Common International Classification of Ecosystem Services (CICES): 2011 Update

European Environment Agency

Paper prepared for discussion at the expert meeting on ecosystem accounts organised by the UNSD, the EEA and the World Bank, London, December 2011

Contract No: No. EEA/BSS/07/007, November 2011

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Executive Summary

The aim of this discussion paper is to review the proposal for a Common International Standard for Ecosystem Services (CICES) made to the United Nations Statistical Division (UNSD) to the in 2010, as part of the revision of the System of Environmental-Economic Accounting (SEEA).

The development of the CICES took note of the considerable body of work that exists in relation to the development of typologies for describing ecosystem services the standards describing economic products and activities. The goal was to propose a standard classification of ecosystem services would both be consistent with accepted categorisations and conceptualisations and allow the easy translation of statistical information between different applications.

Although the original aim for developing CICES was to facilitate the more consistent use of data in constructing ecosystem accounts, recent developments suggest that the classification may have a wider role. It may assist, for example, in linking work on the development of environmental accounts with the more general discussion of how natural capital stocks and flows can be characterised and assessed.

In this paper a number of issues surrounding the application of CICES are considered, in relation to: the analysis of scale and the spatial relationships between supply and demand for ecosystem services; the use of renewability as a boundary condition for the classification; the differentiation of ecosystem goods from ecosystem services; and, the role of CICES in ecosystem capital accounting frameworks. The following issues are then posed for discussion:

- *To what extent is the hierarchical structure of CICES suitable for meeting the requirements for analysis at different spatial and thematic scales of resolution?*
- *To what is the hierarchical structure of CICES able to support the analysis and reporting of changes in the value of different kinds of good generated by ecosystem services?*
- *Does the criterion of renewability remain an appropriate boundary condition for defining the scope of CICES?*
- *Is the present structure of CICES necessary and/or sufficient to support the implementation and testing of the experimental ecosystem capital accounting framework?*

Background

1. The Common International Classification of Ecosystem Services (CICES) was proposed in 2009 as a way of naming and describing ecosystem services (see Haines-Young et al. 2010). It arose from a meeting hosted by the European Environment Agency as part of their work on the development of land and ecosystem accounts.

2. It was noted that many groups and organisations were working on aspects of ecosystem services and that while the classification used in the Millennium Ecosystem Assessment (MA, 2005) was widely employed and acknowledged, there were also differences emerging in the way services were grouped and named. For example, while the classification proposed for the study on The Economics of Ecosystems and Biodiversity (TEEB) used the familiar provisioning, regulating and cultural groups, a new category 'habitat services' was introduced. Elsewhere in the literature other typologies were being debated (e.g. Wallace 2008; Costanza, 2008; Fisher and Turner, 2008) and it was suggested that multiple classifications are perhaps necessary to take account of spatial relationships between the source of the service and the beneficiaries, and the degree to which users can be excluded or can complete for the service. Subsequently, national studies, intended as 'sub-global assessments' that follow the MA approach, have used classification frameworks that diverge from the original schema (e.g. UK National Ecosystem Assessment, 2011).

3. It is recognised that a diversity of approach is probably necessary, given the novelty of the field and the complexity of defining ecosystem services and the ecological functions that underpin them. However, the use of multiple classifications continues pose a problem. Two stand out as significant:

    a. ***That comparison between studies and assessments are more difficult***: As the number of valuation studies has grown, the need to understand better how estimates at different places compare to each other has increased. Value transfer studies, for example, depend fundamentally on being able to make comparisons between different situations in clear and reproducible ways. A common reference standard for the naming and definition of ecosystem services may make this easier.

    b. ***That integration of service assessments with other data is more difficult:*** This was the issue that initially prompted the discussions that lead to the proposal for CICES. There is at present considerable international effort directed towards revising the System of Environmental-Economic Accounting (SEEA), first outlined in 2003. As part of this work the United Nations Statistical Division (UNSD) has commissioned a UN Committee of Experts on Environmental-Economic Accounting (UNCEEA) to develop "Experimental Ecosystem Accounts". The goal is to circulate a draft for global consultation in mid-2012 and prepare a final draft for endorsement by the United Nations Statistical Commission in February 2013. If the successful integration of ecosystem services into such accounts is to be achieved, however, then there needs to be consistency between countries in defining and naming elements of the accounts. More importantly, there needs to be a clear understanding of how particular services, or groups of services, related to other data such as that describing the economic activity or the products generated by economic activity, each of which has their own standard nomenclature.

