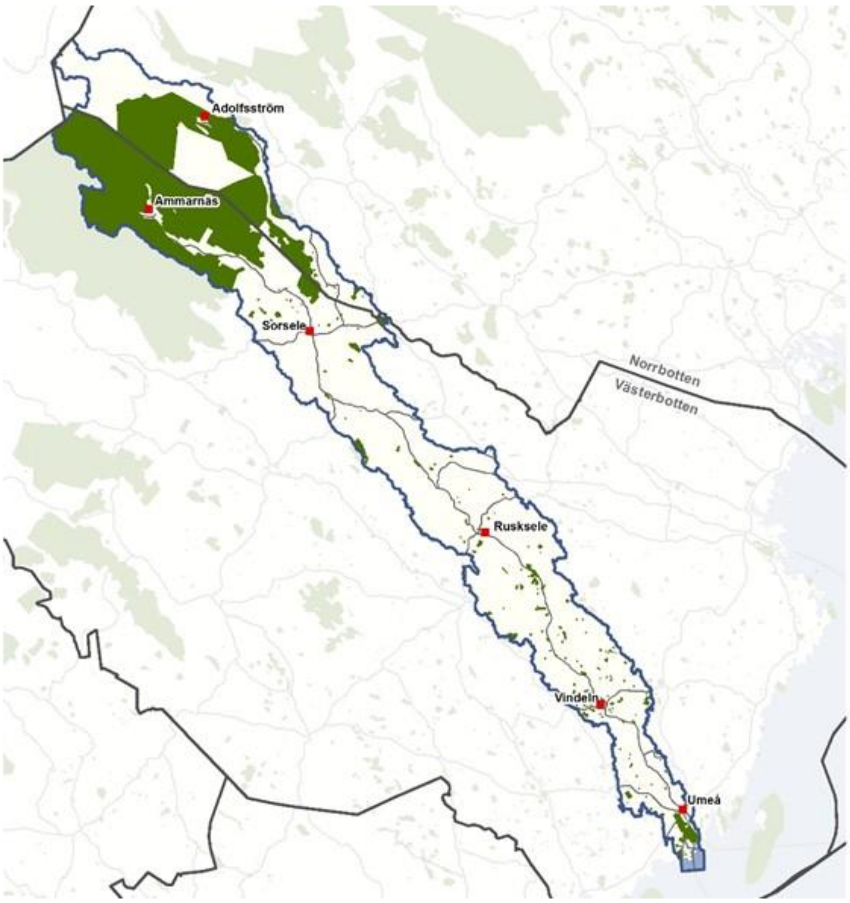


Figure 5.5. Formally protected areas in the Vindelälven-Juhtatdahka river valley. Source: Västerbotten County Administration Board.

Mapping of cultural services

3.1.1.1 Experiential use of plants, animals and landscapes
3.1.1.2 Physical use of plants, animals and landscapes
Indicators: *Distribution (ha) and cover (%) of forest floor lichen / Distribution (ha) and cover (%) of edible berries / Distribution (ha) and cover (%) of ptarmigan habitats.*

With the rich natural resources and landscape features, the long-term rural land-use history and associated socio-cultural influence have enriched the total ES pool in the Vindelälven-Juhtatdahka river valley. Here, the reindeer husbandry and the Sami culture explicitly provide unique values. A large enough reindeer population is a prerequisite not only for the economic life of indigenous people and the rural economic societal life and business opportunities but also for maintaining a grazed, open mountain landscape (Sandström et al. 2016). The open, magnificent mountain landscape provides highly appreciated amenity value and prerequisites for a range of cultural services, goods and benefits alongside with provisioning and regulating and maintenance ES (Blicharska et al. 2017). Grazing is a natural disturbance mechanism in boreal ecosystems. It is well established that the availability of forest floor lichens as a natural food during winter is a limiting factor determining the reindeer population size (Sandström et. al. 2016). Forest floor lichen and also epiphytic lichen favour open and semi open forests. In a landscape that is dominated by forests, open and semi-open areas generally contribute to the landscape diversity and the ES pool. Such forest exists in a natural network on drier and wetter sites, e.g. as poor Scots pine forests on sandy eskers and ridges in the northwest-to-southeast direction of the river valley. These forests and woodlands represent essential grazing and resting areas for reindeers. Thus, their abundance is a regulating factor for reindeer and the ecosystems services associated with reindeer and the Sami culture. A maintained green infrastructure of such open and semi-open habitats is critical for natural reindeer movement and reindeer herding as a land-use culture. The study by Sandström et al. (2016) showed that such forests are decreasing rapidly at a rate of about 70% over a 50-year period.

