Typology/Classification of Ecosystem Services

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Introduction and 'State-of-the-art'

The classification of ecosystem services is challenging both conceptually and technically (cf. Sokal, 1974). It is also urgently needed to facilitate the applications of the ideas in decision making (both policy and management) and (to some extent) in research.

The task of classification is *conceptually challenging* because the idea of ecosystem services is essentially a 'boundary object': it helps to transmit and coordinate thinking between disciplines even though there is no commonly accepted or precise definition of the term. It is useful precisely because it is vague and open to different interpretations. As a result, any common, agreed classification is difficult to achieve. Key definitional issues include:

- Whether ecosystem services *are* benefits (cf. Costanza, 2008), or whether they are the *contributions* that ecosystem services make to well-being (via the benefits supported by a set of 'final' ecosystem services) (cf. Potschin and Haines-Young, 2011).
- Whether ecosystem services are only those ecosystem service outputs that are dependent (to some extent) on living processes or whether they include pure abiotic outputs (e.g. wind and hydro power, salt, physical landscapes).

The design of any classification system is *technically challenging* because (apart from the lack of common definitions) there are a range of purposes or applications that have to be considered which have different requirements in terms of the levels of thematic and spatial resolution needed. Moreover, different disciplinary groups bring different concepts and framings to the table, so that convergence of terminology (and any agreed classification) is difficult. Examples of issues include:

- Whether ecosystem 'services' and ecosystem 'goods' are synonymous or whether we make a distinction between them. For example the UK NEA (http://uknea.unep-wcmc.org/) argues that services are the final outputs and goods are the things that are valued in terms of the benefits they generate. Thus for a forest ecosystem 'trees' are final service and timber one of the 'goods' that are produced and which can be valued alongside, say, other non-timber forest products such as the 'buffering capacity' of woodlands against avalanche.
- How we treat ecosystem services from artificial or semi-natural systems. In the revision of the System of Environmental and Economic Accounts (SEEA, 2012), cultivated crops in the field are not regarded as services – but products (goods); instead 'nutrients and natural feed for cultivated biological resources' in agro-ecosystems are proposed as final services.
- The way we treat ecosystems services that include inputs from other types of capital (financial, manufactured, social, human etc.) is a major issue in the design of any classification system; the way we assess or quantify the contributions that ecosystems make to human well-being is often unclear.

Table 1 provides an overview of the revised Common International Classification of Ecosystem Services (CICES) which has been designed to meet some of these challenges. The table also provides a comparison with the typologies used for the MA and TEEB. It is based on the recent document on the European working group on Mapping and Assessment of Ecosystem Services (MAES, 2014), but has updated and reorganised the information to take account of the revisions suggested for CICES V4.3. Although CICES was initially designed to support environmental accounting (Haines-Young and Potschin, 2013) its hierarchical structure may also assist in mapping and assessment, and at different thematic and spatial scales.

It is *not* intended to replace other classifications but to enable cross comparisons to be more easily made. The hierarchical structure allows studies that are undertaken at different thematic and spatial resolutions to be more easily compared. At present it only deals with services that are dependent on living processes in some way, but it can be extended to cover the various abiotic outputs from natural systems (e.g. wave power) if required (see Table 2). However, we note the many arguments against this in terms of diverting attention away from the importance of *living processes* for sustaining human well-being.

Significance for OpenNESS and specific Work Packages:

In general terms some standardisation of definitions and terminology would be helpful so that cross-comparisons of ecosystem outputs would be possible; it is also valuable in the context of many application areas, such as planning, where clarity is especially important. There is still the opportunity to develop and refine CICES, and so OpenNESS provides the opportunity to test and refine the classification so that it can be used more generally as we move towards operationalisation. The need for some standardisation of terminology is important if we are to integrate discussions on regulatory frameworks (WP2), or with those dealing with the sustainable management of ecosystem services and biodiversity (WP3). Moreover, if we are to use the outputs from the valuation work (WP4) then common definitions and terminology would be essential if value information is to be transferred effectively between studies. Finally, it will be more difficult to generalise from the findings of the case studies (WP5) if we lack a way of cross-referencing their work. A refined and tested classification is likely to be a key element delivered by the 'Common Communication Platform' as required as an output from OpenNESS by the Commission (WP6&7).

