Review of Ecosystem Services Valuation Tools

Prepared for Frenchman Bay Partners

by

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Introduction

Ecosystem services (ES) refer to “benefits people obtain from ecosystems” (MEA 2003). These can include provisioning (e.g. food, water supply, energy and raw materials), regulation (e.g. air quality, water regulation, climate stability) soil formation/nutrient cycling, cultural services (aesthetics, recreation/tourism, spiritual). Such services have value to human communities, but this value is not always captured or monetized. Understanding these values can help inform or support policy decisions. Researchers, modelers and policy makers have developed a number of ecosystem services valuation (ESV) tools to help quantify services. These tools can examine alternate scenarios, uncover connections, develop conservation strategies, and build coalitions. The various ESV tools have different emphases and strengths. What follows is a summary of 14 tools, highlighting their attributes, strengths, weakness, inputs, outputs and scales. This information is also summarized in the excel table Appendix 1.

Methods

This is a survey of currently available tools for ecosystem services valuation as of spring and summer of 2016. It was conducted through Internet searches and literature review. The tool websites, case studies, and a number of review articles provided most of the information for the review. Sources provided information about the tools' backgrounds, best uses, scales, data/technical requirements, usability and limitations. Citations for case studies are included for additional information about the tools' past applications.

A tool was selected for inclusion in this review if it met the following criteria:

1. It is an ESV tool: decision making support is a broad, encompassing category. There are a number of tools that may be useful in guiding a group through the decision making process, but do not provide a value (either monetary or not) to a an ecosystem service.
2. It can be used for marine resources.
3. The tool is currently available for use and currently maintained.
4. Sufficient information about the tool is available.

This document also contains a reference list to assist Frenchman Bay Partners in choosing and evaluating a tool.

Tools

InVest

SOURCES

http://www.naturalcapitalproject.org/invest/

http://ecosystemsknowledge.net/invest

InVEST User Guide (Sharp et al. 2014)

Background

InVest was developed as a partnership between Stanford University, University of Minnesota, The Nature Conservancy, and the World Wildlife Fund. It is a suite of free open source software models. The estimated number of work days to complete a project is 46.

About the models

InVest has an iterative engagement strategy that places an emphasis on stakeholder engagement. It has a strong spatial component and returns maps as outputs. The scale is flexible, and can be used at the local or global levels. It analysis ES related to regulation, provisioning and culture and is designed to work with terrestrial, freshwater and marine ecosystems. Models are based on production functions, and include service supply, as well as the locations and activities of people who benefit from services. The tools can be used independently or as a script tool within Arc GIS or QGIS, and require intermediate level knowledge of GIS. Models include:

- Carbon
- Coastal Blue Carbon
- Coastal Vulnerability

- Crop Pollination
- Fisheries
- Habitat Quality
- Habitat Risk Assessment
- Managed Timber Production
- Marine Fish Aquaculture
- Marine Water Quality
- Nearshore Waves and Erosion
- Offshore Wind Energy
- Recreation
- Reservoir Hydro-power Production
- Scenic Quality
- Sediment Retention
- Water Purification
- Wave Energy

There are a number of help tools including a scenario generator that can compare scenrios through Invest. For example Overlap Analysis can visualize hot-spots. DelineateIT delineates watersheds for particular points. RouthDEM calculates stream flow directions, accumulations and slope from DEMs. InVest Dashboards automate most common synthesis and visualization tasks.

Limitations

Like many tools, InVest may be limited by local data access and quality. Some models may be oversimplified. InVest can be time consuming to use.

Data Requirements

GIS data and tables in CSV format can be used as inputs, and maps are generated as outputs.

Training and support

InVest and all associated models are well documented. The limitations and methodoligies of each the models are outlined. There are training videos available online, along with a forum.

Examples of Use

Cape Fear Catchment, North Carolina (Hamel et al. 2015) .

