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# Session 5 - Overview of methods for mapping and assessment of ES

Dr. Blal Adem Esmail
Institute of Geography | Transformation Metropolitaner Regionen | @PlacesLab | @blal_adem

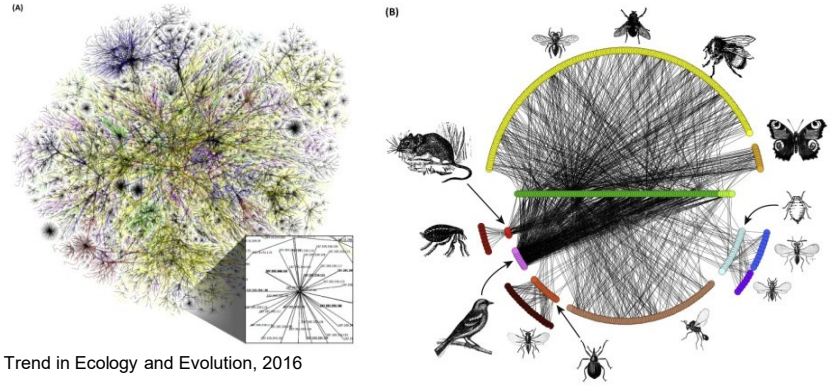
EUP - Session 5: Overview of methods for mapping and assessment of ecosystem services (ES)

# Guiding questions

- Which general approaches exist to assess ecosystem services (ES)?
- What are ES indicators?
- Which methods can be used to assess ES indicators?
- What should we consider when assessing ES indicators in urban contexts?

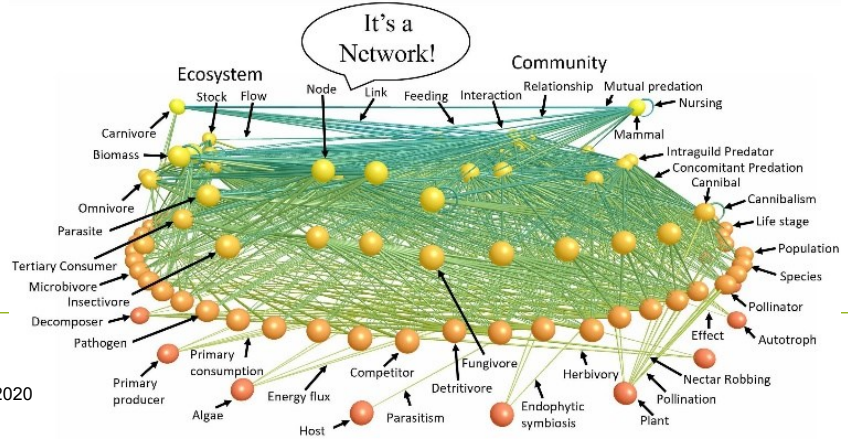
- **Problem analysis** (hand on)

# Complexity of nature

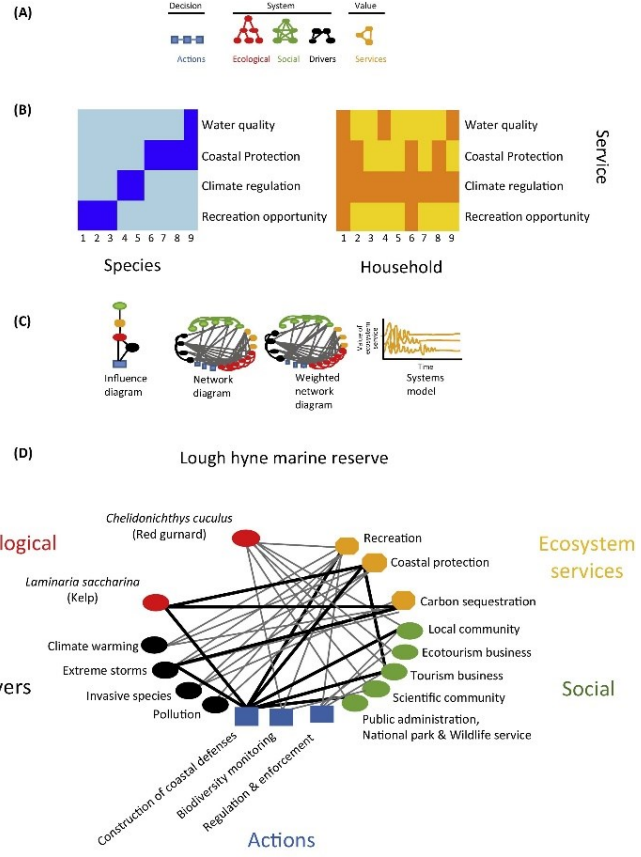


ESS Trend in Ecology and Evolution, 2016

**Food web network = trophic level + feeding relationships**




Martinez. 2020




Dee et al., 2017. Operationalizing Network Theory for Ecosystem Service Assessments

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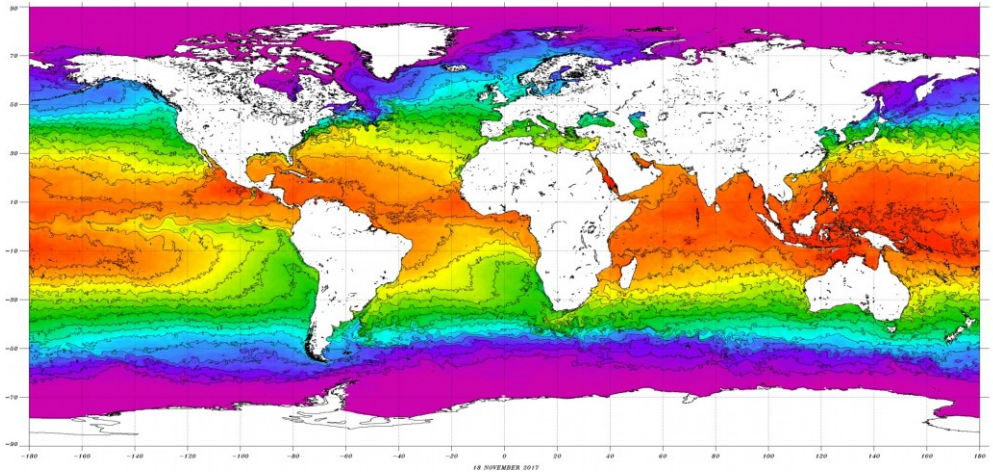
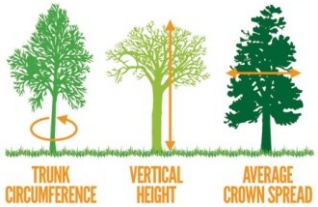
# Rationale for Indicators

- Sea surface temperature (°C)
- Macrobenthos as indicator species in rivers (name, number of)
- Nitric oxide (NOx) levels (ppm) or NOx per unit of GDP
- Trunk circumference (m)

# General examples of environmental indicators

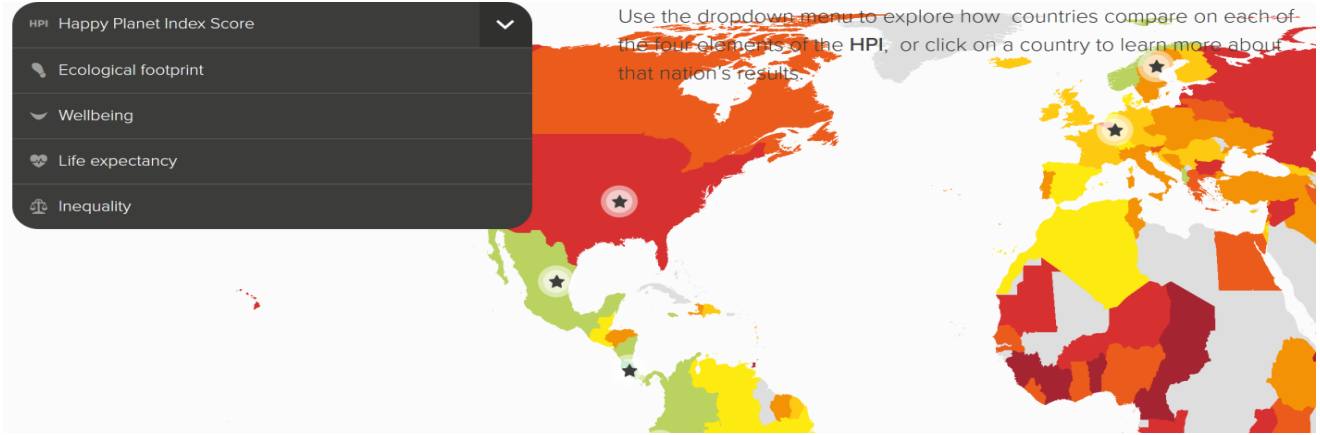
- Our environment is highly **complex and variable**
- **Monitor and measure** everything → not possible
- Indicators are a **practical and economic way** to track the state of the environment





# Other examples of indicators

- Economic (Gross Domestic Product, GDP)
- Social (Employment rate)
- Indices (Air Quality Index, Happiness Index)



# Definitions

“An environmental indicator is a numerical value that helps provide insight into the state of the environment or human health. Indicators are developed based on quantitative measurements or statistics of environmental condition that are tracked over time. Environmental indicators can be developed and used at a wide variety of geographic scales, from local to regional to national levels.” [1]

“A parameter or a value derived from parameters that describe the state of the environment and its impact on human beings, ecosystems and materials, the pressures on the environment, the driving forces and the responses steering that system. An indicator has gone through a selection and/or aggregation process to enable it to steer action.”

Müller & Burkhard (2012)

# Other examples of indicators

"information that efficiently **communicates the characteristics and trends of ecosystem services**, making it possible for policymakers to understand the condition, trends and rate of change in ecosystem services"

- **Interpretation** depends on data sets and proxy indicators, such as land cover and land use.
- **Methods**: Models (InVEST), GIS Mapping, Surveys

**Key definitions**

**Measure (or measurement):** Actual measurement of a state, quantity or process derived from observations or monitoring. e.g. bird counts, total dissolved solids, biomass, runoff.

