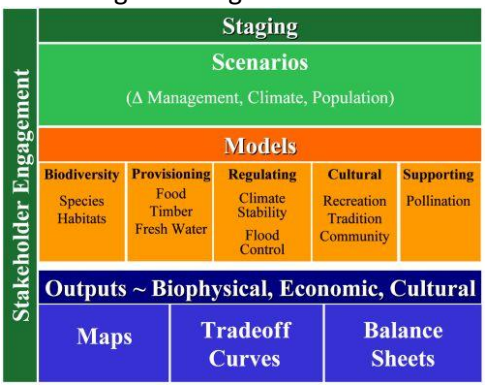
Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) Tool Review

Ecosystem Services Tools

TABLES Project 2012: Mini reviews	
Guidance	*Using your experience and expertise, consider the following tasks in relation to the tool. It may not be possible to complete all tasks for each tool due to a lack of available information, the task not applying to the tool, etc.* ***Please note where this is the case by writing in the reason in the space provided****. Please use a maximum of 6 pages of A4 (excluding diagrams and appendices).* ***Your responses are required in the white spaces****.*
Task 1: Basic information	
Name of the tool	InVEST - Integrated Valuation of Ecosystem Services and Trade-offs
Type of tool (list all that apply)	Mapping, modelling, decision, ecosystem services
Group members	1. Ron Corstanje
	2. Jim Harris
	3. Claudia Carter
	4. Alister Scott
Please provide a brief synopsis of the tool	InVEST is a sophisticated GIS-based tool in ongoing development which incorporates models for ecosystem services. The tool allows valuation of those services and also provides some measure of risk assessment or trade-offs. InVEST can handle scenarios and can be applied across a wide range of decision making needs. InVEST is a major decision support tool for biodiversity in the UK which explicitly includes a biodiversity model, based on habitat rarity and quality, linked to distance from potential threats (infrastructure, inappropriate land-uses, etc.). It enables decision-makers to assess the trade-offs associated with alternative choices and to identify areas where investment in natural capital can enhance human development and conservation in terrestrial, freshwater, and marine ecosystems. InVEST is most effectively used within a decision-making process that starts with a series of stakeholder consultations according to the figure below.  InVEST models are spatially-explicit, using maps as information sources and producing maps as outputs. InVEST returns results in either biophysical terms (e.g. tons of carbon sequestered) or economic terms (e.g. net present value of that sequestered carbon).

Task 2: Use of the tool

Position / Use

Stage	Currently used	Could be used
Ideas	Y	Y
Survey		Y
Assess		Y
Policy / decision		Y
Implement		Y
Evaluate		Y

Please add any further comments here:

Task 3: Existing literature about the tool

Are you aware of any KEY policy and / or academic literature evaluating your tool?

Author & Date	Title Vol pages	Web link (if available)
		http://www.naturalcapitalproject.org/InVEST.html
Nelson *et al.* (2009) Erik Nelson, Guillermo Mendoza, James Regetz, Stephen Polasky, Heather Tallis, D Richard Cameron, Kai MA Chan, Gretchen C Daily, Joshua Goldstein, Peter M Kareiva, Eric Lonsdorf, Robin Naidoo, Taylor H Ricketts, and M Rebecca Shaw	Modeling multiple ecosystem services, biodiversity conservation, commodity production, and trade-offs at landscape scales, *Frontiers in Ecology and the Environment* **7**: 4–11.	
Daily *et al.* (2009) Gretchen C Daily, Stephen Polasky, Joshua Goldstein, Peter M Kareiva, Harold A Mooney, Liba Pejchar, Taylor H Ricketts, James Salzman, and Robert Shallenberger	Ecosystem services in decision making: time to deliver, *Frontiers in Ecology and the Environment* **7**: 21–28.	
Tallis *et al.* (2011) Tallis, H.T., Ricketts, T., Guerry, A.D., Wood, S.A., Sharp, R., Nelson, E., Ennaanay, D., Wolny, S., Olwero, N., Vigerstol, K., Pennington, D., Mendoza, G., Aukema, J., Foster, J., Forrest, J., Cameron, D., Arkema, K., Lonsdorf, E., Kennedy, C., Verutes, G., Kim, C.K., Guannel, G., Papenfus, M., Toft, J., Marsik, M., and Bernhardt, J.	InVEST 2.2.0 User's Guide. The Natural Capital Project, Stanford.	http://ncp-dev.stanford.edu/~dataportal/invest-releases/documentation/current_release/
BSR (May) 2011	New Business Decision-Making Aids in an Era of Complexity, Scrutiny, and Uncertainty Tools for Identifying, Assessing, and Valuing Ecosystem Services. BSR's Ecosystem Services, Tools & Markets Working Group.	http://www.bsr.org/reports/BSR_ESTM_WG_Comp_ES_Tools_Synthesis.pdf

