JNCC Report

No: 584

Tool Assessor

Supporting practical assessment of natural capital in land-use decision making

Howard, B., Neumann, J. & O'Riodan, R.

May 2016

ISSN 0963 8901

For further information please contact:
Joint Nature Conservation Committee
Monkstone House
City Road
Peterborough
PE1 1JY
http://jncc.defra.co.uk

This report should be cited as:

Howard, B., Neumann, J. & O'Riordan, R. 2016. Tool Assessor: Supporting practical assessment of natural capital in land-use decision making. *JNCC Report 584*. JNCC, Peterborough.

Acknowledgements

The Ecosystems Knowledge Network acknowledges the participation of members and others who provided their experience of use of tools, as well as their views on what should be included in a tool assessor. We are also grateful to Neil Parker (Environment Systems Ltd.), Pat Laughlin (UK Business Council for Sustainable Development), Keith Sacre (Barcham Trees) and Prof. Jim Rouquette (University of Northampton) for presentations on individual tools during the dialogue with users. We thank the other tool developers and representatives who provided information on tools they are responsible for. We are grateful to Dr. Ingo Schüder (Brillanto) for hosting the online focus groups. Finally we acknowledge funding from JNCC for this work and guidance from JNCC staff members Dr. Helen Baker and Matt Smith.

This report is compliant with the JNCC Evidence Quality Assurance Policy http://jncc.defra.gov.uk/default.aspx?page=6675 . A complete draft of the report was reviewed by the JNCC project team, and additional views sought from a small group of JNCC staff at a special presentation event.

Summary

Natural capital, green infrastructure and ecosystem services are terms used to help ensure that the environment is planned and managed as an asset of value to all of society. A wide range of analytical tools to process information about the role of the environment in society are now emerging. Outputs include maps, statistics and monetary valuations.

JNCC commissioned the Ecosystems Knowledge Network to develop an information resource on these tools focused on the needs of potential users. The aim of this 'Tool Assessor' is to aid the practical application of the natural capital, green infrastructure and ecosystem service concepts in day-to-day land-use decision-making in the UK.

Following a scoping exercise that examined analytical tools alongside other forms of decision support, 12 tools were reviewed. Some of these have origins outside the UK, while others are being developed in the UK and specifically for the UK. The review involved collecting information about their requirements, capability and where they have been used.

The tools are diverse, ranging from those designed to examine the functions of trees in urban areas to those that have been developed for use in landscapes where natural features are more dominant. Some were spreadsheet-based while others used Geographical Information Systems (computer-based mapping software).

Online events with various potential tool users enabled the Ecosystems Knowledge Network to assess their usage of tools and their requirements for Tool Assessor. This showed that while there is strong interest in tools, there are concerns that the costs of investigating and using tools may outweigh the benefits and also concerns about the reliability of results and the transparency of the underlying assumptions.

There is a strong desire for tools that can be accessed without payment. At the same time, it is clear that despite the existence of portals that make many datasets freely accessible, obtaining and using data required by the tools is a technical area. The data requirements of use of tools (including assessment of the reliability of tool outputs) often necessitate specialist expertise and substantial time resource.

The next step following completion of this project is to make Tool Assessor available online with a search function. It is recommended that this is accompanied by the formation of a user community to ensure that experience and know-how associated with tools for use in the UK is shared.

Contents

Introduction

1.1 Context

The UK National Ecosystem Assessment (UK NEA, 2011 and 2014) is a milestone in our understanding of nature's value to society. It advocates the ecosystem service framework for linking the natural environment with benefits enjoyed by people such as healthy lifestyles and reduced flood risk. Alongside ecosystem services, the concepts of green infrastructure and natural capital were also used in the UK NEA. Green infrastructure and natural capital both refer to the configurations of natural features from which ecosystem services (and value to society) arise.[1] These networks extend across urban, rural and marine areas.

The process of characterising, measuring, valuing and monitoring what nature does for people is complex. It requires the integration of diverse social and environmental data. For this reason, there is growing interest in analytical 'tools' that help us understand the positive connection between the environment and people's wellbeing. The purpose of these tools is to ensure that planning and management of the environment takes into account the diverse ways in which it supports wellbeing. They can provide a structured means of handling data for a defined area, and producing outputs such as maps, statistics and economic valuations.

1.2 The need for a tool assessor

Over the last ten years, a range of analytical tools have been developed to process information about ecosystem services, natural capital and green infrastructure around the world. One of the best-known examples is the InVEST toolkit developed by the US-based Natural Capital Project.[2] Following publication of the UK NEA reports, organisations in the public, private, academic and third sectors in the UK have been involved in developing tools for use in their own territory.

Information about these tools is, however, not readily accessible to potential users. Individual tool developers provide information in many different formats. Many of them (sometimes single individuals) don't have the mandate or resources to provide users with ongoing guidance and support. Finding out about the tools can be time-consuming. Concerns have been expressed that the costs of doing so may outweigh the benefits (BSR, 2013). There are very few studies which compare and contrast the outputs of different tools applied in the same geographic location.[3]

1.3 Development of the tool assessor

In response to the need for a reference point for information about analytical tools to process information about natural capital, green infrastructure and ecosystem services, JNCC[4] commissioned the Ecosystems Knowledge Network to develop an information resource on tools. This resource is to be known as 'Tool Assessor'.

The aim of Tool Assessor is to aid the practical application of the natural capital, green infrastructure and ecosystem service concepts in day-to-day land-use decision-making in the UK. It will form one part of the broader challenge of producing guidance, methods and case studies to facilitate management of the environment as an asset.

---

[1] Natural capital is broader, referring to parts of the sub-surface and the atmosphere, as well as features on the land surface and in marine waters.
[2] InVEST stands for 'Integrated Valuation of Ecosystem Services and Trade Offs'.
[3] See Vorstius and Spray (2015) for an example of a UK comparative study.
[4] JNCC (Joint Nature Conservation Committee) is the public body that advises UK Government and devolved administrations on nature conservation.

This report explains the process for developing the Tool Assessor resource, including identification and review of an initial set of 12 tools. The report is not intended as a definitive listing of the tools that fell within the scope of the project. The development, adaptation and application of tools to process information about natural capital, green infrastructure and ecosystem services is ongoing. It is hoped that as a result of Tool Assessor, more tool developers will identify the products they are working on and share their capabilities.[5]

After a description of the method for the initial development of Tool Assessor and the scope (**Section 2**), an overview of the 12 tools reviewed in the project is available (**Section 3**). This is followed by a summary of the start of dialogue with prospective users of tools (**Section 4**) and consideration of the accessibility of data that the tools either need or benefit from (**Section 5**).

1.4 Future development

The Ecosystems Knowledge Network has agreed that following completion of the Tool Assessor project, it will provide the information about tools reviewed in this report in an online searchable format. The expectation is that this will be a starting point for people needing to identify tools for practical application; informing design, planning and management decisions relating to land, freshwater and coasts. The Network will use additional resources to place the information online and to ensure ongoing development. Opportunities for future development are outlined in **Annex A**.

[5] The Ecosystems Knowledge Network would like to hear from developers of analytical tools. See contact information in the front matter of this report.

2 Project process

2.1 Overview

In accordance with the project's aim of producing a practical Tool Assessor, the project process was:

Stage	Reference
a) **Scoping** of the Tool Assessor, ensuring that it has a clear and practical focus.	Section 2.2
b) Identifying an i**nitial set of 12 tools** for review, and the principal categories of information about each tool that would be required.	Section 2.2
c) **Review** of the initial set of tools. This included cross-checks with developers where appropriate. All information was stored in a spreadsheet.	Section 3 Annex B
d) Dialogue with Ecosystems Knowledge Network members and others over their **requirements for tools and the Tool Assessor**, as well as existing use of tools.	Section 4
e) Creation of **information sheets** portraying summary information about the tools.	Annex C
f) Evaluation of the accessibility of data for use in tools.	Section 5

2.2 Scoping

Focus for Tool Assessor

Tool Assessor is about analytical tools that help to inform land use planning and land management decisions. This means they have internal capacity to process information and data, rather than signposting to other resources. These analytical tools must be seen in the context of the support available to understand the environment as an asset. Types of support on offer are:

Type of support	Examples
Guidance and frameworks	Toolkit for Ecosystem Service Site-based Assessment (TESSA) National Ecosystem Approach Toolkit *Spatial Framework for assessing evidence needs for operational ecosystem approaches* (Medcalf *et al*. 2012) *Guide to Corporate Ecosystem Valuation* (World Business Council on Sustainable Development, 2011) *Talking about our Place* (Porter *et al*., 2011)
Standards	Woodland Carbon Code (developed by Forestry Commission Scotland) Peatland Code (developed by IUCN UK)
Pilots and method statements	Local Economic Development and the Environment Toolkit (Natural England) Ecosystem Accounting for Protected Areas (White *et al*. 2015)

Type of support	Examples
Data portals	Scottish Environment Web
Evidence and reference values	Ecosystem Services Transfer Toolkit (Natural England)[6] Ecosystem Valuation Toolkit (global)

With its focus on analytical tools, the Tool Assessor project is intended to complement more general guidance available such as that found in the National Ecosystem Assessment Toolkit.

Of all the types of support listed above, TESSA provides some of the most detailed guidance on how to undertake an ecosystem service assessment at the local level. This 'toolkit' has been formulated to help inform decisions affecting sites that are important for biodiversity conservation, explaining how changes to the management and use of the land might affect ecosystem service provision. It contains recommendations on the use of existing data as well as how to collect new field data at relatively low cost and effort. While useful, it does not, in and of itself, provide analytical capability.

The decisions that might be informed by analytical tools are diverse. They are continuously evolving in line with public policy, innovation and professional practice. For this reason, 'decision-makers' should not be characterised as a single category, but rather an array of people that is as complex as society itself. Similarly, 'decision-making' should be considered as an ongoing process. The fact that activity relating to natural capital and ecosystem services remains largely exploratory means that the opportunities for improved decisions are only just emerging.

Businesses are taking a strong interest in analytical tools and have many potential applications for them. The global business sustainability group BSR has identified 16 categories of application for ecosystem service tools (BSR, 2013). These range from planning new projects to supply chain management.

In light of this, it is not possible to characterise every possible application of analytical tools. In order to establish a set of criteria for determining the scope of Tool Assessor, eight categories of emerging applications for tools were identified (see **Annex D**).

Tool selection criteria

The criteria for selecting tools for inclusion in Tool Assessor were:

Criterion	Reason for consideration
a. Does the tool integrate data that is otherwise likely to be analysed separately?	*The added value of the ecosystem service framework is to integrate factors that govern how land and water are managed for society.*
b. Is the tool available for deployment in a 'real world' setting, or likely to move beyond a research and development stage during the course of 2016?	*Several tools are in development. The focus of tool assessor was on practical uptake of tools.*
c. Does the tool aid understanding of the connection between the environment and society?	*The concepts of natural capital, green infrastructure and ecosystem services focus on value and benefits derived from the environment.*

[6] A literature review, available in spreadsheet and factsheet form, of the effect of land management actions on the provision of ecosystem services.

Criterion	Reason for consideration
d. Does the tool have capability of analysis of multiple ecosystem services / dimensions of natural capital and green infrastructure?	*Many tools that are focused on single services such as flood regulation and insect pollination don't have the capacity to integrate other data.*
e. Is the tool available for deployment in non-academic contexts in the UK?	*Tool Assessor has a practical focus. The focus for the initial set of tools is ones that will be ready for deployment in 2016.*
f. Is the tool replicable in the UK context and for decisions affecting land and coastal areas in the UK?	*Tool Assessor is being designed for UK usage. This narrows the number of environmental settings and decision-making contexts that are relevant.*
g. Is the tool useful in planning and management decisions?	