An **indicator** uses measures to communicate something of interest. They are purpose and audience specific.

**Metric:** a set of measurements or data collected and used to underpin each indicator.

An **index** comprises a number of measures combined in a particular way to increase their sensitivity, reliability or ease of communication e.g. Red List Index for birds shows changes in threat status over time obtained through a specific formula. Disaggregation and traceability are important.

**Ecosystem service indicators** are information that efficiently communicates the characteristics and trends of ecosystem services, making it possible for policymakers to understand the condition, trends and rate of change in ecosystem services.

*Port Barton, Palawan, Philipines © Mary Allean M Dalas Alas, WorldFish (2011)*

# Other examples of indicators

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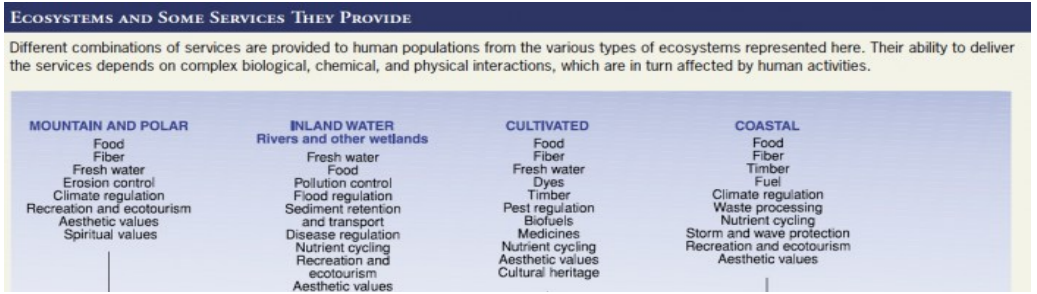
# Ecosystem Services

RESI, Global CCS Institute, ES Finland




**General**

CICES

**Ecosystem**

**National Ecosystem Service Assessment**

Finland

Zambia

- Wetland products: Papyrus and ree
  items, palms used to make palm wi

## Reindeer

Finland has a large population of semiwild reindeer, approximately 200 000 animals. Reindeer are herded in the reindeer management area, which covers more a third of the land area of Finland in the northern part of the country. Reindeer herding is a traditional livelihood of indigenous Saami people, but many Finns own reindeer as well.

Reindeer are herded mainly for meat. Other material products are pelts, skins, antlers and bones. The revenue of reindeer herding before taxes was 23.2 million euros in 2008. There were approximately 4 500 reindeer owners in 2013. Reindeer herds feed mainly on natural pastures such as lichen grounds on forested and alpine heathlands.

# DPSIR Framework

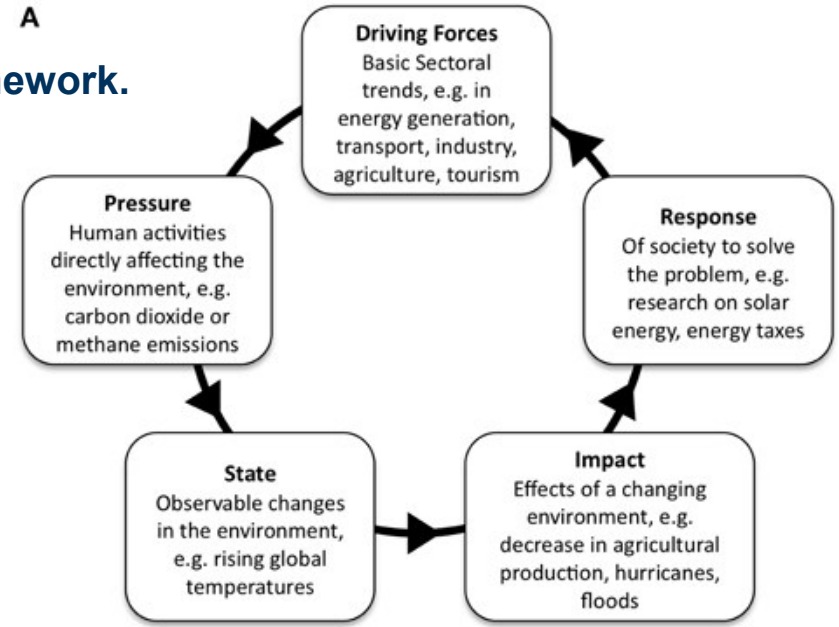
First proposed by the EEA.

**“Drivers, pressures, state, impact, response” framework.**

**Drivers and pressures**- indicators of the human activities and resulting pressures on the environment

**State and impact** indicators- cover the resulting conditions in the environment and the implications for the health of ecosystems and humans.

**Response** indicators- measure the reaction of human society to the environmental issue.




Smith et al. 2016

**Three key criteria:**

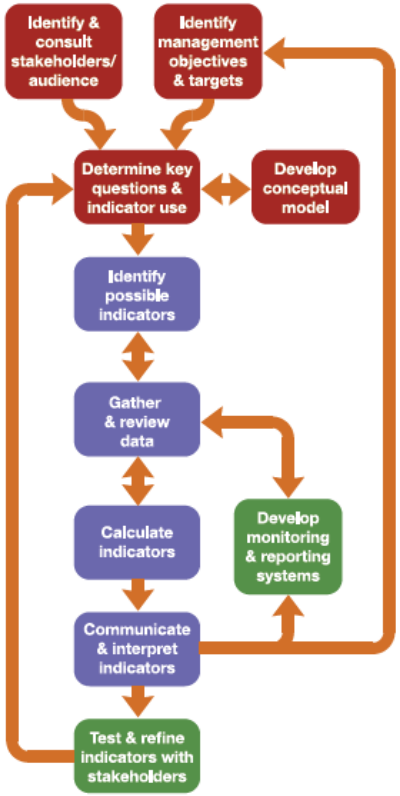
1. scientific credibility policy/social relevance
2. practical monitoring
3. data requirements

# E.g. Developing indicators with DPSIR Concept

**Urban Sprawl?**

Haase, 2007

# ES Indicator Development Framework




### *Step 1: Identify and consult stakeholders and target audience*

**Questions to ask during this step:**

- Who are the relevant stakeholders, and do they all need to be consulted?
- What questions do the stakeholders want answers to regarding the ecosystem service of concern?
- How will the stakeholders want to use the indicator(s)? e.g. for decision making, for reporting, for education.
- Have the inputs, expectations and outputs of the indicator development process been clearly defined for the stakeholders?
- How much ownership and decision making power are different stakeholders going to have over the choice of indicators?

### *Step 2: Identify ES related policy objectives and targets*

### *Step 3: Determine key questions and indicator use*

**Questions to ask during this step**

- What are the key questions that the intended user or audience have about ecosystem services?
- Can the key questions be made more specific or focused?
- How will the indicator be used?
- Who will be using the indicator?
- What level of education and familiarity with the subject does the intended audience already have?

- What ES does this habitat provide?
- Are the ES declining in our country?

- What are the main threats to the ES in the area?
- What is the status of the tourism numbers visiting the park?

### *Step 4: Develop a conceptual model*

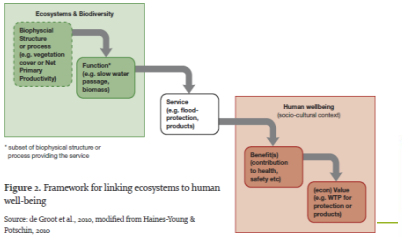
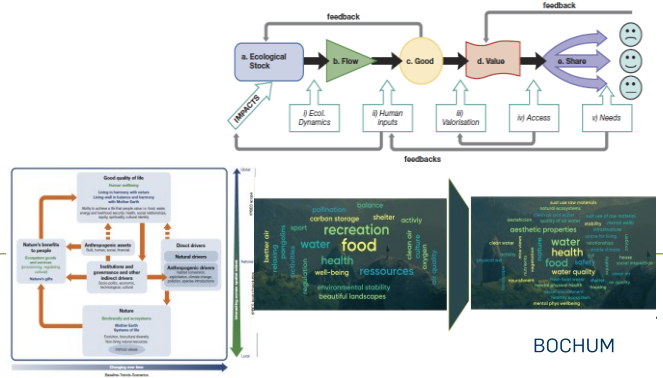



Figure 2. Framework for linking ecosystems to human well-being

Source: de Groot et al., 2010, modified from Haines-Young & Potschin, 2010




UNEP (2014) Measuring Ecosystem Services

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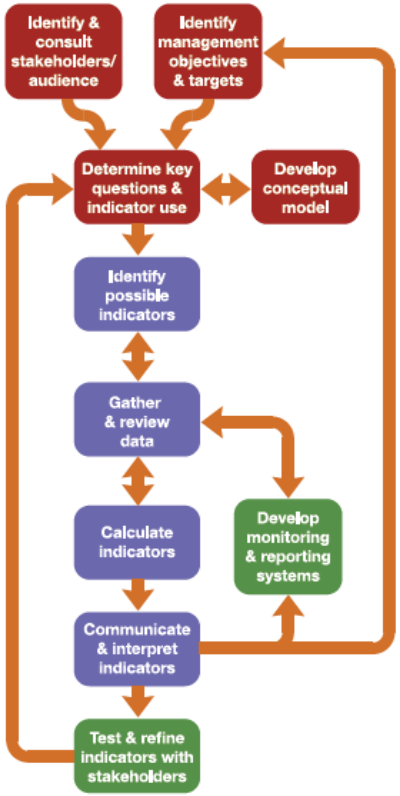
# ES Indicator Development Framework




### *Step 5: Identify possible indicators*

**Questions to ask during this step:**

- Are there existing indicators that can help to answer the key question(s)?
- How well does each of the potential indicators help to answer the key question(s)?
- Is the relationship between the measure used as an indicator and the indicator's purpose scientifically supported and easy for the user to understand?
- Are potential reasons for change in the value of the indicator well understood?
- How easily will it be understood by the intended users?
- Is there suitable data for each of the possible indicators?
- Can existing data be transformed into appropriate indicators?
- What are the resources available now and in the future for producing the possible indicators?
- Who will decide which indicators will be calculated?