4. The development of CICES has therefore taken note of the considerable body of work that exists in relation to the development of typologies for describing ecosystem services, and the development standards for describing economic products and activities. The goal has been to propose a new standard classification of ecosystem services that is both consistent with accepted categorisations and allows easy translation of statistical information between different applications. Following the initial discussions in 2009 led by the EEA, an e-forum on CICES was hosted between November 2009 and January 2010[1]. This was designed to enable a wider international audience to comment on the issues relating to the proposal. Over 150 people registered for the forum; participants were mainly invited members from the international community of researchers dealing with ecosystem services, environmental statisticians and policy customers.

5. As a result of the feedback gained from the CICES e-forum, a revised proposal was prepared and presented to the UNCEEA Committee in June 2010. The consultation has continued, and this paper has been prepared as an update for the expert meeting on ecosystem accounts hosted by the UK Office for National Statistics (ONS) and the Department for Environment, Food and Rural Affairs (DEFRA), on behalf of UNSD, the EEA and the World Bank, December 2011.

CICES: Definitions, Structure and Rationale

6. For the purposes of CICES, ecosystem services are defined as the contributions that ecosystems make to human well-being. They are seen as arising from the interaction of biotic and abiotic processes, and refer specifically to the 'final' outputs or products from ecological systems. That is, the things directly consumed or used by people. Following common usage, the classification recognises these outputs to be provisioning, regulating and cultural services, but it does not cover the so-called 'supporting services' originally defined in the MA. The supporting services are treated as part of the underlying structures, process and functions that characterise ecosystems. Since they are only indirectly consumed or used, and may simultaneously facilitate the output of many 'final outputs', it was considered that they were best dealt with in environmental accounts, in other ways.

7. A hierarchical structure is proposed for CICES. At the highest level are the three familiar 'service themes' of provisioning, regulating and maintenance, and cultural; below that are nested nine principle classes of service. This basic structure is shown in **Table 1**, which also illustrates how the CICES grouping of services relates to the classification used in TEEB (The Economics of Ecosystems and Biodiversity, see: http://www.teebweb.org/).

8. **Table 1** shows that it is relatively straightforward to cross-reference the TEEB categories with the CICES classes. The labels of the classes used in CICES have been selected to be as generic as possible, so that other more specific or detailed categories can progressively be defined, according to the interests of the user. Thus the TEEB categories 'raw materials', 'genetic', 'medicinal' and 'ornamental' resources could be sub-classes of the CICES 'materials class'.

9. The structure for CICES below the class level is shown in **Table 2**, with twenty three 'service groups' and fifty nine 'service types' being proposed. **Box 1** provides the formal definitions of the service themes and classes and the rationale that underpins them.

[1] see www.cices.eu for the archive of the discussions.

Table1: CICES Basic Structure and Relationship of Classes to TEEB Classification.

CICES Theme	CICES Class	TEEB Categories			
Provisioning	**Nutrition**	Food	Water		
	Materials	Raw Materials	Genetic resources	Medicinal resources	Ornamental resources
	Energy				
Regulating and Maintenance	**Regulation of wastes**	Air purification	Waste treatment (esp. water purification)		
	Flow regulation	Disturbance prevention or moderation	Regulation of water flows	Erosion prevention	
	Regulation of physical environment	Climate regulation (incl. C-sequestration)	Maintaining soil fertility		
	Regulation of biotic environment	Gene pool protection	Lifecycle maintenance	Pollination	Biological control
Cultural	**Symbolic**	Information for cognitive development			
	Intellectual and Experiential	Aesthetic information	Inspiration for culture, art and design	Spiritual experience	Recreation & tourism

10. Several features of the structure of the CICES classification scheme should be noted:

    a. ***Both biotic and abiotic outputs from ecosystems are included in the schema***: If ecosystems are defined in terms of the interaction between living organisms and their abiotic environment then it could be argued that an the generation of an ecosystem service must involve living processes (i.e. show **dependency** on biodiversity) (cf. Fisher and Turner, 2008). According to this strict definition, abiotic ecosystem outputs such as salt, wind and snow, for example, would not be included in the schema. The CICES consultation in 2009-10 has suggested, however, that there was support for including both biotic and abiotic ecosystem outputs in the classification. Thus under the Provisioning theme there are separate classes for biotic and abiotic materials, and for renewable biotic and abiotic energy sources. A similar type of distinction is made under the regulation and maintenance theme.

    b. ***The 'regulation and maintenance' theme includes 'habitat services':*** The main difference between the CICES and TEEB classifications is in the treatment of 'habitat services'. While TEEB identifies them as a distinct grouping at the highest level, CICES regards them as part of a broader 'regulating and maintenance' theme. It is proposed that they form a sub-class that captures aspects of natural capital that are important for the regulation and maintenance of 'biotic' conditions in ecosystems (e.g. pest and disease control, pollination, gene-pool protection etc.), and are equivalent to other biophysical factors that regulate the ambient conditions such as climate regulation.