The following types of analytical tool were not included, despite their importance for conservation of biodiversity, environmental management and involving people:

- Tools that have been produced to evaluate habitat connectivity or resilience, without directly relating these to a spectrum of benefits enjoyed by society.
- Tools that have been developed for specific places, but the process of considering how they may be translated elsewhere is at an early stage. An example is the Land Use Information System for Aberdeenshire.
- Tools for engaging local communities in understanding the value of nature.[7]

As part of the development of tool assessor, other reviews and online systems for identifying tools were examined. See **Annex F**. The global scope of many of the sources of information means that it is not easy to identify tools directly applicable to the UK, or with experience of use in the UK.

Cross-comparisons for the capability of different tools are scarce. Bagstad *et al*. (2013) review tools from a global perspective. In the UK, Natural England has commissioned one of the few assessments of a sub-set of analytical tools, namely valuation tools for green infrastructure (eftec and Cascade Consulting, 2013). In this study ten tools were evaluated via a wide range of criteria. This included the extent to which there were clear links to academic standards.

The BESS Ecosystem Service Mapping Gateway[8] provides a useful framework for projects to specifically map ecosystem services. It incorporates a broad range of products, including tools that are in development by research institutions.

[7] Examples are found at http://www.catchmentbasedapproach.org/best-practice.
[8] BESS stands for Biodiversity and Ecosystem Service Sustainability. A research programme of the Natural Environment Research Council.

2.3 Initial set of tools

A selection of 12 tools was identified for review based on knowledge available within the Ecosystems Knowledge Network. Additional tools were identified through the dialogue with users of tools that formed part of this project (Section 4).

The 12 tools were:

- ARIES (ARtificial Intelligence for Ecosystem Services)
- BeST (Benefits of SuDS Tool)
- Co$ting Nature
- EcoServ-GIS
- Green Infrastructure Valuation Toolkit
- InVEST (Integrated Valuation of Ecosystem Services and Tradeoffs)
- i-Tree Eco
- Landmark Ecoservices Platform
- LUCI (Land Utilisation and Capability Indicator)
- NCPT (Natural Capital Planning Tool)
- PGIS (Participatory GIS tool)
- SENCE (Spatial Evidence for Natural Capital Evaluation)

2.4 Review

Each tool was appraised against a set of criteria selected in order to enable people to make informed choices about which tools may be suited to their needs and merit further investigation.

Information was collected for each tool in the following categories:

- Key data sources
- Overview and description
- Input (e.g. GIS or maps data, spreadsheet data)
- Output (e.g. maps, statistics, valuation)
- Original purpose
- User groups
- Original geographic scope and scale
- Habitat type (UK NEA habitat types)
- Type of ecosystem service function provided (regulating, provisioning etc.)
- Terrestrial, freshwater or marine focus
- Specific ecosystem service modelled / valued
- About the model
- Datasets required
- Resource requirement (software and expertise)
- Time requirement / estimated working days required
- Tool accessibility / license costs
- Current version / updates / technical support available
- Developer / developer type / individual contacts
- Website (gateway to the tool)
- Developer terminology
- Publications
- Usage outside of the UK and within UK (examples)
- Tool limitations
- Third party reviews / cross comparisons

The review was not intended to provide:

- Definitive evaluations of each tool (it is recommended that users solicit information from the developers and follow available guidance).
- A verification of claims made by developers, or a professional opinion as to the extent to which tool methods link to available evidence and scientific consensus.
- An assessment of the experiences of tool users.

2.5 Dialogue with users

The purpose of the dialogue with users was to gather views and ideas that will inform how information about tools is presented. The dialogue comprised a webinar (25 February 2016); two online focus groups (7 and 9 March 2016); and informal one-on-one discussions with a variety of Ecosystems Knowledge Network members and other stakeholders. In order to ensure a practical focus, the dialogue included introductions to tools that are already available and being used in the UK. The events were advertised by the Ecosystems Knowledge Network as well as via the mailing lists of other organisations with an interest in tools. The dialogue gathered the views of over 130 individuals.

2.6 Evaluation of data accessibility

The project involved a provisional assessment of the availability of data and information required by tools. This was done by evaluating some of the principal data portals and cross comparing these with the data required by a subset of the tools that were reviewed in the project.

3 Information base

3.1 Overview

Table 3.1 overleaf provides an overview of the 12 tools reviewed as part of this project. It shows that each of the tools is unique in the combination of ecosystem services it is capable of analysing.

Figure 3.1 below shows the broad categories of approach required to run the tools, illustrating the different types of data they require. Clearly GIS and Excel are the most popular computer software platforms for tools. Web-based applications that link to GIS systems are, however, likely to become more common in the future and several tool developers are actively considering how their products might be made available on-line.

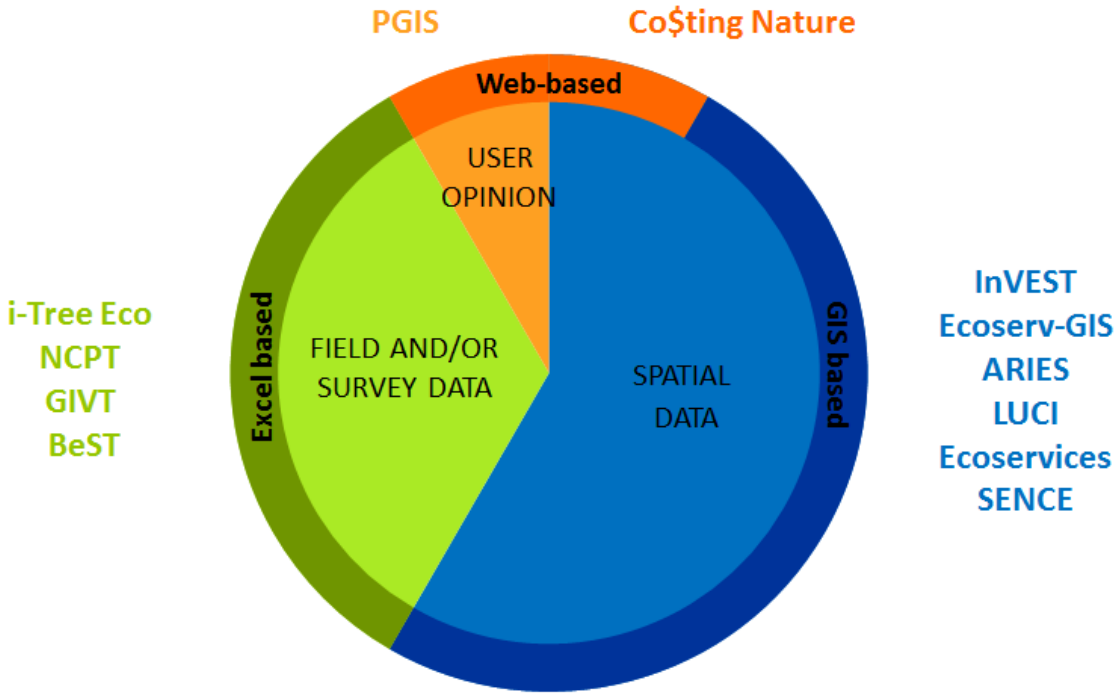


Figure 3.1: Primary type of input data and broad approach required to run the tools. Some tools may require a combination of approaches e.g. Excel-based tools may utilise information obtained from spatial data sources, but it is not essential.

Figure 3.2 provides an indicative illustration of the variation in skill level required to apply the 12 tools included in this review. Statements provided by developers about the GIS skills required to run a tool need to be checked carefully; this is a matter of professional judgement. Nonetheless, the time required to acquire the necessary competence should not be underestimated. In house tools offer the advantage of technical know-how being the responsibility of the provider rather than the user.

Table 3.1: Overview of the initial 12 tools included in tool assessor.

Tool	No. of models within tool	Focus: Types of ecosystem service						Application/ case studies			Access	Type of tool		
		Terrestrial	Freshwater	Marine	Provisioning	Regulating	Cultural	Multi scale	UK	International	Open access	Excel	GIS	Web-based
InVEST	18	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
ARIES	11	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓	
Co$ting Nature	7	✓	✓		✓	✓	✓	✓	?	✓	✓		✓	✓
LUCI	9	✓	✓			✓		✓	✓	✓			✓	
EcoServ-GIS	10	✓	✓			✓	✓		✓		✓		✓	
i-Tree Eco	7	✓				✓	✓	✓	✓	✓	✓	✓		
NCPT	10	✓	✓		✓	✓	✓		✓			✓		
Green Infrastructure Valuation Tool	14	✓				✓	✓		✓		✓	✓		
W045 BeST	19	✓	✓		✓	✓	✓		✓		✓	✓		
Ecoservices	5	✓	✓			✓			✓				✓	
SENCE	?	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	
PGIS	5	✓	✓	✓			✓		✓		✓			✓
TOTAL	Ave 10	12	10	4	6	11	10	6	10	6	8	4	7	2

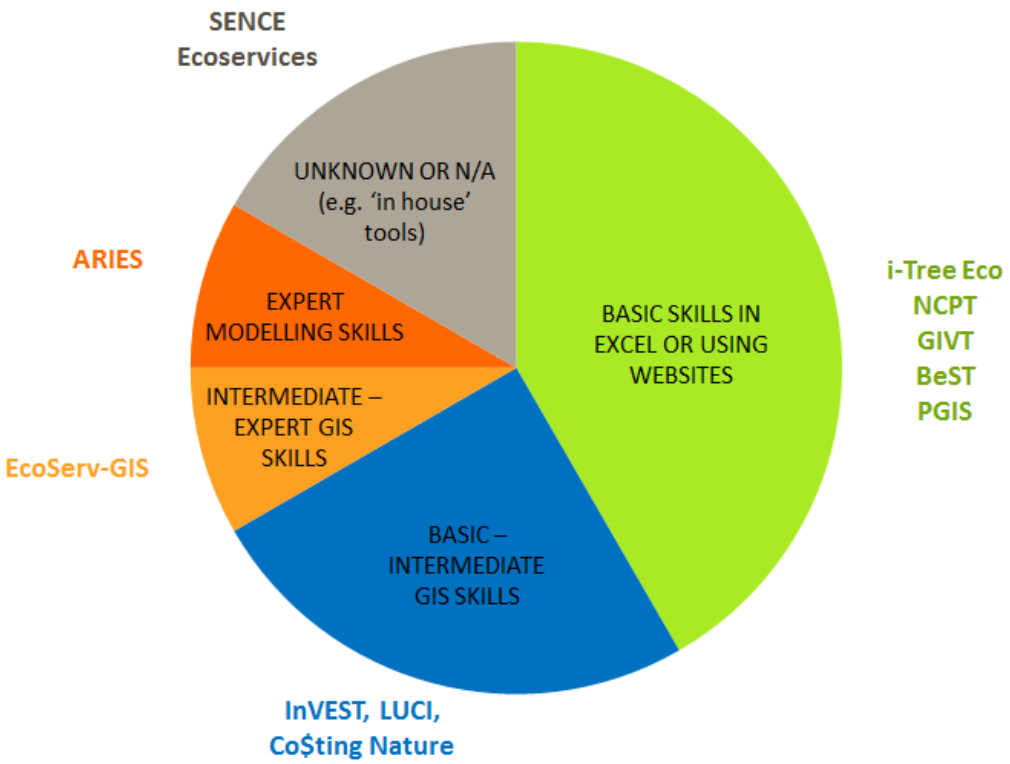


Figure 3.2 Overview of the skills / expertise currently needed to run the tools.

