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EUROPEAN UNION

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Inspire Policy Making with Territorial Evidence

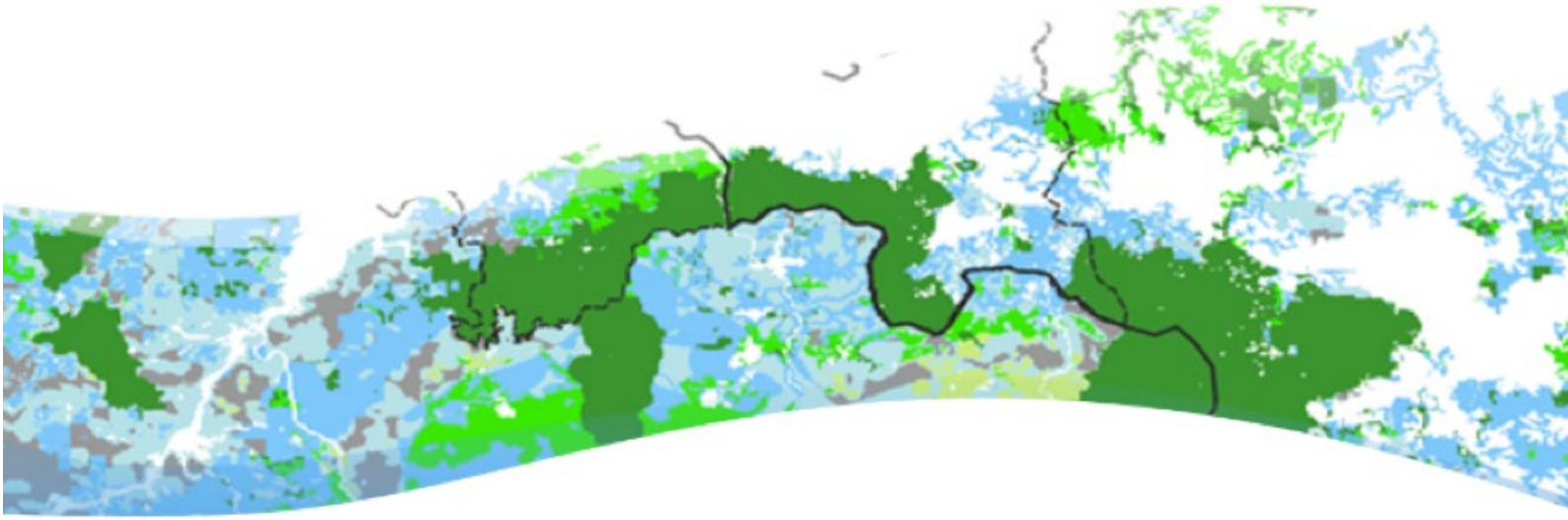
GRETA BRIEFING 3 //

Planning for green infrastructure:

Methods to support practitioners and decision-making

August 2019

https://www.espon.eu/green-infrastructure



Imagine you are responsible for planning an area (either in the countryside or within an urban area) and you are faced with specific challenges which require the prioritization of certain ecosystem service(s), such as flood risk mitigation, effects of climate change, or supporting biodiversity. You would like to assess the potential of green infrastructure to provide such a service and the best way to manage this green infrastructure to fulfil this need.

How would you do this?

This briefing offers a series of steps that can be followed to help with such an assessment. It aims to provide an overview of the methods developed for and used in the GRETA project, which are applicable for considerations around green infrastructure and ecosystem services. It will be relevant for practitioners involved in green infrastructure planning and management who are looking for existing and accessible methodological frameworks to guide their decision making.

Decisions made for green infrastructure planning can impact green infrastructure itself (accessibility or the current state, e.g. through the creation of new green areas) or the enabling factors by affecting the institutional framework (e.g. new legal context, increased political commitment and social awareness).

Figure 1 provides an outline of the steps one might consider when seeking to assess the potential of green infrastructure to provide ecosystem service(s) and how one might manage the green infrastructure to fulfil these needs.