Task 4: Your experience of working on the tool	
Have you done any research/consultancy work on this tool in terms of its development, testing and/or evaluation?	No. However, were able to draw on emerging work by Smart et al.
Guidance	For Tasks 5-7, please also try to consider the **future** development and application of this tool in the TABLES project in your answers.
Task 5: Incorporating the ecosystem approach (EA) and ecosystem services (ES)	
Using examples (from practice, research or consultancy), explain how EA and/or ES are currently incorporated in/by the tool	InVEST determines ecosystem service provision and value of a specific place/area/ by using ecological and economic production functions, where land use and land use change and related management and biophysical data at the point and elsewhere on the landscape(or seascape) are inputs. ES are currently incorporated in various ways, ranging from simple spatial mapping or quantification of ecosystem services to more complex assessments to inform decision-making such as spatial planning, sustainability impact assessment (SIA) or strategic environmental assessment (SEA), and payment for ecosystem services (PES). InVEST can also be used for designing mitigation and climate adaptation. InVEST contains models to quantify ecosystem services (process-based components, land-use coefficients and spatial calculations), all linked to land-use in a climatic context. Coverage of flows of services in terms of water flows, and the use of viewsheds in calculating landscape aesthetics. The model for biodiversity uses habitat quality and rarity as proxies for biodiversity, with distance from threats dictating habitat quality. Some models are dynamic, capable of running at annual time-steps with annual average data. Crucially, InVEST has models for terrestrial ecosystem services **and** marine and coastal ecosystem services. There are **terrestrial/freshwater models** available to quantify biodiversity, e.g. habitat quality and rarity, carbon storage and sequestration, reservoir hydropower production, water purification, nutrient retention, sediment retention, avoided dredging, water quality regulation, managed timber production, crop pollination. **Marine models** quantify wave energy, coastal vulnerability, coastal protection, marine fish aquaculture, marine aesthetic quality. InVEST also performs some spatial and risk assessment analyses (e.g. marine overlap analysis model for fisheries and recreation, marine habitat risk assessment).
How <u>could</u> the ecosystem approach and/or ecosystem services be (further) incorporated within the existing tool?	• Coverage of flows of services within a landscape, and barriers to those flows is limited (other than water flows, and the use of viewsheds in calculating landscape aesthetics). • Development is aiming to improve dynamic modelling to daily, seasonal time-steps for biodiversity. • Development work is in progress to (better) link the models for terrestrial ecosystem services and marine and coastal ecosystem services.

Task 6: Situating the tool within priority questions/criteria arising from the scoping interviews

Explain how the tool can be situated within the priority questions/ criteria that arose in the scoping interviews	**Priority question/criteria**	**Does your tool address/implement this question/criteria?** *If yes, please explain how.*
	Language and communication	
	1. Contribution to aiding the development of shared vocabulary within which principles of EA and ES can be shared with multiple stakeholders across built and/or natural environment	Yes, through visualisation.
	2. Capacity of the tool to develop shared understandings of the many identities and values of places from the perspectives of multiple visitors, residents and businesses	N/A
	3. Capacity of the tool to improve or enable engagement across different publics so avoiding the usual suspect problem	Has the potential to do so through visualization and scenarios. Tool has range of functions and potential applications to suit interest and needs of different 'stakeholders' and 'publics'.
	Learning from experience/pedagogy	
	4. Capacity of the tool to help reveal and value 'hidden' assets that are not recognised by communities or publics that use them	Potential to contain detailed biodiversity data, much of which may be 'unknown' or remain little or un-recognised by communities and publics.
	5. Extent to which tool is building on other tools or EA/ES progress	Uses scenarios. Relevant to range of other tools including, SEA, PES, Local Plans.
	6. Extent to which tool is locally derived or grounded or can be adjusted to closely reflect 'local' context. Is the tool suitable for an open source approach?	Yes, in principle it should be able to be adapted: InVEST can be applied at any scale, depending on data availability, although in practice there may be constraints for some of the models.
	7. Extent to which the tool is open to interpretation and application in a variety of forms (that reflect 'cultural' differences)	Yes, through the networks that feed into and use the models / tool.
	Developing and selecting tools	
	8. Is the tool dependent on a specific funding source? How	N/A