3.2 Spreadsheet

The spreadsheet containing information gathered about the 12 tools is contained in **Annex B**. It is clear from the review that despite the focus of the project around a set of specific criteria (**Section 2.2**), the range of analytical tools available for ecosystem services, green infrastructure and natural capital is very large. At the smallest scale are tools suitable for individual development sites (such as BeST). At the largest scale are tools that have conventionally been applied across land areas equivalent to regions of the UK (such as InVEST).

The task of gathering information about the 12 tools included telephone and email dialogue with developers and involved 16 days of researcher time. This illustrates the importance of having a central resource on tools.

It is clear that most of the tools are suited to analysis at the local to regional scale, with some being suited to site-based scale, national scale or working at multi-scales. While there are tools that appraise urban areas at the site-scale, there is an apparent absence of tools for usage by some of the most common types of land owner and manager, namely farmers.

3.3 Information sheets

A set of 12 information sheets on the tools was created using the information base. These are found in **Annex C**. They represent a way of portraying information about each tool in a way that provides an overview; enabling the reader to determine whether to investigate it further.

4 Dialogue with users

4.1 Introduction

As outlined in **Section 2**, the Tool Assessor project included dialogue with a range of potential users of tools. The purpose was to solicit their views on what tools they use and what they would like to see in a Tool Assessor resource.

4.2 'Tools for the Job' webinar

This event on 25 February 2016 attracted 80 participants from England, Scotland and Wales. As shown in **Figure 4.1** below, approximately half of all participants were representatives of consultancies and public delivery agencies.

Figure 4.1. Sectoral breakdown of participants in the webinar

Two examples from the set of tools reviewed as part of this project were presented during the webinar:

- **The Natural Capital Planning Tool**, developed and piloted by Consultants for Environmental Economics and Policy, the UK Business Council for Sustainable Development and Birmingham City Council (Holzinger *et al*., 2016).
- **SENCE** (Spatial Evidence for Natural Capital Evaluation), a product of Environment Systems Ltd.

Table 4.1 provides some of the key comments and questions that participants provided in relation to these tools. These points are also relevant to other tools and the provision of information in Tool Assessor.

Natural Capital Planning Tool	SENCE
• What are the 'impact values' and weightings and can they be modified? • Data sources: can internally collected data and Local Environmental Record Centre data be used? • Is there a way to gain recognition of the tool in a Local Plan (statutory planning document in England), or to use it to inform a Local Plan process?	• Does SENCE take into account demand for ecosystem services as well as the provision of ecosystem services? • Can SENCE accommodate standard errors for Priority Habitat Inventory data? • Could it be used at the scale of an individual site (e.g. a development site)?

Table 4.1. Comments specific to tools presented in the webinar.

In addition to inviting comments on the two tool examples, four consultation questions were provided to participants:

1. What tools have you used and how were they helpful?
2. What is the key criterion that would help you decide whether a tool would be useful?
3. What decisions do you make in your profession that could benefit from these tools?
4. What are your requirements for a Tool Assessor system?

Participants were invited to respond in the webinar (via a 'chat' function and verbally), as well as via an online survey they were directed to after the event. The following is a summary of the responses received.

Only nine participants had experience of using an analytical tool, of which three had used EcoServ-GIS and two had used i-tree. The limited experience of of tools reflects the fact that this is an emerging area of professional practice. Some tools identified by participants have been recognised widely as a form of ecosystem service analysis. An example is the Public Goods Tool developed by the Organic Research Centre with Defra funding support.

When asked about which criteria are important in a decision about whether to use a particular tool, 12 out of 44 respondents identified knowledge of data requirements as a prime consideration.[9] Among other important criteria were the aim of the tool, the skills required to use a tool, and the overall cost and time in comparison to the output (total 19 out of 44 respondents identified one of these as important).

Participants identified a broad mix of applications for tools, including:

- Highlighting the value of investment in additional green infrastructure:
  - Assessing ecosystem services provided by existing green infrastructure.
  - Providing design advice on green infrastructure.
  - Demonstrating how improvements in the status of biodiversity is beneficial for ecosystem service provision.
  - Identifying which habitats should be protected because they provide many ecosystem services.

[9] Participants were provided with a set of criteria to choose from and supplement, including: requirements for input data, aim of the tool, the skills required, the cost in relation to the output, types of ecosystem service assessed, the relation to the scientific evidence base, the type of output.

- Prioritisation of areas for improvement and land management decisions.
- Informing landscape-scale conservation.
- Identifying priority areas for changes in rural land management.
- Informing the design of payments for ecosystem service schemes.
- Use in procedures that meet statutory requirements, such as Environmental Impact Assessment (EIA).

Participants identified the importance of analytical tools that can be used in rural areas at the farm scale. This was in contrast with the fact that many tools are suitable for site-based use in urban areas or at much larger spatial scales (river catchments, landscape areas or counties). This may mean that any reference to local scale needs to be qualified as it is open to broad interpretation.

The value of a 'one stop shop' for tools (i.e. a Tool Assessor resource) was recognised by webinar participants. They also identified the following information about tools that should be made clear in Tool Assessor:

a. The spatial scale they work at (past experience and future potential).
b. Their limitations (both technical and in terms of their scope).
c. The extent to which data quality is checked and uncertainties are made explicit.
d. The evidence base underlying the model for the tool, as well as precise values for ecosystem service provision.
e. Where they have already been used (including links to case studies).
f. Whether the tool focuses on functions, services, benefits or values (known as the ecosystem service cascade).
g. Whether it is freely available or can be used only under licence.
h. Which ecosystem service classification it uses.[10]
i. The environmental setting in which it can be deployed (including use for the assessment of marine areas)

Participants identified other information and services that Tool Assessor could help with as:

- Guidance to allow users to build tools specific to their needs.
- Sources of training on individual tools.

4.3 Online focus groups for tool users in different environmental settings

In addition to the webinar, two smaller online events ('focus groups') were held with the aim of initiating dialogue about tools for specific environmental settings:

- Managing **river catchments and rural landscapes**, 7 March, 2016. This included a presentation on an application of EcoServ-GIS in the Nene Valley.
- Making the case for **natural features in urban areas**, 9 March, 2016. This included a presentation on a study of London's trees using i-Tree Eco.

A total of 57 people participated in the focus group events. As shown in **Figure 4.2**, they came from a wide range of organisations.

[10] Examples are CICES and the UK NEA (based on the Millennium Ecosystem Assessment)

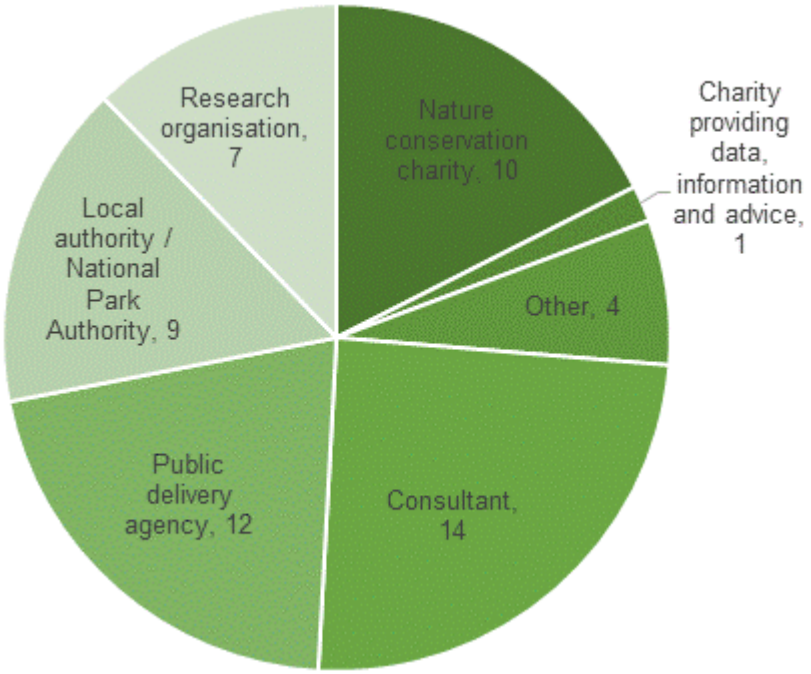


Figure 4.2. Sectoral breakdown of participants in the two online focus groups.

Table 4.3 contains some of the comments that participants made about the two tools presented that are also relevant to Tool Assessor.

EcoServ-GIS in the Nene Valley	**i-Tree Eco in London**
• What is the range of spatial scales that this tool can be deployed at? • What experience is there of the tool being used in decision-making? • How do we know that the tool outputs are verifiable?	• How might it help in a formal procedure such as Ecological Impact Assessment?[11] • How long did it take to generate the field data required by the tool?

Table 4.3. Comments on the tools presented in the focus groups, 7 and 9 March 2016.
Four consultation questions were presented to the focus group participants.

a. What tools have you used and how were they helpful?
b. What would encourage you to investigate an analytical tool?
c. What would discourage you from actually using an analytical tool?
d. What are your requirements for an online system / database that provides information on analytical tools?

Participants were able to respond in the events (via a 'chat' function, online polls and verbally). Where necessary, clarification of some of the comments was obtained from individual participants after the events.

As with the webinar (Section 4.2), a minority of participants of the focus groups had experience of using analytical tools for ecosystem services, green infrastructure or natural capital. Only two participants had experience of using an analytical tool, one of whom had used EcoServ-GIS and the other one was involved in developing an application for InVEST.

[11] Ecological Impact Assessment may be carried out as part of a formal Environmental Impact Assessment (EIA) or to support other forms of environmental assessment or appraisal.

Comments reflected the fact that these analytical tools are a rapidly changing area of professional practice with little overarching guidance available.

Participants were asked to tick their top three criteria (from a list provided) that would *encourage* them to use a tool. The results are shown in **Figure 4.3**. They suggest a general preference for tools that don't have complex IT requirements, are free to use, and are advanced beyond being a prototype. There was also strong interest in tools that generate economic values.

The findings should not be regarded as definitive or representative of all potential users. For instance, there may be misconceptions about the true costs of deploying a tool and acquiring the data for a particular locality.

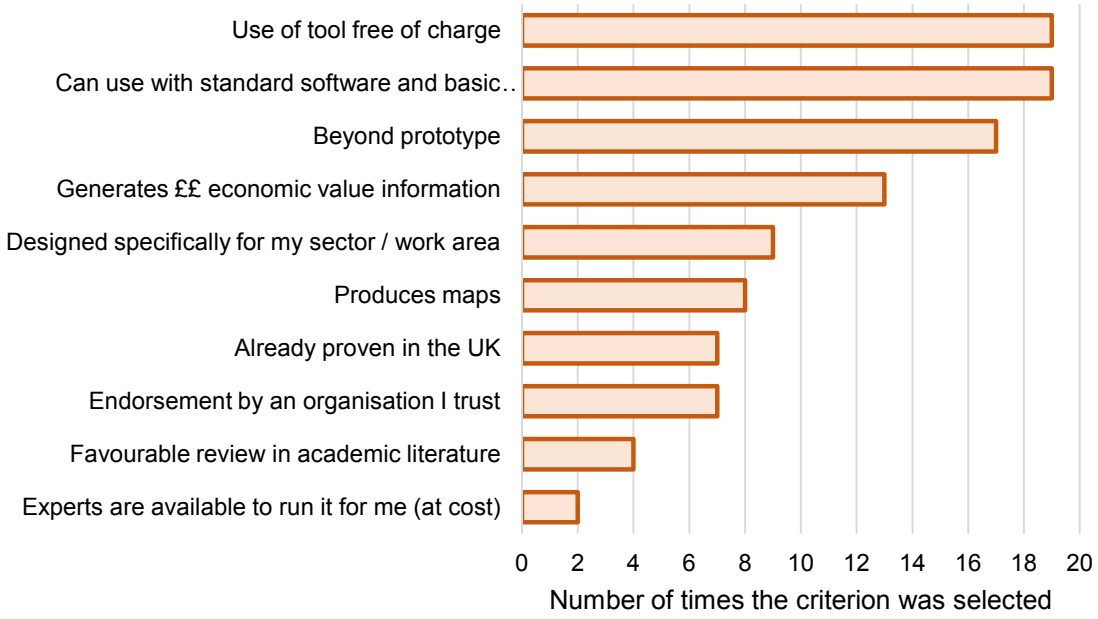


Figure 4.3. Key criteria that would encourage participants to investigate using a tool.