Box 1: Definition of CICS Themes and Classes

Provisioning	*Includes all material and energetic outputs from ecosystems; they are tangible things that can be exchanged or traded, as well as consumed or used directly by people in manufacture. Both biotic and abiotic outputs are covered, but in the context of material outputs those derived from sub-soil assets (e.g. minerals) are excluded. Similarly, in the context of energy outputs, sub-soil assets such as coil and oil are excluded.* *Within the Provisioning Service Theme, three major **Classes** of Services are recognised:* • ***Nutrition*** *includes all ecosystem outputs that are used directly or indirectly for as foodstuffs (including potable water)* • ***Materials*** *(both biotic and abiotic) that are used in the manufacture of goods* • *Biotic and Abiotic renewable **Energy** sources* *Within the Provisioning Services Classes, additional **Types** and **Sub-types** may be recognised. The classification allows the distinction between ecosystem outputs that are used mainly for subsistence or for exchange in markets.*
Regulating and Maintenance	*Includes all the ways in which ecosystems control or modify biotic or abiotic parameters that define the environment of people, i.e. all aspects of the 'ambient' environment; these are ecosystem outputs that are not consumed but affect the performance of individuals, communities and populations and their activities.* *Within the Regulating and maintenance Theme, four major **Classes** of Services are recognised:* • ***Regulation and remediation of wastes****, arising naturally or as a result of human action* • ***Flow regulation****, which covers all kinds of flows in solid, liquid or gaseous mediums.* • ***Regulation of physical environment****, including climate at global and local scales* • ***Regulation of biotic environment****, including habitat regulation and maintenance, through such phenomena as pest and disease regulation, and the nursery functions that habitats have in the support of provisioning services etc.* *Within the Regulation and Maintenance Classes, additional **Types** and **Sub-types** may be recognised. The classification allows these to be distinguished by process and whether the processes operate 'in situ' or 'ex situ'.*
Cultural and Social	*Includes all non-material ecosystem outputs that have symbolic, cultural or intellectual significance* *Within the Cultural or Social Service Theme, two major **Classes** of Services are recognised:* • ***Symbolic*** • ***Intellectual and Experiential*** *Within the Cultural Class, additional **Types** and **Sub-types** may be recognised. The classification allows these to be distinguished using criteria such as whether it involves physical or intellectual activity*

Table 2: The CICES Classification (V3, 2011)

Theme	Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Provisioning	**Nutrition**	**Terrestrial plant and animal**	Commercial cropping	eg. by crops	Cereals, vegetables, vines etc.
			Subsistence cropping	eg. by crops	Cereals, vegetables, vines etc.
			Commercial animal production	eg. by animal	Sheep, cattle for meat and dairy products
			Subsistence animal production	eg. by animal	Sheep, cattle for meat and dairy products
			Harvesting wild plants and animals for food	eg. by resource	Berries, fungi etc
		Freshwater plant and animal	Commercial fishing (wild populations)	eg. by fishery	By species
			Subsistence fishing	eg. by fishery	By species
			Aquaculture	eg. by fishery	By species
			Harvesting fresh water plants for food	eg. by resource	Water cress
		Marine plant and animal	Commercial fishing (wild populations)	eg. by fishery	Includes crustaceans
			Subsistence fishing	eg. by fishery	Includes crustaceans
			Aquaculture	eg. by fishery	Includes crustaceans
			Harvesting marine plants for food	eg. by resource	Seaweed
		Potable water	Water storage	eg. by feature	Spring, well water, river, reservoir, lake
			Water purification	eg. by habitat	Wetlands
	Materials	**Biotic materials**	Non-food plant fibres	eg. by resource	Timber, straw, flax
			Non-food animal fibres	eg. by resource	Skin, bone etc., guano
			Ornamental resources	eg. by resource	Bulbs, cut flowers, shells, bones and feathers etc. (Stones? Gems?)
			Genetic resources	eg. by resource	Wild species used in breeding programmes
			Medicinal resources	eg. by resource	Bio prospecting activities
		Abiotic materials	Mineral resources		Salt, aggregates, etc. (EXCLUDE subsurface assets)
	Energy	**Renewable biofuels**	Plant based resources	eg. by resource	Wood fuel, energy crops etc.
			Animal based resources	eg. by resource	Dung, fat, oils
		Renewable abiotic energy	Wind	eg. by resource	
			Hydro	eg. by resource	
			Solar	eg. by resource	
			Tidal	eg. by resource	
			Thermal	eg. by resource	

Table 2: The CICES Classification (V3), cont.