Figure 5.6illustrates forest floor lichen cover through probability modelling based on NILS data. The total area of lichen rich (> 25% forest floor lichen cover) forests in the area is about 48 kha (NFI data), equal to 9% of the productive forest land. Figure 5.6 also illustrates the probability of occurrence and cover of bilberry in the coastal zone and ptarmigan habitats in the mountain zone. Berry picking, both as business for industrial purposes and for household purposes, is common in the area. The annual production of bilberry and lingonberry has been estimated to around 24,000 kkg and 13,700 kkg, respectively (NFI data). Also small-game hunting of ptarmigan is common and a typical activity in the mountain environment, both for household hunting and for hunting tourism. With climate change, the shrub-dominated alpine habitats preferred by ptarmigans risk to transform into tree-dominated through upward movement of the alpine tree line.

The mapping and assessment example provided here also contribute to other ES, such as wild plants, algae and their outputs (1.1.1.3) and experiential use of plants, animals and landscapes (3.1.1.1) because of their connection, e.g., to reindeer husbandry and wildlife experiences, and are also indicative for a range of regulating and maintenance ES as they exemplifies natural structures and species in their habitat and landscape contexts.

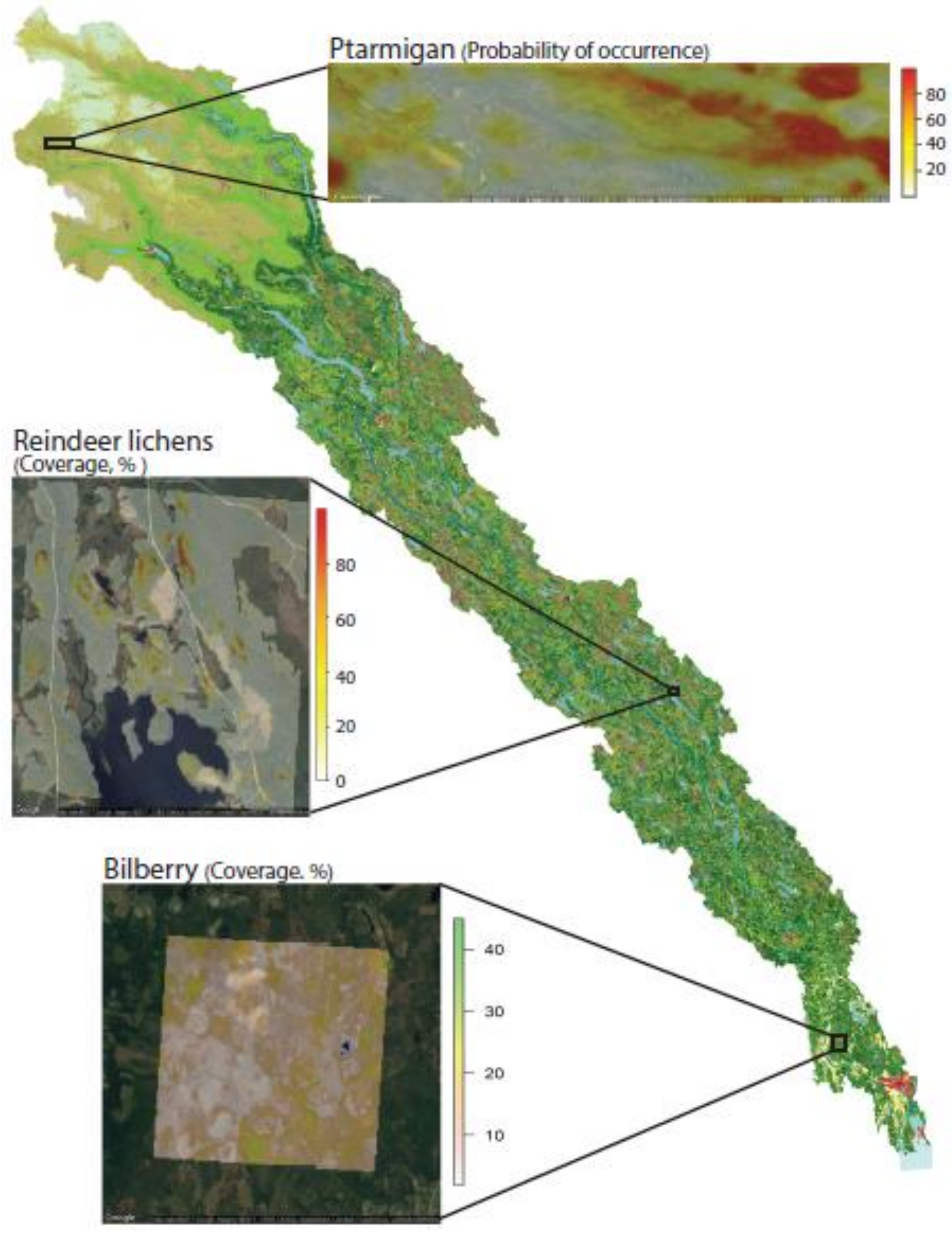


Figure 5.6. Mapping and assessment of occurrence of ptarmigan habitats (mountain zone), forest floor lichen cover (forest zone) and bilberry cover (coastal zone). The model is based on data from the National Inventory of Landscapes in Sweden (NILS; lichen, ptarmigan) monitoring program and the Swedish National Forest Inventory (NFI; bilberry) combined with land cover data for wall-to-wall modelling and auxiliary data. Source: Västerbotten County Administration Board.

5.4.3. ES mapping and assessment: socio-cultural methods

Socio-cultural methods were applied to map and assess the premises for presence and abundance of reindeer in the landscape (Reared animals and their outputs; 1.1.1.2) and the experiential and physical presence of reindeer husbandry (Experiential use of plants, animals and landscapes; 3.1.1.1, and Physical use of plants, animals and landscapes; 3.1.1.2).

Reindeer husbandry in Sweden occurs according to legal rights on 55% of the Swedish land base, within in total 51 defined Sami community territories (Sandström 2015). Each Sami community consists of a varying number of semi-separate business enterprises. No strict land ownership is associated with the land use. Instead, reindeer husbandry occurs simultaneously with other land use on land owned by the state, private forest companies, private household forest owners, municipalities, the church, etc. Hence, conflict do occur. The