Participants were asked to tick their top three criteria (from a list provided) that would *discourage* them from using any one tool. The results are shown in **Figure 4.4**. It is clear that ready access to data to inform a tool is a key concern. There was also an apparent reluctance to select tools that are high in cost (in the view of the user) or are associated with long-term dependence on the developer.

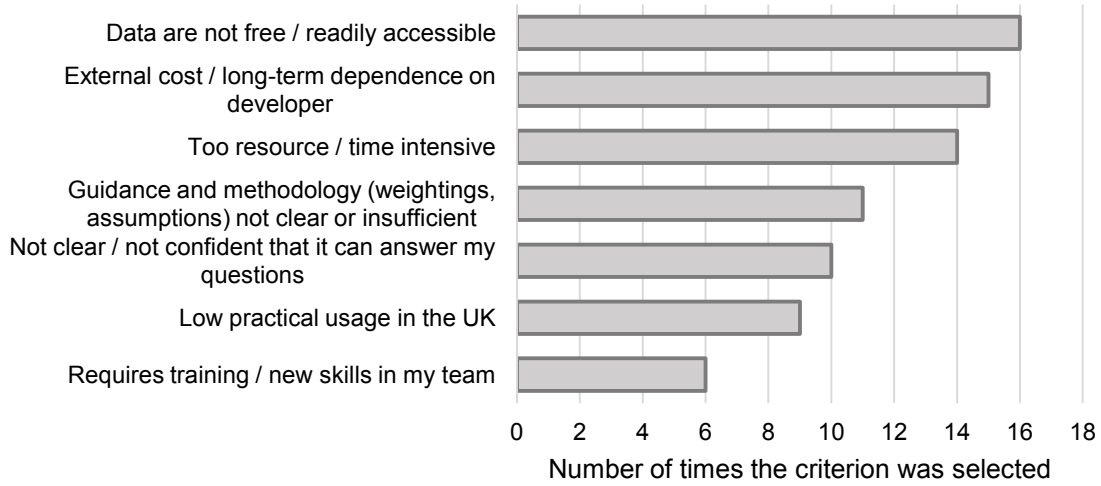


Figure 4.4. Key criteria that would discourage participants from using a tool.

Focus group participants were shown draft information sheets on the EcoServ-GIS and BeST tools. These were generally received as helpful in both layout and content. Some specific requests were made for Tool Assessor:

- A knowledge-base would be useful in answering questions, to enable people to learn from other's experience with similar questions;
- Hyperlinks to individual case studies should be made available.
- There should be a searchable database of information about the tools.
- There should be a focus on tools that can be applied in the UK.
- Inclusion of examples of the outputs of tools would be helpful.

5 Data accessibility

5.1 Context

The accessibility of data for use in the type of analytical tools included in Tool Assessor forms just one part of the broader challenge of improving access to information on how the environment provides benefits to people.

While the accessibility of environmental information in general has been a subject of concern for many years, there have been relatively few projects to assess access to information about ecosystem services, green infrastructure and natural capital.

One of the few approaches to evaluating the role of habitats in delivering ecosystem services is the *Spatial Framework for Assessing Evidence Needs for Operational Ecosystem Approaches* (Medcalf *et al*. 2012; JNCC Report 469). The framework presents information about ecosystem service provision in a matrix format. For each habitat within that a defined area (local, regional or national), rows in the matrix are used to denote the ecosystem services it provides. Columns in the matrix show the attributes of importance and the knowledge and quality of the data available and the assessment made of the tier allocation.

The Spatial Framework project illustrated the differences in quality, resolution and scale of data for regulating, supporting and provisioning services. It highlighted how data representing cultural services are often inaccessible. Nonetheless, in evaluating access to data it pointed out the importance of fitness-for-purpose; while high resolution data may not be required for strategic purposes, it is for local planning purposes.

Since production of the JNCC Spatial Framework, a Monitoring Action Plan has been developed as part of the Living with Environmental Change Ecosystem Task Force *Roadmap for Realising the Value of Nature* (Parr and Smith, in press). This includes detailed assessment of the data required by local authorities, public agencies, government and business to measure and monitor natural capital and ecosystem services across the UK's land area. Among the recommendations is that there should be better links between datasets and decision support tools. The present Tool Assessor project has set out to make an initial assessment for the 12 tools that were reviewed.

Natural England is currently exploring the potential for ecosystem service mapping methods that don't require local users to expend resources in acquiring and processing data. In 2014 this agency produced maps of ten ecosystem services at the scale of the whole of England (Natural England, 2014). These use habitat data derived from Land Cover map as a proxy for ecosystem service provision. (Land Cover Map is a product available through purchase of a licence.) Most notably, a case study was undertaken using this Natural England method of producing maps at the South Downs Nature Improvement Area.[12] This included a 10 km^2 area focused on the town of Lewes. Consultation with local users as part of the case study demonstrated that the maps were not reliable at this spatial scale without additional and more accurate data. This demonstrates the crucial importance of data access, even if a tool can, in theory, be used at a variety of scales. The broader South Downs case study illustrated the need for careful explanation of what maps of ecosystem services mean, taking into account the inevitable limitations of the data that are used to produce them.

5.2 Tools and their different data requirements

The tools included in the Tool Assessor require the user to provide data or information in a range of different formats. These include, for example, descriptive (qualitative) and quantitative data collected 'on site' or in the field; GIS or map information (i.e. spatial data); local survey data; and user opinion.

[12] The case study is described in Section 4 of Natural England (2014).

Based on the 12 tools reviewed, it is possible to group tools into three broad categories of data requirement:

1) **Excel-based tools** – these are tools that require the user to provide qualitative or quantitative information about their site or study area into Excel (note that other information may also be required e.g. local survey data). Examples include the Natural Capital Planning Tool (NCPT), the Green Infrastructure Valuation Toolkit, i-Tree Eco and Benefits of SuDS Tool (BeST).
2) **Web-based tools** – these are tools that are fully integrated as part of an interactive website or web-based interface (i.e., there is no standalone software required). An example would be the Participatory GIS tool for Morecambe Bay (PGIS). Co$ting Nature could also fit in this category.
3) **GIS-based tools** – these are tools that require spatial data information to run. In a number of cases, some or all of the spatial GIS or map data required are provided as part of the tool package (examples include Co$ting Nature, Ecoservices, ARIES, Spatial Evidence for Natural Capital Evaluation (SENCE)). In other cases, the user is required to source and provide the necessary data (examples include Land Utilisation Capability tool (LUCI), EcoServ-GIS and InVEST).

These are not definitive categories. Tools that are Excel-based may also be supported by additional information derived from spatial datasets. For instance, users of the Green Infrastructure Valuation toolkit can obtain population census data (Indices of Multiple Deprivation) or land-use information from sources such as InFuse or Magic (see **Annex E**). Likewise, users employing BeST may use Biodiversity Action Plan (BAP) Habitat or Landscape Character Assessment data to help populate their model parameters (see **Annex E**).

5.3 Data portals for UK spatial data

First and foremost, a user should choose the tool that they consider to be most appropriate for their needs. However, the data requirements (and subsequent access to these data) may be an important factor when deciding which tool to employ as this affects the cost to benefit ratio of using the tool. This is especially true for tools that require the input of spatial GIS or map data.

In the UK, there are a number of different data portals that provide spatial datasets and information (usually in a GIS compatible format such as shapefiles, Map Info TAB files, GML, raster Geotiff and ASCII).

Annex E lists some of the main data portals that are currently available and which may be useful or relevant to the tools listed in the Tool Assessor. The list is not comprehensive as this is a rapidly evolving topic area, driven by the desire of government to ensure more data are Open Access. In many cases there may be overlap where the different portals link to one another (or provide the same information). **Annex E** focuses on data portals for England, Scotland and Wales. The key data portals included in **Annex E** are:

- Environment Agency Geostore
- Magic
- OS Open Data
- CEH (Centre for Ecology and Hydrology) Environmental Information Platform
- Forestry Commission
- LandIS
- Scotland's Environment Web
- Scottish Environment Protection Agency (SEPA)
- Lle Geo-Portal for Wales
- European Environment Agency

- UK Data Service Census Reports (InFuse)
- Office for National Statistics
- Monitor of Engagement with the Natural Environment (MENE)
- National Atmospheric Emissions Inventory (NAEI)

There are also a wide range of sources of local environmental data, including data accessed through the National Biodiversity Network Gateway.

5.4 Links between spatial data requirements and accessibility via data portals

The specific focus for Tool Assessor is the relative ease with which spatial data required by tools can be accessed through national data portals. In some circumstances, new data may need to be generated for deployment of the tool. Some tools may rely on external expertise to source and process data into formats that are ready for incorporation into a tool.

In order to assess the links between spatial data requirements of tools and accessibility of these data via portals, five tools with experience of usage in the UK were chosen for more systematic assessment (**Table 5.1**).

It's important to mention that some of the data listed in the table may not require the user to access spatial data sources, for example, soil or habitat surveys conducted in the field may yield suitable information. Nonetheless, other users may require the use of spatial data in the absence of field surveys or site records, and thus the information has been included in the table. Additionally, the table does not provide a comprehensive list of all the data that are required to run each tool, it merely focuses attention on those that have a spatial component.

Datasets / Tool	EcoServ-GIS	NCPT	BeST	LUCI	Ecoservices
OS MasterMap™ Topography Layer (Partnerships can access under licence from OS)	A	-	-	-	-
OS Vector Map (OS Open Source)	B	-	-	-	-
Urban areas (OS Open Source, CEH Landcover Map, Corine)	B	-	B	-	-
Open Space Survey (Local Authorities, MENE)	B	-	B	-	-
Landscape Character Assessment (Geostore, Magic)	B	-	B	-	-
Habitat type (or BAP Habitats) (Geostore, Magic, Local Authorities)	B	-	A	-	-
Digital Elevation Model (OS Open Source)	B	-	-	A	C
Woodland Survey / Inventory (Forestry Commission, Magic)	B	-	-	-	C
Landuse / landcover data (CEH Landcover Map, Corine)	B	A	-	A	C

Datasets / Tool	EcoServ-GIS	NCPT	BeST	LUCI	Ecoservices
Socio-economic population data (InFuse, Office for National Statistics, MENE)	B	A	-	-	-
Soil type (LandIS, Magic, Local Authorities)	B	B	-	A	C
Public Access (Local Authorities, Geostore, Magic)	B	-	-	-	-
Air quality data (National Atmospheric Emissions Inventory)	-	-	B	-	-
Flood risk assessment (Geostore)	-	-	B	-	-
Water quality status (Geostore, Magic, Local Authorities)	-	-	B	-	-
Meridian 2 River Network (OS Open Source)	-	-	-	-	C

Table 5.1: Assessment of spatial data requirements and accessibility, including suggestions about where data may be sourced from (not definitive).

