Rapid ecosystem services assessment tools: a user-based categorization

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Bahir Dar, Ethiopia, May 2019

Why assess ecosystem services?

- Biosphere reserves provide a range of ecosystem services that are key to human well-being.

- If the ecosystem services-concept needs to support the sustainable management of Biosphere reserves, we need a ***systematic, robust and credible assessment*** of the state and trends of these ecosystem services.

- Such an assessment will allow managers to evaluate threats endangering various ecosystem services, and to develop ***actions*** to counter negative trends.

- It will also contribute to communicate the added value of Biosphere reserves.

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Category	Definition	Threshold
Functionally extinct	Service no longer supplied in the region and is practically unrecoverable	Lost
Dormant	Service no longer supplied in the region but is potentially recoverable	
Critically endangered	Current levels of demand exceed supply and the ratio of supply to demand declining or expected to decline	Undersupplied
Endangered	Current levels of demand exceed supply; ratio of supply to demand is stable but supply is declining	
Stable but undersupplied	Current levels of demand exceed supply; neither supply nor ratio of supply to demand declining	
Vulnerable	Ratio of supply to demand is declining or expected to decline such that supply is likely to be insufficient to meet demand within a set time horizon	At risk
Least concern	Supply currently meets or exceeds demand, and does not meet the criteria for Vulnerable	Secure
Data deficient	Inadequate information is available about either or both of supply and demand to assess the level of threat	n/a

Threat categorization framework for ecosystem services (Maron et al., 2017)

How to translate the booming scientific interest for ecosystem services….

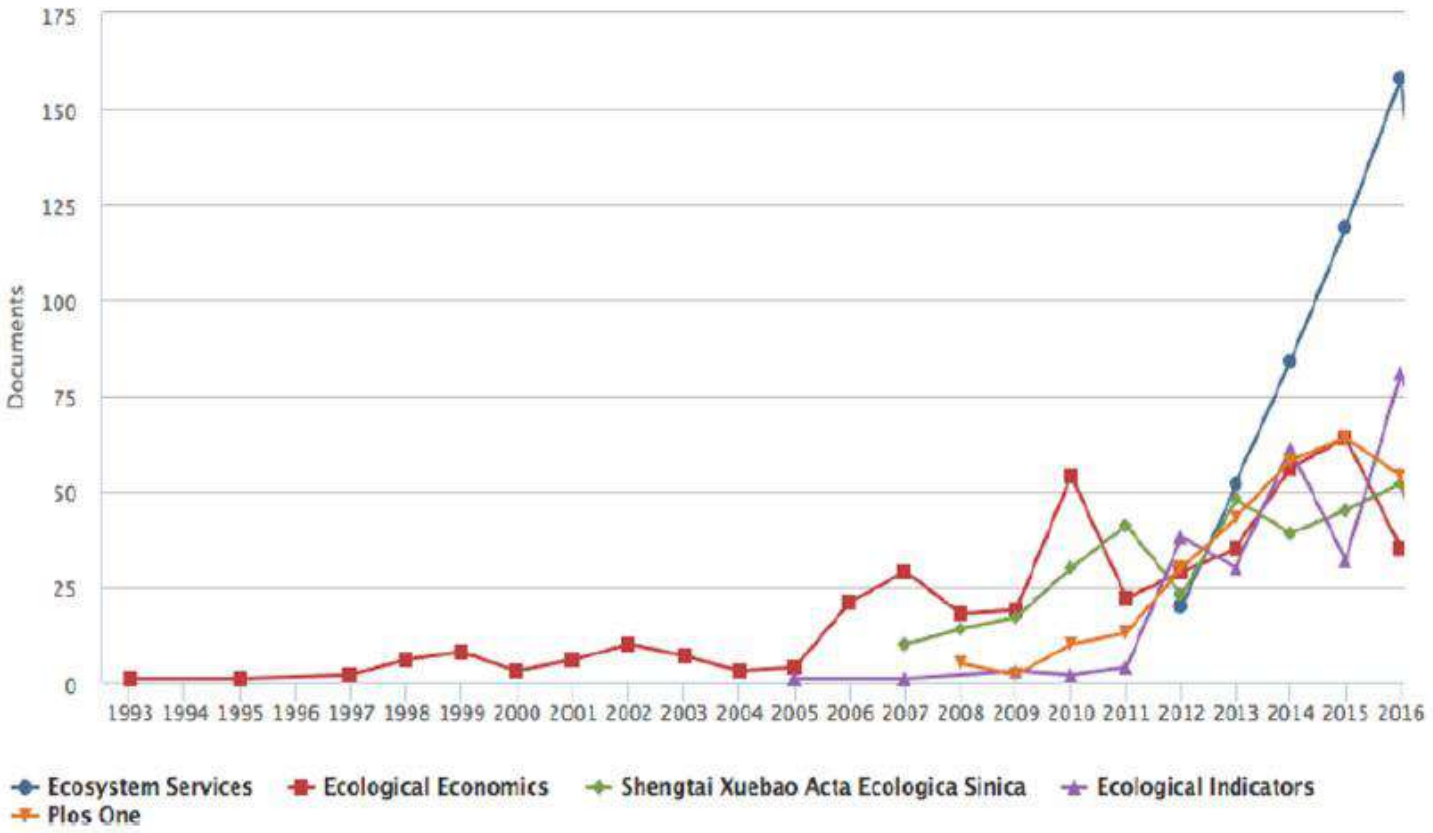

Fig. 4. Top journals publishing papers on ecosystem services (from SCOPUS search, April 3, 2017).

Costanza et al., 2017

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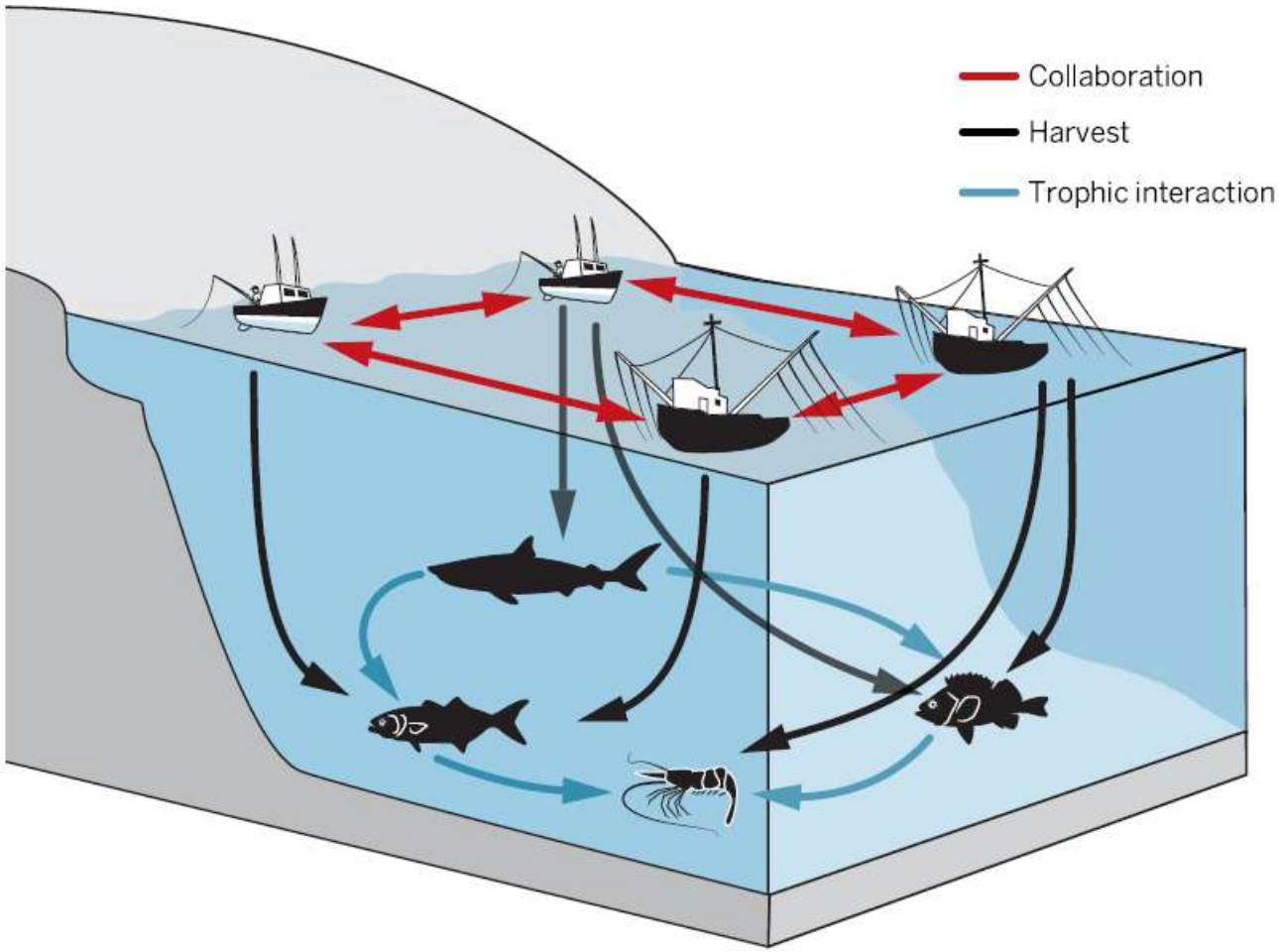
…into sustainable management actions?