### *Step 6: Gather and review data*

**Questions to ask during this step:**

- Are the methods of data collection and analysis scientifically valid and defensible (considering the conceptual model)?
- Have all the steps for calculating the indicator been documented so that someone without prior experience of the indicator can follow them?

### *Step 7: Calculating indicators*

### *Step 8: Communicate and interpret indicators*

**Questions to ask during this step:**

- Is the indicator presented appropriately to facilitate communication?
- Does the indicator communicate a story to the intended audience?
- What kind of media do I want to use to communicate the indicator storyline?
- Have I tailored the indicator outputs to the intended audiences?

### *Step 9: Test & refine indicators with stakeholders*

**Questions to ask during this step:**

- Does the indicator answer the users' key question(s)?
- Is the indicator fit for purpose?
- Is the indicator understood in the intended manner by the users?
- What improvements could be made to the indicator and its presentation?

### *Step 10: Develop monitoring and reporting systems*

**Questions to ask during this step:**

- Is there sufficient institutional technical capacity and resources to produce the indicator now and in the future?
- Is there a clear institutional responsibility for the continued production and reporting of the indicator?
- Do data collection and monitoring systems or agreements need to be strengthened?

# Other approaches

- Example of the ESMERALDA proposed framework

| Stages of ES mapping assessment process | Description |
|---|---|
| What kind of questions do stakeholders have?  | **1. Domains and themes** |
| | (a) Nature Conservation |
| | (b) Climate, Water and Energy |
| | (c) Marine and Maritime Policy |
| | (d) Natural Risk |
| | (e) Urban and Spatial Planning |
| | (f) Green Infrastructure |
| | (g) Agriculture and Forestry |
| | (h) Business, Industry and Tourism |
| | (i) Health |
| Identification of relevant stakeholders and network creation and involvement  | **2. Categories of stakeholders** |
| | (a) Competent authorities |
| | (b) Other experts |
| | (c) Business |
| | (d) General Public |
| | **3. Level of involvement** |
| | (a) Inform |
| | (b) Consult |
| | (c) Involve |
| | (d) Collaborate / Partnership |
| | (e) Empower |
| Mapping and assessment process  | **4a. Ecosystem types** |
| | (a) Urban |
| | (b) Cropland |
| | (c) Grassland |
| | (d) Woodland and forest |
| | (e) Heathland and shrub |
| | (f) Sparsely vegetated land |
| | (g) Wetlands |
| | (h) Rivers and lakes |
| | (i) Marine inlets and transitional waters |
| | (j) Coastal |
| | (k) Shelf |
| | **4b. Ecosystem conditions assessment** |
| | Yes (How?) |
| | No |
| | **4c. Selection of ES** |
| | (a) Scientist-driven |
| | (b) Stakeholders'-driven |
| | **4d. Selected ES & Applied method** |
| | (a) Biophysical methods |
| | (b) Economic methods |
| | (c) Socio-cultural methods |
| Dissemination and communication (D&C)  | **5. Target of the D&C activities** |
| | (a) Scientific publication |
| | (b) D&C to Competent Authorities |
| | (c) D&C to General Public |
| Implementation  | **6. Increasing level of Impact** |
| | (a) People aware of, understand and discuss ES |
| | (b) Stakeholders focus on ES and articulate different positions |
| | (c) Alternative choices based on ES mapping and assessment |
| | (d) Plans & policies consider ES mapping and assessment |
| | (e) New policy and finance mechanism established |

**Geneletti, Adem Esmail et al., (2020)** Ecosystem services mapping and assessment for policy- and decision-making: Lessons learned from a comparative analysis of European case studies. One Ecosystem 5: e53111. https://doi.org/10.3897/oneeco.5.e53111



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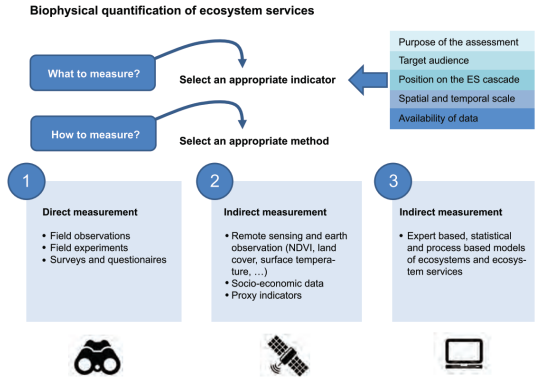
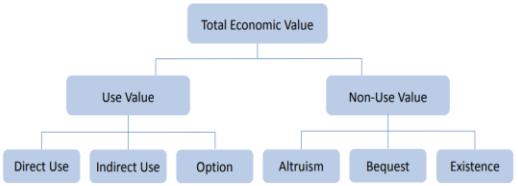
# Overview of Indicators and Methods

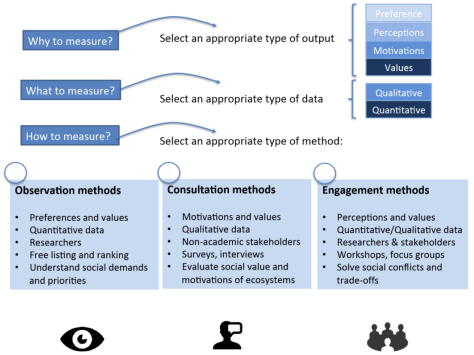
## Biophysical




## Economic

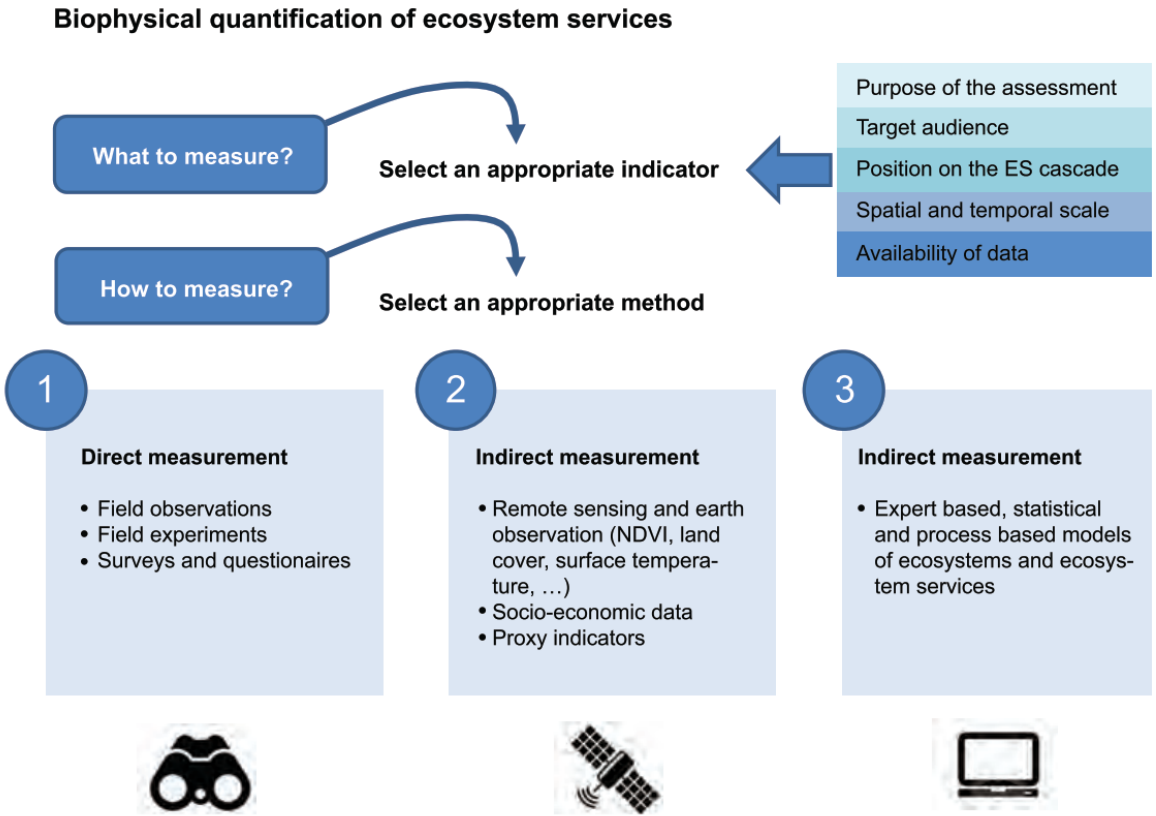



## Social




http://www.maes-explorer.eu/ http://database.esmeralda-project.eu/home

# Indicators and Methods: E.g. Biophysical




Vihervaara at al, 2017

# Same indicator, one ES?

**Different indicators** can be used to measure or indicate a **single ES**.

So **hundreds of indicators** available or possible.