onerous is the application procedure? What are the chances of success?	
9. Does skills development (essential or optional?) and support exist for the tool or is there a body to ensure the optimal and correct use of it?	The user needs to be trained to used the GIS tool: specialist skills are required to make it effective.
10. Extent to which current statutory hooks can be exploited by the tool or will benefit the quality or application of the tool (e.g. NPPF's duty to cooperate, SUDS, ecol. networks)	N/A
Informing resultant policies effectively	
11. Extent to which the tool informs or improves policies/decisions. What does the tool cover? (full range of positive and negative economic, social and environment impacts / tradeoffs?)	InVEST has been applied in case studies in the Americas and Africa. Examples include policy and conservation planning in the Willamette Basin USA, private landowners in Hawaii USA, multi-stakeholder planning in Tanzania, permitting and licensing in Colombia, and priority setting for international aid in the Amazon Basin.
12. How does the tool link into the planning system (applications and processes). At what cost / extra burden?	This does not apply at the moment.
Delivering management objectives	
13. Suitability or capacity of the tool to assist with managing visitor needs and pressures within protected areas / the considered area? How?	The tool can be used to support this, depending on the user's wishes.
Local ownership/new governance	
14. To what extent can the tool assist in developing statutory plans (local and management plans) and improve ownership and use by publics?	In principle it should be able to visualize the delivery of ecosystem services.
15. To what extent does/could the tool contribute to a new form of community governance in management of the environment?	Wide ranging functions and application potential but data hungry at the local scale / the more detailed the scale/focus.
Improved tools: understanding flows, interconnections and spatial issues	
16. Capacity to improve spatial understandings of the flows and interactions of various ecosystem services between sectors and at different scales	The tool is very effective with this.
17. Capacity of the tool to reconcile assessments of options and	Very effective.

benefits across different scales (and sectors)	
18. Extent to which the tools is capable or can be manipulated to work across sectoral and administrative boundaries	It is a GIS based tool that can be applied at a variety of scales (see examples of applications listed under point 11).
19. Extent to which the tool can handle data shortages and gaps (or is effectiveness considerably compromised?)	The tool will struggle with gaps and data shortages.
20. To what extent has/could the tool put landscape/nature conservation and designated species/sites on the radar (positively or resulting in resentment?)	The tool is able to visualise and depict the benefits.

Please add any further comments here:

Task 7: A SWOT analysis of the tool

Referring back to the relevant policy and academic literature (listed in Task 3), plus your own expertise (listed in Task 4) and the way in which the tool is situated within the priority questions/criteria (listed in Task 6), please complete a summary SWOT analysis ensuring that each point is well justified

Strengths *(of the tool in delivering intended outcomes)*
Simple, technical not complex

Weaknesses *(factors that detract from the tool's ability to deliver intended outcomes)*
Cannot effectively handle complex interactions and trade-offs

Opportunities *(consider opportunities for application of the ecosystem approach and services)*
High and currently will be applied in BESS WESSEX