TESSA (Toolkit for Ecosystem Services Site Based Assessment)

Links and sources: http://tessa.tools/

http://www.birdlife.org/worldwide/science/Toolkit_for_Ecosystem_Service_Site-Based_Assessment/How_TESSA_is_different_from_other_tools

Background

TESSA was developed in UK, and used throughout the world for site specific scoping in conservation projects. It is designed to take use local knowledge and stakeholder engagement and be relatively accessible to those with out in-depth technical knowledge. It is not a spatially explicit model, but TESSA aims to help "non-experts" evaluate several ecosystem services "quickly, cheaply, but robustly....and estimate the difference between current state and plausible alternatives" (Peh et al. 2013) The median time to carry out a project is 39 person days.

About the model

TESSA is tool kit specifically developed for conservation planning the site scale (100-100,000 ha). It has a participatory emphasis and has mostly been used in the United Kingdom. It requires some understanding of both scientific and socio-economic methods along with computer and mathematical skills, but does not require any in-depth technical knowledge, and relies on comparatively simple models using information gathered locally. TESSA is rapid, robust, and provides guidance for low-cost methods. It does not focus on spatial techniques or outputs, but does provide opportunity for comparative valuation and visualization of the impact of change. TESSA requires a computer with an internet connection, field equipment and staff/or volunteers to carry out the analysis.

Ecosystem services valued include:

- Harvested wild goods

- global climate regulations
- cultivated goods
- cultural*
- coastal protection*
- Pollination*
- Nature based rec
- Water (provision and quality)

*note that some of these models are still in development.

TESSA is made up of an eight step process, with stakeholder engagement included throughout. The eight steps include:

1. Scoping
2. Identify and engage with decision makers
3. Preliminary scoping appraisal
4. Determine the alternative statements
5. Collect data for the alternative state
6. Methods selection
7. Analyze data
8. communicate results

The toolkit includes:

- step by step guidance for scoping and appraisal
- decision trees/flow charts to help select the most appropriate methods based on site characteristics
- information about 50 different methods for assessing ecosystem services

- guidance/tips about assessing benefits across local, national and global communities
- guidance about how to disaggregate values at the local level to determine inequities
- templates and examples
- guidance on data synthesis

Data requirements

Data requirements will vary depending on project and methods selected. Often uses primary data collected in the field.

Limitations

TESSA is not a spatial tool. TESSA is designed for small scales. It does not measure all services, but is designed more for scoping.

Trainings and support

TESSA has strong support online with case studies, documentation and webinars.

Examples of Use

Yala Swamp Complex in Kenya (Akwany 2015)

ARIES (Artificial Intelligence for Ecosystem Services)

Links and Sources: http://aries.integratedmodelling.org/

http://ecosystemsknowledge.net/aries

Background

ARIES was developed in 2007 by NSF, UVM, Earth Economics and Conservation International. It hopes to "quantify the benefits that nature provides to society in a manner that accounts for dynamic complexity and its consequences" (http://aries.integratedmodelling.org/?page_id=632). There is an emphasis on beneficiaries along with spatial and temporal dynamics. It analyzes ES related to the areas of regulation, provisioning and culture. ARIES brings to together appropriate models and data based on user input. ARIES can be used to study terrestrial, freshwater and marine ecosystems. It can be used many scales from local to national. It is open access and there is no cost for the tool for non profit organizations and universities. The estimated number of working days required for a project is 130. Training is available and strongly suggested.

About the model

ARIES is a spatially explicit. It uses modular model components that are most appropriate for each situation. It depends on the underlying software, k. LAB, which is specifically designed to examine socioeconomic and environmental modeling problems. K. LAB is networked which allows for researchers to share models. ARIES requires significant technical knowledge.

ARIES can be used for spatial mapping and qualification of ES, spatial economic valuation of ES, natural capital accounting, optimization of payment schemes for ES, conservation planning, spatial policy planning, and forecasting of change in ES provision. Aries requires the k.Lab software tool environment.