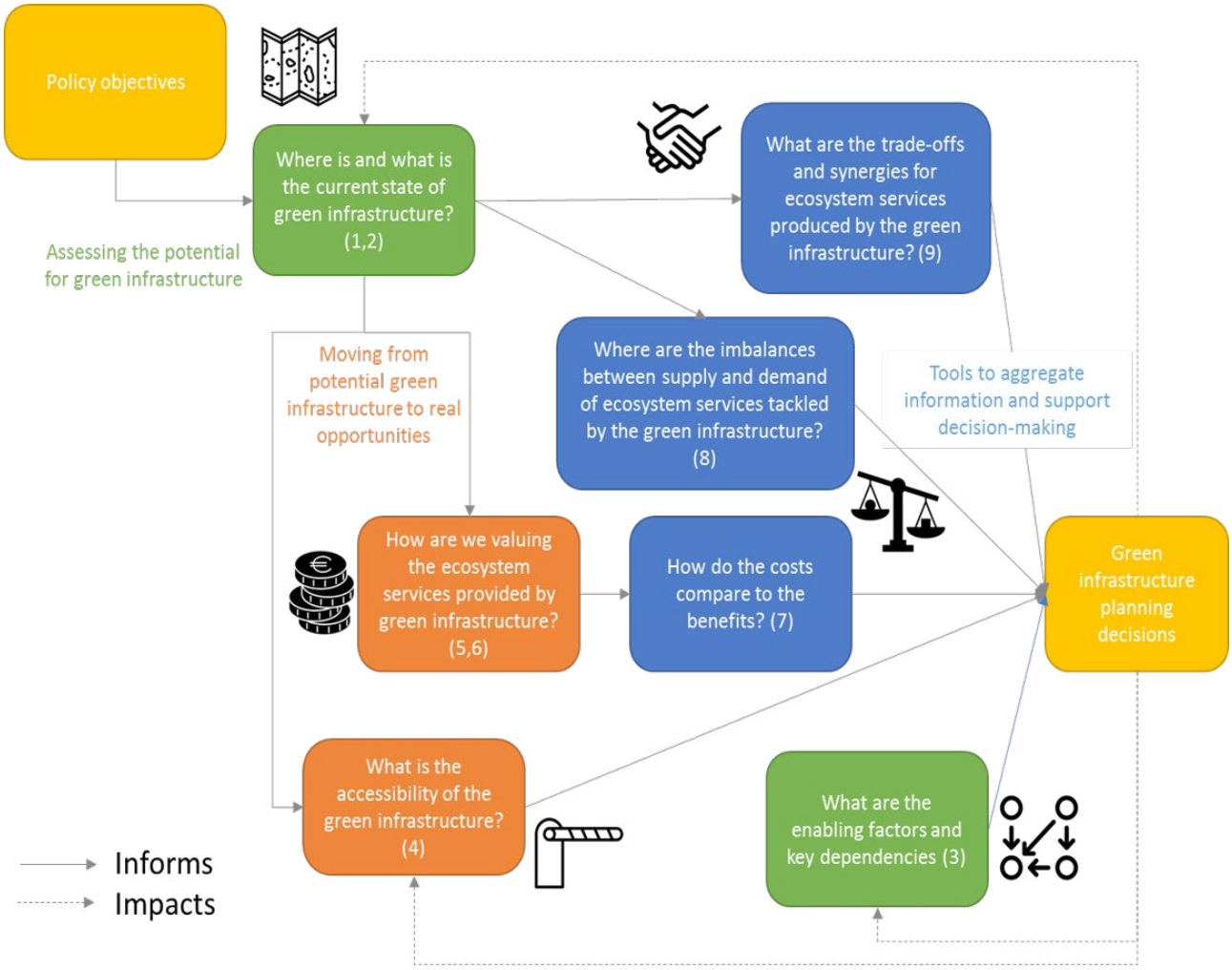


Figure 1. Steps and methods used in the GRETA project to support practitioners in green infrastructure planning and decision-making. Numbers correspond to specific methods which are summarized in this briefing. Dotted lines refer to impacts of the planning process on green infrastructure characteristics; solid lines indicate the flow of information from the initial definition of the objective or priority to be addressed to the final green infrastructure implementation. For a full description of each method, refer to the Scientific Annexes of the GRETA project reports *(https://www.espon.eu/green-infrastructure) [Source: Elaboration by GRETA research team. Icons from https:// thenounproject.com/; see image credits at end of Briefing.]*

The first step (methods 1 and 2) would be to determine the current state of green infrastructure: what natural and semi-natural features are currently present in the geographic area? By identifying these elements and understanding their state and capacity to supply specific ecosystem services (multifunctionality) to support policy objectives (Figure 2), one would then be able to identify the potential green infrastructure according to the objectives.

This first step would be complemented by an assessment of enabling factors and barriers for implementing green infrastructure (method 3). If providing social benefits is one of the priorities, the next step would then be to assess whether a population would have access to the potential green infrastructure (method 4). By assessing the current state of green infrastructure and accessibility, alongside a valuation of ecosystem services (methods 5 and 6), one would be able to identify the opportunities for action to adjust the supply of ecosystem services through green infrastructure without compromising its multifunctionality (method 8). These opportunities can inform decision making, alongside assisting a cost benefit analysis of actions (method 7), while keeping in mind synergies and trade-offs (method 9) between ecosystem services provided by green infrastructure.