semi-domestic herding system follows the natural migration behavior of the wild reindeer, which for many Sami communities means annual migration from the mountains in the early fall to the coast and back in the spring and early summer; a one-way migration distance as long as up to 400 km. To function, the landscape needs to contain the necessary habitat prerequisites, and these need to be accessible for the free-ranging reindeers. Hinders and barriers prevent the free-ranging behavior and force more active herding, including transporting on trucks and artificial feeding. Urban areas, roads, railways, regulated water reservoirs (for hydroelectricity), mines, and wind mill parks represent such barriers, but also forestry land-use that modifies the natural habitat and landscape structures; e.g. too dense forests that prevent forest floor and epiphytic lichens to occur in enough quantities. In addition, predators such as the golden eagle, wolf, bear, lynx and wolverine cause impact. Connectivity and availability of suitable habitats for grazing, resting, calving and moving are critical for the ES pool associated with the reindeer husbandry and the Sami culture. Lack of connectivity and availability implies a reducing pool. The concept of green infrastructure is thus generically applicable for multiple-scale mapping, assessment of planning of those ES and supporting functions that are associated with reindeer husbandry, the Sami culture and the open, magnificent character of the Scandinavian Mountain Range.

The socio-cultural ES mapping is based on key areas, core areas, migration routes and barriers. The data has been compiled by the herders themselves based on their traditional knowledge of how the reindeer moves in the landscape and the different annual phases in the reindeer autecology. Figure 5.7 shows the location of the seven Sami communities that has territory within the Vindelälven-Juhtatdahka area (left panel) and key areas, core areas, migration routes and barriers specifically for the Ran Sami community (right panel).

Following a strict definition of direct or final ES, it may be argued that the reindeer itself as an animal is the provisioning service, that the immediate impact of the reindeer on ecosystems (e.g., grazing or scraping with the antlers on trees) is the regulating and maintenance service it generates, and that the human wellbeing created by experiencing the reindeer is the cultural ES. However, in practice the interfaces between services, goods and benefits are prominent. Furthermore, since the Sami indigenous culture, traditions, language, etc. are strongly associated with the natural and cultural values associated with reindeer husbandry and with the Scandinavian Mountain Range characteristics, the socio-cultural mapping and assessing approach has followed a wider understanding of ES.