The choice for an indicator depends on many factors including:

- purpose
- audience (pollination: scientist, farmer, policy officer)
- position on the ES cascade
- spatial and temporal scale considered (pollination vs. carbon)
- availability of data

# Examples of indicators

**Provisioning**

- **Water for drinking:**
  - ❑ *Proportion of population using an improved drinking water source*

**Regulating**

- **Climate regulation:**
  - ❑ *UHI Effect reduction by trees: Temperature reduction effect by tree cover in each land use multiplied by m2 of plot trees cover in °C*

**Cultural**

- **Recreation:**
  - ❑ *Green space supply: Percentage of green space of the total area of the city (%)*

# E.g. of indicators from the EU MAES project

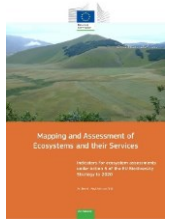
| Ecosystem services | Main terrestrial and freshwater ecosystem | Indicator for terrestrial and freshwater ecosystems | Indicator for marine ecosystems |
|---|---|---|---|
| Cultivated crops | Cropland | ● Area and yields of food and feed crops | ● Yield |
| Reared animals and their outputs | Cropland Grassland | ● Livestock | ● Landings<br>● Catch per unit effort (where applicable) |
| Wild plants, algae and their outputs | Forest | ● Distribution of wild berries (modelling | |
| Wild animals and their outputs | Forest | ● Population sizes of species of interest | |
| Plants and algae from in-situ aquaculture | | | |
| Animals from in-situ aquaculture | Lakes and rivers | ● Freshwater aquaculture production | |
| *Water* (Nutrition) | Lakes and rivers | ● Water abstracted | |
| *Biomass* (Materials) | Cropland Forest | ● Area and yield of fibre crops<br>● Timber production and consumption s | |
| *Water* (Materials) | Lakes and rivers<br>Forest | ● Water abstracted<br>● Total supply of water per forest area (r | |
| Plant-based resources<br>Animal-based resources<br>Animal-based energy | Forest | ● Fuel wood statistics | |
| (Mediation of waste, toxics and other nuisances) | Forest | ● Area occupied by riparian forests<br>● Nitrogen and Sulphur removal (forests | |
| Mass stabilisation and control of erosion rates | Forest<br>Cropland<br>Grassland | ● Soil erosion risk or erosion protection | |
| Buffering and attenuation of mass flows<br>Hydrological cycle and water flow maintenance | | | |
| Flood protection | Wetlands | ● Floodplains areas (and record of annua<br>● Area of wetlands located in flood risk | |
| Storm protection<br>Ventilation and transpiration | Cropland<br>Grassland | ● Amount of biomass | |
| Pollination and seed dispersal | Cropland<br>Grassland | ● Pollination potential | |

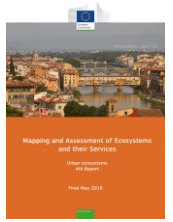
● available indicator to measure the condition of an ecosystem, or the quantity of an ecosystem service at a given CICES level for which harmonised, spatially-explicit data at European scale is available and which is easily understood by policy makers or non-technical audiences. Spatially-explicit data in this context refer to data that are at least available at the regional NUTS2 level or at a finer spatial resolution. CICES classifies ecosystem services at 4 hierarchical levels. Sometimes, it is more cost-effective to consider an assessment of ecosystem services at a higher CICES level than at class level, especially if aggregated indicators are available. Indicators that aggregate information at higher hierarchical CICES level can therefore also have a green label.

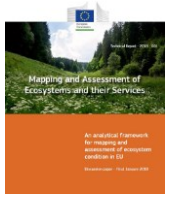
● available indicator to measure the condition of an ecosystem, or the quantity of an ecosystem service at a given CICES level but for which either harmonised, spatially-explicit data at European scale is unavailable or which is used more than once in an ecosystem assessment, which possibly results in different interpretations by the user. This is typically the case for indicators that are used to measure ecosystem condition, which are reused to assess particular ecosystem services. This colour also includes indicators that capture partially the ecosystem service assessed.

● available indicator to measure the condition of an ecosystem, or the quantity of an ecosystem service at a given CICES level but for which no harmonised, spatially-explicit data at European scale is available and which only provides information at aggregated level and requires additional clarification to non-technical audiences. This category includes indicators with limited usability for an ecosystem assessment due to either high data uncertainty or a limited conceptual understanding of how ecosystems deliver certain services or how ecosystem condition can be measured. The ability to convey information to end-users is limited and further refined and/or local level assessments should be used for verifying the information provided by this type of indicators.

● unknown availability of reliable data and/or unknown ability to convey information to the policy making and implementation processes.



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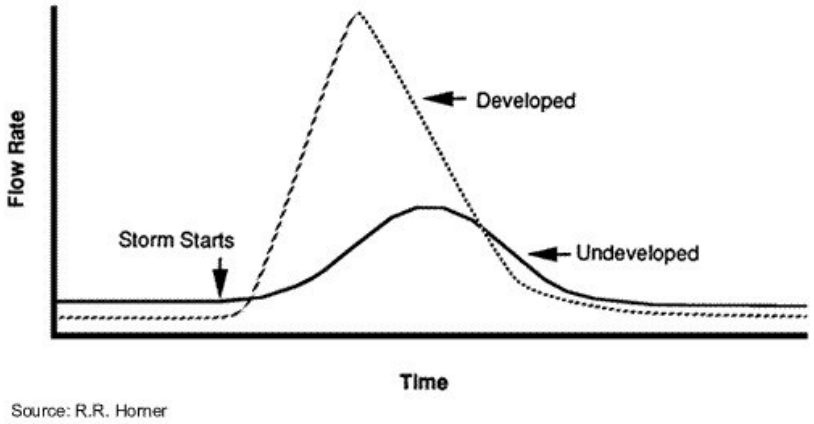
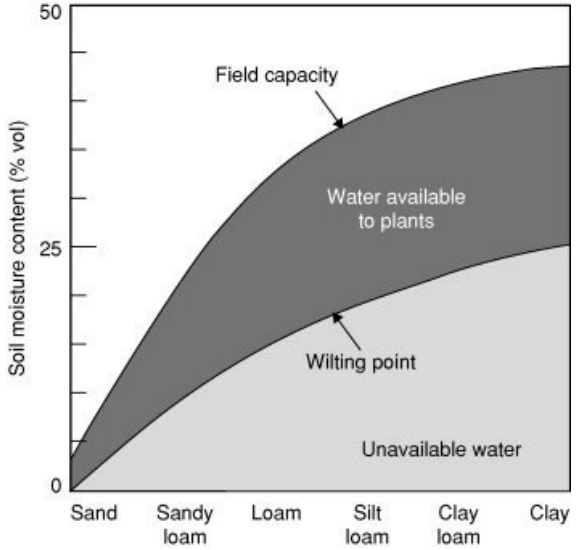
# Question: Which ES do these indicators indicate?

- Soil field (water) capacity (%)
- Direct run-off (mm/yr.)
- Peak flow reduction downstream (%), return time (10) years
- Area of recent floodplains minus built-up settlement areas and transport space (ha)



Source: R.R. Horner

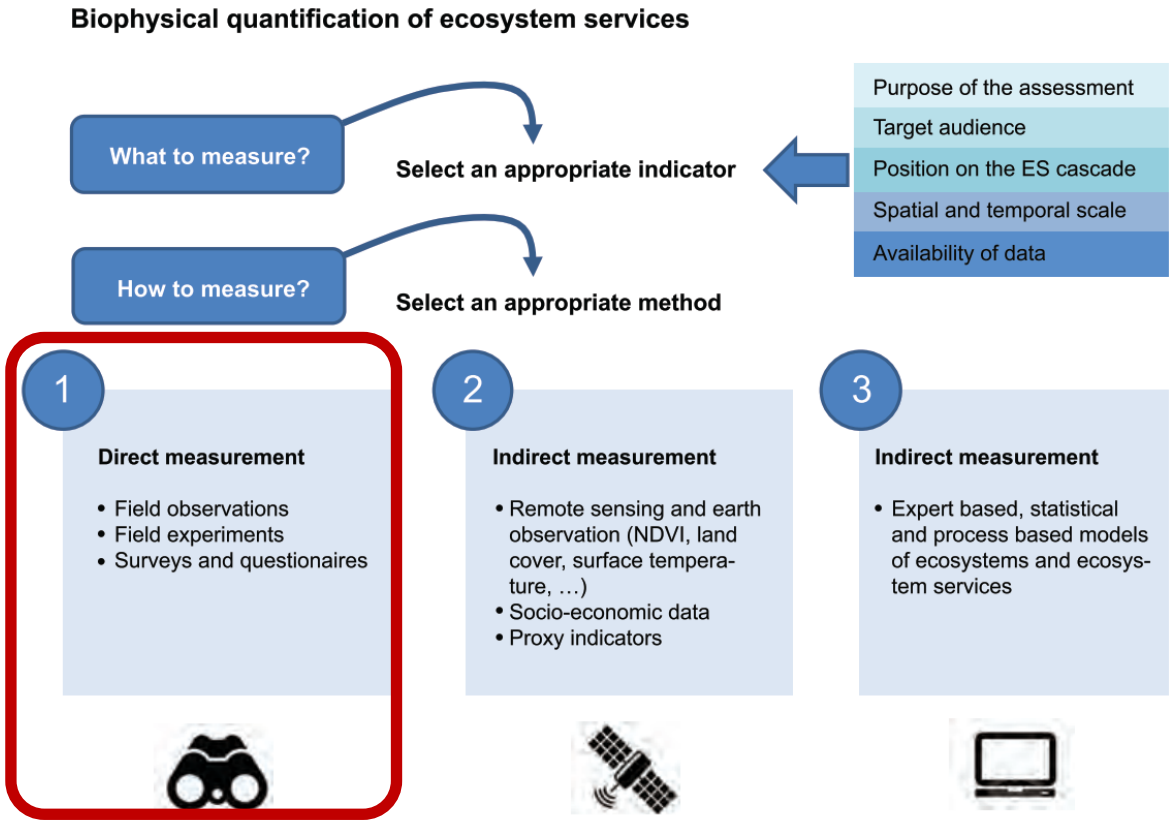



**Water regulation**

# Indicators and Methods: E.g. Biophysical

**Most accurate** means to quantify ES.

Time, money and **resource consuming**. Mostly suitable for **site level or local scale**.