The specific ecosystem services modeled include:

- Carbon sequestration and storage
- Riverine flood regulation
- Coastal flood regulation
- Nutrient regulation
- Sediment regulation
- Water supply
- Fisheries
- Pollination
- Aesthetic value
- Open space proximity
- Recreation

A web-based tool for non technical users, called k.Explorer, is in development and should be available in 2017.

Data requirements

GIS data and maps make up the inputs. Outputs include maps, quantitative data and an environmental asset portfolio.

Limitations

ARIES currently requires experienced modelers to consult for application.

Trainings and support

Aries is well supported online. There are a number of workshops offered and custom trainings are available.

Examples of Use

- Villa et al. (2014) Madagascar water quality valuation
- Bagsted et al (2014) Carbon sequestration in Washington State.

Co$ting Nature

links and sources

http://www.policysupport.org/costingnature

http://ecosystemsknowledge.net/coting-nature

Background

Co$ting Nature was developed by Kings College London, Ambio TEK, UNEP-WCMC. It is intended for conservation/development NGOs, governmental/non-governmental policy analysts, agriculture/industry, and education and research. It is applicable for a range of land uses.

About the model

Co$ting Nature is web-based and spatially explicit. The inputs spatial data sets at 1 ha or 1 sq km. Maps are created as the outputs. It is a free (for non-commercial use), open access web-based tool. GIS software is helpful for analysis of output maps, but is not necessary. The following services are modeled:

- Water Quantity
- Water quality
- Water provisioning
- Carbon storage and sequestration
- Recreation
- Biodiversity
- Conservation Priority
- Threats and Pressures

Data is provided with the tool, but users may provide additional or more specific data. Time requirements for the tool are considered to be low, but no estimate of working days is available. Co$ting Nature calculates a base line for current ESV provided (1950-200). Scenarios, policy interventions etc. can then be calculated and compared to baseline.

Data requirements

Basic data is included in the tool. Users may supply their own more detailed data.

Limitations

The Costing Nature Model may be too simple for some uses. It does not currently support the mapping of the valuation and trade-offs associated with individual services.

Trainings and support

Extensive videos and trainings are available online. Users can make suggestions and design the future of the tools.

Examples of Use

Amazon Rain Forest, Brazil (http://costingnature.infoamazonia.org/en/)

EcoMetrix

links and sources

http://www.ecometrixsolutions.com/ecometrix.html

Background

EcoMetrix is a proprietary decision support system from EcoMetrix Solutions Group. The tool purports to balance robustness with ease of use. EcoMetrix develops a conceptual models for each function examined. EcoMetrix is designed to be used by ESG professionals generally at the site scale.

About the model

EcoMetrix is based on algorithms for determining ecosystem function scores describing how well each relevant function is performed. These algorithms are developed for the EcoMetrix data base in a four step process. Each function to be examined has a corresponding conceptual model, which outlines the key attributes to functional performance. The conceptual model illustrates how the physical attributes are connected to carry out the service. The conceptual model is developed by EcoMetrix. Units are measure are then selected for each attribute. The units of measure can be either quantitative or qualitative. These measures are used to calculated scoring curves to show how a sites ecosystem functional performance will change with respect to changes in the various attributes. The functional performance scoring algorithms consist of an aggregation of the individual attributes identified in the conceptual model. These are connected to the scoring tables in the EcoMetrix database. Weights may be incorporated to capture ecological priories, regional differences, policy goals, etc. The individual function measures are used to calculated the performance of the ecosystem. The performance is defined as a gain or loss of services. This measure can then be used to calculate economic or non economic values.

Data requirements

The conceptual models, which are developed as part of the analysis, determine the specific data needs.

Limitations

EcoMetrix is a proprietary tool so analysis and data collection would not occur in-house. As a result, projects may be more costly.

Trainings and support

EcoMetrix is a proprietary tool. ESG professionals create models, collect data, conduct analysis.