The remainder of this briefing is divided into three sections; clustering the nine different methods according to what they can do and the types of overarching questions they can address. Each description additionally touches on how the method relates to the others, the type of data needed, the method's limitations, and why it might be selected over another similar type of method.

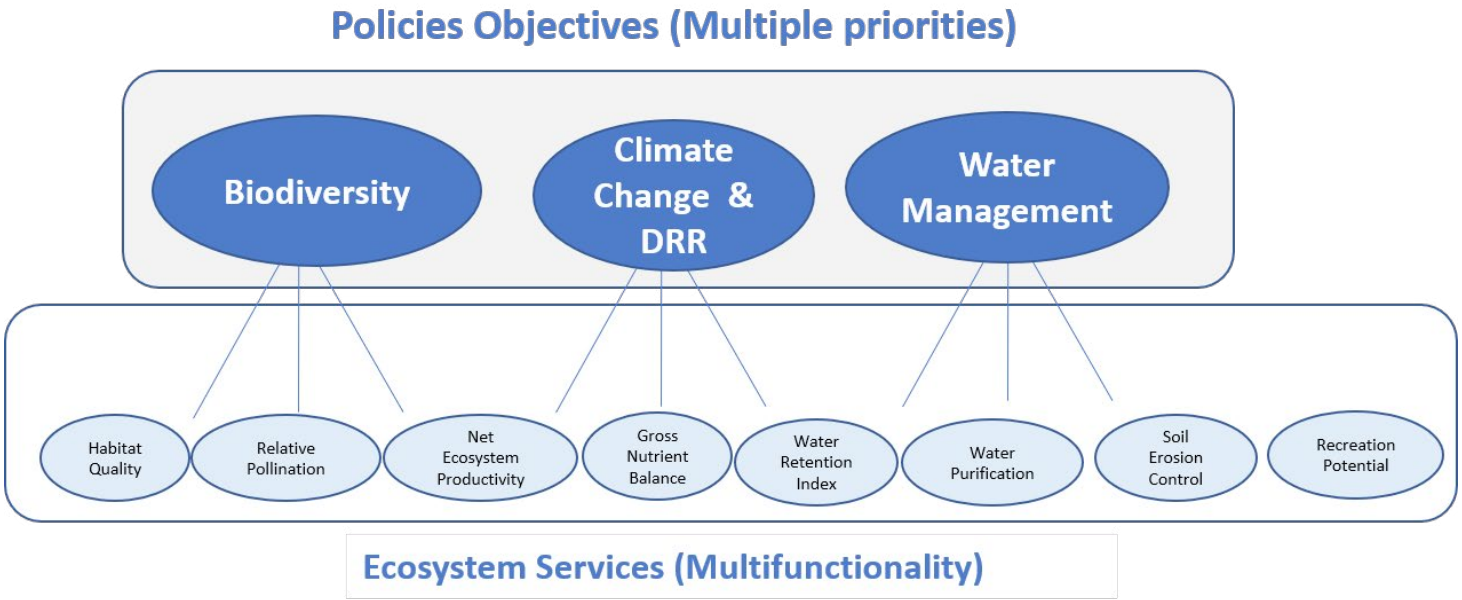


Figure 2. Identification of the ecosystem services that best serve the purpose of three policy priorities. The figure reflects the ecosystem services and policies considered in the GRETA project. [DRR = Disaster risk reduction]

Section I: Assessing the potential for green infrastructure (methods 1, 2, 3)

1. Physical Mapping Method – Assessing and connecting valuable natural areas

What does it do? Maps the spatial distribution of land use and cover features which fit the definition of green infrastructure[1], in this instance natural and semi-natural features (see Box 1), and assesses the connectivity among them.

How does it relate to other methods? Provides a base map for strategic planning and multifunctional green infrastructure assessment.

What questions could it answer? Which land use and land cover features could provide green infrastructure? Where are these located? Are they homogenously distributed? Are green infrastructure elements connected throughout the urban, peri-urban and rural settings? Where is fragmentation hampering the deployment of green infrastructure?

What are the data needs? Land use and land cover maps identifying natural and semi-natural features. Maps of existing areas under environmental protection or that are providing natural ecosystems with exceptional services conditions (e.g. high nature value farmland).

What are the limitations? Requires existence of high-resolution maps available at relevant scale; for example, at the EU level, this can be provided through the CORINE Land Cover Map.

Why this method over others? It can be applied at different spatial scales and it is easy to compute over large spatial areas. It is based on the spatial distribution of natural and semi-natural features, thus enabling a comparison of regions with different ecosystems.

2. Ecosystem Service Base Mapping Method – Assessing multifunctionality

What does it do? Assesses the performance of the physical green infrastructure by determining the ecosystem services being supplied and, therefore, the multiple demands supported (see Box 2).