Theme	Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Regulation and Maintenance	Regulation of wastes	Bioremediation	Remediation using plants	eg. by method	Phytoaccumulation, phytodegredation, phytostabilisation, rhizodegradation,
			Remediation using micro-organisms	eg. by method	In situ (Bioremediation), ex situ (composting), bioreactors
		Dilution and sequestration	Dilution	eg. by method	Wastewater treatment
			Filtration	eg. by method	Filtration of particulates and aerosols
			Sequestration and absorption	eg. by method	Sequestration of nutrients in organic sediments, removal of odours
	Flow regulation	Air flow regulation	Windbreaks, shelter belts	eg. by process	
			Ventilation	eg. by process	
		Water flow regulation	Attenuation of runoff and discharge rates	eg. by process	Woodlands, wetlands and their impact on discharge rates
			Water storage	eg. by process	Irrigation water
			Sedimentation	eg. by process	Navigation
			Attenuation of wave energy	eg. by process	Mangroves
		Mass flow regulation	Erosion protection	eg. by process	Wetlands reducing discharge peak
			Avalanche protection	eg. by process	Stabilisation of mudflows, erosion protection [reduction]
	Regulation of physical environment	Atmospheric regulation	Global climate regulation (incl. C-sequestration)	eg. by process	Atmospheric composition, hydrological cycle
			Local & Regional climate regulation	eg. by process	Modifying temperature, humidity etc.; maintenance of regional precipitation
		Water quality regulation	Water purification and oxygenation	eg. by process	Nutrient retention in buffer strips etc. and translocation of nutrients
			Cooling water	eg. by process	For power production
		Pedogenesis and soil quality regulation	Maintenance of soil fertility	eg. by process	Green mulches; n-fixing plants
			Maintenance of soil structure	eg. by process	Soil organism activity
	Regulation of biotic environment	Lifecycle maintenance & habitat protection	Pollination	eg. by process	By plants and animals
			Seed dispersal	eg. by process	By plants and animals
		Pest and disease control	Biological control mechanisms	eg. by process	By plants and animals, control of pathogens
		Gene pool protection	Maintaining nursery populations	eg. by process	Habitat refuges
Cultural	Symbolic	Aesthetic, Heritage	Landscape character	eg. by resource	Areas of outstanding natural beauty
			Cultural landscapes	eg. by resource	Sense of place
		Spiritual	Wilderness, naturalness	eg. by resource	Tranquillity, isolation
			Sacred places or species	eg. by resource	Woodland cemeteries, sky burials
	Intellectual and Experiential	Recreation and community activities	Charismatic or iconic wildlife or habitats	eg. by resource	Bird or whale watching, conservation activities, volunteering
			Prey for hunting or collecting	eg. by resource	Angling, shooting, membership of environmental groups and organisations
		Information & knowledge	Scientific	eg. by resource	Pollen record, tree ring record, genetic patterns
			Educational	eg. by resource	Subject matter for wildlife programmes and books etc.

11. ***That the service descriptors become progressively more specific at lower levels:*** A key feature of the classification is its hierarchical structure. The feedback gained during the consultation on CICES suggested that the naming of the higher levels should be as generic and neutral as possible. Thus 'regulation of flows' is suggested, for example, as opposed to 'regulation of hazards'. The assumption is that users would then identify the specific services that they are dealing with as 'types' and 'subtypes', and use the hierarchal structure to show where the focus of their work lies, or aggregate measurement into the broader groupings for reporting or for making comparisons.

Developing and applying CICES

12. In support of the original proposal for CICES and analysis was made of the relationship between the structure of the classification and the international standards used to describe products (The UN Common Products Classification, CPC-V2), economic activities (International Standard Industrial Classification of All Economic Activities, ISIC-V4), and consumption (Classification of Individual Consumption by Purpose, COICOP). Subsequent discussion suggests that the cross-referencing with the classification of products (CPC-V2) is likely to be the most useful in potentially linking ecosystem service and economic accounts.

13. Apart from the initial cross-comparison of CICES and the various international standards no further test of the compatibility of the different classification systems has been made, pending the development of the "experimental ecosystem accounts" themselves. However, from the discussion that has taken place in the interim, it is clear that the potential value of CICES does not rest entirely with this one, narrow accounting need. It is apparent that CICES may have a useful role in bridging work on the development of environmental accounts with the more general discussion of how natural capital stocks and flows can be characterised and assessed.