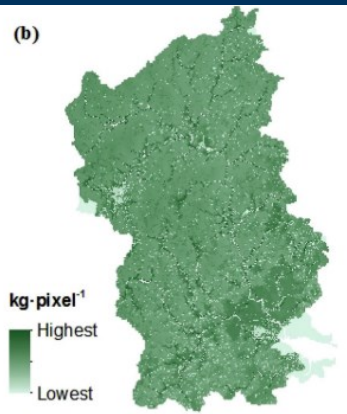

Vihervaara at al, 2017

# Methods: Models and Mapping ES

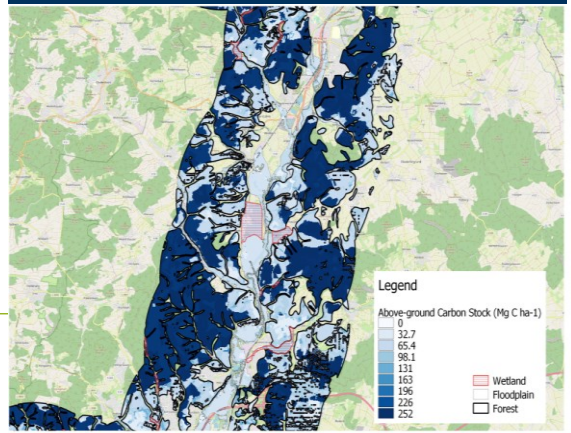
## Models

- Combine types of data
  - ❑ Measured (direct) data, i.e. precipitation, nitrogen loads
  - ❑ Background data, i.e. Elevation
  - ❑ Parameters, i.e. Water retention coefficients
  - ❑ Look-up tables

**Nitrogen export (kg/pixel)**

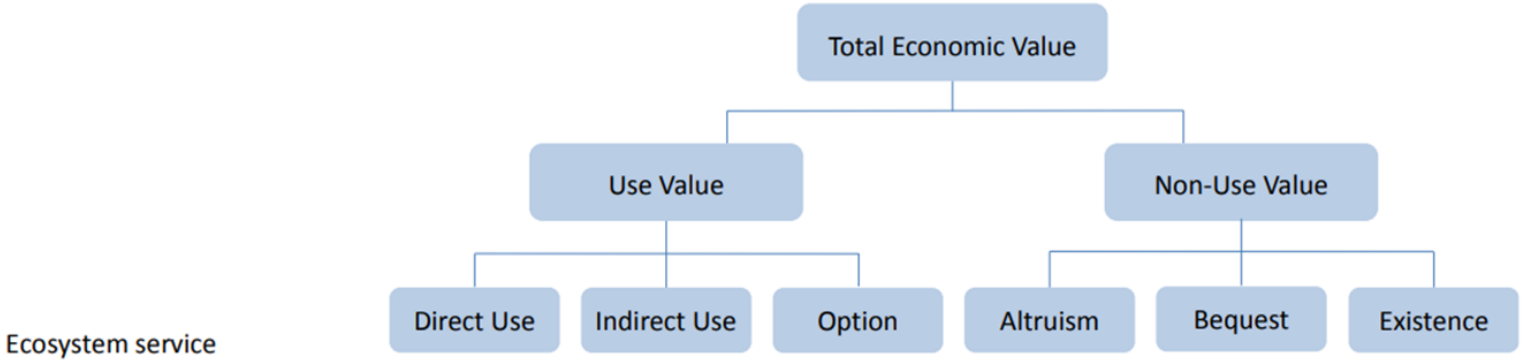



**Above ground carbon stock (Mg C/ha)**



# ES valuation: Monetary valuation

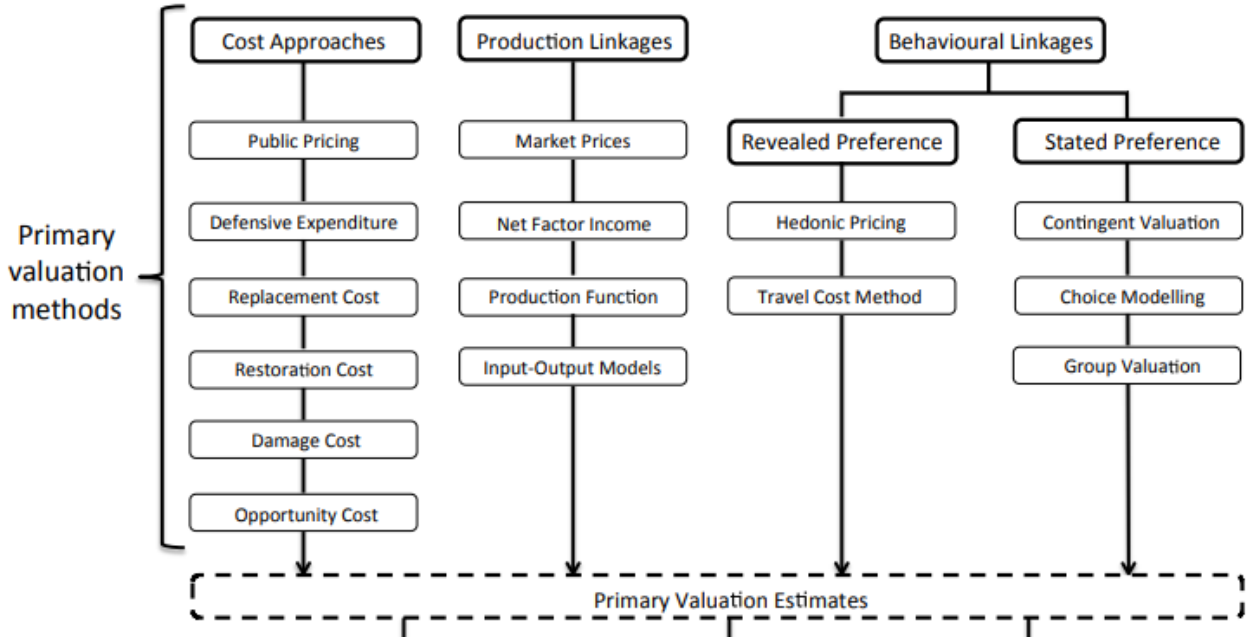
The components of **Total Economic Value** (Pearce and Turner, 1990) and correspondence with ES categories.




Brander et al. (2018). Report on economic mapping and assessment methods for ecosystem services. Deliverable D3.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

# ES valuation: Monetary valuation (2)

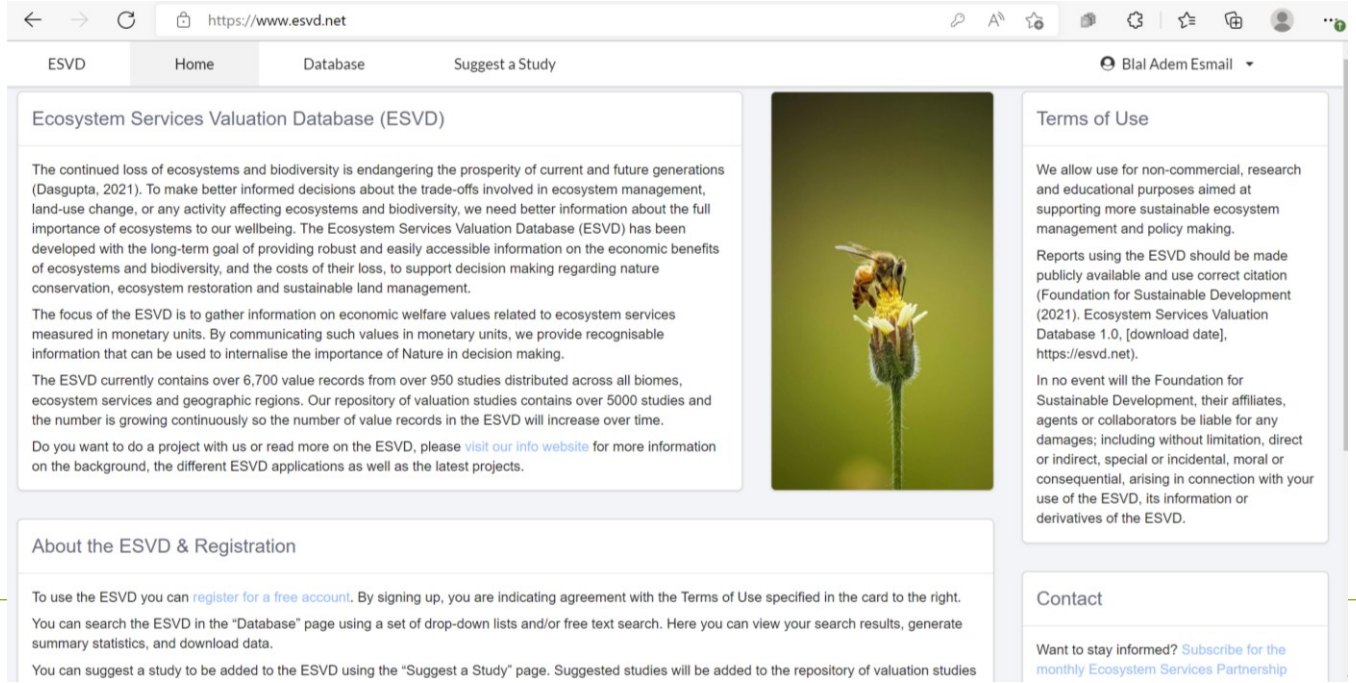
Overview of primary valuation and value transfer methods




Brander et al. (2018). Report on economic mapping and assessment methods for ecosystem services. Deliverable D3.2 EU Horizon 2020 ESMERALDA Project, Grant agreement No. 642007.