How does it relate to other methods? Builds on the physical map of green infrastructure (see method 1) to identify the ecosystem services supplied by the network. This feeds into the assessment of trade-offs and synergies (see method 9).

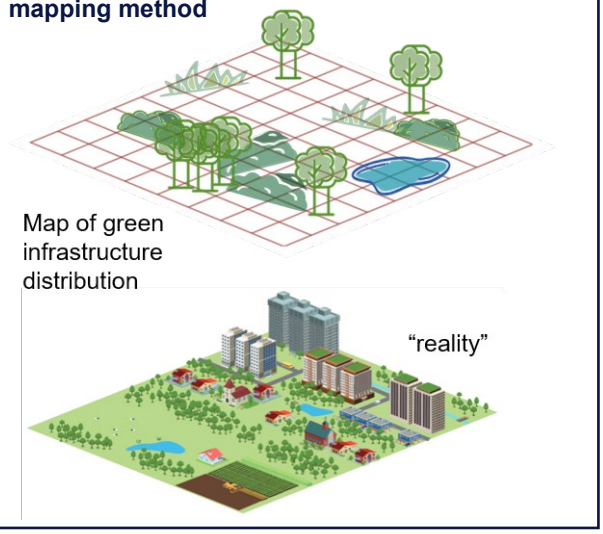
What questions could it answer? Where is the provision of ecosystem services highest within the network? Which areas of the green infrastructure network provide the highest number of ecosystem services? Which demands can be supported by green infrastructure? Which areas need to be conserved and which ones need to be restored?

What are the data needs? Maps of ecosystem services provision for the identified green infrastructure network.

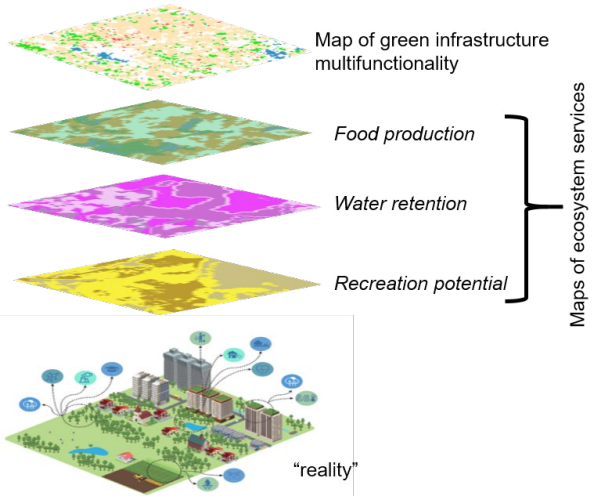
What are the limitations? Data for certain ecosystem services are still scarce, or the temporal/spatial resolution is not yet useful for planning and management, therefore some of the information that is context specific will be lost.

Why this method over others? It is relative and standardised. The method can combine for ecosystem services measured in *different units and can compare multifunctionality across different ecosystems and geographical regions.*

Box 1. Conceptual representation of physical mapping method



Box 2. Conceptual representation of ecosystem service base mapping method



[1] The European Union defines this as a strategically planned network of natural and semi-natural areas with other environmental features designed and managed to deliver a wide range of ecosystem services. It incorporates green spaces (or blue if aquatic ecosystems are concerned) and other physical features in terrestrial (including coastal) and marine areas. European Commission. 2013. Communication from the Commission to the European Parliament, The Council, The European Economic and Social Committee and the Committee of the Regions 'Green Infrastructure (GI) — Enhancing Europe's Natural Capital'.

3. Enabling Factors and Dependencies Method – Causal Loop Diagram

What does it do? A Causal Loop Diagram is a conceptual tool that aids in visualizing how different elements, agents and actors related to green infrastructure are interrelated. This graphical representation helps to understand how institutions, public perception, regulations, funding, land prices, benefits of the green infrastructure, etc. mutually interact (see Figure 3 for example).

How does it relate to other methods? This method complements geographical mapping approaches by situating potential green infrastructure within social and institutional settings. Mapped areas of potential green infrastructure might only fully develop into a functional network of green infrastructure if the right actors engage with the process and the right institutions (rules, legal frameworks and organizations) are developed and supported.

What questions could it answer? Where are the current barriers in the creation of green infrastructure? Where to act, in the institutional framework, to facilitate the implementation of green infrastructure? What virtuous and vicious circles are likely to emerge with an intervention on green infrastructure?

What are the data needs? The method relies on interviews with stakeholders, collecting information on ecosystem functioning, ecosystem services, population health and wellbeing, socio-economic data and planning opportunities (and any other important elements within the system), as well as the links (positive and negative) between these elements.

What are the limitations? It is a simplification of the system and strongly dependent on the number of stakeholders involved in the interviews and their representativeness.