Problems/Issues

1 Do the differences in classification approaches matter in terms of operationalising the concept? If there are barriers how do we overcome them?

The "WP1 brainstorming meeting" (Garmisch, Feb.2013) concluded that classification issues were important and that OpenNESS should address them; the classification problem is part and parcel of the conceptual framework being developed in WP1, but it needs to be practical in its orientation so that it can be used and tested across the work programme. The classification systems used need to be consistent with the key definitions captured in the OpenNESS conceptual framework; ***we recommend that a consistency check forms part of the first stages of the work****.*

2 Do we need to think of several different classifications systems that in fact link together to provide a better read-across between 'functions', 'services' and 'benefits'? For example the US Environment Protection Agency (EPA) classification of beneficiaries is a useful adjunct to CICES and can help identify who uses what and where and for what purposes (Landers and Nahlik, 2013). Do we need classification systems at each interface across the cascade?

The brainstorming meeting concluded that the CICES system was a start, and recommend that it be used as a way of exploring issues initially*. It was recognised, however, that probably several linked classification systems were needed in order to achieve full operationalisation. For example a classification of benefits and beneficiaries would probably be needed if we are to fully value services and link the outputs to any kind of accounting system, or measures of human well-being. Similarly systems for classifying underlying functions were needed, since these are poorly handled in some of the existing classification systems.*

Definitions

Clear and consistent definitions are an essential basis of any classification system. Key definitions that need to be agreed include those for 'ecosystem services', 'ecosystem function' 'benefits' and 'well-being' – as well as the service categories like 'provisioning', 'regulating' and 'cultural'. These definitions are covered in the discussion of the cascade model (Potschin and Haines-Young, 2014).

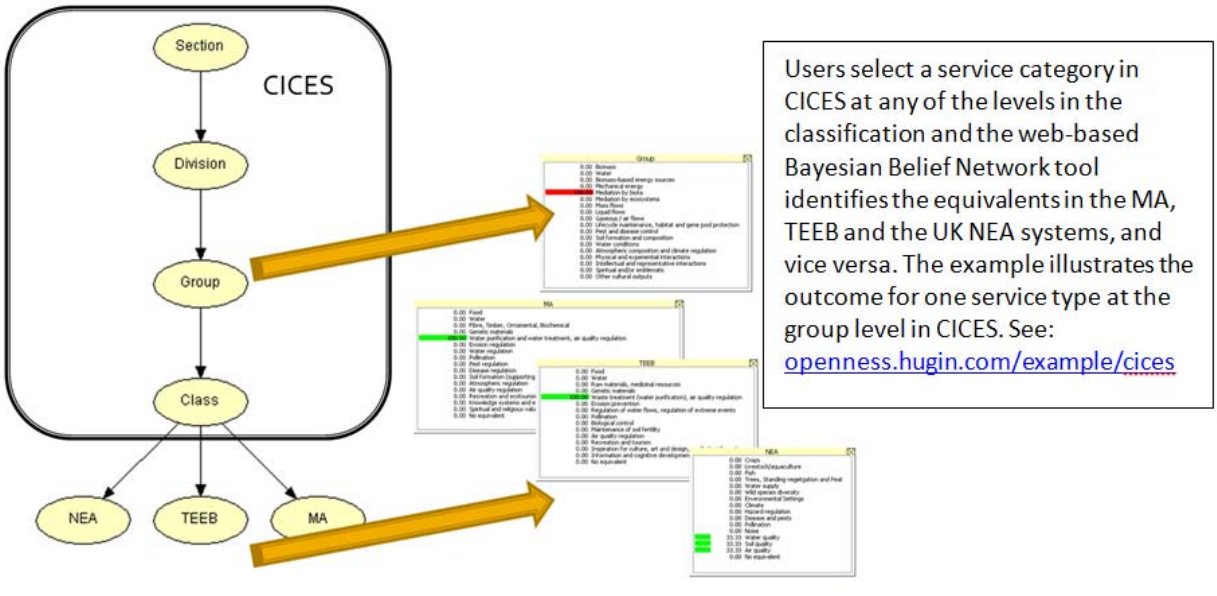
Relationship to the 'Four Challenges' being addressed by OpenNESS