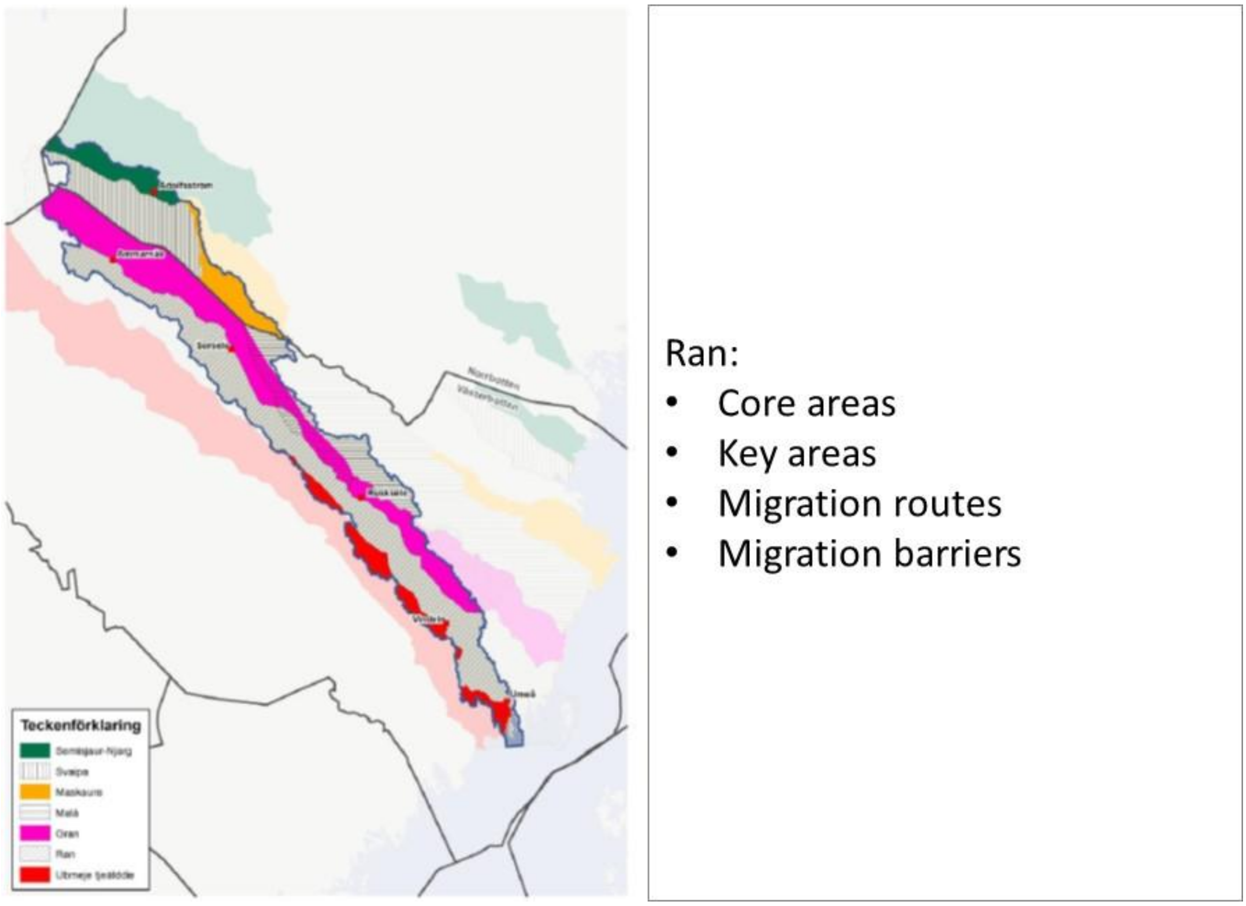


Figure 5.7. Location of the seven Sami communities within the Vindelälven-Juhtatdahka river valley (left), and key areas, core areas, migration routes and barriers for the Ran Sami community (right). Source: Västerbotten County Administration Board / Ran Sami Community.

Mapping of provisioning services

1.1.1.2 Reared animals and their outputs
Indicators: Numbers of reindeer (no) / Slaughter reindeer (no/kg) / Amounts of reindeer products, such as meat, skin, bones, antlers, milk used for tools and handicraft
General indicators: Areal extension of core areas (ha), including subdivision into specific areas / Areal extension of key areas (ha), including subdivision into specific areas / Length (m) or density (m/ha) migration routes and other types of functional links between core and key areas / Migration barriers (no) / Type of migration barrier (qualitative)

Reindeer generate products that are used as food, handicraft and tools, either directly by the Sami and other local people or for sale. Processing units such as abattoirs, corals, tool and handicraft manufactures etc. structures are owned and operated within Sami communities, commonly between Sami communities, or by single herding businesses. By tradition, local use of goods and benefits are pre-dominant, either as family consumption or by local restaurants specialized in local food.