Scale and the Spatial Relationships between Supply and Demand

14. Although there has been attempt to design the CICES Groups and Classes so that they are at roughly the level of thematic resolution, it is clear from the more general body of work on ecosystem services that question linked to thematic and spatial scales are amongst the most difficult to tackle in making any assessments. The level of generality needed by decision makers may be different at different spatial scales. Moreover, as the size of the assessment area increases, the mix of services that has to be considered in any trade-off analysis, for example, may change. Finally, the extent to which the ecosystems providing a service and those who benefit are 'co-located' with also vary with spatial scale and this may change conclusions about the adequacy of service outputs and the values that might ultimately be assigned to them. Thus in looking to the development and application of CICES, it is important to clarify how questions of scale might be handled.

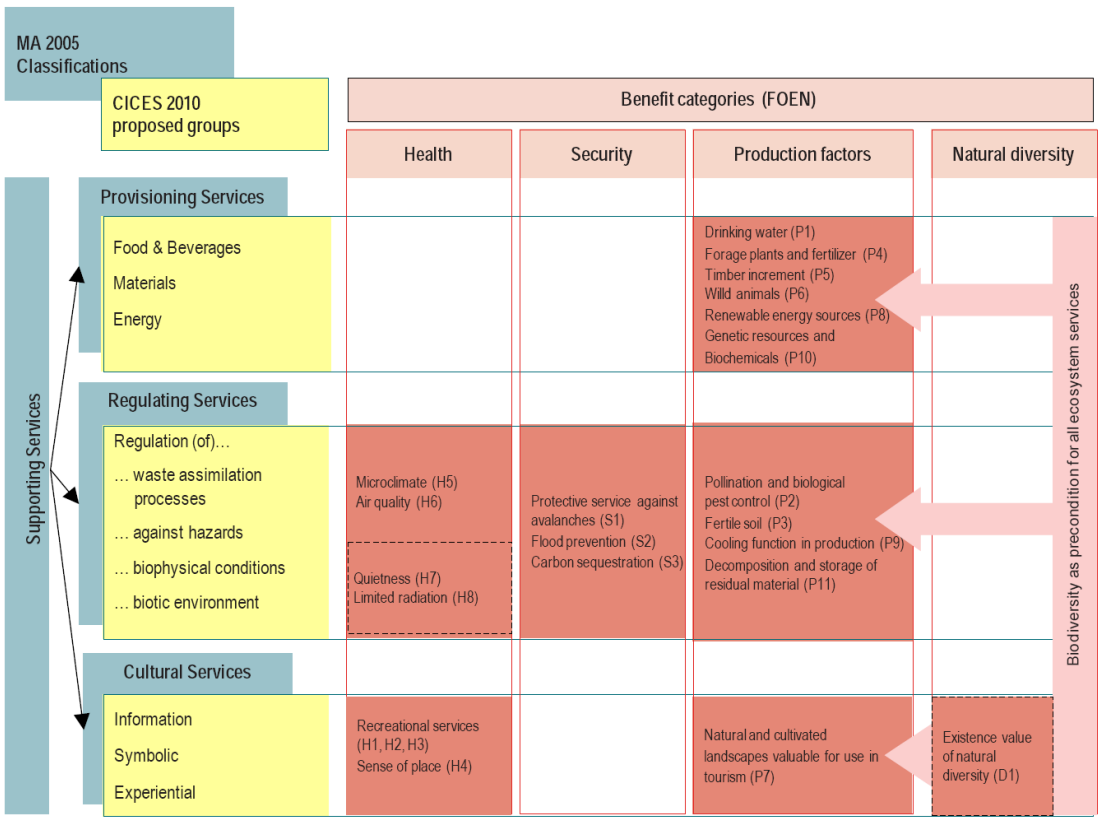
15. The hierarchal structure of CICES is helpful in handling some of challenges that arise in relation to spatial scale. Accounts, like more general assessments, have to be based on a well-defined and credible metrics which are often specific to particular geographical or situations or ecosystem types. For the purposes of reporting or comparison these may need to be aggregated and generalised. Thus the hierarchical structure allows users to go down to the most appropriate level of detail required to design a robust indicator. In general, as we move to local scales, more thematically specific measures at lower levels in the CICES structure would be needed. However,

there is no assumption that in any particular application all services would have to be considered at the same level in the hierarchy. Indeed, it may well be that while provisioning services could be looked at in detail at fine spatial scales, the assessment or measurement of many of the regulating services may only make sense at the scale of whole landscapes or regions, and some kind of allocation on a per unit area basis may be appropriate.

16. In terms of the spatial relationships between the supply of a service and the beneficiaries, CICES is neutral about what particular measures are used to represent a service, and whether these refer to supply or demand. Thus, under Flow Regulation, for example, for wave attenuation one may use mangrove area to calculate 'supply side' measure of the contribution that this habitat type makes to coastal protection, in areas that would otherwise be vulnerable. Alternatively, one my use estimates of the 'populations protected and at risk' to gain a better picture of the demand for this service. To the extent that accounts and assessments in general need to take a view of both supply and demand, then it seems to follow that two distinct analyses are needed and that these may not cover the same geographical area. For accounting purposes, some estimate of the import and export of services may, in fact, be needed. The implication in terms of applying CICES is that while the classification can potentially support the analysis of supply and demand, whatever metric is selected, users should be clear about what aspect is being represented.