Why this method over others? It uses an integrative system approach to: understand a wide environmental problem; identify key main components; understand the relations among them; and highlight complex feedback loops that can create unsustainable dynamics and undesired outcomes. It derives semi-quantitative indicators from qualitative information.

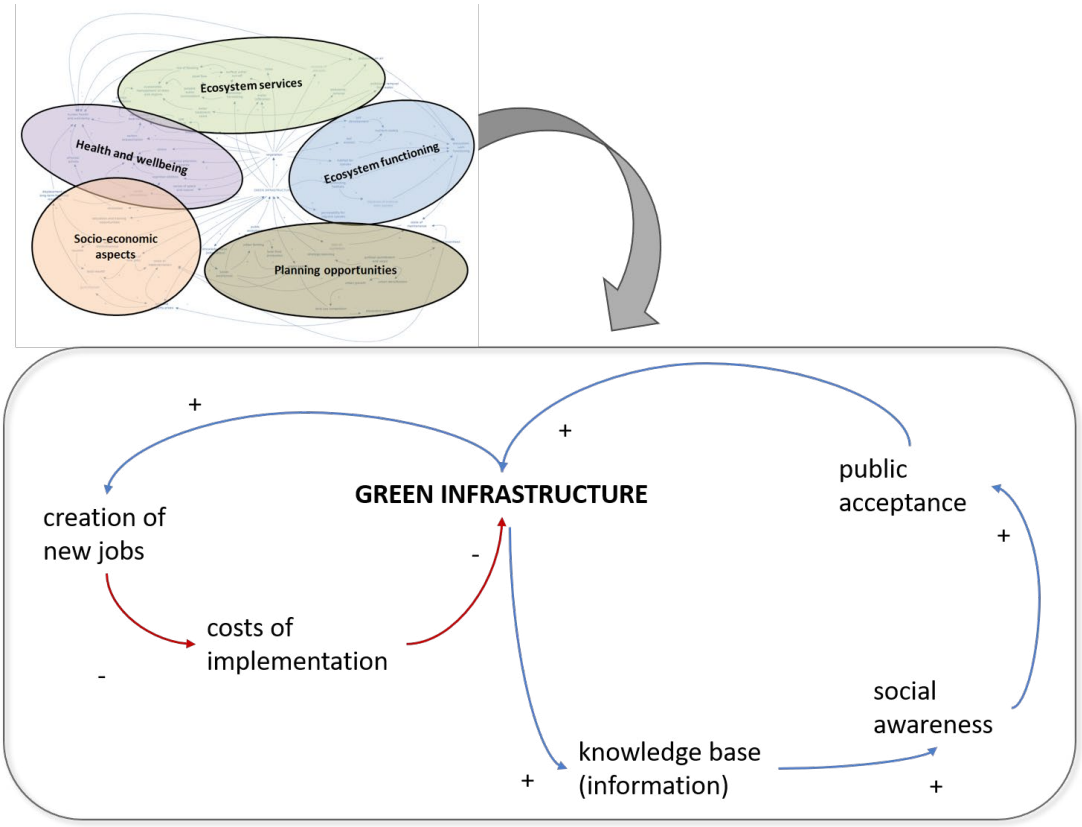


Figure 3. Example of factors that interact and influence the implementation of green infrastructure using a Causal Loop Diagram. The upper diagram represents all the possible interactions between different components, grouped by relevant domains (socio-economic, health, planning system, ecosystem services and ecosystem functioning). The lower diagram represents a subset of actors. Blue line: positive impact; red line: negative impact. For example, planning of green infrastructure could create new jobs, which, in turn, could increase the cost of implementation resulting in an obstacle for further development.

Section II: Moving from potential green infrastructure to real opportunities– assessing and measuring the potential for multiple benefits (methods 4, 5, 6)

4. Accessibility Method – Mapping distance

What does it do? Quantifies accessible areas of green infrastructure in peri-urban areas within defined travel distances by car from an urban center[2]. This method is particularly relevant when the provision of social benefits is to be included in the multifunctional green infrastructure. This method is primarily used with respect to accessibility for urban populations.

How does it relate to other methods? Uses green infrastructure maps (see methods 1 and 2).

What questions could it answer? What is the urban population for whom this green infrastructure is accessible? Are there inequalities related to green infrastructure accessibility between different neighborhoods?

What are the data needs? Map of green infrastructure, transport network, population.

What are the limitations? Does not account for individuals' abilities to access green infrastructure e.g. disabled access options, feelings of insecurity, perceived accessibility, available public transport and commuting options. Does not take into account accessibility by public transport.

Why this method over others? This method provides more realistic figures than available green infrastructure per inhabitant since it integrates accessibility. It is relatively easy to apply at large spatial scales and it enables comparisons between locations.