Bodin et al., 2017

There are tools to do this!

- There are many tools and methods to ‘translate’ ecosystem services data into management-relevant actions and into insights for decision-makers and for the general public.

- These tools often have different objectives :
  - Data collection tools
  - Visualisation tools
  - Models (forecasting tools)
  - Participatory tools
  - Economic valuation tools

- The requirements in terms of time, skills and scope of application range widely.

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How to select the right tool(s)?

- Despite the wealth of tools that have been developed, their application is often limited.

- This can be due to unrealistic data requirements, to the lack of specialized skills and/or the lack of financial, human and time resources to apply these tools in the field, and/or to the inappropriate scope (mismatch between the users' needs and what the tool can offer).

- **Which tools can be used to assess ecosystem services in Biosphere reserves?**

- **What are the pros and cons of each tool?**

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The EVAMAB approach to ES tool assessment

- **Step 1**: Longlist of tools
- **Step 2**: Identification of user-generated criteria to assess tools
- **Step 3:** Categorization of tools
- **Step 4**: Field application of a selection of tools

Step 1: Longlist of tools to be assessed

Selection criteria:

- Generalizable
- Applicable at the landscape scale
- Applicable independently (*i.e.* without *a priori* requiring external expertise)
- Affordable (*i.e.* without requiring a priori financial investment)
- Able to assess multiple ecosystem services
- Rapid (*i.e.* requiring less than a year to apply the tool)

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Step 1: Longlist of tools to be assessed

- *Literature review,* using the these keywords: ecosystem services assessment, ecosystem services tool, ecosystem services toolkit, ecosystem services framework, ecosystem services guideline(s) and ecosystem services assessment method.

- Additional tools were identified from *Ecosystem Knowledge Network* (https://ecosystemsknowledge.net/), the *Ecosystem Services Partnership* (https://www.es-partnership.org/) and the *ValuES* method navigator (http://www.aboutvalues.net/method_navigator/).

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Contents lists available at ScienceDirect

Ecosystem Services

journal homepage: www.elsevier.com/locate/ecoser

A comparative assessment of decision-support tools for ecosystem services quantification and valuation

Kenneth J. Bagstad [a,*], Darius J. Semmens [a], Sissel Waage [b], Robert Winthrop [c]

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A comparative analysis of ecosystem services valuation approaches for application at the local scale and in data scarce regions

B. Pandeya[a,*], W. Buytaert[a,b], Z. Zulkafli[b,c], T. Karpouzoglou[d], F. Mao[e], D.M. Hannah[e]

IUCN

Tools for measuring, modelling, and valuing ecosystem services

Guidance for Key Biodiversity Areas, natural World Heritage sites, and protected areas

Rachel A. Neugarten, Penny F. Langhammer, Elena Osipova, Kenneth J. Bagstad, Nirmal Bhagabati, Stuart H. M. Butchart, Nigel Dudley, Vittoria Elliott, Leah R. Gerber, Claudia Gutierrez Arellano, Kasandra-Zoica Ivanić, Marianne Kettunen, Lisa Mandle, Jennifer C. Merriman, Mark Mulligan, Kelvin S.-H. Peh, Clara Raudsepp-Hearne, Darius J. Semmens, Sue Stolton and Simon Willcock

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Step 1: Longlist of tools to be assessed

→ **19 tools selected**

Co$ting Nature

The Protected Areas Benefits Assessment Tool

GEOMOD
A Geographic Information Systems-based LUC change model

ARIES - ARtificial Intelligence for Ecosystem Services

SITE framework (**SI**mulation of **T**errestrial **E**nvironments)

Ecosystem Services Review

Ecosystem Services Review for Impact Assessment

WORLD RESOURCES INSTITUTE

SWAT Soil & Water Assessment Tool

Interdisciplinary Decision Support Dashboard (IDSD)

tessa

InVEST integrated valuation of ecosystem services and tradeoffs

MARXAN conservation solutions

Social Values for Ecosystem Services (SolVES)

Green Infrastructure Valuation Toolkit

i-Tree

ESP
The Ecosystem Services Partnership Visualization tool

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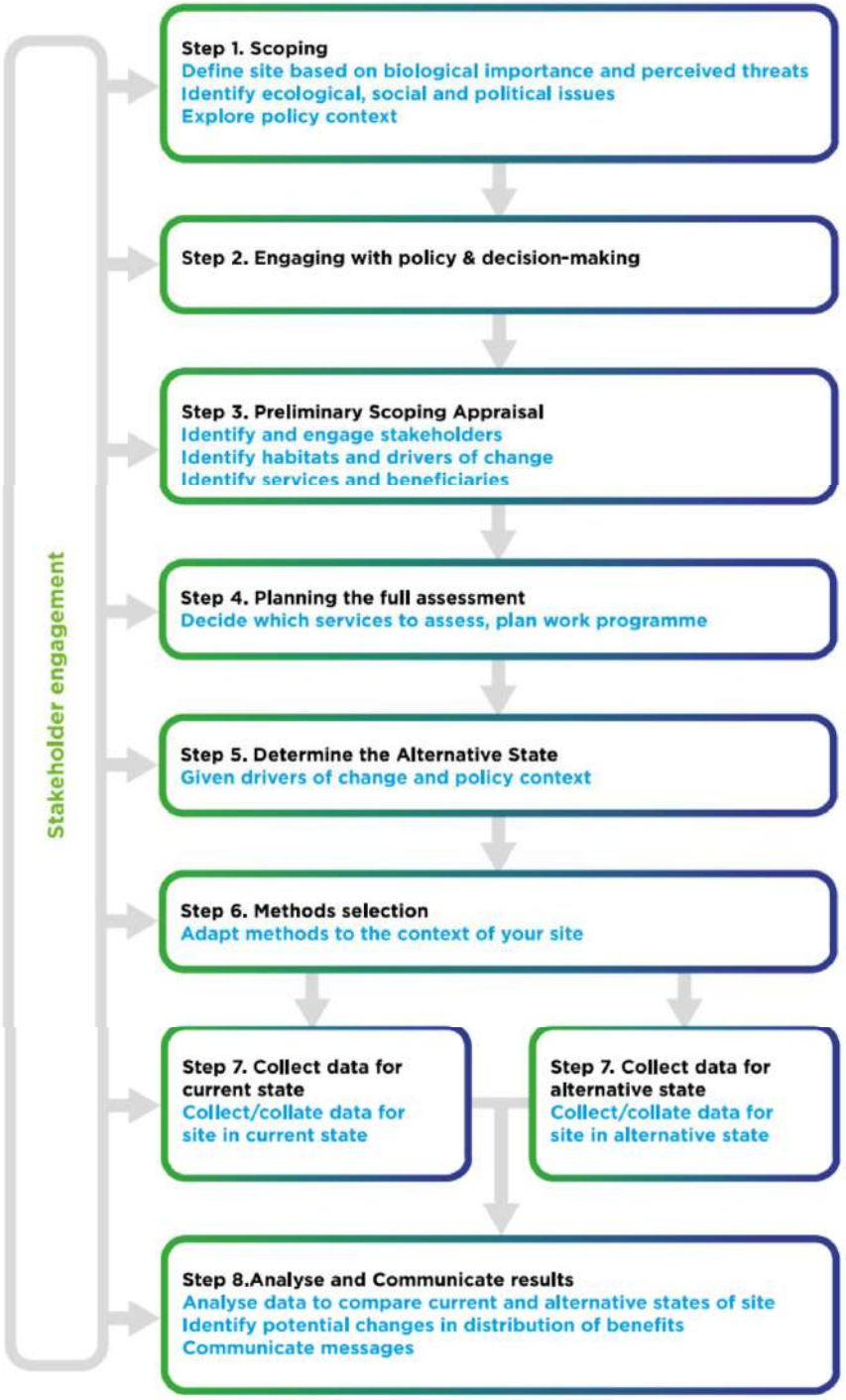
- Examples:

tessa

Toolkit for Ecosystem Service Site-based Assessment

- **Purpose:** Prioritization, quantification and monetary estimation of ES; Comparing current situation with a most likely state of the site
- **Time:** days→ months
- **Inputs:** Stakeholder-based input; Available data; Field sampling
- **Skills:** Stakeholder involvement
- **Outputs:** Quantitative data; Qualitative data; Economic valuation
- **ES:** Regulating: climate regulation, flood protection, water quality improvement; Provisioning: harvested wild and cultivated goods, water provision; Cultural: nature-based recreation



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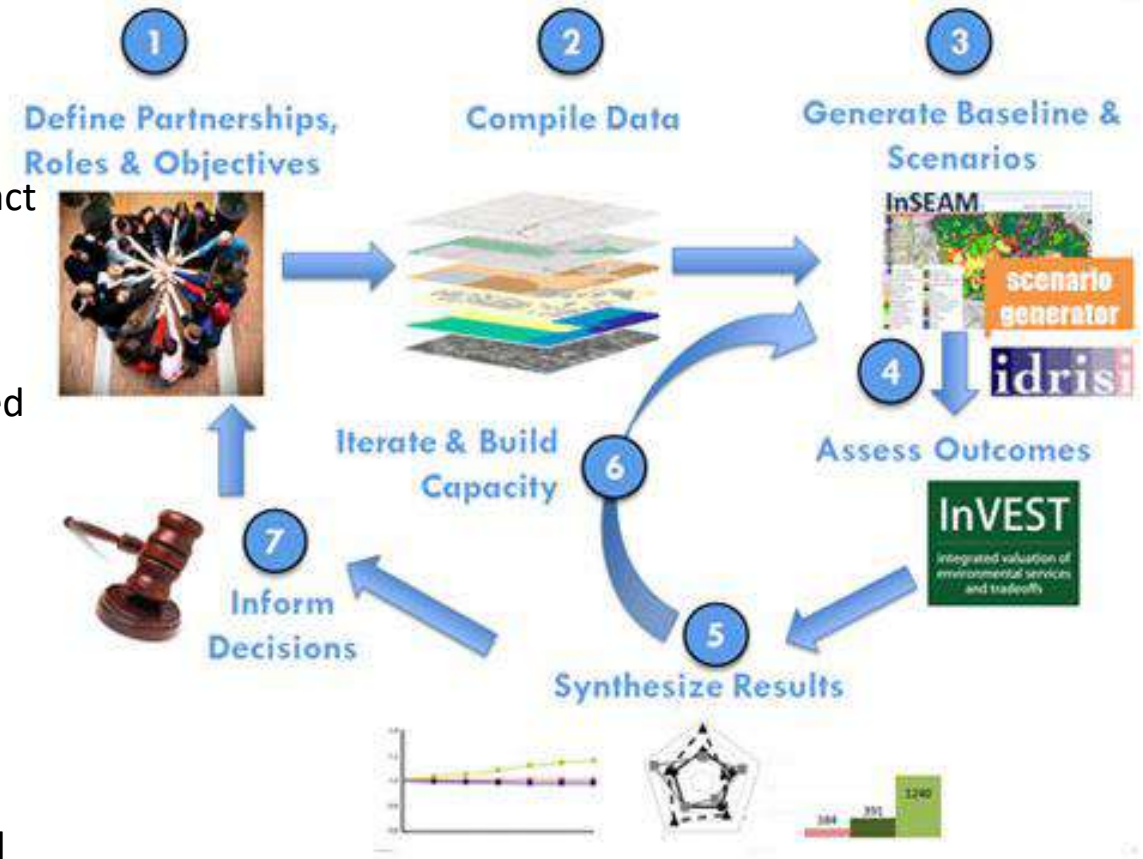
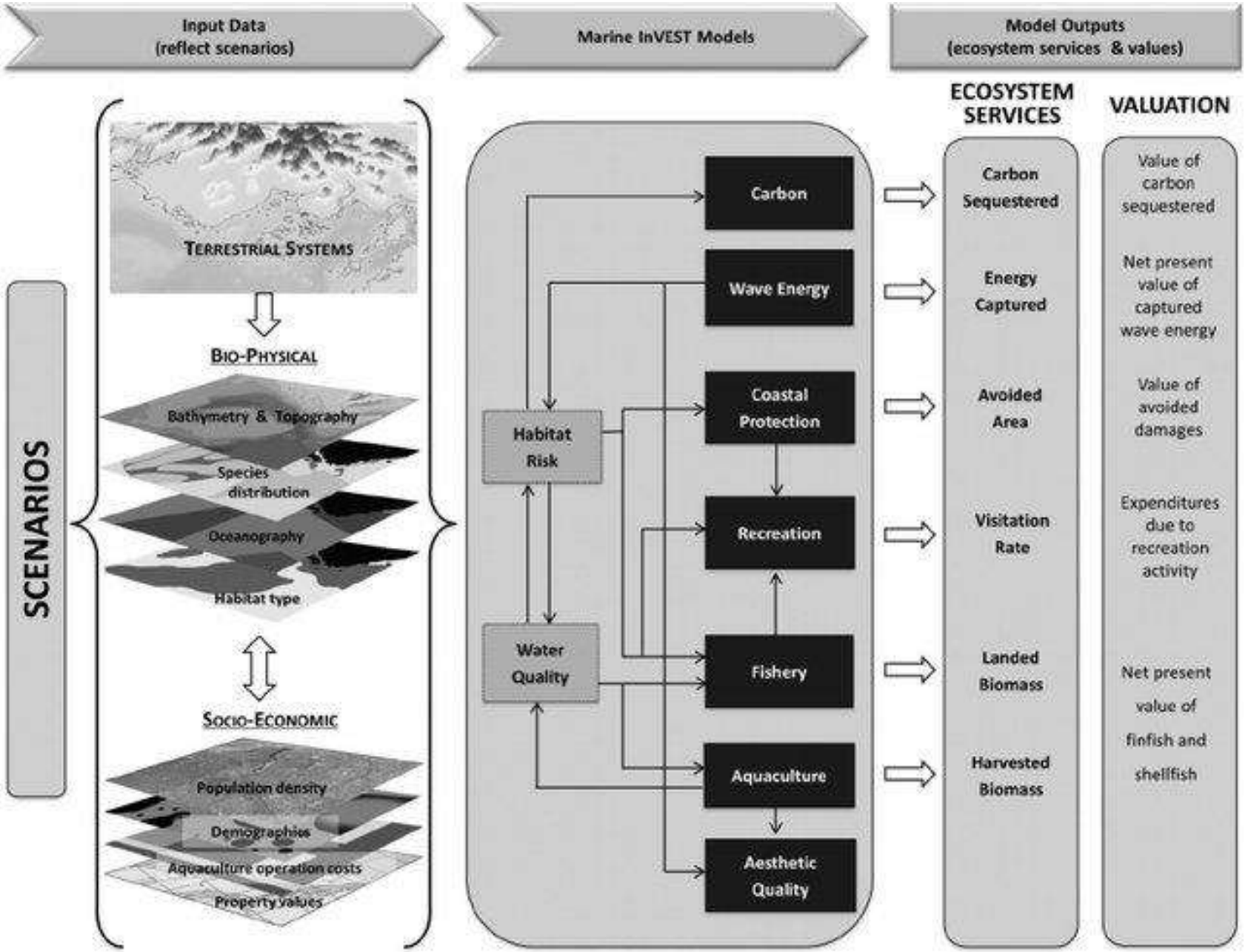
- Examples:

InVEST
integrated valuation of ecosystem services and tradeoffs

- **Purpose:** Mapping ES; Supporting spatial planning and conservation strategies; Comparing scenarios; Impact assessment
- **Time:** months → years
- **Inputs:** Spatial data; Stakeholder-based input; Available data
- **Skills:** GIS, Stakeholder involvement
- **Outputs:** Spatial data; Quantitative data; Economic valuation
- **ES:** Supporting: habitat quality, water purification; Regulating: crop pollination, climate regulation, coastal protection, marine water quality, habitat risk assessment; Provisioning: timber production, energy production, aquaculture production; Cultural: scenic quality, nature-based recreation and tourism





Guerry et al., 2012

Step 2: Identification of user-generated criteria to assess the tools

- Synthesis of criteria proposed in the scientific literature
- Validation & identification of additional criteria by way of a Delphi survey among experts present at AfriMAB 2017
- Delphi is an iterative survey which allows participants to air their opinion (round 1), and to possibly modify their initial opinion in round 2, after having been exposed to anonymized responses of their peers.
- Delphi allows to identify criteria for which there is consensus or not.

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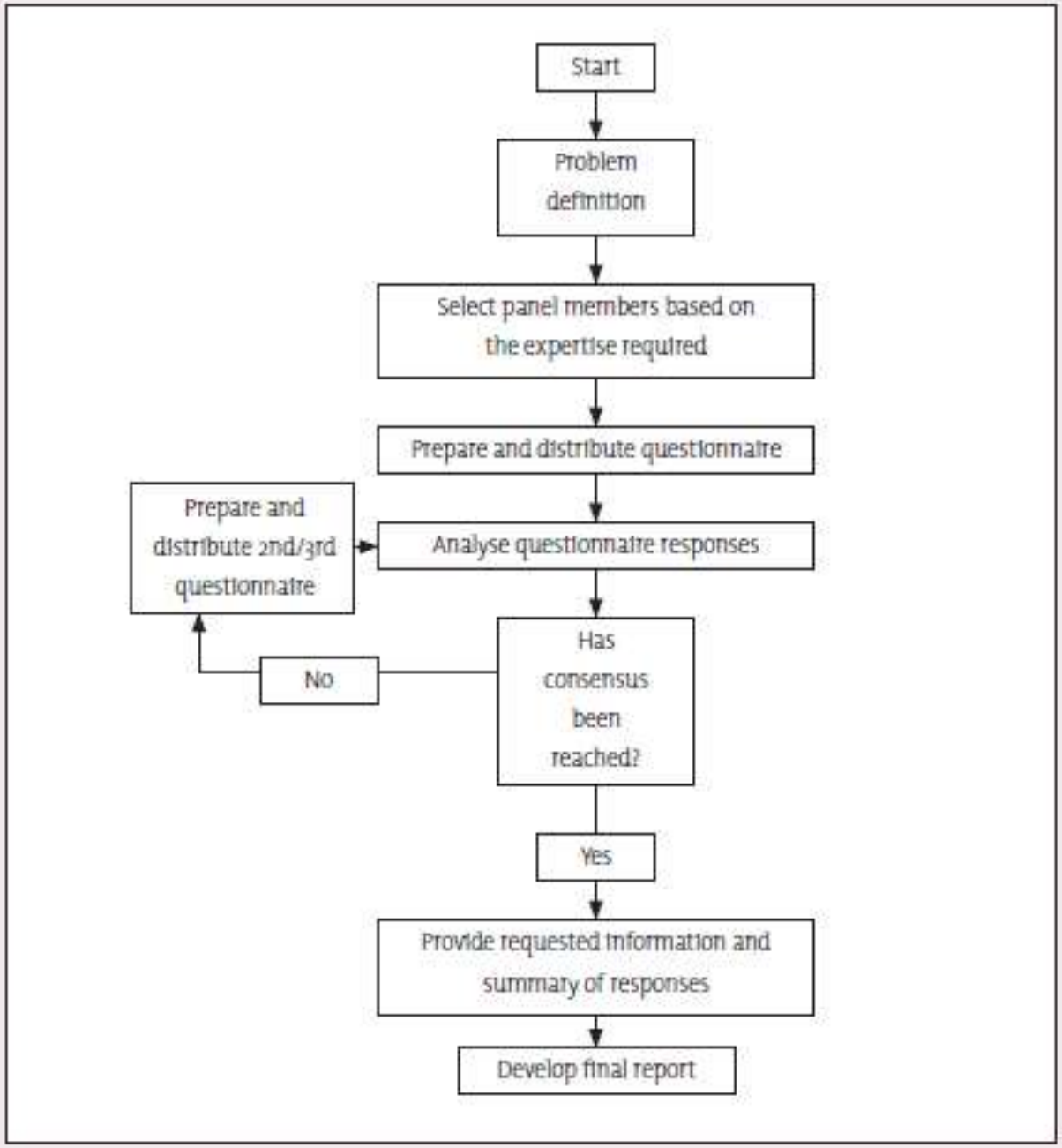
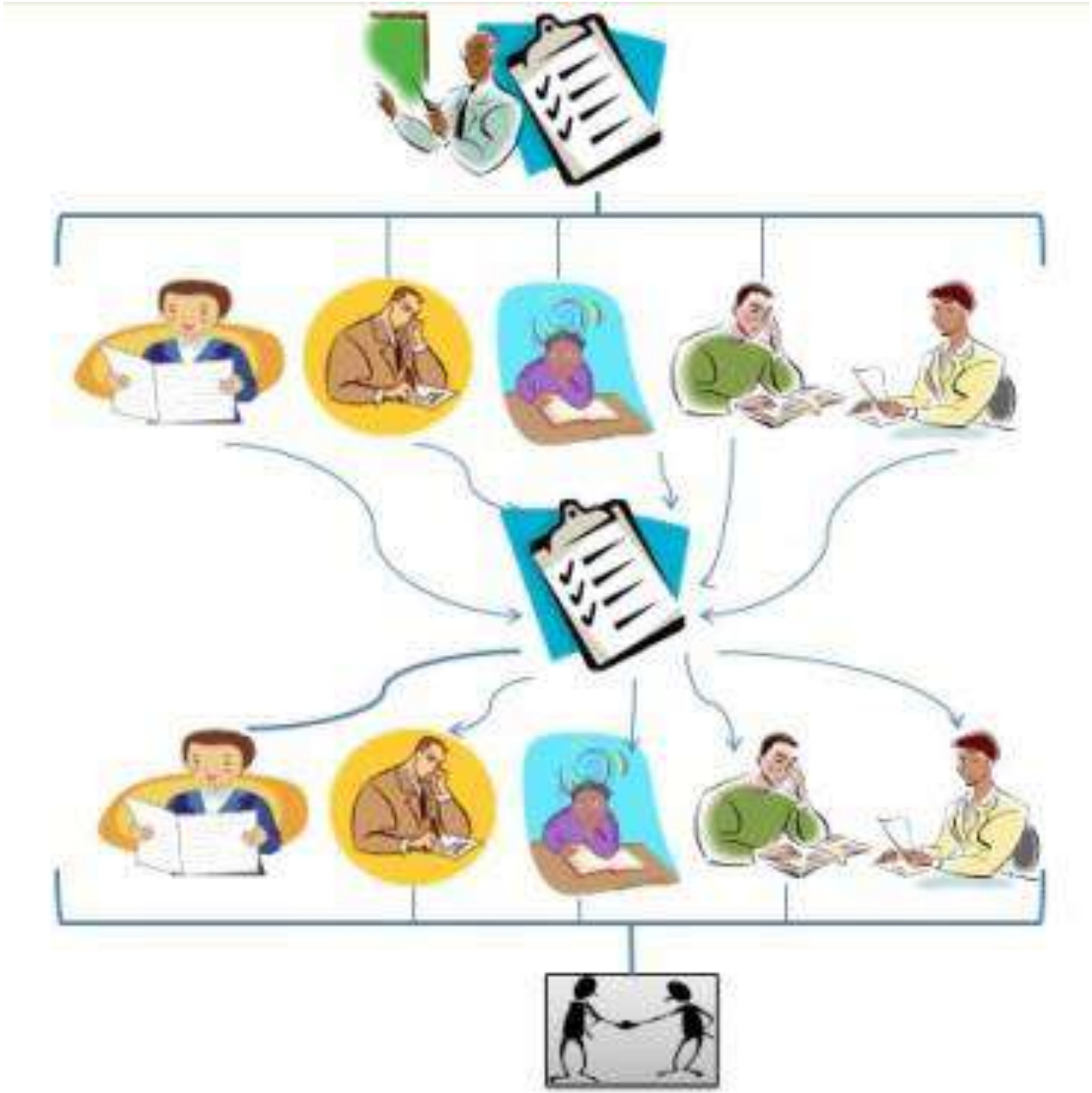
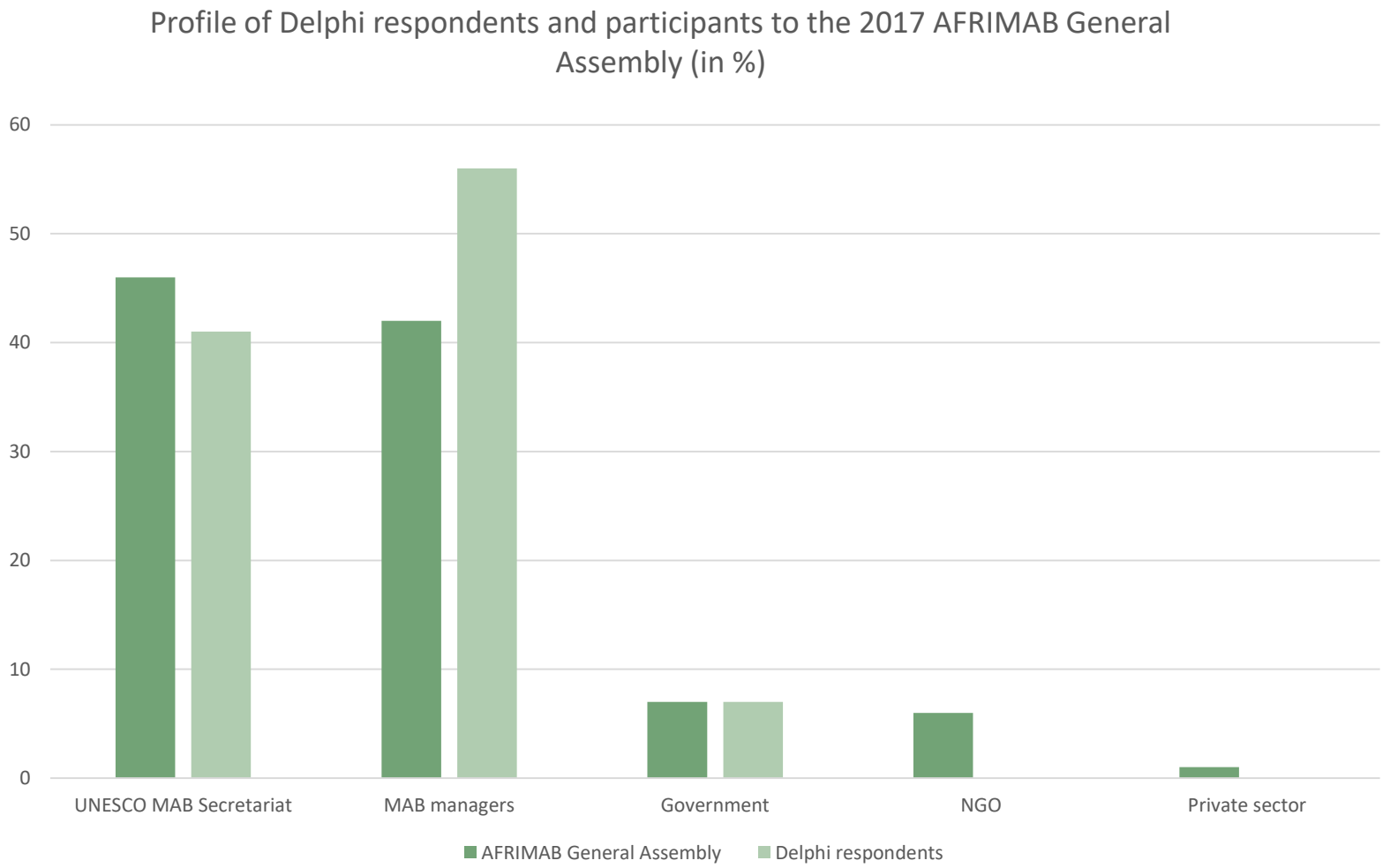