Mapping of regulating and maintenance services

Regulating and maintenance ES was not approached per se in the socio-cultural method. As noted above, however, the reindeer husbandry and Sami cultural land use interacting with ecosystems have regulating and maintenance relevance for ecosystems function and processes generally relevant to ES.

Mapping of cultural services

3.1.1.1 Experiential use of plants, animals and landscapes
3.1.1.2 Physical use of plants, animals and landscapes
Indicators: *Numbers of reindeer (no) / Areal extension of open, grazed alpine heath (ha) / Remains on ecosystems that are associated with reindeer and Sami culture (no)*
General indicators: *Areal extension of core areas (ha), including subdivision into specific areas / Areal extension of key areas (ha), including subdivision into specific areas / Length (m) or density (m/ha) migration routes and other types of functional links between core and key areas / Migration barriers (no) / Type of migration barrier (qualitative)*

It is well established that a large enough population of reindeer is needed to maintain the magnificent landscape in the Swedish Mountain Range, with those amenity and other values that are the foundation for a vital small- and large-scale tourism business. Seeing reindeers and the remains and impact of reindeers and the Sami culture in the environment certainly is central for a range of different cultural ES. The local identity with maintained traditions and presence of Sami culture and reindeer husbandry sustain a sense of belonging that generates the intrinsic capacity for a sustainable development and economic life along the whole stretch of the Vindelälven-Juhtatdahka river valley.

5.4.4. ES mapping and assessment: economic methods

Economic methods for mapping and assessment of ES was not applied in this study.

5.5. Use and integration of ES mapping and assessment results

5.5.1. Addressing the policy question

The ES mapping and assessment has been put in the context of planning and implementing sustainable development. The Vindelälven-Juhtatdahka river valley area is in the candidacy process for the UNESCO Man and Biosphere Program. With the overarching aim to support sustainable development following the Sustainable Development Goals and Agenda 2030, the UNESCO MAB approach to landscape planning includes a zonation of the area into core areas, buffer zones and development areas. The different zones reflect the natural, social and economic aspects of improved human livelihoods and equitable sharing of services, goods and benefits of natural and managed ecosystems. Hence, ES are outlined, described, mapped and assessed, and indicators and other measures are proposed, developed and tested, for developing, supporting and conserving the natural and cultural identity and values. The foci in the ESMERALDA ES mapping and assessment was on forest habitats, forest management and forests in a landscape context, and on the indigenous Sami culture reindeer husbandry. These foci are key ingredients in the MAB zoning approach to sustainable development and will assist in balancing different and sometimes conflicting interest and views on multiple geographical scales.

5.5.2. Dissemination and communication of results

For academic purposes, the approach and results presented here will be used for the continuing building of know-how on ES applications within the Swedish EPA research and communication programs. With the direct anchorage with the County Administrative Board of Västerbotten and the Municipality Boards involved in the UNESCO MAB-process, this will also contribute to regional and local ES understanding and use as input data in territorial planning. Furthermore, through the MAB-program and the following steps towards formal reserve membership for the Vindelälven-Juhtatdahka site, this also supports ES applications as a key ingredient in the global MAB-network with the Sustainable Development Goals and Agenda 2030 as a main framework. At site, for exploring and solving the conflict risks but also for elucidating integration and synergy opportunities between reindeer husbandry and other land uses as well as among other land uses, appropriate ES mapping and assessment is needed for stakeholder-informed and sustainable operational landscape planning.

5.6. References & Annexes

5.6.1. References

Blicharska, M., Smithers, R.J., Hedblom, M., Hedenås, H., Mikusiński, G., Pedersen, E., Sandström, P., Svensson, J. 2017. Shades of grey challenge practical application of the cultural ecosystem services concept. Ecosystem Services 23:55-70.

Fridman, J., Holm, S., Nilsson, M., Nilsson, P., Ringvall, A.H., Ståhl G. 2014. Adapting National Forest Inventories to changing requirements - The case of the Swedish National Forest Inventory at the turn of the 20th century. Silva Fennica 48, art. no. 1095.

Geijzendorffer, I.R., Roche P.K. 2013. Can biodiversity monitoring schemes provide indicators for ecosystem services? Ecological Indicators 33: 148-157.