Data requirements:

A = required for the model but needs to be sourced separately;
B = beneficial but not essential;
C = provided with the tool / accessed by the tool

6 Discussion and next steps

6.1 Status of tool availability

The process of scoping Tool Assessor and reviewing an initial set of 12 tools demonstrates the diversity of tools available to analyse ecosystem services, green infrastructure and natural capital. It is a rapidly evolving area of innovation, with more tools expected to be made available in 2016 and 2017. Examples include:

- Tools being developed for landowners as part of NaturEtrade (EU LIFE+ Project).
- The Natural Capital Standard for Green Infrastructure (being developed by Scottish Wildlife Trust).
- Ecomaps (a national mapping product being developed by the Centre for Ecology and Hydrology).
- Online ecosystem service mapping portals for Scotland, expected to form part of implementation of the second Land Use Strategy for Scotland (Scottish Government, 2016).
- Development of urban functionality within the InVEST toolkit.

The variability in the needs and capabilities of potential users of the tools should not be underestimated. For this reason, it is important to demonstrate to users that the benefits of using any one tool should outweigh the costs. This will mean ensuring visibility of case studies, with clarity on what difference the availability of tool outputs made, and the reliability of the results.

Dialogue with users during this project suggested a strong preference for tools that can be used without payment for a licence or software. On the other hand, the costs of accessing and processing the many specialist datasets required by many tools can be considerable. Despite the existence of national portals that provide Open Access to environmental data, there is likely to be a role for external specialists in individual tools (developers, owners, frequent users) to run them on behalf of others.

As noted in the introduction, the Ecosystems Knowledge Network has agreed to use its own resources to put Tool Assessor online in April 2016. Suggestions for how this might be done are provided in **Annex A**.

6.2 Future needs

Additional tools for use at the national and local level will become available later in 2016. For this reason, an on-line version of Tool Assessor will need to be kept up to date regularly by the **Ecosystems Knowledge Network**.

Despite the diversity of tools available, it would be beneficial if the **research community** could compare and contrast the outputs of tools when applied to the same geographic area. While each tool is unique, more studies like those by eftec and Cascade Consulting (2013), Bagstad (2013) and Vorstius and Spray (2015) are likely to help users gain confidence that tools are robust. It would also help them to understand the capabilities and limitations of different tools.

Given that usage of analytical tools in the UK remains largely in the domain of pilot studies, it is recommended that a '**user community**' on analytical tools is formed alongside the Tool Assessor resource. This could help to identify tools that work in particular situations. It would also help to integrate the need for simplicity (ensuring tools deliver outputs that are low cost and easy to understand) and accuracy (ensuring that tools take into account the best possible evidence and benefit from expert professional input).

Given the complexity of the task of accessing the data required by tools, it would be beneficial if **developers of open-access tools** can make the data requirements of their products clearer to UK users. This means explaining any situations where a pilot project may have been made possible only because of unique local access to data, or expertise to process the data.

Public agencies with a role in improving access to environmental data would benefit from periodic reviews of practical experiences with accessing the data required by some of the most common open-access tools for use in the UK. A detailed understanding of the data requirements of analytical tools could also inform where investments in improved access to data will be of greatest benefit. This is particularly important in facilitating local applications of the ecosystem service, natural capital and green infrastructure concepts, where resources for accessing data are often most limited. It would be beneficial if local partners such as Environmental Record Centres were enabled to play a greater role in applying analytical tools of the type reviewed in this project.

7 References

Bagstad, K.J., Semmens, D.J., Waage, S. & Winthrop, R. (2013) A comparative assessment of decision-support tools for ecosystem services quantification and valuation. *Ecosystem Services*, **5** (2013) e27-e39.

BSR (2013) *Measuring and Managing Corporate Performance in an Era of Expanded Disclosure. A Review of the Emerging Domain of Ecosystem Services Tools*. Accessed 4th March 2016.

Defra (2013) Payments for Ecosystem Services: A Best Practice Guide. Prepared by URS. Accessible on via http://ecosystemsknowledge.net.

eftec and Cascade Consulting (2013) Green Infrastructure – Valuation Tools Assessment. Commissioned by Natural England. Accessed 4th March 2016.
eftec, RSPB and PwC (2015) *Developing Corporate Natural Capital Accounts*. Final Report for the Natural Capital Committee, London.

Land Marc Solutions (2014) *Landmarker V1. Natural Capital Decision Support Tool.* Accessed 4th March 2016.

Medcalf, K. A., Small, N., Finch, C., & Parker, J. 2012. Spatial framework for assessing evidence needs for operational ecosystem approaches – User Guide. JNCC Report No 469.

Nesta (2016) *Learning to Rethink Parks*. Nesta: London. Accessed 4th March 2016.

Smith, M.A.E & Parr, T.W. (in press). Monitoring Action Plan for Biodiversity, Natural Capital and Ecosystem Services. JNCC Report, No. 583, JNCC, Peterborough.

Porter, J., Brookes, J., Harman, D., Mahony, P. & Jagota, L. (2012) *Talking About Our Place*. Scottish Natural Heritage. Accessed 4th March 2016.

Rogers, K. & Evans, G. (2015) Valuing the Natural Capital of Area 1. A pilot study. Treeconomics and Evans Associates. Accessed 4th March 2016.

Scottish Government (2016) Land Use Strategy for Scotland, 2016 - 2021. Scottish Government: Edinburgh. Accessed 31st March 2016.

UK NEA (2011) UK National Ecosystem Assessment. Main Report. World Conservation Monitoring Centre: Cambridge.

UK NEA (2014) UK National Ecosystem Assessment. Synthesis of the Follow-on Reports. World Conservation Monitoring Centre: Cambridge.

Vorstius, A.C. & Spray, C.J. (2015) A comparison of ecosystem services mapping tools for their potential to support planning and decision-making on a local scale. *Ecosystem Services*, **15**: 75-83.

WBCSD (2011) Guide to Corporate Ecosystem Valuation. World Business Council on Sustainable Development: Geneva. Accessed 4th March 2016.

White, C., Dunscombe, R., Dvarskas, A., Eves, C., Finisdore, J., Kieboom, E., Maclean, I., Obst, C., Rowcroft, P.& Silcock, P. (2015) Developing ecosystem accounts for protected areas in England and Scotland. Department for Food, Environment & Rural Affairs/The Scottish Government.

Annex A – Opportunities for future development of Tool Assessor

Introduction

As mentioned in **Section 1**, the Ecosystems Knowledge Network plans to use its own resources to make a tool assessor system available online in April 2016. This Annex provides an overview of the system that is anticipated.

The online Tool Assessor will allow people to get information on different tools and see where other people have used them. It will include a searchable database of tools that allows people to enter search criteria and determine which tools would be most suitable for them to use. It will include:

- A webpage for each tool, providing information in a standardised format.
- A search facility.
- The opportunity for a user community with moderated comments specifically on the application of tools, including user experiences and developer comments.
- Listings of tools that do not fall within the scope of Tool Advisor but nonetheless are helpful.
- A chance to suggest tools for inclusion in the tool assessor / query information on tool assessor.
- An introduction to other sources of information about tools and toolkits.

A search facility

The search facility will be informed by the dialogue with users described in **Section 5**. Key considerations in designing the search function will be:

- The number of search criteria and the response categories must be proportionate to the number of tools featured in Tool Assessor (avoiding cases where no tool is identified to match an individual user's needs).
- The search will focus on information about tools that is clear-cut and not likely to open to variable interpretation.

Search criteria will be listed in drop-down menus or in tick boxes. An illustrative set of general search criteria that may be appropriate to the initial 12 tools is shown below:

Criterion	Potential response categories
Is the tool and associated guidance available to download and use without payment?	Yes / no / not known
Level of technical expertise anticipated	GIS / Excel skills / modelling skills / N/A (tool is deployed by an external provider) / online (basic computer skills only)
Spatial scale at which it is intended for use	Site-based / Local / regional / County / Catchment / National / multi scale
Output	Maps showing ecosystem services / graphs / data tables / economic valuation / cost-benefit assessment / ecosystem service impact score / development impact score
Settings in which the tool has been used	Urban / transport infrastructure / catchment management / forest management / urban drainage

Criterion	Potential response categories
Habitat types that the tools can be use in (from UK NEA)	Mountains, moors and heaths / Semi-natural grasslands / Enclosed farmland / Woodland / Freshwater, wetlands and floodplains / Urban / Marine / Coastal margins

A user community

The facility to leave moderated comments will allow the development of a user community where Network members will be able to learn from one another. The facility will be focused on practical experiences of using tools in specific places in the UK and in a decision-making context. Data will be captured as part of the user comment system which will enable other users to see who the tool was used by, the geographical location and habitat type, and how the tool was used to help them in their work. This will gradually build up to a large community of user experiences and comments on the tools.

It is not expected to offer subjective 'ratings', or solicit viewpoints that are not based on practical experience. Developers of tools will also be given opportunity to respond to comments made.

There will be a separate section for comments on analytical tools in general, including capabilities that users would like tools to have but that do not yet exist, and the option to suggest tools that could be included.

Annex B – Information Base

(Contained as a separate Microsoft Excel file. Information to be provided in the on-line version of Tool Assessor.)

Annex C

One page information sheets of tools reviewed in the project

Tool Assessor

Information Sheet

Ecosystems Knowledge Network

ARIES

Quick Facts

Inputs

Maps or GIS databases

Outputs

Environmental asset portfolio, maps, quantitative data about ecosystem services

Scale

Local, regional, national and multi-scale

Context

A range of land uses

Cost

Open access for non-commercial use

Software required

Standalone k.Lab software tool environment, k.Explorer will run on the web

Skills Required

Good understanding of environmental modelling, GIS skills beneficial, Bayesian modelling skills beneficial

Developer

National Science Foundation, University of Vermont, Earth Economics and Conservation International.

Description

ARIES (ARtificial Intelligence for Ecosystem Services) is a networked collaborative software designed for rapid ecosystem service assessment and valuation. It gives equal emphasis to supply, demand and flow to quantify actual service provision and use by society (as opposed to quantifying potential service benefits). It aims to provide a suite of models that support science-based decision-making.

Ecosystem services included

11 ecosystem services across provisioning, regulating and cultural categories.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, mountains, moors and heaths, marine, coastal margins and urban.

How does it work?

ARIES is based on technology which allows researchers to contribute models and scientific data that simulate and integrate environmental and socioeconomic systems. Collaborative information is hosted on a network and when provided with a user query, ARIES connects all the agents involved into a flow network and creates the best models for each agent and connection. It assesses benefits including carbon sequestration, river and coastal flood regulation, freshwater supply, sediment regulation, fisheries, recreation, aesthetic viewsheds, and open-space proximity values. ARIES prototypes are currently available for experienced modellers (training is recommended), however a web-based ARIES Explorer (k.Explorer) will allow non-technical users to use the tool in the next year (2016-17).

Case studies in the UK

ARIES has not yet been used in the UK.

Where can I get it?

http://aries.integratedmodelling.org/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

BeST

BeST (Benefits of SuDS Tool)

Quick Facts

Inputs

SuDS scheme data in an Excel spreadsheet

Outputs

Graphs, tables and guidance

Scale

Site-based / local scale

Context

A range of land uses, generally urban

Cost

Open access

Software required

Microsoft Excel

Skills Required

Microsoft Excel, basic level

Developer

CIRIA

Description

BeST (Benefits of SuDS Tool) helps practitioners estimate the impacts and benefits of Sustainable Urban Drainage Systems (SuDS). It uses ecosystem services to understand the overall benefits that SuDS provide over conventional piped drainage, and estimates the economic value of the benefits.

Ecosystem services included

19 ecosystem services across provisioning, regulating and cultural categories.

Habitats

Terrestrial and freshwater habitats

How does it work?