Figure 1: Relationship between CICES classification and the services and benefits recognised in the Swiss Federal Office for the Environment (FOEN) (after, Staub et al. 2011)

Interpretation assistance: for example, the FEGS "Natural supply of ground and service water usable as drinking and process water" (P1), which is assigned in the FOEN Inventory (red) to the "Factors of production", is coded in the MA class (blue) "Provisioning services". This class is also found in the CICES (yellow), although in a slightly altered form, with the subgroups food and drinking water, materials and energy. The FEGS P1 can also be assigned to this CICES class.



17. An understanding demand and supply relationships is at the core of the ecosystem service paradigm, and it is unlikely that the complexities can be solved by means of a classification framework such as CICES. However, classification systems like CICES can clearly contribute to resolving some of the analytical challenges. An illustration of what might be achieved, is provided by the recent study from the Swiss Federal Office for the Environment (FOEN) (Staub et al. 2011), which aimed to develop proposals for operationalising an 'Inventory of Final Ecosystem Goods and Services' (FEGS). Figure 1, which has been reproduced from the study shows how the services included in the inventory relate to the MA and CICES classes, and in particular how they link to the various benefit categories considered to be important by FOEN. The diagram is of interest because it shows how metrics selected as relevant in a particular application can be 'located' in relation to broader ecosystem service categories using CICES, and how they can be used to express the way these services relate to 'needs', expressed in terms of the different benefit groupings. In this particular study the metrics covered supply and demand, in the sense that the suite of indicators proposed measure use as well as well as output. It is proposed that they could then be combined to create an Ecosystem Services Index that could be used alongside measures such as GDP in wider public debates and decision making.

- ***Issue for discussion:*** *To what extent is the hierarchical structure of CICES suitable for meeting the requirements for analysis at different spatial and thematic scales of resolution?*

Goods and Services

18. In the initial proposal for CICES it was suggested that following the MA, the terms 'goods' and 'services' would be used synonymously and that both referred to the final outputs from ecosystems. With the publication of the UK National Ecosystem Assessment (UK NEA), however, a different position on this terminology has subsequently emerged. Bateman et al. (2011a) and Mace et al. (2011) have argued that from an 'economic perspective' ecosystem services are 'contributions of the natural world which generate goods which people value'. Thus, *goods* are the things people value and services are the things ecosystems generate that give rise to them. For them, goods can include things that can be traded in markets as well as ecosystem outputs which have no market price; that is, goods can have both use and non-use values.

19. If we follow the terminology suggested by the UK NEA, then the implication for CICES would be something like the structure suggested in **Figure 2**. Application of the framework to create accounts, for example, would involve recording the output of final ecosystem services such as 'the standing crop (biomass) of trees' and cross referencing this to the value of the goods that can be realised from it, such as timber. As **Figure 2** also indicates, services may be valued in terms of sets of goods that refer to more than one component of 'total economic value' (TEV), Moreover, it should be noted that while the TEV framework is used, there is no implication that only monetized estimates of value might be used.

20. The motivation for developing CICES was the desire to link ecosystem service assessments to economic accounts. Clearly if services can be linked to economic products or activities then these can be viewed as 'goods' whose value is measured by their 'direct use' and so market-based estimates can be introduced into the accounts or the assessment using this kind of cross-linkage. However, it was never the intention to limit CICES to only those services for which market-based estimates of value could be made. As Box 1 shows, a distinction can be made between market-based and subsistence use.

Figure 2: Indicative relationship between CICES classification and types of value associated with ecosystem services

Services			Goods				
Theme	**Class**	**Group**	**Direct use**	**Indiect use**	**Option value**	**Bequest value**	**Existence Value**
Provisioning	Nutrition	Terrestrial plant and animal foodstuffs					
		Freshwater plant and animal foodstuffs					
		Marine plant and animal foodstuffs					
		Potable water					
	Materials	Biotic materials					
		Abiotic materials					
	Energy	Renewable biofuels					
		Renewable abiotic energy sources					
Regulation and Maintenance	Regulation of wastes	Bioremediation					
		Dilution and sequestration					
	Flow regulation	Air flow regulation					
		Water flow regulation					
		Mass flow regulation					
	Regulation of physical environment	Atmospheric regulation					
		Water quality regulation					
		Pedogenesis and soil quality regulation					
	Regulation of biotic environment	Lifecycle maintenance & habitat protection					
		Pest and disease control					
		Gene pool protection					
Cultural	Symbolic	Aesthetic, Heritage					
		Religious and spiritual					
	Intellectual and Experiential	Recreation and community activities					
		Information & knowledge					

Notes: Intensity of colour suggests what types of value might be associated with different types of good; although the 'total economic value' framework is used importance's can be assessed using biophysical parameters as well as monetized values.