Threats *(factors which negatively affect the tool and its outcomes)*

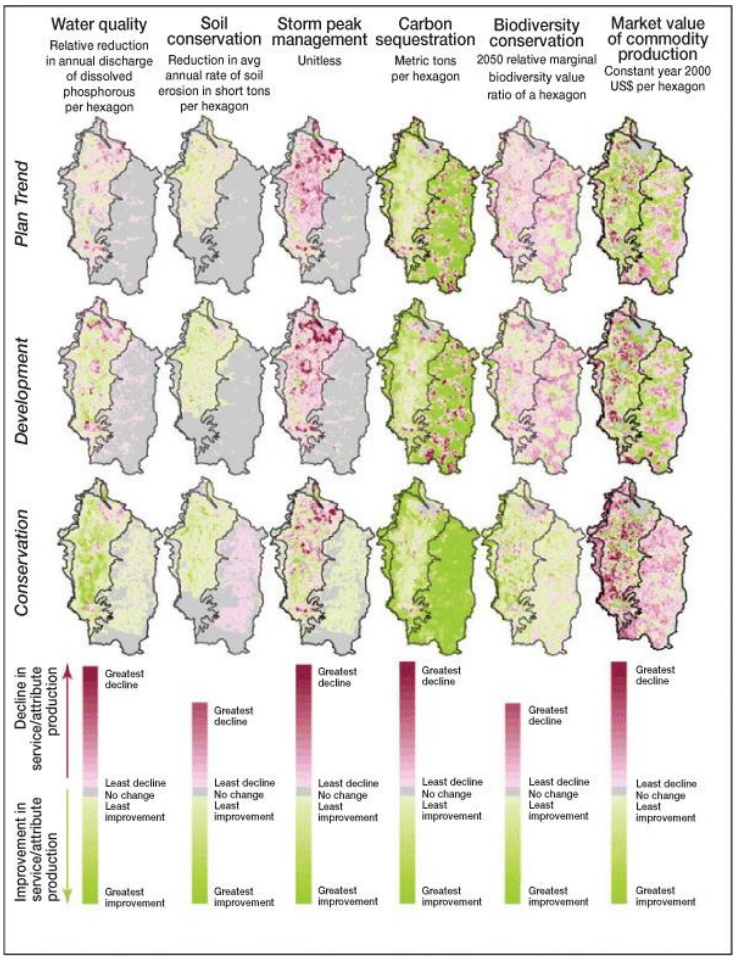
Threat	Seriousness (high, medium, low)	Probability of occurrence (high, medium, low)
Over simplification	Medium	
GIS expertise	Medium	

Please add further comments here:

Guidance	*Please now use the remainder of the document (box below) to make any general comments, observations or analyses of the tool*
Further comments	The limitations and assumptions of each model are explained, the methodologies are presented and transparent. Data quality may be used to inform risk assessment – see the chapter on Habitat Risk Assessment in Tallis *et al.* (2011).

Appendix 1

Figure: InVEST output for the Willamette Basin



InVEST - Integrated Valuation of Ecosystem Services and Tradeoffs

http://www.naturalcapitalproject.org/InVEST.html

Developed as part of the natural capital project InVEST is a family of tools to map and value the goods and services from nature which are essential for sustaining and fulfilling human life.

InVEST enables decision-makers to assess the tradeoffs associated with alternative choices and to identify areas where investment in natural capital can enhance human development and conservation in terrestrial, freshwater, and marine ecosystems.

InVEST determines ecosystem service provision and value at a point on the landscape by using ecological and economic production functions, where land use and land use change and related management and biophysical data at the point and elsewhere on the landscape(or seascape) are inputs.

Source: Pagella, T (2011). Review of Spatial Assessment Tools for the Mapping of Ecosystem Services. Report 3/11, Wales Environment Research Hub, Bangor, p38 (Appendix 1).