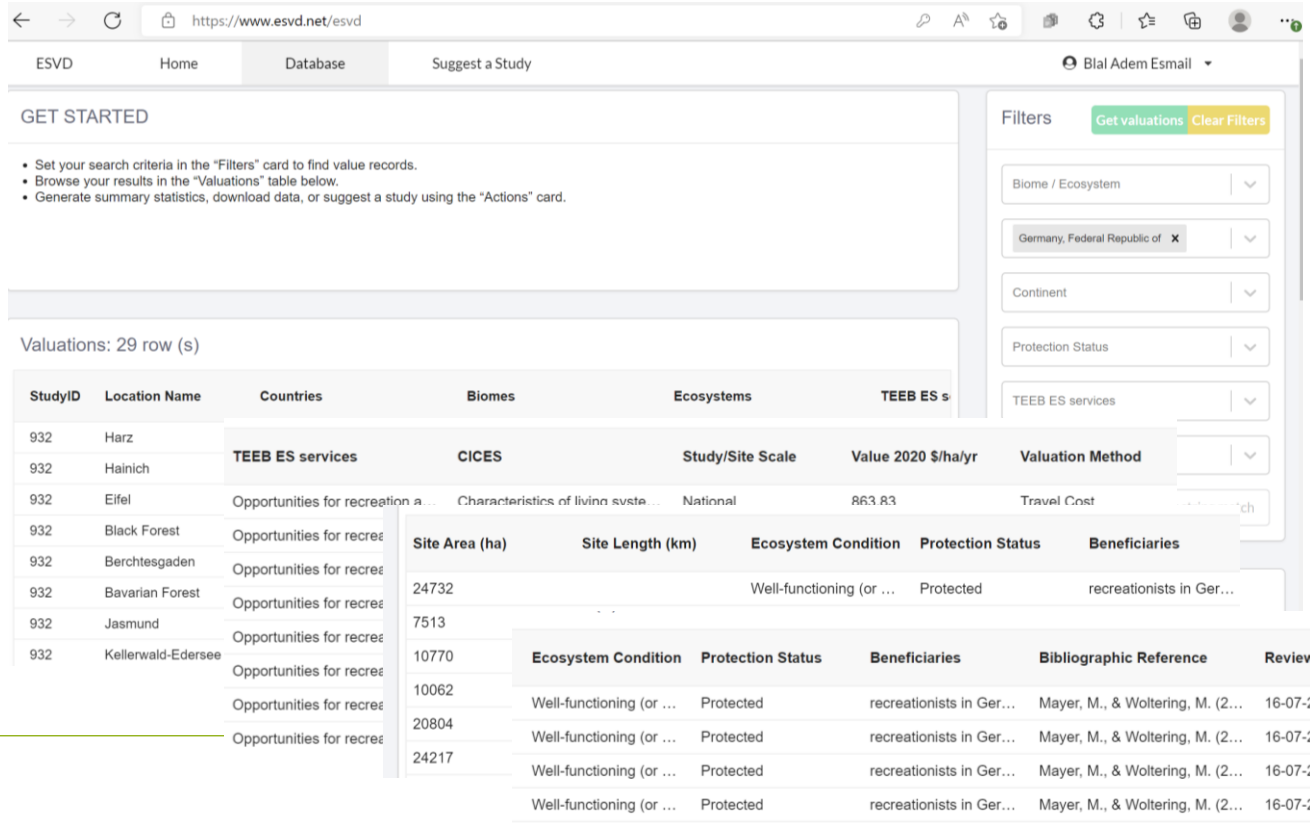
# Ecosystem Services Valuation Database (ESVD)

Officially launched during an online event on 14 October 2021. More information on ESVD can be found here. Interested in this topic? Sign up for the ESVD mailing list here.

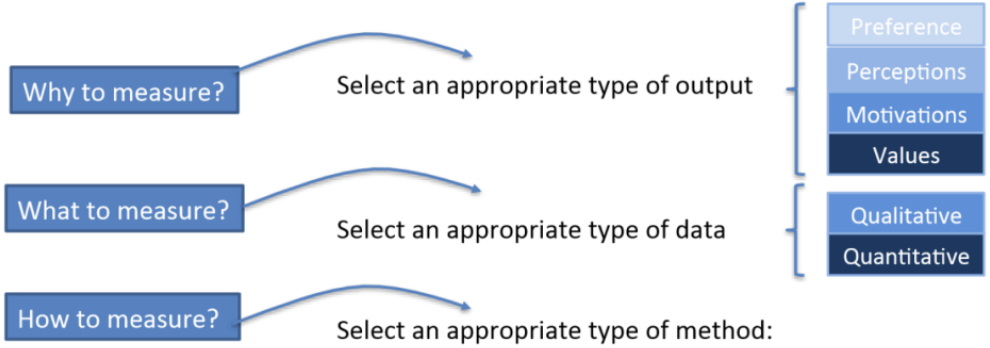



https://www.esvd.net/esvd

# Ecosystem Services Valuation Database (ESVD)



# Indicators and Methods: E.g. Socio-cultural




**Observation methods**

- Preferences and values
- Quantitative data
- Researchers
- Free listing and ranking
- Understand social demands and priorities

**Consultation methods**

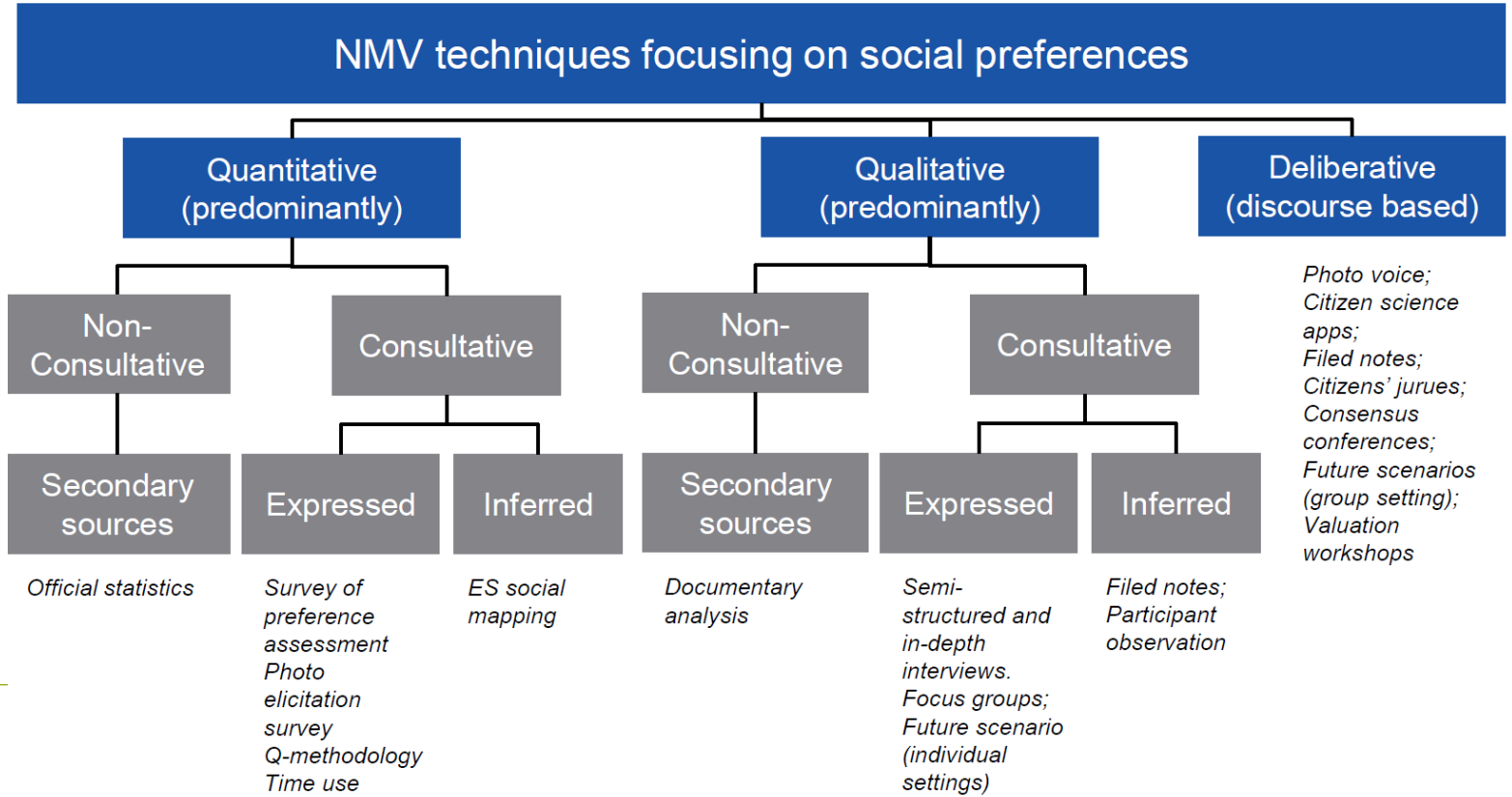
- Motivations and values
- Qualitative data
- Non-academic stakeholders
- Surveys, interviews
- Evaluate social value and motivations of ecosystems

**Engagement methods**

- Perceptions and values
- Quantitative/Qualitative data
- Researchers & stakeholders
- Workshops, focus groups
- Solve social conflicts and trade-offs

Vihervaara at al, 2017

# ES valuation: Non-monetary valuation




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

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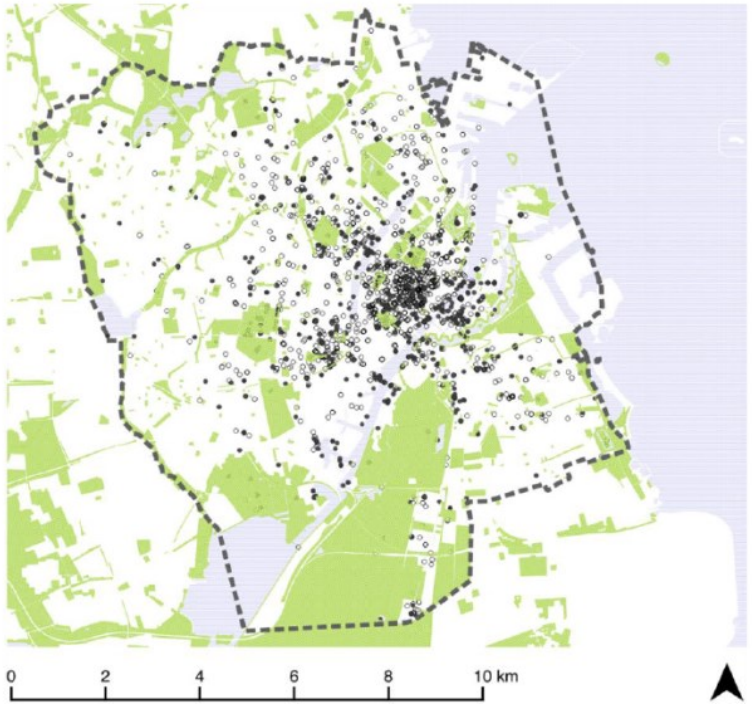
# Methods: Models and Mapping ES

Immaterial, socio-ecological benefits from nature (knowledge, spiritual, aesthetic)