Hansen, K., Malmeus, M. 2016. Ecosystem services in Swedish forest. Scandinavian Journal of Forest Research 31: 626-640.

Hedblom, M., Adler S., Blicharska M., Hedenås H., Mikusiński G., Sandström S., Sandström P., Svensson J., Wardle D. In prep. Linking physical landscape properties to perceived landscape features: potentials in NILS monitoring program.

Liquete C, Kleeschulte S, Dige G, Maes J, Grizetti B, Olah B, Zulian G. 2015. Mapping green infrastructure based on ecosystem services and ecological networks: A Pan-European case study. Environmental Science & Policy 54:268-280.

Mononen, L. 2017. Monitoring ecosystem services and biodiversity. From biophysical measures to spatial representations. Dissertations in social sciences and business studies. Publications of the University of Eastern Finland. No. 160.

Naturvårdsverket. 2017. Ekosystemtjänstförteckning med inventering av dataunderlag för kartläggning av ekosystemtjänster och grön infrastruktur. Rapport 6797. In Swedish.

Sandström, P. 2015. A toolbox for co-production of knowledge and improved land use dialogues – The perspective of reindeer husbandry. Acta Universitatis Agriculturae Suecicae - Silvestra 2015, 20.

Sandström, P., Cory, N., Svensson, J., Hedenås, H, Jougda, L., Brochert, N. 2016. On the decline of ground lichen forests in the Swedish boreal landscape – Implications for reindeer husbandry and sustainable forest management. Ambio 45: 415-429.

Ståhl, G., Allard, A., Esseen, P.-A., Glimskär, A., Ringvall, A., Svensson, J., et al. 2011. National Inventory of Landscapes in Sweden (NILS) - scope, design, and experiences from establishing a multiscale biodiversity monitoring system. Environmental Monitoring and Assessment 173, 579-595.

Svensson, J., Mikusinski, G., Esselin, A., Adler, S., Blicharska, M., Hedblom, M., Hedenås, H., Sandström, P., Sandström, S., Wardle, D. 2017. Nationell miljöövervakning och utvärdering av ekosystemtjänster i fjäll och skog. Naturvårdsverket, Rapport 6754. In Swedish

Svensson, J. Andersson, J., Sandström, P., Mikusinski, G., Jonsson, B.G. In revision for Conservation Biology. Landscape trajectory of natural forest loss – what's left to build a functional boreal green infrastructure?

5.6.2. Annexes

Annex 1: Examples of ecosystem services, use of services, business opportunities and indicators, specifically for reflecting the local natural and cultural landscape values in the Vindelälven-Juhtatdahka river valley.

Category	Examples	Use	Business	Indicators
Provisioning	Wood fiber; Fire wood; Tree bark, roots and conks; Reindeer – meat, skin, antlers and bones; Wild ungulates, birds and fish; Wild berries, fruits and mushrooms; Clean surface drinking water	Household consumption of fire wood, berries, mushrooms, meat, natural medicine and drinking water; Handicraft production based on plant and animal material.	Organized berry picking hunting and fishing; Forest management; Reindeer husbandry; Wildlife tourism; Local food and handicraft	Amount picked berries, mushrooms; Growth and harvest of trees; Amount reindeers, game and fish processed; Amount of natural drinking water consumed
Regulating and maintenance	Intact habitats, flora and fauna; Natural wetlands with peat formation; Growing forest; Natural riparian buffer areas towards water bodies; Natural forest edges	Storm protection, ventilation and transportation; Mass stabilization and erosion control; Functional ecosystems, habitats and hydrological cycles; Natural flora and fauna	Functional ecosystems for tree growth, reindeer populations, wild game and fish. Access not natural landscapes and local culture	Area formally protected nature; Density natural forest edges and riparian zones; Density natural river rapids; Density restored waterways; No. of avalanches and other mass flows; No. of wind thrown trees
Cultural	Open, lands in the mountain region, open mires and farmland. Habitat diversity on landscape scale; Biological legacy of long-term sustainable land-use culture; Large, old trees; Natural rapids and whitewater	Access to natural and cultural landscapes; A sense of naturalness, originality and belonging; Fishing places, hunting areas, bird watching. Trails, shelters, snow mobile routes, access roads;	Access to natural landscapes with cultural remains; A sense of naturalness and originality; Organized fishing places and hunting areas. Trails and shelters for hiking; Campgrounds; Handicraft, local food and products	Area open land; Density old, large trees; Density trails, shelters, camp grounds, information signs, fishing places; Numbers of research projects