Human well-being: If ways of measuring changes in well-being are to be developed then we need to understand how services map onto the different components of well-being via the benefits they generate. Hence a consistent set of classifications linking all aspects of the cascade are probably needed.	**Sustainable Ecosystem Management:** If ecosystem functioning is to be restored then we need a set of consistent metrics that measure service output; thus any classification of services has to support a consistent, tractable and responsive set of measures of service output that allow changes to be monitored over time.
Governance: The design and evaluation of regulatory frameworks and policies needs to be based on a clear and measurable set of targets so that progress towards policy or management goals can be measured. This will require a consistent and accepted typology of services which is defendable in the public arena.	**Competiveness:** Advocates of the importance of ecosystem services to the green economy suggest that investment in natural capital can assist in the development of new economic sectors and activities. Thus a 'mapping' of services onto economic sectors and activities is important if fully integrated economic and environmental accounting is to be developed and implemented. This will require the careful alignment of different classification systems. Gains and losses of competitiveness is also dependent on understanding the trade-offs between sectors. Trade-off analysis will require consistent definitions and classification typologies if it is to be effective and defendable.

A typology translator is available via the HUGIN website at: http://openness.hugin.com/example/cices

The CICES classification is set up as the "working classification" for the OpenNESS project. Not everyone will be completely satisfied with each part of the classification or will need it in such detail. Also, there are studies which already have used other classifications, especially those of the MA. This is permissible as long as these can be translated again into the CICES classification, which also requires that participants are aware of the latter classification in order to assess data in a manner that allows such translation. An illustration of the web-based tool based on the HUGIN Expert Bayesian Belief Network software, that uses CICES to translate between different classifications systems, is shown in Figure 1. This tool is now being extended to allow the inclusion of national implementations of CICES such as that made in Belgium (CICES-Be).

Fig. 1: Web-based tool for translating between ecosystem service classifications based on CICES



Key Paper

Executive Summary in: Haines-Young, R. and Potschin, M. (2013): Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012. EEA Framework Contract No EEA/IEA/09/003. Download at www.cices.eu and spread sheet.

Background and Cited Papers

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Appendix Table 1: (Comparison of CICES, the MA and TEEB Classifications – adapted from MAES, 2012)

CICES for ecosystem service mapping and assessment					
CICES for ecosystem accounting					
Section	**Division**	**Group**	**Class**	**MA**	**TEEB**
This column lists the three main categories of ecosystem services	***This column divides section categories into main types of output or process.***	***The group level splits division categories by biological, physical or cultural type or process.***	***The class level provides a further sub-division of group categories into biological or material outputs and bio-physical and cultural processes that can be linked back to concrete identifiable service sources.***	***MA provides a classification that is globally recognised and used in sub global assessments.***	***TEEB provides an updated classification, based on the MA, which is used in on-going national TEEB studies across Europe.***
Provisioning	Nutrition	Biomass	Cultivated crops	Food	Food
			Reared animals and their outputs		
			Wild plants, algae and their outputs		
			Wild animals and their outputs		
			Plants and algae from in-situ aquaculture		
			Animals from in-situ aquaculture		
		Water	Surface water for drinking	Water	Water
			Ground water for drinking		
	Materials	Biomass	Fibres and other materials from plants, algae and animals for direct use or processing	Fibre, Timber, Ornamental, Biochemical	Raw materials, medicinal resources
			Materials from plants, algae and animals for agricultural use		
			Genetic materials from all biota	Genetic materials	Genetic materials
		Water	Surface water for non-drinking purposes		
			Ground water for non-drinking purposes		
	Energy	Biomass-based energy sources	Plant-based resources		
			Animal-based resources		
		Mechanical energy	Animal-based energy		

Appendix Table 1, cont. (Comparison of CICES, the MA and TEEB Classifications – adapted from (MAES, 2012)