It is based on research evidence from ecosystem services and Triple Bottom Line (accounting) frameworks, which consider the social, financial and environmental bottom line.

The tool uses an 'impact-pathway' approach. This looks at the ecosystem services altered by a SuDS scheme and how these changes contribute to human welfare.

Where possible, it uses values and decisions input by the user to quantify and monetise the benefits of a SuDS scheme for a given area over a specified time period.

The tool can be used for new developments or existing sites.

Case studies in the UK

BeST was used by Yorkshire Water at Roundhay Park, Leeds to assess options for reducing combined sewer overflow and improve water quality. They compared benefits and costs of SuDS and conventional drainage approaches. It was also used in Glasgow in an EIA to assess costs, flood risk benefits and wider benefits provided by surface water management including SuDS.

Where can I get it?

http://www.susdrain.org/resources/best.html

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor

Information Sheet

Ecosystems Knowledge Network

Co$ting Nature

Quick Facts

Inputs

Global data (GIS, remote sensing) is provided by the tool. Users can also provide their own datasets

Outputs

Summary raster maps that represent aggregated ecosystem service indices

Scale

Local, regional, national, global and multi scale

Context

A range of land uses

Cost

Open access for non-commercial use

Software required

The web (Firefox works best)

Skills Required

Basic internet use skills

Developer

Kings College London, AmbioTEK and United Nations Environment Programme - World Conservation Monitoring Centre.

Description

Co$ting Nature is a web based policy-support tool for natural capital accounting and analysis of ecosystem services provided by natural environments. It identifies the beneficiaries of these ecosystem services and assesses the impacts of human interventions.

Ecosystem services included

Four ecosystem services across provisioning, regulating and cultural categories.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, mountains, moors and heaths, and urban.

How does it work?

It incorporates global datasets, spatial models for biophysical and socioeconomic processes and scenarios for climate and land use. It calculates the ecosystem service baseline and allows interventions to understand the impact on ecosystem service delivery. The focus is on costing nature (i.e. understanding the resource - land area and opportunity cost of protecting nature to produce ecosystem services) as opposed to valuing nature (i.e. how much someone is willing to pay for it). It calculates the distribution of ecosystem services for water, carbon, hazard mitigation and tourism and combines these with maps of conservation priority, threatened biodiversity and endemism to understand the spatial distribution of critical ecosystems. These data are combined with threats to determine conservation priorities.

Case studies in the UK

The tool has been used to examine biodiversity, ecosystem services, pressures and threats, and conservation priorities in the UK. It determined areas of greatest carbon value, greatest water value, and highest ecosystem service benefits.

Where can I get it?

http://www.policysupport.org/costingnature

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

EcoServ-GIS

Quick Facts

Inputs

Freely available GIS datasets & OS MasterMap Topography data

Outputs

Maps showing ecosystem services

Scale

County or regional scale

Context

A range of land uses

Cost

Open access

Software required

ArcGIS Desktop (10.2.2) with the Spatial Analyst Extension (Advanced Licence)

Skills Required

GIS user, intermediate - expert level

Developer

Jonathan Winn / Durham Wildlife Trust

Description

EcoServ-GIS is a Geographic Information System (GIS) toolkit for mapping ecosystem services at a county or regional scale. It uses input GIS/map data to generate fine-scale maps that illustrate human need or demand for ecosystem services as well as the capacity of the natural environment to provide them.

Ecosystem services included

Nine ecosystem services across regulating and cultural categories.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, and urban.

How does it work?

EcoServ-GIS adopts a 'service-based' approach, using information about natural processes and how they deliver services in the environment.

It overlays datasets incorporating aspects of the physical landscape (e.g. habitat) and socio-economic factors (e.g. health deprivation). This allows users to identify where ecosystem services occur, where there is high demand for a service, and where there is high capacity to provide it. Capacity and demand maps can be overlaid to visualise areas where they coincide ("benefiting areas") or where action is needed to improve service delivery ("management zones").

Case studies in the UK

EcoServ-GIS has been used in Cumbernauld, North Lanarkshire to map green networks and spaces that benefit the local population. It has also been used in pilot studies for Somerset, Sussex and Northamptonshire Wildlife Trusts

Where can I get it?

https://drive.google.com/folderview?id=0B_v9QO2jyC4eNlVUbzY1UUstZU0&usp=sharing

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

GI Valuation Toolkit

Quick Facts

Inputs

Data about the project area and local population statistics in Excel

Outputs

Reports including a cost-benefit assessment and economic value summary

Scale

Local scale

Context

A range of land uses

Cost

Open access

Software required

Microsoft Excel

Skills Required

Microsoft Excel, basic level

Developer

A consortium from Natural Economy Northwest, Tees Valley Unlimited, The Northern Way, Natural England, Design for London, CABE, Defra, and five regional development agencies. The toolkit was prepared by Genecon.

Description

The Green Infrastructure Valuation toolkit provides a set of calculator tools to assess the value of a green asset or a proposed green investment. Where possible, the benefits of green infrastructure (GI) are given an economic value. Other quantitative (e.g. number of jobs) and qualitative (e.g. links to case studies or research) contributions can also be provided to give a complete view of the value of an asset.

Ecosystem services included

14 ecosystem services across regulating and cultural categories.

Habitats

Urban, semi-natural grasslands, woodland, freshwater, wetlands and floodplains, and enclosed farmland.

How does it work?

The benefits provided by GI are assessed in terms of the function that it may perform, support or encourage. Benefits are grouped into 20 ecosystem services (14 of which are currently functioning). The information upon which the tool is based has been obtained from published studies and sources including Defra, Natural England, Forest Research and Ecotec. The tool provides insight into key evidence and concepts from a range of sectors including economic development and regeneration, public health and nature conservation. The economic valuation aspect of the tool means that it has the potential to translate findings into a business case.

Case studies in the UK

The tool has been used in Belvedere, Erith and Thamesmead, London to enhance the environmental and social quality of 156 ha of marshland. Total benefits generated by the improvements are estimated to be approx £55m, whilst the cost of regeneration is £10.54m making it a good rate of return on investment.

Where can I get it?

www.bit.ly/givaluationtoolkit

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

InVEST

InVEST
integrated valuation of ecosystem services and tradeoffs

Quick Facts

Inputs

GIS map data, data in tables (usually .csv format)

Outputs

Maps showing ecosystem services (tiff images)

Scale

Local to national scale & multi-scale

Context

A range of land uses

Cost

Open access

Software required

Models run on windows, no specific software needed to view tiff outputs. ArcGIS, QGIS or similar required for further analysis of outputs

Skills Required

GIS user, basic - intermediate level. Python scripting not needed (but may be useful)

Developer

Natural Capital Project

Description

InVEST is a suite of open-source software models for mapping and valuing ecosystem services provided by land and seascapes. It uses data about the environment to explore how changes in ecosystems are likely to affect the flow of benefits to people. It is designed to inform decisions about natural resource management.

Ecosystem services included

18 ecosystem services across provisioning, regulating and cultural categories.

Habitats

Mountains, moors and heaths; semi-natural grasslands; enclosed farmland; woodland; freshwater, wetlands and floodplains; urban, marine, Coastal margins.

How does it work?

InVEST consists of 18 software models for mapping and valuing ecosystem services. Models can be applied at multiple scales.

Most models use a 'production function' approach, which means that the output (a map of ecosystem services) is derived from information about the environment's condition and it's processes.

The final map result is expressed in either biophysical terms (i.e. a quantity) or economic terms (monetary value). InVEST is suitable for users who wish to look at multiple services or have multiple objectives for their area of interest.

Case studies in the UK

Urban-BESS in Milton Keynes modelled carbon storage, soil erosion and pollination to test model outputs against spatial resolution of input data. Wessex-BESS also used it for pollination modelling. In Scotland, the James Hutton Institute and Aberdeenshire Council used it for water and pollination modelling.

Where can I get it?

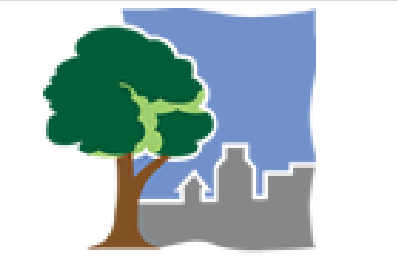
http://www.naturalcapitalproject.org/invest/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

i-Tree Eco



Quick Facts

Inputs

User-collected field data, air pollution data, weather data, GIS shapefile of study area (optional)

Outputs

Charts, tables and reports

Scale

Site-based, local, regional and multi-scale

Context

Urban forests

Cost

Open access

Software required

Windows XP Service Pack 2 (Windows 7), Microsoft Excel, ArcGIS Desktop with Spatial Analyst Extension (optional)

Developer

US Dept. Agriculture Forest Service, with Davey Tree Expert Company, the Arbor Day Foundation, Society of Municipal Arborists, the International Society of Arboriculture, and Casey Trees.

Description

i-Tree Eco is a software application designed for urban forest assessment. It uses field data from complete inventories or randomly located plots, along with hourly air pollution and meteorological data. It quantifies the structure and environmental effects of urban forests (or trees) and calculates their value to communities.

Ecosystem services included

Seven ecosystem services across regulating and cultural categories.

Habitats

Woodland and urban.

How does it work?

i-Tree Eco is one of a suite of i-Tree products which were developed in the US. i-Tree Eco allows users to collect data on the urban forest and estimate the ecosystem services that it provides. This includes information on urban forest structure, pollution removal, energy effects, rainfall interception, carbon sequestration and storage, and resource value.

Tree data is collected and entered into the software; these data are then merged with local air pollution and meteorological information. A series of algorithms calculate structural and functional information about the value of each tree (if 100% of trees are sampled i.e. a 'full inventory'), or an estimate for the total tree population (if a 'sample inventory' is conducted using plots randomly located throughout the study area).

Case studies in the UK

i-Tree Eco studies have been done for London, Glasgow, Wrexham, Bridgend, the Tawe Catchment and Torbay.

Where can I get it?

www.itreetools.org

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor

Information Sheet

Landmark Ecoservices Platform

Quick Facts

Inputs

Maps / GIS data

Outputs

Georeferenced raster maps as tiff images or data feeds

Scale

Local and regional scale

Context

A range of land uses, not urban

Cost

The tool is a consultancy service from Landmark

Software required

None - the tool is run by Landmark. It is run using ArcGIS.

Skills Required

None - the tool is run by Landmark. Further analysis of map outputs require GIS skills

Developer

Landmark Information Group (Consultancy) and University of Leeds

Ecosystems Knowledge Network

Description

Ecoservices is an online GIS platform designed to mitigate dangers to the water supply in river landscapes using nature-based solutions. The platform runs the best available datasets through its model and algorithms to provide raster map outputs. These maps indicate where habitat creation will offer the greatest ecosystem service benefits within a study area.

Ecosystem services included

Five regulating ecosystem services.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, mountains, moors and heaths and Coastal margins.

How does it work?

The tool uses grid-based map analyses of risk factors associated with erosion control, reduction of soil adsorbing pollutants, reduction of water soluble pollutants, flood mitigation and groundwater retention.

The risk factors are indexed and all locations of interest are ranked by combining each indexed (and appropriately weighted) factor; a reference threshold is applied to select the highest ranked areas. A raster map output identifies where the most effective interventions/ habitat creation should be implemented. Multiple objectives can be modelled, sensitivity analysis undertaken and certain actions in different areas prioritised or excluded to suit the landscape.

Case studies in the UK

At The Nant Crew, Brecon Beacons, it was used to identify areas where habitat creation could help to ameliorate reservoir silting. It identified where trees should be planted to intercept maximum flows, where woodland should be retained, and areas that should be reverted to semi-natural grassland.

Where can I find out more?