- **Intangible--- How to measure? How to map?**

- **Indicators (proxy):**
  - ❑ Visitors to a park
  - ❑ Pictures taken
  - ❑ Emotional association to places

**Spatial distribution of urban nature (filled symbols) and Not Urban nature images (outline symbols)**




Guerrero, 2016; Plieninger, 2013

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# Methods: Models and Mapping ES

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**Emotional association to places**

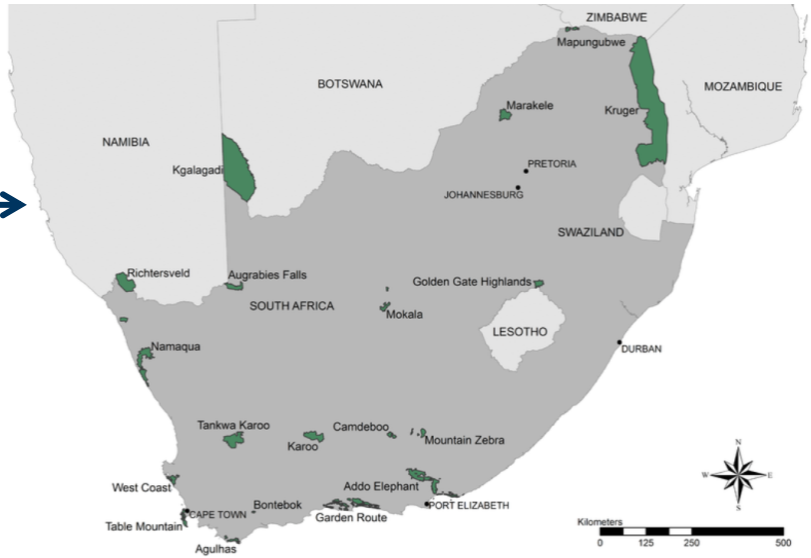
| (Dis)service | Definition |
|---|---|
| Spiritual services | Sites of spiritual, religious, or other forms of exceptional personal meaning |
| Educational values | Sites that widen knowledge about plant and animal species |
| Inspiration | Sites that stimulate new thoughts, ideas or creative expressions |
| Aesthetic values | Sites of particular beauty |
| Social relations | Sites serving as meeting points with friends |
| Sense of place | Sites that foster a sense of authentic human attachment, in German language commonly epitomized as *Heimat* ("home") |
| Cultural heritage values | Sites relevant to local history and culture |
| Recreation and ecotourism | Sites used for recreational activities (walking, dog walking, horse riding, swimming, gathering wild foods, angling, hunting, etc.) |
| Unpleasantness | Sites that are neglected, abused, damaged, or unpleasant |
| Scariness | Sites that feel dangerous or threatening |
| Noisiness | Sites that are disturbingly noisy |

Guerrero, 2016; Plieninger, 2013

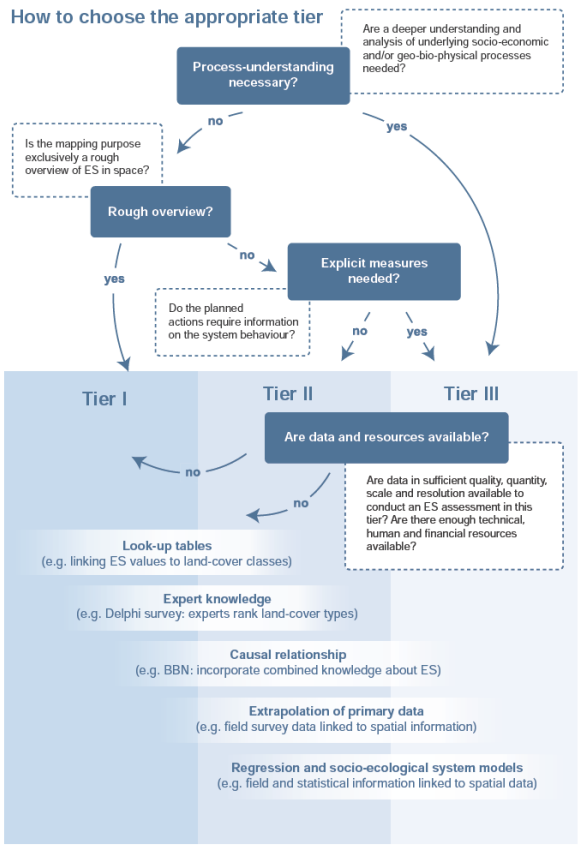
# Methods: CES Surveys linked to maps

| Survey statement | Indicator variable | Mean response (± SD) | Median response |
|---|---|---|---|
| **Aesthetic** | | | |
| Looking at big mammals | Big mammals | 4.43 (± 0.72) | 5—Strongly agree |
| Sitting, enjoying the view | View | 4.38 (± 0.70) | 4—Agree |
| Looking at birds | Birds | 4.11 (± 0.94) | 4—Agree |
| Looking at flowers | Flowers | 3.72 (± 1.02) | 4—Agree |
| Looking at reptiles | Reptiles | 3.52 (± 1.09) | 4—Agree |
| Trying to identify plants | Plants | 3.38 (± 1.10) | 3—Neutral |
| Looking for and or listening to frogs | Frogs | 3.06 (± 1.13) | 3—Neutral |
| **Cultural and heritage** | | | |
| The experience reminds me of my childhood | Childhood | 3.48 (± 1.21) | 4—Agree |
| It helps me to understand my culture and or history | Culture and history | 3.31 (± 1.11) | 3—Neutral |
| **Educational** | | | |
| Learning more about nature | Learning | 4.25 (± 0.75) | 4—Agree |
| Doing guided tours | Guided tours | 3.18 (± 1.16) | 3—Neutral |

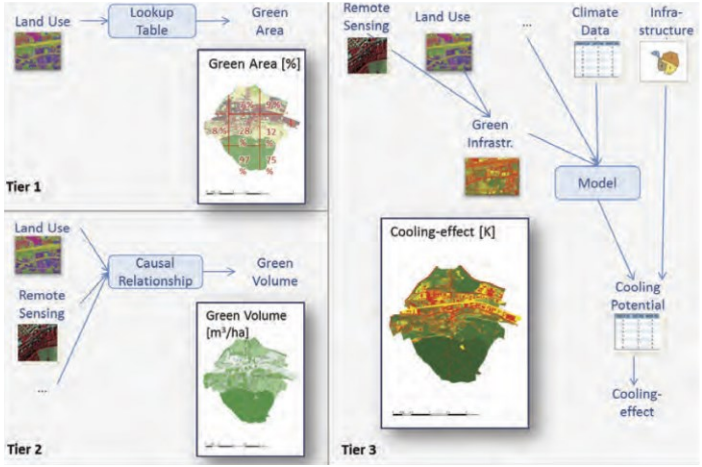
Map of South African National Parks linked to survey responses



# Critical for indicator decision: DATA




- ❑ Process-understanding necessary?
- ❑ Rough overview enough?
- ❑ Explicit measures needed?
- ❑ Are data and resources available?




Grêt-Regamey et al. (2017)

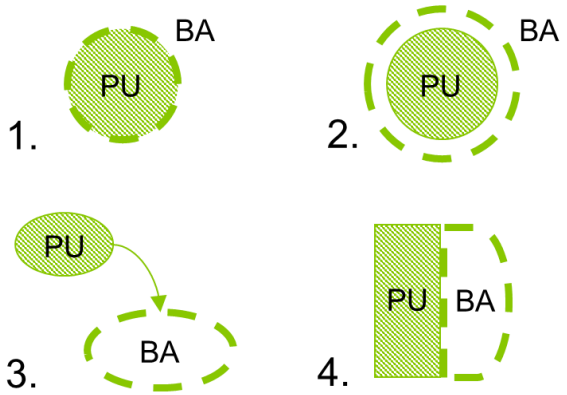
# Critical for indicator decision: DATA

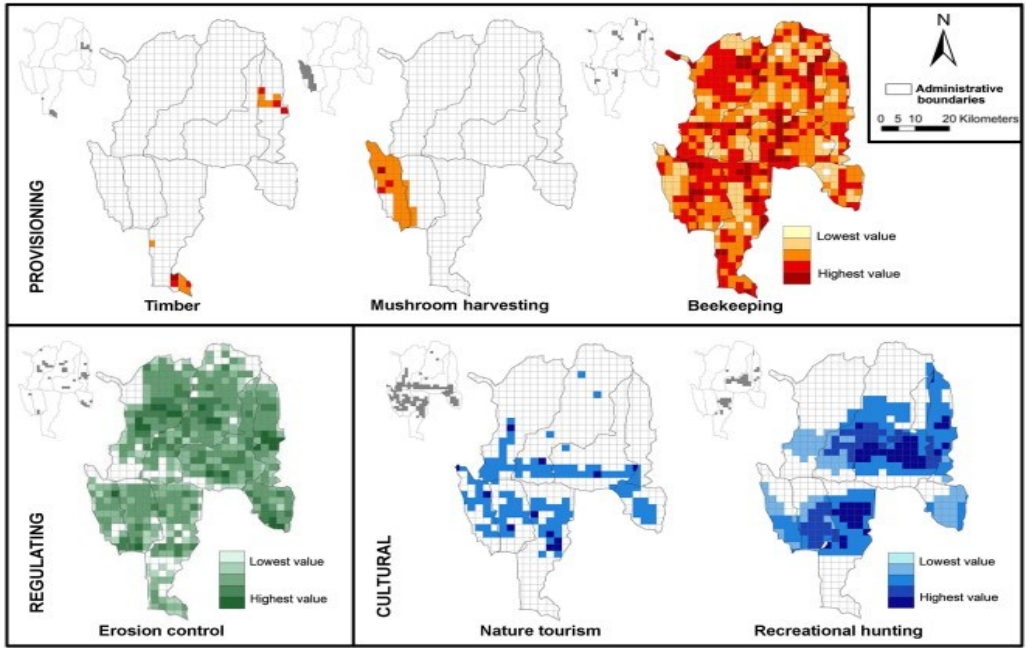
From:

- ❑ Surveys
- ❑ Monitoring Data
- ❑ Satellite or Drone Data (NDVI)
- ❑ Look-up tables (coefficients, adapt)
- ❑ Laboratory Tests
- ❑ Formulas
- ❑ Proxy indicators
- ❑ Other ideas…?