21. As an example of how ecosystem assessments and accounts might usefully combine monetised market and non-market values, as well as non-monetized estimates of importance is provided in the scenario analysis of the UK NEA (Bateman et al., 2011b). **Figure 3** shows a comparison of the marginal monetized values of services between different future scenarios using the present situation as the base-line, as well as an estimate of their non-monetized impacts on biodiversity. The point that is being made in the UK NEA with these data is that according to the scenarios, future increases in market values could only be gained with the loss of nonmarket ecosystem services. Thus any policy decision should not be based on market values alone. Although environmental accounts are more concerned with the present than hypothetical futures, it is clear that if CICES is to be useful then it must cover ***all*** types of service, and not just those for which market-based estimates of value can be made.

22. Thus while the goal of CICES is to make a bridge between economic and environmental accounting, the classification can be used more generally as a way of bringing different aspects of value together into common accounting or assessment frameworks. **The distinction suggested in the UK NEA between services and goods seems to make this clearer and so it is proposed that this revised terminology is used in future discussions of CICES.**

    - ***Issue for discussion:*** *To what is the hierarchical structure of CICES able to support the analysis and reporting of changes in the value of different kinds of goods generated by ecosystem services?*

Figure 3: Summary impacts for the change from the 2000 baseline to 2060 under each of the UK NEA Scenarios for Great Britain (after Bateman et al. 2011b)

	GF High	GF Low	GPL High	GPL Low	LS High	LS Low	NS High	NS Low	NW High	NW Low	WM High	WM Low
	£millions p.a. (real values, £2010)											
Market agricultural output values*	590	220	-30	-290	430	350	1,200	680	-110	-510	880	420
Non-market greenhouse gas emissions†	-810	-800	2,410	2,410	570	-100	3,400	3,590	4,570	4,590	-1,680	-2,130
Non-market recreation‡	4,120	5,710	5,160	6,100	1,100	1,540	3,340	4,490	23,910	24,170	-820	5,040
Non-market urban greenspace¶	-1,960	-1,960	2,350	2,350	2,160	2,160	-9,940	-9,940	4,730	4,730	-24,000	-24,000
Total monetised values§	1,940	3,170	9,890	10,570	4,260	3,950	-2,000	-1,180	33,100	32,980	-25,620	-20,670
	Non-monetised impacts**											
Change in farmland bird species‡‡	0	0	0	0	0	0	-1	-1	-1	-1	0	0
Bird diversity (all species)††	++	++	++	++	-	-	++	+++	++	++	--	+
Rank: Market values only	4	8	9	11	5	7	1	3	10	12	2	6
Rank: All monetary values	8	7	4	3	5	6	10	9	1	2	12	11
Rank: positive monetary values & number farmland bird losses	6	5	2	1	3	4						
Rank: positive monetary values & biodiversity gains	4	3	2	1								

Notes: Scenarios are as follows: GF = *Go with the Flow*; GPL = *Green and Pleasant Land*; LS = *Local Stewardship*; NS = *National Security*; NW = *Nature@Work*; WM = *World Markets*. Each scenario has 'high' and 'low' emission impacts variants.

* Change in total GB farm gross margin.
† Change from baseline year (2000) in annual costs of greenhouse gas (greenhouse gas) emissions from GB terrestrial ecosystems in 2060 under the UK NEA Scenarios (millions £/yr); negative values represent increases in annual costs of greenhouse gas emissions.
‡ Annual value change for all of GB.
¶ Annuity value; negative values indicate losses of urban greenspace amenity value.
§ We acknowledge some double counting between urban recreation and urban greenspace amenity values. Further data is needed to correct for this.
** Note that some commentators prefer to use monetised values for biodiversity. See discussion in Chapter 22 of UK NEA Technical Report.
†† Based on relative diversity scores for all species.
‡‡ Expected impact on the mean number of species in the seeds and invertebrates guild (including many farmland bird species) present in each 10 km square in England and Wales from 1988 to 2060 (rounded to the nearest whole number)—the 2000 baseline has 19 species in this guild (See Bateman et al. 2011b for further details).