Start
Problem definition
Select panel members based on the expertise required
Prepare and distribute questionnaire
Analyse questionnaire responses
Has consensus been reached?
No
Prepare and distribute 2nd/3rd questionnaire
Yes
Provide requested information and summary of responses
Develop final report



Delphi: profile of the participants



What should rapid ecosystem services assessment tools do ?
(Results of the two-round Delphi survey among MAB experts & professionals)

Characteristic		Consensus level	Score variance	Trend in scores between rounds
Purpose of the tool	Environmental awareness raising & education	70%	10%	↓
	Scoping & description of provided ES	65%	10%	↑
	Supporting ES monitoring & evaluation	65%	25%	↑
	Identifying livelihood, development &investment opportunities	55%	25%	↓
Characteristics of the tool	Be able to assess multiple types of ES	60%	10%	↓
	Require a low degree of expertise to be applied	55%	20%	↑
	Provide results that are easy to communicate	55%	5%	↑
Outputs	Quantitative output	53%	15%	↑
	Economic evaluation	58%	5%	↑
Inputs	Maps	78%	15%	↓
	Quantitative input	83%	5%	=
	Qualitative input	61%	5%	↓
Hiring someone to apply ES assessments tool	Yes	84%		↑
Most restrictive criterion for fieldwork	Technically demanding	56%	20%	↑
	Epensive	67%	10%	↑

Only characteristics with scores showing >50% consensus are presented

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Step 3: Categorization of tools

Table 4: Description of ecosystem services assessment tools. (⏱ indicates that applying the tool typically takes days-weeks, ⏱⏱ weeks-months and ⏱⏱⏱ months-year).

Tool	Input	Skills	Output	Ecosystem services	Purpose	Sources
A Geographic Information Systems-based LUC change model (GEOMOD) ⏱⏱	Spatial data; Available data	GIS	Spatial data; Quantitative data;	A-Supporting: biodiversity, water purification, soil formation; B- Regulating: climate and water regulation, erosion control, moderation of extreme events; C-Provisioning: food & fibre, raw materials; D-Cultural: recreation, cultural diversity.	Modelling land use/cover changes between two time periods	Estoque & Murayama, 2012
ARIES Artificial Intelligence for Ecosystem Services ⏱/⏱⏱	Spatial data; Available data	GIS	Spatial data; Quantitative data; Qualitative data: Economic valuation	A-Supporting: water supply; B-Regulating: carbon sequestration and storage, flood regulation, nutrient regulation, sediment regulation; C-Provisioning: subsistence fisheries; D-Cultural: open space proximity, aesthetic viewsheds, recreation	Modelling and mapping ES flows and distribution of beneficiaries; Comparison between different scenarios (*e.g.* climate, land use…)	Bagstad *et al.*, 2011; Villa *et al.*, 2009
CLIMSAVE Integrated Assessment (IA) Platform ⏱⏱	Available data		Spatial data; Quantitative data; Qualitative data	A-Supporting: /; B-Regulating: climate regulation, flood regulation, water flow regulation, pollination; C-Provisioning: food, fresh water, raw materials; D-Cultural: /	Impact prediction of climate change and vulnerability; Identifying adaptation strategies and their cost-effectiveness	Harrison *et al.* 2015