Examples of Use

Bagsted et al (2014) Carbon sequestration in Washington State.

ESII (Ecosystem Services Identification and Inventory) Tool

Links and Sources

http://www.ecometrixsolutions.com/esii-tool.html

http://www.esiitool.com/

Background

ESII was designed by TNC, Dow Chemical Company and EcoMetrix Solutions Group. It is designed for rapid and inexpensive analysis for communities, organizations or businesses. ESII can identity and estimate values for ES. It is designed for those without in-depth ecological training. It is still in development, though early adopters are welcome. There is no cost for version one. Though it has not been tested in marine environments, it is designed to be used in a broad range of geographies. It does not calculate a monetary value for the resources, but does generate values that can be used in such valuation.

About the model

There are two parts of the ESII tool: a web-based project workspace and an iPad app for data collection in the field. Beyond the app, no third party software is required.

Five steps

1. Identify the site
2. Set up the project workspace
3. Collect data with the app through questions and photos.
4. Review data and identify missing data
5. Run models and Examine results

Ecosystems Services modeled include

- Aesthetics—noise and visuals

- Air Quality—Nitrogen and Particulates
- climate regulations
- carbon uptake
- erosion control
- Mass wasting
- flood mitigation
- Water quality—Nitrogen and Sediment
- Water Provisioning
- Water quality control
- Other ecosystem services will be added in the future.

While ESII does not provide a monetary value for resources, it generates outputs that can be used in other valuation models.

Data requirements

Site specific data is collected in the field through photos and a questionnaire.

Limitations

ESII does not provide monetary values. ESII is not well tested in marine environments.

Trainings and support

There is an online forum and strong information on the website. Some initial training is recommended. Additional support services, including personalized support and trainings, are available for a fee.

Examples of use

Dow Chemical company land re-development project (http://www.esiitool.com/about/)

ESR (Ecosystem Services Review for Impact Assessment)

Links and Sources

http://www.wri.org/publication/weaving-ecosystem-services-into-impact-assessment

(Wbcsd 2011)

Background

ESR is a spreadsheet methodology that has been used internationally and at multiple scales. It is primarily a screening tool (Bagstad et al. 2012).

About the model

ESR is a six step spreadsheet methodology that analyzes the impacts and dependencies on ecosystem services of a project. It includes environmental and social impacts. It identifies strategies to mitigate project impacts on ES and ways manage dependencies. The outputs include a list of services, the identification of key services and stakeholders, the assessment of project impacts and dependencies, and the determination of mitigation measures. The open source tools are available for download. It is a mostly qualitative tool, and not spatially explicit. It it relatively quick to use, though no time estimate is available.

Sub-models include:

- Atmosphere
- Lithosphere
- Hydrosphere
- Biosphere
- Anthroposphere

There are four outputs:

1. A list of ecosystem services
2. Identification of priority ES and key stakeholders
3. Assessment of potential impacts and connections within priority ES
4. Potential measures to mitigate project impacts.

Data requirements

Most data is qualitative and gathered through stakeholder engagement or secondary data. Other useful data sources include censuses, historical texts, land cover maps, resource specific data, etc.

Limitations

ESR is mainly qualitative and does not provide monetary valuation.

Trainings and support

ESR is well documented online.

Examples of use

Walmart Brazil and CEMEX (Wbcsd 2011)

MIMES (Multi-scale Integrated Models of Ecosystem Services)

Links and Sources

http://www.natureserve.org/conservation-tools/ecosystem-based-management-tools-network/mimes.html

Boumans (2011)

Background

Mimes was developed by UVM and is managed by AFORDable futures LLC. It is currently under revision. It takes a systems approach and includes stakeholder involvement. MIMES has been used internationally. It has three objectives (Boumans and Costanza 2007):

1. A suite of dynamic ecological economic computer models specifically aimed at integrating our understanding of ecosystem functioning, ecosystem services, and human well-being across a range of spatial scales.
2. Development and application of new valuation techniques adapted to the public goods nature of most ecosystem services and integrated with the modeling work.
3. Delivery of the integrated models and their results to a broad range of potential users.