CICES and the place of renewable natural capital

23. In the discussions which led to the original proposal for CICES several a 'boundary' conditions were suggested for classification. It was proposed, for example that the classification should only cover 'renewable' biotic and abiotic assets. As subsequent discussions have highlighted, for example, the criterion of renewability is not as clear cut as it might seem; by designating a service as renewable does not imply that unconstrained use can occur. The issue arose, for example, in relation to citing peat as an example of a 'renewable biofuel', and the extent to which the classification appeared to endorse extraction.

24. The problem with renewable resources is that while, in principle, they can be re-generated, the process may require such a long time scale that in human terms they are, in effect, finite. Moreover, consumption of some proportion of the stock of the resource may actually damage or reduce its capacity to regenerate. This is clearly the situation for peat as a 'biofuel' at levels of extraction above those for subsistence. It also applies to the harvesting of many other

biologically generated resources, such as those that depend on the integrity of species populations or ecological communities.

25. In the experimental framework for ecosystem capital accounting proposed for Europe (Weber, 2011) the concept of the 'ecosystem resource accessible surplus' was used to describe the level of resources that can be used without jeopardising the capacity of the ecosystem to reproduce itself. With this concept in mind, we suggest that by describing a service as 'renewable' in CICES there is no implication that the service can be used without considering what the level of *sustainable* use is possible or appropriate. Indeed, it should be part of the purpose of ecosystem accounts to document levels of use and determine whether they are such that the integrity of a natural asset is being eroded. Thus as part of developing the ways to measure service output within CICES, there should be some consideration of how the level of 'accessible surplus' can be determined. However, this should be form part of the broader analysis based on CICES and not part of the classification itself.

    - ***Issue for discussion:*** *Does the criterion of renewability remain an appropriate boundary condition for defining the scope of CICES?*

CICES and ecosystem capital accounting frameworks

26. With the drafting of the experimental framework for ecosystem capital accounting (EFECA) proposed for Europe (Weber, 2011) it is possible to explore how CICES would support the future development of such framework. These 'capital accounts' are broader in scope than those dealing only with the 'final ecosystem services' described in CICES, and so it is important to clarify the role that CICES might play in such work.

27. The European EFECA seeks to represent the interactions between the economy and ecosystems in terms of a set of key indicators and aggregates that describe the consumption and replenishment of natural capital. To make progress in constructing such accounts and the associated indicators and it is proposed that the first implementation focuses on three groups of ecosystem services, namely accessible biomass/carbon, accessible water, and accessible regulating and cultural services. The underlying assumption in the construction of the accounts and the indicators is that for each of these service groups, the use must be lower than the accessible surplus and that there should not be significant trade-offs between them.

28. The important point to note about the EFECA proposal in relation to CICES is that while the three groups proposed reference the major service themes covered in the classification, they do <u>not</u> represent final services in the sense defined by CICES. The question arises, therefore, about the role of CICES in making such capital accounts operational.

29. A review of the EFECA suggests that there is a potentially close relationship between the structure of CICES and these capital accounts, in two respects, in terms of:

    a. ***Using the ecosystem services defined in CICES to construct aggregate measures that enter into the capital accounts:*** In the case of calculating the carbon balance, for example, the fraction of the net ecosystem productivity consumed is calculated as the sum of the ecosystem carbon extracted via harvesting of crops, animal products, timber, fish etc. Thus the CICES classification can be used to define systematically the way key measures relating to use of capital stocks are estimated.

b. ***Using capital account aggregates to measure the potential of ecosystems to deliver CICES services:*** For example, the aggregate for 'Net Ecosystem Accessible Fresh Water Surplus' sets the boundary conditions for the sustainable use of all the CICES services that depend on water as an intermediate or supporting factor. An analysis of the way the available water is distributed across the different uses can assist in understanding patterns of trade-off between different services, as well as the use of water in the services associated with different landscape or ecosystem types.

30. Thus the capital accounts can potentially be used to characterise the integrity of the natural capital stocks that underpin the output of the final services captured in the CICES classification, and to summarise the impacts of the use of ecosystem services in relation to the capacity of natural capital stocks for renewal.

- ***Issue for discussion:*** *Is the present structure of CICES necessary and/or sufficient to support the implementation and testing of the experimental ecosystem capital accounting framework?*

Conclusion and Next Steps

31. CICES has been put forward to meet a number of practical needs. The aim of this discussion paper is to review whether its structure remains sufficient both to support the development of integrated economic and environmental accounting frameworks, and to better ground such work in wider efforts to develop better decision support tools for the management of our natural capital. In proposing CICES as a standardised, the intention is not to create a fixed classification, but to develop a flexible structure that can accommodate different kinds of use. That structure now needs to be reviewed conceptually and tested empirically to determine whether using the present framework data from different areas of analysis can be brought together in an efficient, productive and parsimonious way.

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