# Methods: Service providing Units (SPUs)

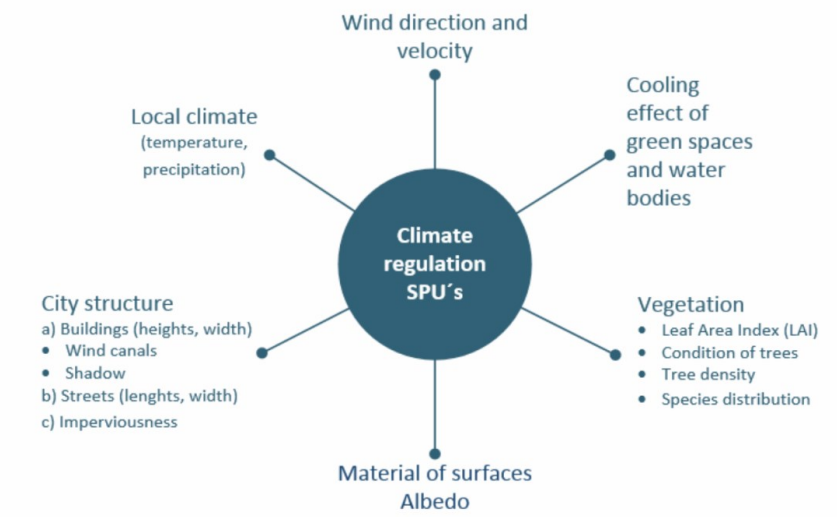
Systematic quantification of the key components of nature that provide services for human wellbeing.



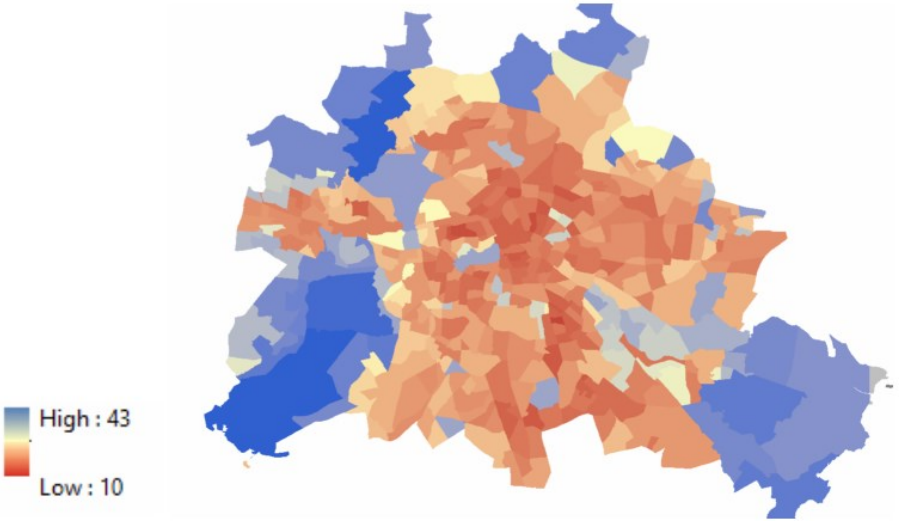




Garcia-Nieto et al., (2013)

# Methods: Development of an Urban ES SPU




Climate regulation supply: high score of six climate regulating SPU's in Berlin, with high score indicating good climate regulating potential




- ~ Index for an ES (normalized)
- More precise results
- Overparameterization issues

# ESMERALDA


Welcome to ESMERALDA MAES Explorer, an online guidance tool created by the collaborative EU Horizon 2020 funded Coordination and Support Action for research and innovation "ESMERALDA - Enhancing ecosystem services mapping for policy and decision making".

This website provides directions on the process of mapping and assessment of ecosystem services as required by Action 5 of the EU Biodiversity Strategy to 2020. Action 5 foresees that the European Commission helps countries set up a knowledge base on ecosystems and ecosystem services and to use this knowledge in policy and decision-making at different levels of governance.

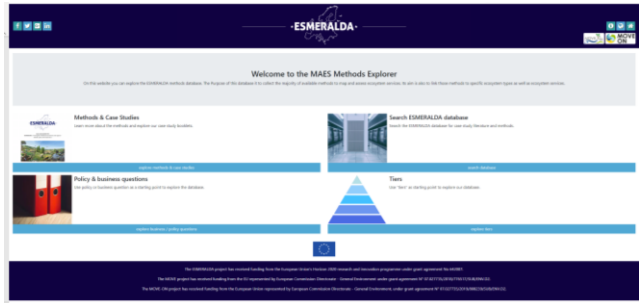
ESMERALDA worked closely together with the working group MAES on Mapping and Assessment of Ecosystems and their Services to develop guidance which is tailored to the member states of the EU.

Start exploring the guidance by clicking on one of the entry points below:

## Questions and Themes

1. What kind of questions do stakeholders have?
2. Identification of relevant stakeholders
3. Network creation and involvement of stakeholders
4. Mapping and assessment process
5. MAES case study applications
6. Dissemination and communication
7. Implementation

Download PDF of full report.




http://www.maes-explorer.eu/ http://database.esmeralda-project.eu/home



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# Hands-on Environmental Urban Planning

**Task:** Analyze the Skarpnäck district and map existing **problems**, focusing in of the **4 key socio-environmental challenges:**

**CH 1: Urban heat island**

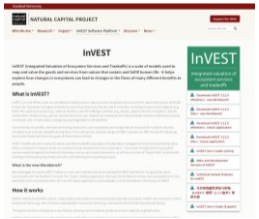
**CH 2: Loss of biodiversity**

**CH 3: Flooding risks**

**CH 4: Social cohesion & Quality of life**

**Source:**

- Stockholm City Plan, 2018 + Vision
- Geodatabase
- Relevant publication – Literature review
- **ESMERALDA MAES Explorer** Link
- **InVEST modelling** NatCap Link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*Article*

**Teaching Scenario-Based Planning for Sustainable Landscape Development: An Evaluation of Learning Effects in the Cagliari Studio Workshop**

**Christian Albert [1,2,*], Christina von Haaren [1], Juan Carlos Vargas-Moreno [3] and Carl Steinitz [4,5]**

[1] Institute of Environmental Planning, Leibniz Universität Hannover, Herrenhäuser Str. 2, 30419 Hanover, Germany; E-Mail: haaren@umwelt.uni-hannover.de

[2] Department Environmental Politics, Helmholtz Centre for Environmental Research—UFZ, Permoserstraße 15, 04318 Leipzig, Germany; E-Mail: christian.albert@ufz.de

[3] GeoAdaptive LLC, 250 Summer Str., Boston, MA 02210, USA; E-Mail: jcvargas@geoadaptive.com

[4] Centre for Advanced Spatial Analysis, University College London, 90 Tottenham Court Road, W1T 4TJ London, UK

[5] Graduate School of Design, Harvard University, 48 Quincy Street, Gund Hall, Cambridge, MA 02138, USA; E-Mail: steinitz@gsd.harvard.edu

* Author to whom correspondence should be addressed; E-Mail: albert@umwelt.uni-hannover.de; Tel.: +49-511-762-2652; Fax: +49-511-762-3791.

Academic Editor: Marc A. Rosen

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**Abstract:** This paper investigates the contributions of an intensive educational workshop to advance students' understanding and skills for collaborative, scenario-based landscape planning. The research design involves a case study workshop with thirty international students and several regional experts as well as a multi-stage, in-process evaluation. The workshop resulted in six different alternative futures for the region of Cagliari, Italy, and a seventh combined version that was considered best by regional reviewers. The students' learning evaluation showed substantial advances in their relevant understanding and skills. Key aspects of the workshop pedagogy and the evaluation are discussed, and recommendations for future applications presented.

# Hands-on Environmental Urban Planning

**Each Team** prepares a **10 min presentation**, based on its **Problem Analysis** in the Skarpnäck district using the lens of the selected **socio-environmental challenges**

Imagine that you are presenting to an audience that knows nothing about your study/project, so try to **provide all necessary elements** so that they are able to follow and provide feedback

You may consider making **a joint presentation**: given that most of the background information is the same (e.g. Swedish Planning System, Stockholm City Plan, and Vision, Skarpnäck etc.)

# Thank You

PLACES Lab - blal.ademesmail@rub.de

# Suggested readings


- Brown, C., Reyers, B., Ingwall-King, L., Mapendembe, A., Nel, J., O'Farrell, P., Dixon, M. & Bowles-Newark, N. J. (2014). Measuring ecosystem services: Guidance on developing ecosystem service indicators. UNEP-WCMC, Cambridge,UK. https://www.unepwcmc.org/system/dataset_file_fields/files/000/000/303/original/1850_ESI_Guidance_A4_WEB.pdf?1424707843

- Browse the following two sites: 1) Guidance on ES Mapping and Assessment: http://www.maesexplorer.eu/ and 2) MAES Methods Explorer: http://database.esmeralda-project.eu/home

- Burkhard B, Maes J (eds) (2017) Mapping Ecosystem Services. Pensoft Publishers, Sofia, 374 pp. https://ab.pensoft.net/articles.php?id=12837 (Chapter 4, 5)

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- Grunewald, K., Richter, B., Meinel, G., Herold, H., & Syrbe, R. (2017). Proposal of indicators regarding the provision and accessibility of green spaces for assessing the ecosystem service “recreation in the city” in Germany. International Journal of Biodiversity Science, Ecosystem Services management, 13(2), 26–39. http://doi.org/10.1080/21513732.2017.1283361

- Grunewald, K., Syrbe, R., Walz, U., Richter, B., & Meinel, G. (2017). Germany ’ s Ecosystem Services –State of the Indicator Development for a Nationwide Assessment and Monitoring. http://doi.org/10.3897/oneeco.2.e14021