Contact angus.middleton@landmark.co.uk

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

LUCI

Quick Facts

Inputs

Maps / GIS data available at a national scale

Outputs

Maps indicating value and opportunity for change, data tables on ecosystem service changes

Scale

Site-based, local, regional, national and multi-scale

Context

A range of land uses

Cost

The aim is to make it free for non-profit organisations. It is currently unavailable and requests are considered on a case-by-case basis

Software required

ArcGIS 10.1 or above

Skills Required

Intermediate GIS skills

Developer

Unspecified. Bangor University developed earlier version of the tool, Polyscape

Description

LUCI (Land Utilisation and Capability Indicator) explores the capability of a landscape to provide ecosystem services. It uses map data to look at how the landscape is being used and the services that are currently being provided, and compares these to an estimate of the landscapes potential to provide services. This is used to identify areas where change may be beneficial, or where existing landscape features should be preserved.

Ecosystem services included

Six regulating ecosystem services.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, mountains, moors and heaths and urban.

How does it work?

LUCI is a process-based tool that maps individual ecosystem services and their interdependence and connectivity within the landscape. It uses a range of algorithms that maintain biophysical principles and spatial connections. It also identifies where trade-offs or co-benefits exist. Changes in land management can be input into the tool and deficiencies in data can be reduced by incorporating local stakeholder knowledge. Colour coded maps are produced to identify the impact of different decisions. It is particularly useful if a user is interested in the cumulative impact of many small features on a variety of services. LUCI is a negotiation tool to help inform stakeholders where changes in a landscape may be beneficial.

Case studies in the UK

It has been used in the Glastir Monitoring and Evaluating Programme in Wales, to map and quantify effects from 6 intervention scenarios. It identified trade-offs and co-benefits, provided data to Welsh Government and helped identify spatial targeting of farmer payments.

Where can I get it?

http://www.lucitools.org/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

Natural Capital Planning Tool

RICS Research Trust

Quick Facts

Inputs

Data about proposed development site in an Excel spreadsheet

Outputs

Ecosystem service impact score, development impact score, guidance

Scale

Site-based and local scale

Context

A range of land uses

Cost

The current version is a demo and not yet available.

Software required

Microsoft Excel

Skills Required

Microsoft Excel, basic level

Developer

Team from Birmingham City Council, Consultancy for Environmental Economics and Policy (CEEP) and UK Business Council for Sustainable Development (UK BCSD).

Description

The Natural Capital Planning Tool (NCPT) allows for an indicative assessment of ecosystem services over 25 years. The user inputs data about a development site and the tool calculates an Ecosystem Service Impact Score; and a Development Impact Score (overall effect of the proposed development on all ecosystem services).

Ecosystem services included

Ten ecosystem services across provisioning, regulating and cultural categories.

Habitats

Urban, semi-natural grasslands, woodland, freshwater, wetlands and floodplains, enclosed farmland, coastal margins, mountains, moors and heaths.

How does it work?

The tool seeks to determine the maximum potential positive outcomes for natural capital from the 'Masterplan' stage and for 25 years post-development. The Ecosystem Service Impact Score (ESIS) assesses the impact for each service, and these scores combined provide the Development Impact Score (DIS). If a proposed development scores negatively, the tool outlines design strategies and provides guidance to improve impact on ecosystem services.

Case studies in the UK

The tool is being used by Birmingham City Council on a sustainable urban extension. The aim is to provide high standards of design and sustainability and a network of green spaces to achieve a net positive outcome for natural capital. It has also been used in Rugeley, Staffordshire by the Environment Agency on a flood alleviation scheme.

Where can I find out more?

http://www.rics.org/uk/knowledge/research/research-reports/natural-capital-tool-planning-/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

Participatory GIS Tool

Quick Facts

Inputs

Personal user information, user-added pins, descriptions and photographs or evidence

Outputs

Information provided to the tool developers

Scale

Local and regional scale

Context

A range of land uses

Cost

Open access

Software required

A device (e.g. PC, laptop, tablet) with an internet connection

Skills Required

Basic knowledge of how to access and use a website

Developer

ADAS and The Research Box for Natural England, in association with the Morecambe Bay NIA and the Arnside and Silverdale AONB Partnership.

Description

The PGIS tool is an interactive website that the public can use to record their perceptions about the natural environment of the Morecambe Bay area. It captures simple information about the user and seeks to identify the locations where people experience cultural ecosystem services, and ascertain why they are important or valuable.

Ecosystem services included

Five cultural ecosystem services.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, coastal margins and urban.

How does it work?

PGIS aims to improve understanding of how the public perceive and value different landscapes. The tool considers five cultural ecosystem services: outdoor recreation; local history, heritage and learning; solitude, calm and tranquillity; beauty and inspiration; and wildlife and nature. Users place digital pins onto Ordnance Survey and satellite maps to show locations where they experience cultural services. They can record notes and upload photos to give an indication about the activities they undertake and why they find that place special. This dataset can then be layered with other map data in a GIS (e.g. landcover, site designations, rights of way) to identify correlations and areas that provide multiple ecosystem services. Ultimately the information can be used as part of the evidence base in planning and development scenarios.

Case studies in the UK

This tool currently only functions for the Morecambe Bay area. The case study generated heat maps which identified areas that provided multiple service values. Data overlaid with landcover maps identified that users valued woodlands, rough grasslands, fens and marshes, freshwater and urban areas (amongst others).

Where can I get it?

http://web1.adas.co.uk/pgis/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Tool Assessor
Information Sheet

Ecosystems Knowledge Network

SENCE

Quick Facts

Inputs

GIS datasets, other data sources such as remote sensing to fill gaps

Outputs

Maps, statistics, diagrams and an interpretive report

Scale

Local, catchment, County, regional, national scale

Context

A range of land uses

Cost

The tool is a consultancy service from Environment Systems

Software required

None - the tool is run by Environment Systems. It is run using GIS software. A web map service is also available

Skills Required

None - the tool is run by Environment Systems

Developer

Environment Systems Ltd

Description

SENCE (Spatial Evidence for Natural Capital Evaluation) provides information to support evidence based decision-making on ecosystem services. It is based on the idea that any area of land is capable of contributing to one or more ecosystem services. That capability is based on factors including habitat, soil and geology, landform and hydrology, how land is managed and how it is culturally understood.

Ecosystem services included

19 ecosystem services across provisioning, regulating, supporting and cultural categories.

Habitats

Semi-natural grasslands, woodland, enclosed farmland, freshwater, wetlands and floodplains, mountains, moors and heaths, coastal margins, marine, and urban.

How does it work?

Based on biophysical indicators from multiple datasets, scientific knowledge is used to weight or score each factor to model ecosystem services. This results in a series of maps and layers designed to be integrated into a GIS, available as separate files or via a web map service.

Case studies in the UK

SENCE was used as part of the Scottish Borders pilot regional land use framework. It was used to identify the multiple benefits that come from planting native woodland, including natural flood management, biodiversity, water quality and soil carbon.

It was also used to map ecosystem services for Winchester City Council, where it determined the ability of land to retain water and reduce rainwater runoff.

Where can I get it?

http://www.envsys.co.uk/sence/

Development of the Tool Assessor database and information sheets was funded by JNCC.

Annex D – Categories of application for tools

For the purpose of establishing criteria for the selection of tools for Tool Assessor, the following broad categories of application were generated:

Tool application	Explanation
1. Formulation of statutory planning documents, including Community Plans, Local Plans, Local Development Plans, Area Plans and Neighbourhood Plans.[1]	These documents, together with supporting guidance and evidence, guide development throughout the UK. Some are using an ecosystem service framework. An example is the Local Plan for North Devon and Torridge (to be adopted in 2017).
2. Formal management plans for landscape scale initiatives (statutory and other).	Landscape areas with statutory designation, such as National Parks and Areas of Outstanding Natural Beauty are required to produce periodic management plans. Prioritisation of activities can be informed by an understanding of where the opportunities to increase ecosystem service provision (and restore natural capital) are.
3. Design of masterplans for development sites.	There is now strong interest in enhancing green infrastructure in and around development sites. While there is a paucity of published analysis of the green infrastructure and ecosystem service provision around individual development sites, this is likely to change in the near future. The work commissioned by National Grid to appraise ecosystem service provision on its sites provides an example.[2]
4. Making the case for funding and new governance for urban greenspace.	Studies such as *Rethinking Parks* (Nesta, 2016) highlight the financial and management challenges for the future of greenspace in urban areas. Assessments of the economic, health and cultural value of parks, trees and water bodies in urban areas can help identify new models for investment and governance.
5. Strategic decisions about the management of natural assets such as forests, wetlands, and vegetation along infrastructure routes.	Statutory processes such as Natural Resources Management Planning in Wales require comprehensive assessment of natural features but also their role in the landscape. Combined with this, the role of individual features is important (see, for example, Rogers and Evans, 2015).

[1] Note different terms apply according to planning policy in each UK jurisdiction.
[2] See the http://ecosystemsknowledge.net for a webinar on this topic.

Tool application	Explanation
6. Estate management	A Corporate Natural Capital Accounting framework has been trialled by a variety of land owners and managers (eftec *et al*., 2015). Alongside this, individual estate managers have developed their own tools to help them manage their land with ecosystem services in mind. An example is the Landmarker tool for Ministry of Defence land (Land Marc Solutions, 2014).
7. Participation in, or brokering of, land management incentive schemes and payments for ecosystem service schemes.	The concept of new financial arrangements between organisations that influence ecosystem service provision and those who benefit from that provision is now popular in many parts of the UK (Defra, 2013). Alongside this, there is interest in incentivising actions that enhance ecosystem service provision or restore natural capital (such as woodland planting). New agreements will need to be based on a detailed understanding of what is currently being provided, as well as the trade-offs involved in any change to land management.
8. Pursuit of core and project funding for landscape scale initiatives.	Securing funding for large-scale integrated action to improve the environment benefits from a demonstration of what environmental assets are and where the best opportunities for enhancing them may be.

The above applications were identified through review of the following:

i. The Response Options Chapter of the UK NEA (UK NEA, 2011).
ii. The National Ecosystem Approach Toolkit.
iii. Examination of a local and national policy documents
    a. Examples of green infrastructure strategies for counties and regions.
    b. The first Scottish Land Use Strategy (Scottish Government, 2011 and subsequent consultation on a second strategy).
    c. Biodiversity Strategies for England, Scotland and Northern Ireland.
iv. Activities within the membership of the Ecosystems Knowledge Network.