5. Economic Valuation Method – Stated and revealed preference[3]

What does it do? Valuation methods are a way to provide a monetary value to ecosystem services that have no market price (e.g. recreation) – making them comparable to costs and to each other. They are based on measuring individuals' willingness to pay for these benefits.

How does it relate to other methods? These monetary values can then be included in a cost benefit analysis. It complements direct use and consumption valuation methods (see method 6) by providing a way to measure non-market benefits and non-use values.

What questions could it answer? They can provide an estimate of the benefits and welfare improvements provided by green infrastructure in a monetary unit.

What are the data needs? Valuation methods require predictions or measurements of ecosystem services provided by green infrastructure in physical units (reduced CO2 emissions, improved water quality in terms of nitrogen content, etc.).

What are the limitations? Valuation methods are more easily implemented for certain types of ecosystem services (e.g. recreation).

Why this method over others? There are two main types of methods that are commonly used: stated preferences methods and revealed preferences methods. Stated preferences methods are based on surveys of potential beneficiaries of green infrastructure. These potential beneficiaries are asked to state how much they would be willing to pay to see the green infrastructure project be implemented. The advantage of these methods is that they measure the use value as well as the non-use value of green infrastructure. Revealed preferences methods are based on the observation of actual market behaviors which reveals how much individuals are willing to pay to benefit from green infrastructure, either by observing how much they pay to visit green infrastructure (e.g. a park) or how much more they pay to live in properties located close to green infrastructure. These methods only measure the use value of green infrastructure.

6. Economic Valuation Method – Direct use and consumption valuation

What does it do? Identifies demand for ecosystem services through valuing goods provided by ecosystems (e.g. food production).

How does it relate to other methods? Links to multifunctional green infrastructure assessment (see method 2) which identifies supply of ecosystem services.

What questions could it answer? Where is there a mismatch between supply and demand? Where does the demand exceed ecosystem service supply?

What are the data needs? Market values for goods provided by ecosystem services. Consumption levels of goods provided by ecosystem services.

What are the limitations? Only enables estimation of current use, therefore it underestimates levels of demand by not including estimates of where demand exceeds supply. It only captures goods that have a market value.

Why this method over others? Rooted in market values and real-world behavior.

[2] This method is separate to research being conducted on access to green infrastructure within urban areas on foot.

[3] For more details on how these methods can be implemented, see Defra report (http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/valuing_ecosystems

Section III. Tools to aggregate information and support decision-making (methods 7, 8, 9)

7. Economic Valuation Method – Cost benefit analysis

What does it do? Cost benefit analysis can be useful as one of many criteria for decision making to help gauge whether the benefits gained by society from a green infrastructure project are worth the public expenditure.

How does it relate to other methods? It builds on valuation methods (see methods 5 and 6).

What questions could it answer? Cost benefit analysis can be implemented ex ante – as a way to decide whether to go ahead with a green infrastructure project or not – or ex post as a monitoring tool. It can also be used to opt between alternative green infrastructure projects and pick the project that will yield the most benefits to society per euro spent.

What are the data needs? Cost benefit analysis requires a measure of costs and benefits of green infrastructure expressed in a common unit (usually in monetary terms).

What are the limitations? It requires all costs and (environmental and health) benefits to be quantified and expressed in a common unit, often monetary terms.

Why this method over others? This method is useful to complement other approaches rather than replacing them.

8. Supply and Demand Method – Mapping

What does it do? Assesses the balance between the demand and supply of ecosystem services provided by green infrastructure at a regional scale (see Figure 4 for illustration).

How does it relate to other methods? Brings together ecosystem services supply and demand mapping with green infrastructure assessment (methods 1 and 2). The elements to consider when analyzing ecosystem services supply and demand are defined by the main components of the green infrastructure's socio-ecological system (delineated as a causal loop diagram, see method 3).

What questions could it answer? Where are the needs to increase ecosystem services supply to meet demand? Where are the potential areas to promote exploitation of ecosystem services?

What are the data needs? Supply and demand of ecosystem services and multifunctional green infrastructure assessment.

What are the limitations? Heavy data needs. Where spatially explicit data are limited, this protocol risks missing local needs.

Why this method over others? Common framework easily applicable for different ecosystem services which compares areas and looks for the extremes rather than looking for complex calculations on ecosystem capacity. It is also easily scalable, given available data.