About the model

MIMES is an iterative set of models that can be used at multiple scales. It is spatially explicit and can provide monetary valuation of ES. It is designed for both land and marine applications. According to Bagstad et al (2013), MIMES is open source, but requires commercial modeling software SIMILIE and contracting with a modelling group to develop a model. As of 2013, it was considered by Bagstad as time consuming to run. MIMES examines the dynamics of ES, how ES are linked to human welfare, how the value of ES might change under different situations.

Data requirements

MIMES requires relevant spatial data. Other data needs are dictated by ES system, locale and scale.

Limitations

Some models are still in development. Resources are limited. Use of MIMES would probably require hiring an experienced systems modeler. While MIMES is highly scalable, local models would need to be adapted or developed.

Trainings and support

There are some web resources for MIMES, including a webinar. However, much of the information has a theoretical focus. Specific supporting resources are limited.

Examples of use

Massachusetts Ocean; Albemarle-Pamlico Sound (Boumans et al. 2015)

MIDAS (Marine Integrated Decision Analysis System)

Links and Sources

http://people.bu.edu/suchi/midas/index.html

http://www.seaplan.org/blog/project/midas/

Background

MIDAS was developed to assist in the management of Marine Managed Areas (MMAs). MIDAS is a graphic user interface between MIMES and needs of ocean mangers and stakeholders. It is opensourced, web-based and spatial. There is an emphasis on coastal areas and the ocean and stakeholder interaction. MIDAS has three objects:

1. Determine the socioeconomic, governance and ecological effects of MMAs
2. Determine the critical ecological, socioeconomic and governance factors, and time that affect MMA efforts
3. Provide management tools for predicting the influence of MMA on ecological, socioeconomic and governance variables along with the outputs that illustrate the results of different management decisions or actions.

About the model

Stakeholder discussions provided the information that is imput into the model in the fifteen Critical Determining Factors, five for each of the following categories: governance, socioeconomic, and ecological. These ratings are input via drop down menus.

Governance CDFs

- Stakeholder involvement
- Stakeholder compliance with rules and regulations

- Management operations
- Support from government agencies
- Empowerment

Socio-Economic

- Perceived threat due to developments
- Perception of local extractive resources
- Non extractive alternative livelihoods
- Socio-Economic benefits from establishment of MMAs
- Perception of seafood availability

Ecological

- Level of fishing effort
- Relative change in habitat extent
- Habitat quality-of-life
- Herbivory
- Focal species abundance

These inputs are visualized into four outcomes or indexes: governance, livelihood, ecological health and resilience, and MMA effectiveness.

Data requirements

Information is gathered at public meetings and input into the model.

Limitations

MIDAS is limited to marine systems. It is designed to be used along with MIMES.

Trainings and support

There is limited, dated information available about MIDAS online.

Examples of use :

Belize, Panama (Patel et al. 2011)

Envision

Links and Sources

http://envision.bioe.orst.edu/

Background

Envision is a spatially explicit alternative futures modeling tool developed by Oregon State University. It was also known as Evoland.

About the model

It was developed and tested for the Pacific North West, but users may provide necessary data. It has also been used in Colombia and New Zealand It is designed for the landscape scale, and has an emphasis on agent based modeling. It is open-source and available at no cost. Though it is is primarily a scenario modeling tool, it can provide some monetary valuation. It also allows for non monetary ranking of preferences. It depends different “plug-ins” to carry out the models, and users can create custom “plug-ins”. Envision requires Windows. Envision must be customized for each location, which means that it is both costly and time consuming. Bagstad et al report that new applications cost $100,00-$150,000 and take about one year (Bagstad et al. 2012).