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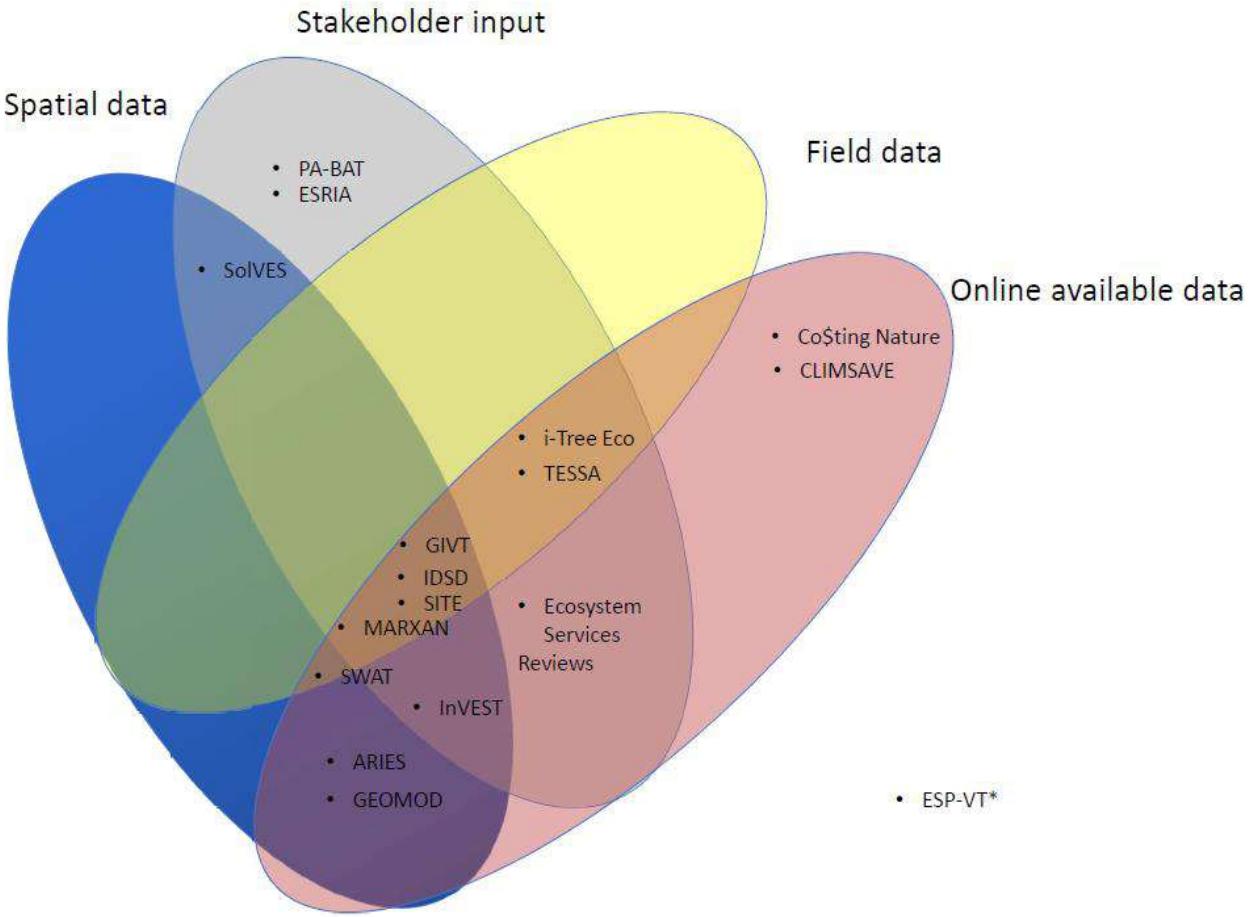
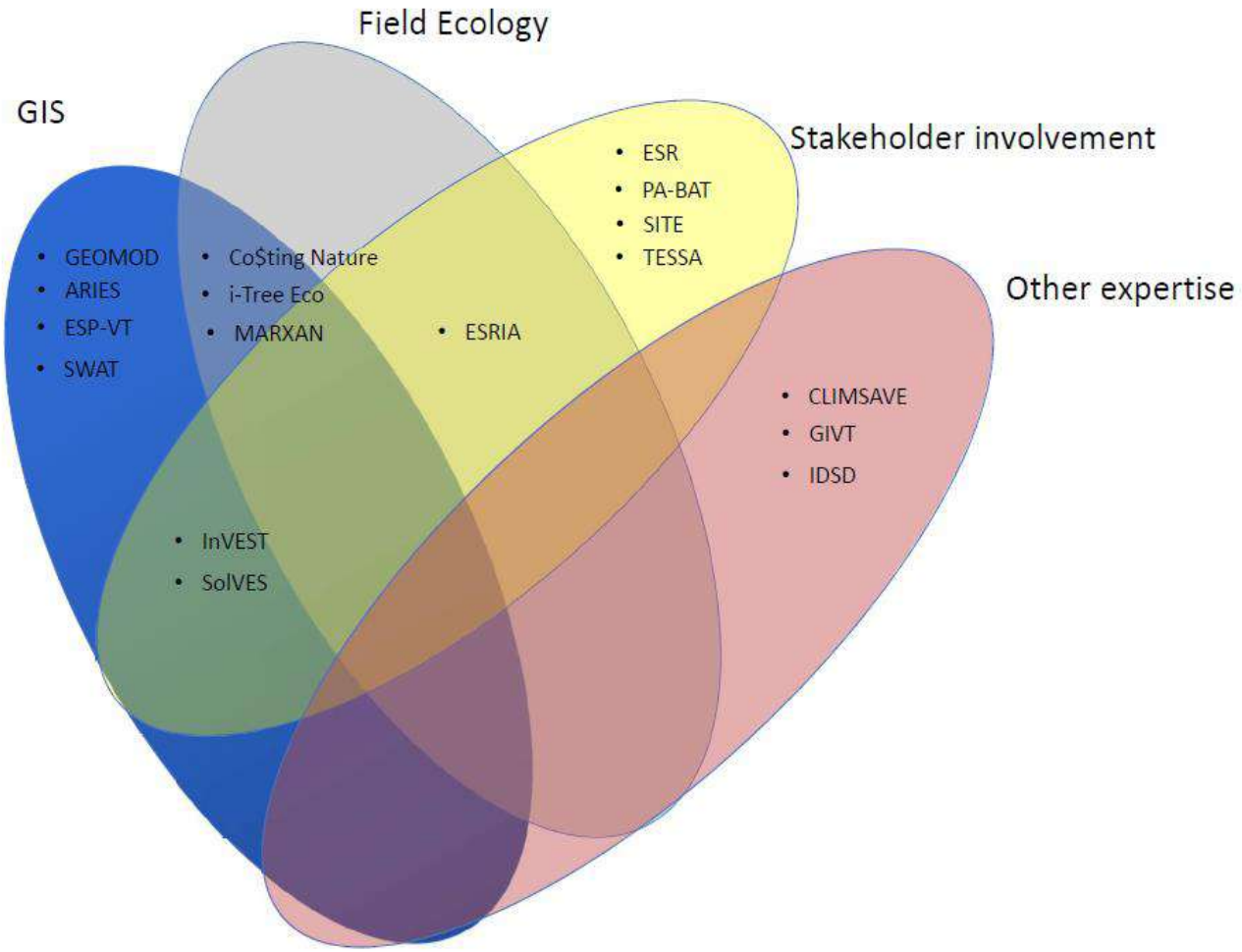
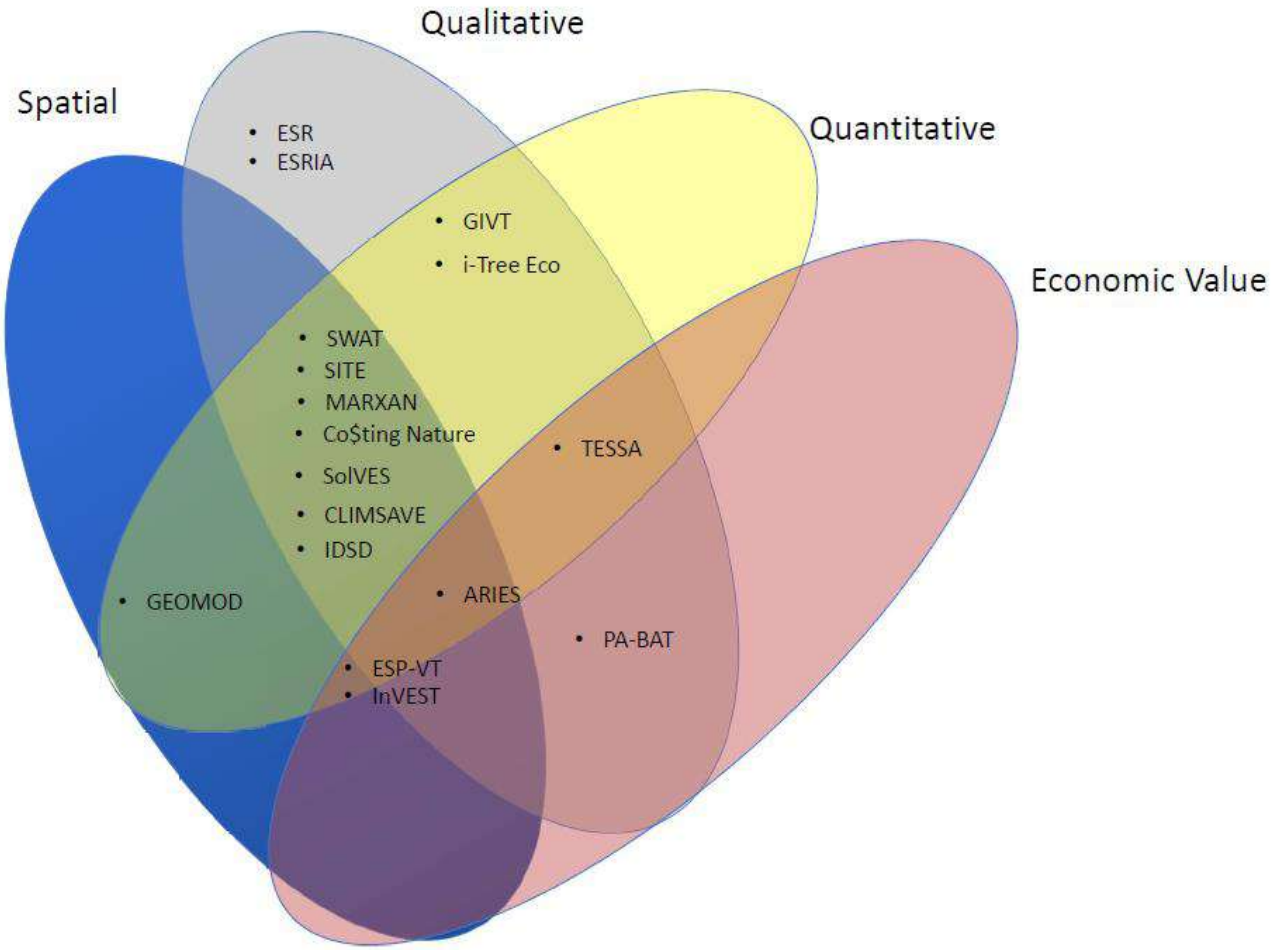
Step 3: Categorization of tools based on required input