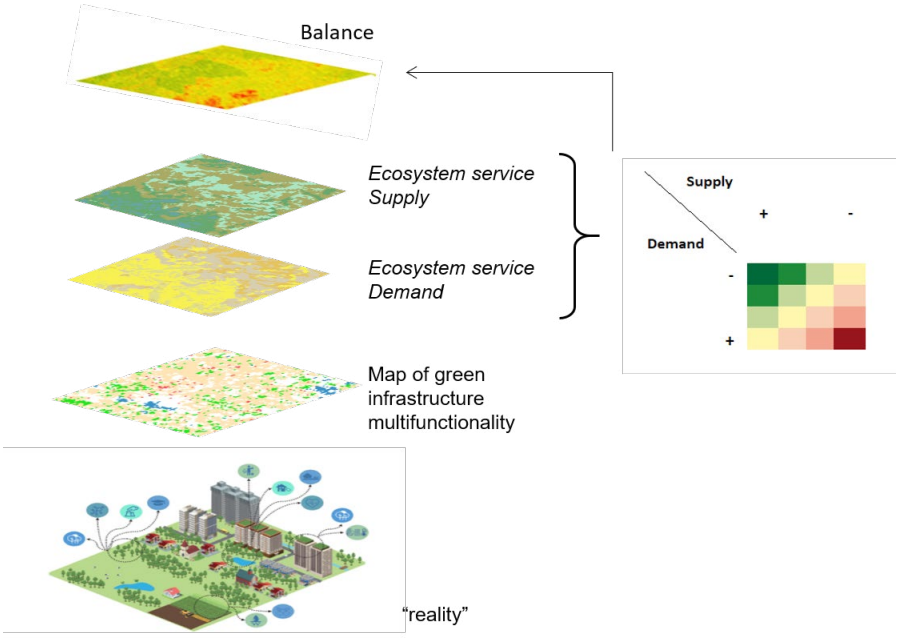


Figure 4. Example of supply and demand method. The balance is assessed by the matrix which establishes all possible links between supply and demand, Green cells in the matrix reflect those combinations where provision of ecosystem services is low to high and demand medium to low. On the opposite, red cells reflect those areas where the provision is medium to low and the demand is medium to high. Yellow cells reflect intermediate situations, with a potential neutral balance. Finally, the balance between demand and supply is depicted in the map.

9. Synergies and Trade-offs Method – Statistical graphical analysis

What does it do? Investigates and characterizes interactions among ecosystem services. Figure 5 depicts all possible types of interactions between pairs of ecosystem services.

How does it relate to other methods? Uses ecosystem service supply maps (method 2) to correlate occurrences of services across space. Provides overview of spatially detailed maps provided by multifunctional green infrastructure assessment.

What questions could it answer? Which ecosystem services can occur alongside one another? Which ecosystem services are not currently observed alongside one another? Where might conflicts arise because trade-offs between ecosystem services?

What are the data needs? Maps of ecosystem service supply and green infrastructure. For applying the data, good regional and local knowledge of services.

What are the limitations? Graphical representation loses local context in which ecosystem services can (or cannot) be produced in the same location. Comparisons can be made between only two ecosystem services at a time.

Why this method over others? Facilitates the identification of areas that deviate from the general pattern.