CICES for ecosystem service mapping and assessment

CICES for ecosystem accounting

Section	Division	Group	Class	MA	TEEB
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	Bio-remediation by micro-organisms, algae, plants, and animals	Water purification and water treatment, air quality regulation	Waste treatment (water purification), air quality regulation
			Filtration/sequestration/storage/accumulation by micro-organisms, algae, plants, and animals		
		Mediation by ecosystems	Filtration/sequestration/storage/accumulation by ecosystems		
			Dilution by atmosphere, freshwater and marine ecosystems		
			Mediation of smell/noise/visual impacts		
	Mediation of flows	Mass flows	Mass stabilisation and control of erosion rates	Erosion regulation	Erosion prevention
			Buffering and attenuation of mass flows		
		Liquid flows	Hydrological cycle and water flow maintenance	Water regulation	Regulation of water flows, regulation of extreme events
			Flood protection		
		Gaseous / air flows	Storm protection		
			Ventilation and transpiration		
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	Pollination and seed dispersal	Pollination	Pollination
			Maintaining nursery populations and habitats		
		Pest and disease control	Pest control	Pest regulation	Biological control
			Disease control	Disease regulation	
		Soil formation and composition	Weathering processes	Soil formation (supporting services)	Maintenance of soil fertility
			Decomposition and fixing processes		
		Water conditions	Chemical condition of freshwaters		
			Chemical condition of salt waters		
		Atmospheric composition and climate regulation	Global climate regulation by reduction of greenhouse gas concentrations	Atmospheric regulation	
			Micro and regional climate regulation	Air quality regulation	Air quality regulation

Appendix Table 1, cont. (Comparison of CICES, the MA and TEEB Classifications – adapted from (MAES, 2012)

CICES for ecosystem service mapping and assessment					
CICES for ecosystem accounting					
Section	**Division**	**Group**	**Class**	**MA**	**TEEB**
Cultural	Physical and intellectual interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Physical and experiential interactions	Experiential use of plants, animals and land-/seascapes in different environmental settings	Recreation and ecotourism	Recreation and tourism
			Physical use of land-/seascapes in different environmental settings		
		Intellectual and representative interactions	Scientific	Knowledge systems and educational values,	Inspiration for culture, art and design, aesthetic information
			Educational		
			Heritage, cultural		
			Entertainment		
			Aesthetic		
	Spiritual, symbolic and other interactions with biota, ecosystems, and land-/seascapes [environmental settings]	Spiritual and/or emblematic	Symbolic	Spiritual and religious values	Information and cognitive development
			Sacred and/or religious		
		Other cultural outputs	Existence		
			Bequest		

Appendix Table 2: Accompanying classification of abiotic outputs from natural systems (Provisional)

Section	Division	Group	Examples
Abiotic Provisioning	Nutritional abiotic substances	Mineral	e.g. salt
		Non-mineral	e.g. sunlight
	Abiotic materials	Metallic	e.g. metal ores
		Non-metallic	e.g. minerals, aggregates, pigments, building materials (mud/clay)
	Energy	Renewable abiotic energy sources	e.g. wind, waves, hydropower
		Non-renewable energy sources	e.g. coal, oil, gas
Regulation & Maintenance by natural physical structures and processes	Mediation of waste, toxics and other nuisances	By natural chemical and physical processes	e.g. atmospheric dispersion and dilution; adsorption and sequestration of waters in sediments; screening by natural physical structures
	Mediation of flows by natural abiotic structures	By solid (mass), liquid and gaseous (air)flows	e.g. protection by sand and mud flats; topographic control of wind erosion
	Maintenance of physical, chemical, abiotic conditions	By natural chemical and physical processes	e.g. land and sea breezes; snow
Cultural settings dependent on abiotic structures	Physical and intellectual interactions with land-/seascapes [physical settings]	By physical and experiential interactions or intellectual and representational interactions	e.g. caves
	Spiritual, symbolic and other interactions with land-/seascapes [physical settings]	By type	e.g. sacred rocks or other physical structures or spaces