Appendix 2

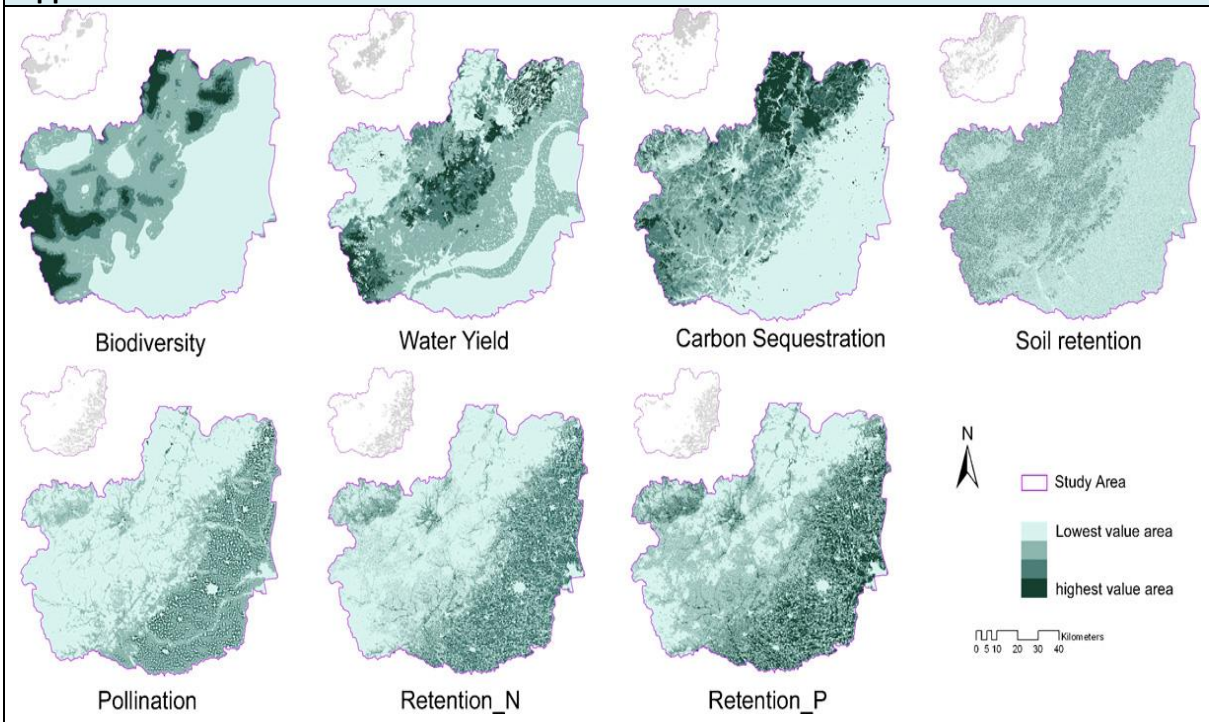


Figure 1:Spatial distributions of biodiversity and the six ecosystem services using the InVEST tool in Baiyangdian watershed (China)(Bai et al. , 2011). Only 3 of the ecosystem services illustrated (water yield, soil retention and retention_P) manifest solely within the surface catchment area. The other services clearly leak out the side (or would require mapping of the sub surface catchment (i.e. Retention N) to map properly). Source: Pagella, T (2011). Review of Spatial Assessment Tools for the Mapping of Ecosystem Services. Report 3/11, Wales Environment Research Hub, Bangor, p22.

Appendix 3

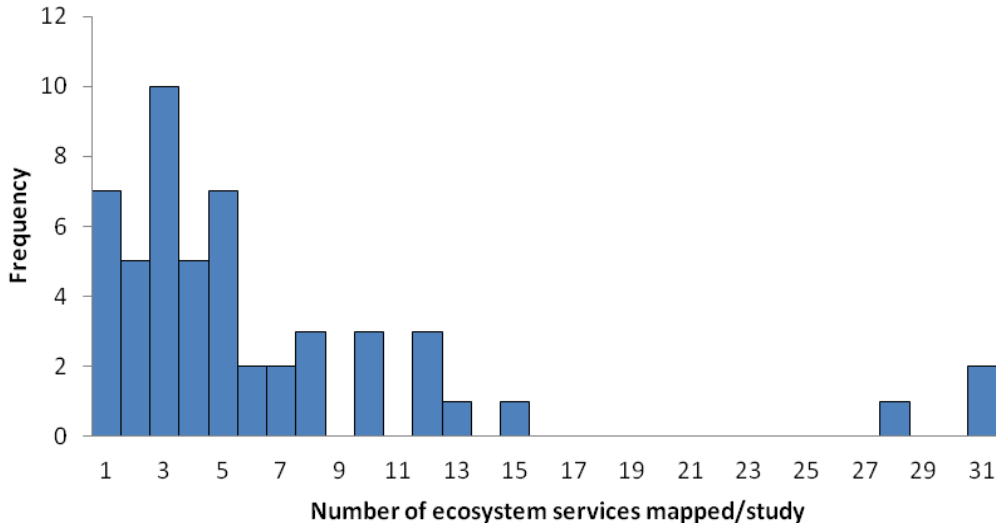


Figure 2: Distribution of number of ecosystem services mapped/study. Note: One study ((He et al., 2011) did not clearly indicate the number of ecosystem services mapped (The proceeding study (in Chinese) suggests three, based on interpretation of presented graphs). Source: Pagella, T (2011). Review of Spatial Assessment Tools for the Mapping of Ecosystem Services. Report 3/11, Wales Environment Research Hub, Bangor, p23.

Note that of the services mapped, the most common were regulating and provisioning services. Supporting services (where they were not part of the stakeholder focused studies considered in this report) were not mapped.