Data requirements

New locations must supply all necessary data. This includes land use, land cover, ecological and economic data.

Limitations

Envision is time consuming and costly to apply in new areas. Data availability is also a challenge.

Trainings and support

Envision comes with a number of tutorials. There are some additional support resources available online, along with a developers guide.

Examples of use

Tillamook Coastal Futures (http://envision.bioe.orst.edu/StudyAreas/Tillamook/)

Willamette Water (http://envision.bioe.orst.edu/StudyAreas/WW2100/)

SolVES

Links and Sources

http://solves.cr.usgs.gov/

Background

SolVES was developed by USGS and the Geosciences and Environmental Change Science center to assess social values of ecosystem services. It has been used is coastal areas as well as forests.

About the model

SolVES is a toolbox for ArcGIS. As a result it requires ArcGIS and intermediate GIS knowledge. It is spatially explicit. The goal of SolVES is to quantify perceived social values, what stakeholders think “ought to be”. As a result, it has an emphasis on cultural services, including aesthetics and recreation. It does not provide monetary values, but does rank according to preferences. A 10 point social values metric, the Value Index, is calculated through a combination of spatial and non spatial responses to public value surveys. It also takes into account measurable environmental traits and metrics. SolVES currently measures aesthetic appreciation, recreation, spiritual experience and identity, tourism. It is designed to work on the landscape or watershed scale, and is relatively fast to use once data is collected. The outputs include maps of social values of ecosystem service. Months to years may be necessary to collect the required survey data.

Data requirements

SolVES requires environmental data in raster form. Community responses to survey data must be collected and associated with raster environmental data.

Limitations

SolVES requires specifically formatted data. The survey data can be time consuming to collect and code.

Trainings and support

SolVES is well documented online.

Examples of use

National Forests in CO and WY (Bagstad et al 2015; Sherrouse et al 2011)

Hinchinbrook Island National Park in Australia (Van Riper et al 2012)

ESValue

Links and Sources

www.entrix.com

Background

ESValue is a proprietary model developed by Cardno Entrix. It has been previously used by FBP.

About the model

ESValue is spreadsheet based and depends on rankings in a survey. It establishes stakeholder preferences and relative values for ecosystems rather than monetary values. It is designed to for at the landscape to site level. Stakeholder involvement is an important part of ESValue. It is well suited for comparisons. It is designed for the landscape to site-level scale. It is The BSR report estimates that ESValue would take require about 200 hours to apply and analyze.

Data requirements

Data is collected through surveys at public meetings.

Limitations

ESValue is not spatially explicit. Spreadsheets may not be intuitive.

Trainings and support

ESValue is a proprietary model. There is not much online support. Personal training or support may be available for a price.

Examples of use

FBP used ESValue during the fall of 2014. Surveys were distributed before a series of two public events, and 52 people participated.

EMDS (ecosystem management decision support)

Links and Sources

http://1726-4482.el-alt.com/

Background

EMDS is a spatial decision support system made up of several tools. It is designed to be used at a number of geographic scales. It was developed by the forest service under a contract with Mountain View Business Group and is still in development. EMDS has been used internationally.

About the model

EMDS is a proprietary tool and an add-on to ArcMap. It is designed to be used for planning, but not necessarily valuation. EMDS has been applied to study carbon sequestration, conservation, the design and siting of ecological reserves, ecosystem sustainability, forest management, hydrology, land classification, landscape evaluation, landscape restoration, pollution, social issues in natural resource management, soil impacts, urban growth and development, watershed analysis, wetlands management, wildlife habitat management, wildland fire danger. It uses Netweaver Logic Engine and Priority Analyst to model decision making and planning implications. Netweaver is useful in situations when data might be incomplete. It also allows for evaluation of missing data.

Data requirements

Data requirements depend on the resources evaluated. Spatial data, formatted for Arc GIS is required.

Limitations

Like all tools, EMDS depends on the quality of the data. The tool is still in development and new features will be available in the future.