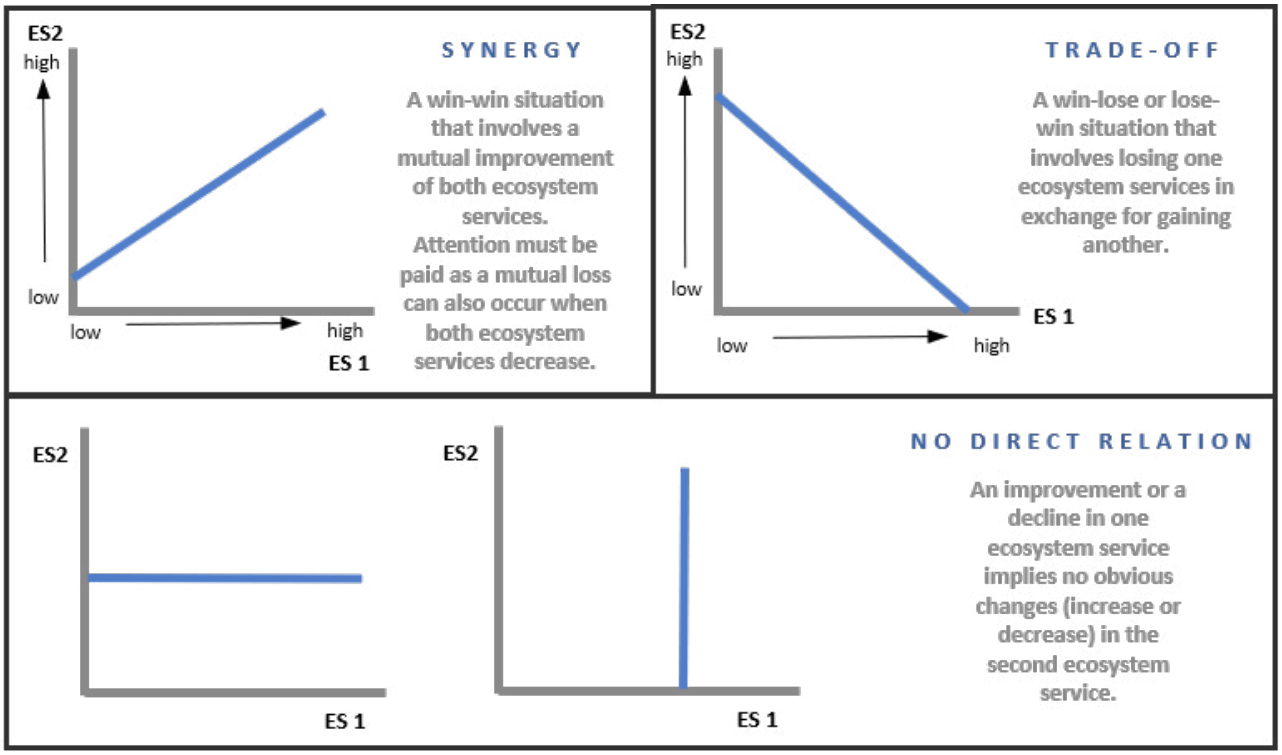


Figure 5. Type of interactions that may occur between a pair of ecosystem services (ES1 and ES2)

In Practice - Copenhagen

The aim of the Greater Copenhagen Committee is to eliminate the cross-border barriers that prevent economic growth and business development in the region – trying to connect people across countries and cultures. The **potential for green infrastructure** is high given the existing 'green wedges' in Demark and 'green structures' in Sweden, as well as the emphasis of the committee on connectivity. Assessment of **accessibility** is able to take advantage of the focus of the committee on day-to-day mobility of people between Denmark and Sweden. Likewise, the existing net- works of the committee for understanding cross-border issues related to work can feed into understanding **demand** for ecosystem services from green infrastructure.

The Greater Copenhagen region green infrastructure **supplies** ecosystem services in the form of health and wellbeing, recreation, green economy (e.g. tourism, job creation), supporting identities and opportunities for education, training and social interactions. Taking advantage of the existing networks of the Greater Copenhagen Committee will enable understanding of **opportunities for ecosystem service provision**, and the **trade-offs and synergies** between ecosystem services. **Planning** for green infrastructure would benefit from the existing capacity of the committee, and feed into the stated goal of enhanced exchange in leisure time activities.

In Practice - Nature Based Solutions for reducing heat stress and improving connectivity between green spaces in Benicalap-Ciutat Fallera district

Grow Green Valencia, a Horizon 2020 project, has used green infrastructure to address heat island effects in Valencia, Spain. The network created to address increasing temperatures provides an extensive **potential green infrastructure,** which can address many other ecosystem service needs. **Accessibility** of this network is high given its location throughout the city of Valencia. In addition to cooling effects, this network **supplies** protection for biodiversity (e.g. via habitats and connectivity) and cultural heritage (e.g. via supporting identities), areas for food production, health and wellbeing, recreation, supporting identities and opportunities for education, training and social interactions. Multiple stakeholders were involved in understanding the **demand** for ecosystem services, as well as identifying the **opportunities for provision** from green infrastructure, and considering the **trade-offs and synergies** to co-design **infrastructure and planning decisions**. This stakeholder involvement continues through monitoring and management.

Icons: Scales ahmad from Noun Project; Coins Jeehan@design from Noun Project; Map Creative Mania from Noun Project; Enabling Knut M. Synstad from Noun Project; Handshake Aneeque Ahmed from Noun Project; Ruler Dinosoft Labs from Noun Project; Trees Artem Kovyazin from Noun Project; Water Nick Bluth from Noun Project; Shrubs Gregory Montigny from Noun Project; Grass wira wianda from Noun Project; Connectivity Populat from Noun Project; Heat Island Effect Vectors Market from Noun Project; Flooding Adrien Coquet from Noun Project; Water Retention Carlos Dias from Noun Project; Health and Wellbeing Rediffusion from Noun Project; Education Adrien Coquet from Noun Project; Land and Property values Luis Prado from Noun Project; Job creation Dan Hetteix from Noun Project; Food Production Made from Noun Project; Air Pollution Amos Kofi Commey from Noun Project

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The ESPON EGTC is a European Grouping on Territorial Cooperation. ESPON started in 2002 and have continued since then building a pan-European knowledge base related to territorial dynamics.

As part of a renewal and upgrade of ESPON for the period 2014-2020 and beyond, an EGTC has been established according to European law to act as Single Beneficiary and deliver the content envisaged by the ESPON 2020 Cooperation Programme.

The ESPON EGTC is established in Luxembourg and has an Assembly composed by the three Belgian regions of Flanders, Wallonia and Brussels Capital as well as Luxembourg.

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