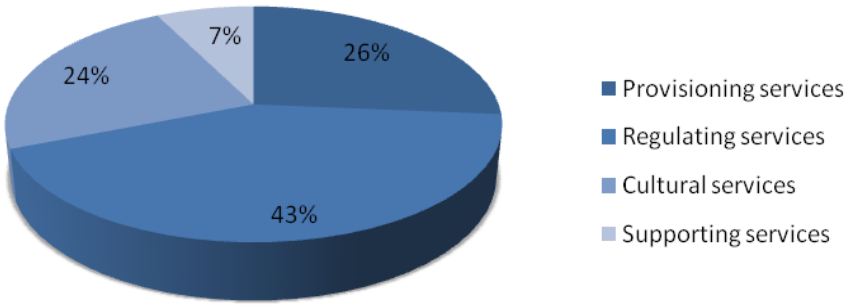


Figure 4.3: Proportion of different ecosystem categories mapped. Source: Pagella, T (2011). Review of Spatial Assessment Tools for the Mapping of Ecosystem Services. Report 3/11, Wales Environment Research Hub, Bangor, p23.

Appendix 4

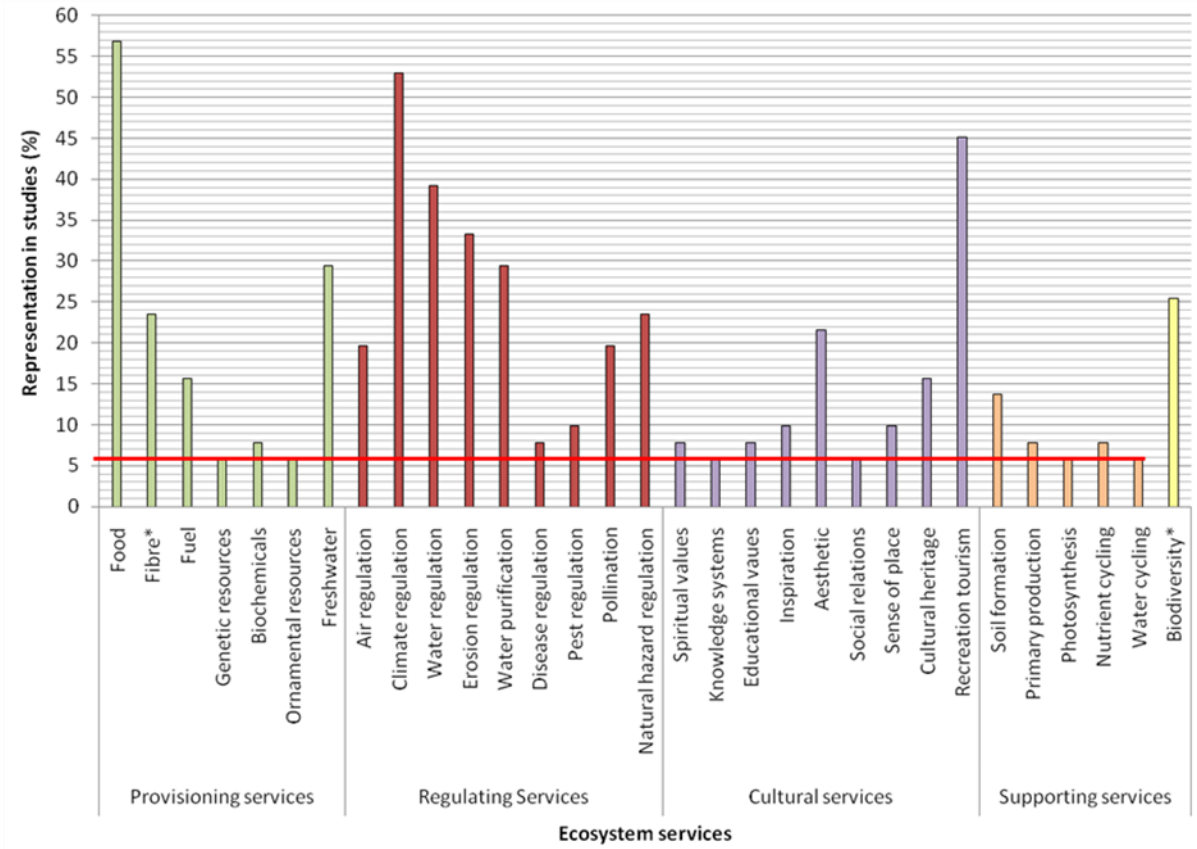


Figure 4: The types and frequency of ecosystem services mapped (based on the MA Ecosystem service typology (MA , 2005)). The studies below the redline addressed all ecosystem services. Source: Pagella, T (2011). Review of Spatial Assessment Tools for the Mapping of Ecosystem Services. Report 3/11, Wales Environment Research Hub, Bangor, p24.