Trainings and support

There is good documentation and strong online support with a forum to share issues.

Examples of use

Watershed analaysis in Northern CA (Walker et al 2007)

EnviroAtlas

Links and Sources

https://www.epa.gov/enviroatlas

Pickard et al 2015

https://toolkit.climate.gov/tool/enviroatlas

Background

EnviroAtlas is the developed by EPA and partners. It is still under development. It is an interactive tool designed for a variety of users to explore the benefits people receive from ecosystems. It includes both web-based components and tools to use within GIS. Downloaded data can, in turn, be used in other tools. It is not an accounting tool, but it is meant to aid in the evaluation of ecosystem services, including the social value. Little technical knowledge or scientific background is necessary.

About the model

There are seven benefit categories:

- Clean air
- Clean, plentiful water
- natural hazard mitigation
- climate stabilization
- recreation, culture, and aesthetics
- food, fuel materials
- biodiversity conservation

These are further divided into supply, demand and drivers of change.

Data is available at both the watershed level and the census block level. It relies on land cover data, along with census and other publicly available environmental and economic data. There are a number of statistical and analytical tools to analyze the data. Maps, charts and graphs are the outputs.

Data requirements

Data is available through the web-based tool. Data is very limited for Alaska and Hawaii.

Limitations

Some data may be at too course a resolution. Data is suitable to examine the current condition.

Trainings and support

EnviroAtlas is well supported online with User's Guide, videos, tutorials.

Examples of use

Cost effective manure storage in Chesapeake Bay Watershed 2015

(https://www.epa.gov/enviroatlas/enviroatlas-use-cases)

Other related tools and useful references

There are a number of other tools that, while not ecosystem valuation tools, are decision support tools. These tools help guide conservation organizations through planning and strategic sessions. For reference, the following sites include a list of these type of tools: https://greatlakesinform.org/decision-tools-search/search?keywords=&sort_bef_combine=title+ASC and https://www.data.gov/ocean/ocean-tools.

Similarly, SERVES (Simple and Effective Resource for Valuing Ecosystem Services, http://esvaluation.org/) does not appear to be current and is not a publicly available tool, but the website includes methodological summaries and case studies in the researcher library.

Evaluation and Next Steps

Ecosystem services valuation tools is a broad and disparate category. In choosing a tool, there are several factors to consider.

Goals and Scope of Analysis

First, one must carefully consider the goals of the evaluation, along with what service to value, and the spatial and temporal scales. Some tools are better suited to different services and different scales.

Type of tool

The organization must determine what type of tool is most appropriate. For example, is it important for the analysis to be spatially explicit? Will tables calculated through spreadsheets provide the necessary information or would a more flexible, more qualitative framework be more informative? Similarly, the organization must determine whether a monetary valuation is required or if the services can be ranked or valued in another unit.

Uncertainty

Uncertainty is an inherent concern in modeling. Different tools handle uncertainty differently. Organizations will need too determine which methods fits their needs best along with the acceptable level of uncertainty.

Resources

Organizations must also consider their own resources, including time, money and knowledge/expertise, to decide who will conduct the analysis. Some tools are proprietary and require a license or specialized software. Others require a consultant to carry out the analysis. Data availability is also a key concern. Some data is publicly available; some must be collected in the field. Some tools may depend on access to comparable studies.

Role of Stakeholders

Generally, stakeholder input is an important part of ESV analysis. However, some tools rely on stakeholder knowledge more than others.

Caveats

The review of these tools presented several challenges. The greatest challenge was that ESV tools are not always comparable. Some tools consist of sophisticated computer software while others are a framework to be used during collaborative meetings. Further narrowing the scope of the project might allow for more direct comparisons.

Next Steps

In order to select feasible tool FBP will determine the scope and needs of the specific valuation project. These scoping discussions can generate specific questions to direct further tool investigation and finally select a tool.

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