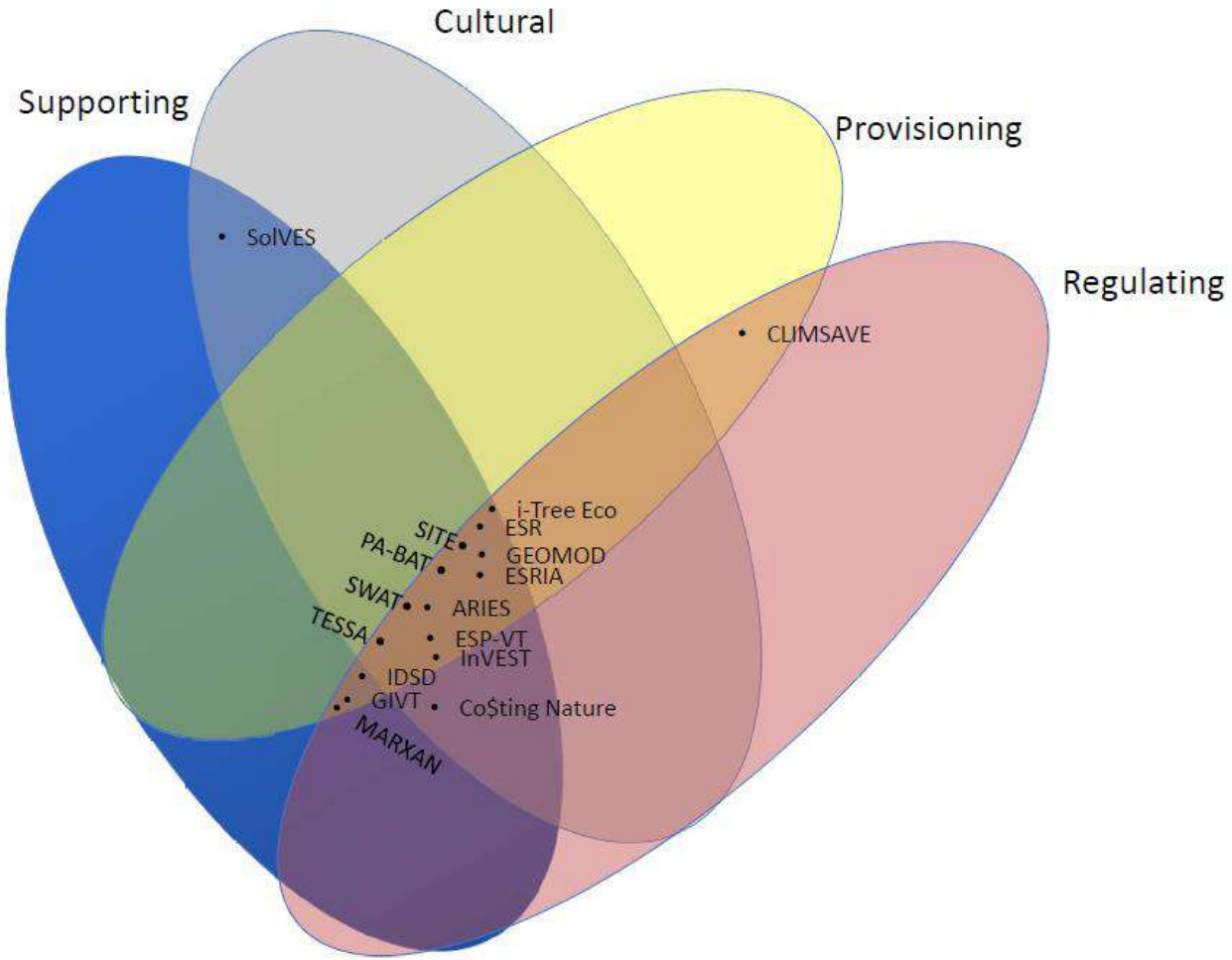
Step 3: Categorization of tools based on required skills



Step 3: Categorization of tools based on generated output



Step 3: Categorization of tools based on the ecosystem services addressed



Step 4: Application of tools in the field

- Case study locations of EVAMAB (Benin, Ethiopia, Tanzania, Uganda) plus additional applications in Senegal, Kenya and the Republic of Congo

- Modification of existing tools (*e.g*. TESSA-inspired Nominal Group Technique)

- Application of complementary methods, such as judgement elicitation methods (*e.g.* Q methodology to map stakeholders' perceptions)