Annex E – Online data portals and interactive map applications for tool users

Data Portal	Information
Environmental data	
Environment Agency Geostore **At a glance:** **Coverage: England (and Wales)** **Service: Data Download Facility** **Type of data: Varied**	What does the portal do? Geostore is the main DataShare portal for environmental spatial information in England (and in some cases Wales). The datasets are provided by Defra and its agencies and can be downloaded directly as digital GIS data (shapefiles, TAB files, GML, geodatabases) or they can be accessed as an Open Geospatial Consortium (OGC) Web Map Service (WMS) or Web Feature Service (WFS). What data does the portal provide? The data cover rural, urban, coastal and marine environments. Data themes include administrative boundaries, environmental management, flooding, priority habitat, site designations, heritage, Water Framework Directive, marine, public access, National Character Areas, conservation and Environmental Stewardship Agreements (amongst others). What does the portal not provide? Geostore does not provide information on soil type, geology, forestry or land use. Nor does it provide general socio-economic or population data. Accessibility: The data are freely available to download and use, subject to the terms and conditions of the specified licences. Most data are available under Open Government Licence (OGL). Other licences may require registration and some do not allow commercial use.
Magic **At a glance:** **Coverage: Great Britain**	What does the portal do? Magic provides an interactive map application and an online portal for spatial data download. What data does the portal provide? It covers rural, urban, coastal and marine environments across Great Britain. Data themes include site designations, habitats and species, administrative and geographic boundaries,

Service: Interactive Map Application and Data Download Facility **Type of data: Varied**	access, marine data, land-based schemes, landscape data (e.g. geology and soils) and backdrop maps. Interactive map service: The interactive map application enables users to search and identify different layers of geographic information from the above themes. This is a good way for tool users to find out general information about a study area without the need to download and view data in a GIS. Data download facility: The data download facility allows users to download data directly or provides links to other websites (e.g. Geostore, Forestry Commission, LandIS, Ordnance Survey) where the data can be obtained. In addition to what is available on Geostore, Magic includes or links to other data portals that contain national forestry, species, geology and soils, energy/ nuclear power stations data and OS backdrop maps. What does the portal not provide? It does not provide or link to any definitive land use / land cover data. Accessibility: The data are freely downloadable in GIS-ready formats (shapefiles, TAB files, Geotiff etc.) Descriptive information, including metadata, licence agreements and the organisation that provided the data, are listed. Data that are not currently available for download due to licence restrictions are also clearly listed.
OS Open Data **At a glance:** **Coverage: Great Britain** **Service: Data Download Facility** **Type of data: Ordnance Survey data**	What does the portal do? OS Open Data provides free access to a range of Ordnance Survey datasets (shapefile, GML, TAB, Geotiff, CSV, ASCII formats) for Great Britain. What data does the portal provide? Datasets include OS Backdrop Maps at a range of spatial scales (local, regional, national), settlement names, road names, postcodes, road network, river network, topographic contours and digital elevation model, administrative boundaries, hydrology, urban areas and woodlands. Many of these datasets are not readily accessible via Geostore or Magic and may provide

	valuable context for tool map outputs. Accessibility: Free and open access (according to OS Open Data Terms).
CEH (Centre for Ecology and Hydrology) Environmental Information Platform **At a glance:** **Coverage: Great Britain (and Northern Ireland)** **Service: Interactive Map Application and Data Download Facility** **Type of data: Varied and includes landcover**	What does the portal do? The Environmental Information Platform provides enhanced access to CEH's key data holdings. It enables users to visualise (e.g. interactive map applications), interrogate and in some cases download the diverse environmental datasets held by CEH. What data does the portal provide? More than 400 datasets including land cover data, meteorological data (inc. UK daily and monthly rainfall data, drought statistics) and Ecological Status Index (biodiversity data). Accessibility: Some datasets are available under Open Government licence. The latest land cover data (e.g. Landcover Map 2007) is available under licence for academic, non-commercial and commercial use. It is free of charge to academics for non-commercial purposes (administration costs may apply). Charges may apply for other users and commercial works.
Forestry Commission At a glance: **Coverage: Great Britain** **Service: Data Download Facility** **Type of data: Forestry**	What does the portal do? The Forestry Commission has made a range of their forestry-based data available for download in shapefile format. Users can also access the data via Web Map Services (WMS). Data are available for Great Britain, England, Wales and Scotland. What data does the portal provide? Datasets include the National Forest Inventory, National Forest Estate Boundaries and Recreation points, Stock and Roads, Grants and Regulations data, Felling Licences, Scottish Native Woodlands and Plant Health. Accessibility: In all cases the download is an ESRI Shapefile accompanied by metadata. Downloads are covered by the Open Government Licence that the user signs up to on registration.

LandIS **At a glance:** **Coverage: England and Wales** **Service: Reports and Interactive Map Application** **Type of data: Soils**	What does the portal do? LandIS datasets contain digital soil information (reports, interactive online maps and data) for England and Wales. What data does the portal provide? The 'Soils Site Reporter' allows users to download site-specific soil reports for neighbourhoods, development sites, farms etc. 'Soilscapes Viewer' is an interactive map application where users can identify the main soil types across England and Wales (1:250,000 'regional' scale – useful for a summary). National Soil Map GIS data (soil profiles, topsoil chemistry, soil types etc.) are also available. Accessibility: Soils Site Reports are provided free of charge to licenced organisations and authorised members of Crown Government Departments (not including Local Councils and Executive Agencies). Other users may access this service for a fee payable per report. The Soilscapes Viewer Interactive Map is free to access. Arrangements for access to digital soil data are governed by an agreement between Cranfield University and Defra acting on behalf of the Crown.
Scotland's Environment Web **At a glance:** **Coverage: Scotland (and Europe)** **Service: Interactive Map Application, Data Visualisation and Download Facility** **Type of data: Varied**	What does the portal do? Scotland's Environment website includes an interactive map application where users can view different layers of data relevant to Scotland. Interactive data visualisation is available in the form of graphs, images and tables - many of these datasets can be exported as pdfs, images and CSV files (possibly also GIS formats) either directly, or through links to external websites (including European Environment Agency and Scottish Environment Protection Agency). What data does the portal provide? The Interactive Map Application focuses on four 'State of the Environment' themes: air, water, land, people and the environment. The data visualisation application (and related data export) includes, but is not limited to, air quality, climate trends, bathing waters, agriculture, household waste, food standards, protected areas, greenspaces and pollution release. Accessibility: User access to different datasets is specified online.

Scottish Environment Protection Agency (SEPA) **At a glance:** **Coverage: Scotland** **Service: Data Download Facility** **Type of data: Water, Waste, Pollution**	What does the portal do? SEPA publishes a range of environment datasets for Scotland in formats including Excel tables, CSV, shapefiles and pdf reports. What data does the portal provide? Data include water body classification, groundwater, river basin management planning, water levels, bathing waters, aquaculture, waste and pollutant release inventory. Accessibility: Most datasets are open access and published under the EU Inspire Directive. Other licence agreements or use restrictions are specified (usually where data are sourced from an external website).
Lle Geo-Portal for Wales **At a glance:** **Coverage: Wales** **Service: Data Download Facility** **Type of data: Varied**	What does the portal do? The Lle Geo-Portal serves as a hub for data and information covering a wide spectrum of environmental topics. Data download is supported in spatial formats, including shapefile, KML, GML, either directly or from external websites (including National Assembly for Wales, Welsh Government, European Environment Agency, Forestry Commission, Office for National Statistics). What data does the portal provide? 65 pieces of spatial data including, but not limited to, administrative boundaries, basemaps, biodiversity, climate change, agriculture, flooding, marine, legislation, protected areas, forestry, waste and water. Accessibility: Most datasets are open access and published under the Open Government Licence. Other licence agreements or use restrictions are specified (usually where data are sourced from an external website).
European Environment Agency **At a glance:** **Coverage: Europe**	What does the portal do? The European Environment Agency provides downloadable data about Europe's environment in a range of formats. Datasets can also be viewed via interactive map applications and as reports, graphs, charts and other documents.

Service: Interactive Map Application and Data Download Facility **Type of data: Varied and includes land cover**	What data does the portal provide? Over 100 datasets including topics on Corine land cover, ecosystem types, biogeographic regions, air quality, air emissions, green economy, climate change, industry, soil, noise, water, coasts and seas, biodiversity, chemicals, waste management. Accessibility: Direct download from the website.
Socio-economic/ population data	
UK Data Service Census Reports (InFuse) **At a glance:** **Coverage: England, Wales, Scotland (and Northern Ireland)** **Service: Data Download Facility** **Type of data: Socio-economic**	What does the portal do? InFuse provides aggregate statistics from the UK 2011 Census for geographic output areas across England, Wales, Scotland and Northern Ireland. The data (downloadable in tabular and GIS format) include counts of people and households from a wide range of demographic and socio-economic characteristics (see also Office for National Statistics). What data does the portal provide? Topics include age, gender, migration, ethnicity, housing, identity, language, religion, health, unpaid care, short-term residents, workday populations, communal establishments, families and the labour market. Accessibility: InFuse provides both academic and non-academic researchers with free, open access to 2001 (England and Wales) and 2011 (UK) Census aggregate statistics under the Open Government Licence. Data from the 1971 – 2001 Census can be downloaded for free from Casweb.
Office for National Statistics **At a glance:** **Coverage: UK** **Service: Interactive Map Application and Data Download Facility**	What does the portal do? The Office for National Statistics is the UK's largest independent producer of official statistics and the recognised national statistical institute of the UK. Neighbourhood Statistics allows users to view maps and download tabular data relating to local areas. What data does the portal provide? Statistics relating to the economy, population and society at national, regional and local levels. Accessibility:

Type of data: Socio-economic	Direct download from the website.
Monitor of Engagement with the Natural Environment (MENE) **At a glance:** **Coverage: England, Wales, Scotland (and Northern Ireland)** **Service: Data Download Facility** **Type of data: Culture and recreation**	What does the portal do? The MENE survey data provide information about the ways that people engage with the natural environment. Data are provided in tabular format (e.g. Excel and CSV tables) which can be processed to represent spatial data in a GIS. What data does the portal provide? Data include type of destination, duration, mode of transport, distance travelled, expenditure, main activities, motivations, barriers to visiting. Accessibility: Data available under Open Government Licence.
Air quality data	
National Atmospheric Emissions Inventory (NAEI) **At a glance:** **Coverage: UK** **Service: Interactive Map Application and Data Download Facility** **Type of data: Emissions**	What does the portal do? NAEI allows users to find and download emissions data (Excel tables, CSV, ASCII GIS format). The interactive map application also allows users to explore and interrogate the data at a variety of scales and perform data queries. What data does the portal provide? Greenhouses gases, air pollutants, heavy metals and base cations, particulate matter. Accessibility: The data and information made available is subject to Crown copyright protection licenced under Open Government Licence (unless specified).
Other local data	
Other data sources for local spatial data and survey information	Local Biodiversity Record Centres Local Authorities e.g. County Councils National Biodiversity Network (NBN) Gateway Conservation Organisations e.g. Wildlife Trusts, RSPB reserves, National Parks Authority Local institutions including Universities, colleges, businesses, planning offices etc. Local library and planning/development records.

Annex F – Pre-existing sources of information about tools

Current sources of information on tools

As shown in **Table F1**, a variety of international programmes have sought to list the capabilities of ecosystem service assessment tools and methods. The global scope of many of the sources of information shown in the table means that it is difficult to identify tools directly applicable to the UK situation. The pre-existing sources of information about are, however, useful for informing the best way of providing information about tools for use in the UK.

The EBM Toolkit is the most similar in aim to the Tool Assessor resource. This characterises tools according to the following functions:

- Modelling and analysis
- Decision support
- Visualisation
- Stakeholder engagement and outreach
- Project management

These functions are, however, open to wide interpretation and overlap with each other (e.g. a visualisation tool can be used for stakeholder engagement).

The ValuES Method Database includes a 'method navigator', which invites users to choose criteria that meet their needs, or guides them through some basic categories of end use. It is limited though because most of the applications don't relate to the UK context.

Information source	Description
Bagstad et al. (2013)	A review of 17 ecosystem service assessment tools, rating their performance according to the potential for widespread application.
Ecosystem Based Management (EMB) Toolkit	Methods and software/web tools that can help improve coastal-marine spatial planning and management decision making.
ValuES Project Methods Database	Guidance for selection of methods, approaches and tools – global in scope
US EPA EcoService Models Library	Designed to help users find ecological models, or EMs, for estimating production of ecosystem goods and services.
Ecosystem Service Partnership webpage on guidelines and toolkits	Links to sources of information on tools, but limited in scope.
Catchment Based Approach	A variety of community engagement tools
National Ecosystem Assessment Toolkit	Links to some specialised tools (e.g. LUCI) but not up to date.

Table F1: sources of information on tools