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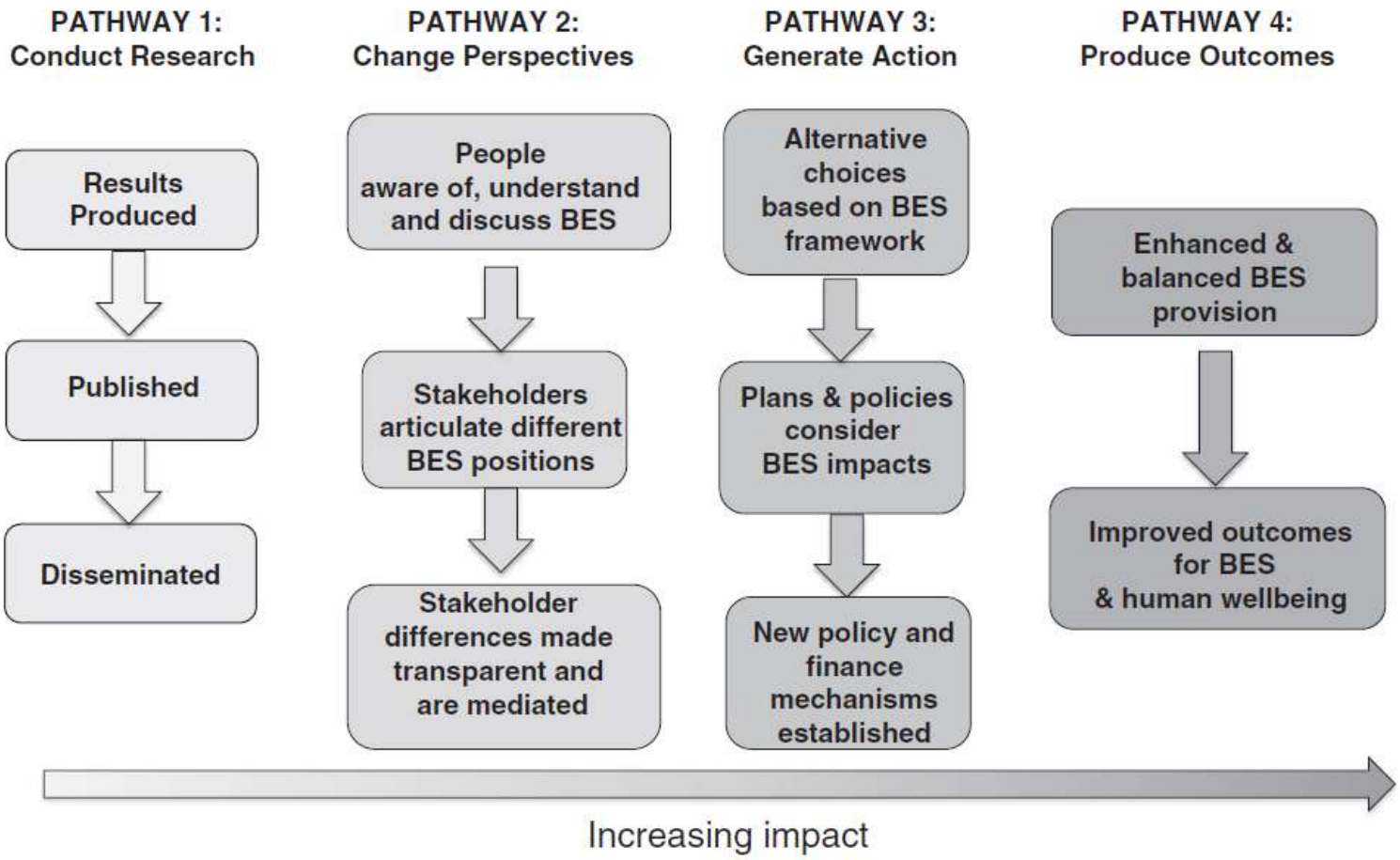
Example (°Kenya): priority ecosystem services mentioned in 7 workshops of TESSA-NGT

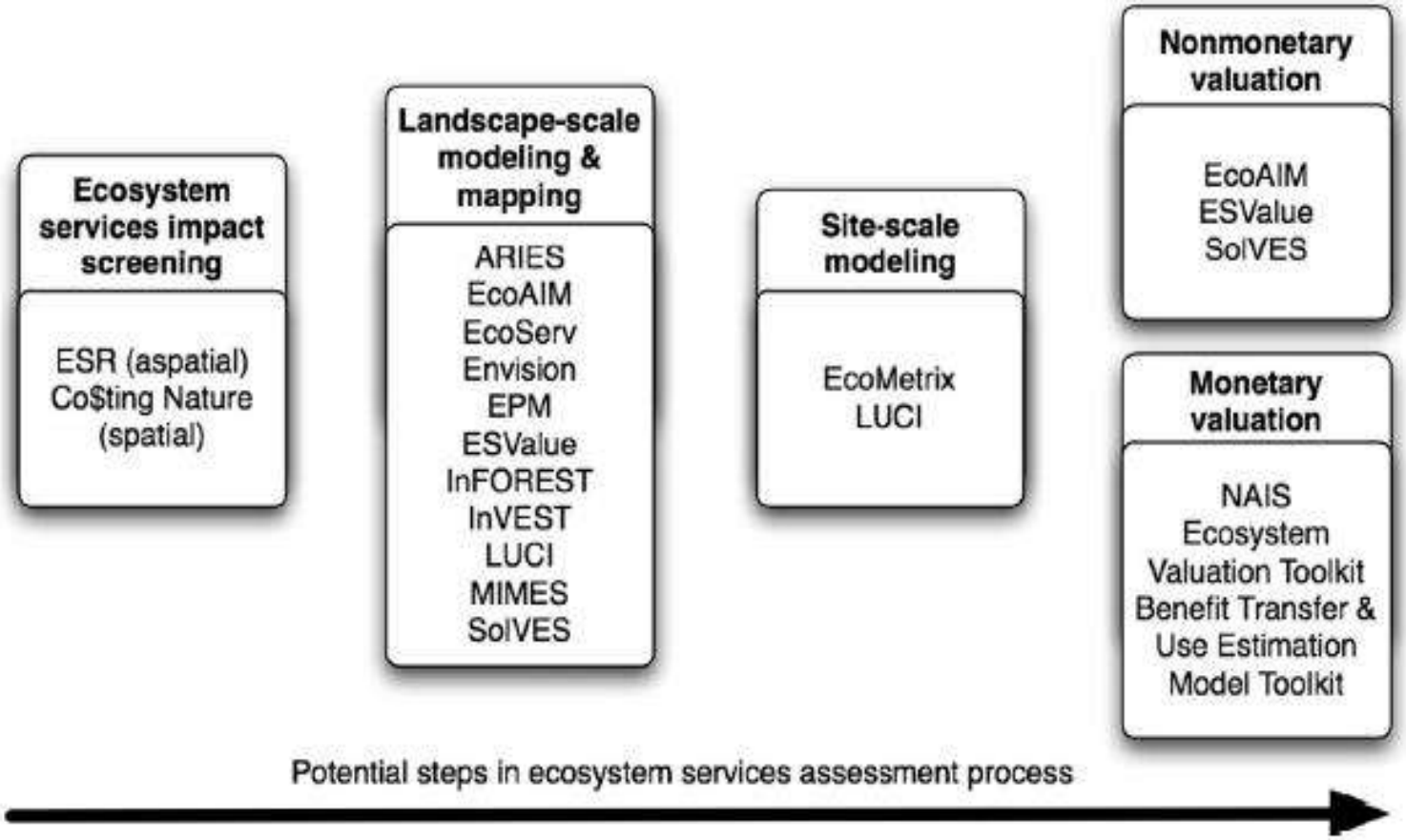
List of ES mentioned in **ALL 7 workshops** – (65 participants in total)

ES Category	Ecosystem service	a. Overall score	b. Total no. of votes	c. Total no. of workshops mentioned
Provisioning	***Fisheries***	***178***	***48***	***7***
	Construction poles	73	24	7
	Firewood	41	14	5
	Medicinal value/traditions	37	13	4
	Habitats	24	11	4
	Aquaculture	18	10	5
	Food/Fish for sale	19	7	2
	Mangrove seedlings sale	10	5	3
	Water household provision	8	4	2
Regulating	***Carbon sequestration/trading***	***87***	***20***	***4***
	Reduced wave actions/strong waves	32	12	4
	Increased rainfall	24	9	4
	Fresh air/Oxygen	11	5	2
Cultural	***Ecotourism***	***99***	***31***	***7***
	Job creation	39	18	5
	Seaweed farming/agribusiness	39	11	3
	Education	27	8	2
	Shrines	15	4	2
	Recreation	8	4	2

From tools to decision-making



Ruckelshaus et al., 2015



Bagstad et al., 2013

Concluding reflections

- The diversity of available tools is a plus, but can also be overwhelming: which tool should one select?
- The EVAMAB approach allows to motivate tool selection, and is validated by experts-potential users.
- The practical application of tools, and the experimentation with hybrid methods allows to adapt and fine-tune existing methods, as challenges and methods keep evolving.
- How to anchor ecosystem services into decision-making regarding Biopshere reserves?

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