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PROPOSAL FOR A COMMON INTERNATIONAL CLASSIFICATION OF ECOSYSTEM GOODS AND SERVICES (CICES) FOR INTEGRATED ENVIRONMENTAL AND ECONOMIC ACCOUNTING

Paper prepared by Centre for Environmental Management,
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*Background document**

* Report to the European Environment Agency.

Proposal for a Common International Classification of Ecosystem Goods and Services (CICES) for Integrated Environmental and Economic Accounting (V1)

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Report to the

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Executive Summary

1. The aim of this document is to propose a Common International Classification for Ecosystem Services (CICES). The need for CICES arises because despite recent efforts, there is no accepted definition or classification of ecosystem goods and services and as a result it is difficult to integrate and compare different data sources.

2. The proposal for CICES has been based on the proposition that any new classification has to be consistent with accepted typologies of ecosystem goods and services currently being used in the international literature, and compatible with the design of Integrated Environmental and Economic Accounting methods being considered in the revision of SEEA 2003.

3. **Ecosystem goods and services are defined here as the contributions that ecosystems make to human well-being, and arise from the interaction of biotic and abiotic processes**. Following the Millennium Ecosystem Assessment, the term 'services' is generally taken to include ***both*** goods and services. While this is a convenient short-hand, in this proposal we distinguish the material and energetic outputs from ecosystems as 'goods' and the non-material outputs as 'services'.

4. The general structure of CICES is shown in Table E.1, and described in more detail in Table E.2.

5. Three broad thematic categories are suggested as the basis of CICES. These cover the provisioning, regulating and cultural outputs from ecosystems. These widely recognised types of ecosystem output are further subdivided into nine generic classes, which nest into the major 'functions of natural capital' identified by the SEEA 2003 (Table E.1).

Table E.1: Relationship between the structure of CICES and functions of natural capital described in SEEA2003

CICES Theme	CICES Class	Correspondence to SEEA 2003 'functions' of natural capital
Provisioning	Nutrition	Resource function
	Materials	Resource function
	Energy	Resource function
Regulation and Maintenance	Regulation of wastes	Sink function
	Flow regulation	Service function (environmental quality)
	Regulation of physical environment	Service function (environmental quality)
	Regulation of biotic environment	Service function (environmental quality)
Cultural	Symbolic	Service function (amenity)
	Intellectual and Experiential	Service function (amenity)

Table E.2: Thematic, Class and Group Structure Proposed for CICES

Theme	Class	Group
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

6. The generic naming of the proposed groups allows CICES to be cross referenced to the existing standard classifications for activities and products used in the System of National Accounts, namely: the International Standard Industrial Classification of All Economic Activities (ISIC V4), the Central Products Classification (CPC V2), and the Classification of Individual Consumption by Purpose (COICOP). An indicative cross-tabulation for each of them is presented.

7. The cross tabulation of CICES groups with international standard classifications for products and activities assists in identifying the 'final outputs' of ecosystems, and potentially helps overcome the problem of 'double counting' in valuation studies. By focusing on 'final products' arising from ecosystems, the scheme does not cover supporting services, which are assumed to be embedded within each of the categories included in CICES.

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Proposal for a Common International Classification of Ecosystem Services (CICES) for Integrated Environmental and Economic Accounting

1. Introduction

The recent report of the US EPA Science Advisory Board (EPA, 2009) suggests that for ecosystem services to be readily and accurately valued then two things are essential. We must be able to identify relevant ecosystem services as a common list that can serve different purposes and that classification methodologies should follow some basic principles. They also argue that it is essential that classifications should help us avoid the problem of double counting and so provide the basis for accurate assessments and valuations. As a way forward it is proposed that the contributions ecosystems make to human well-being should be defined in terms that are both concrete terms and meaningful to those whose lives are affected by them.

It is against the background that the motivation for developing a consistent classification of ecosystem services is set. One approach to resolving the problems of identifying 'concrete outcomes', for example, would be to cross reference services with existing classifications of products or activities, so that the *contributions that ecosystems make* in the form of services can be better identified and quantified. The need for these better understandings is particularly important in the context of the on-going international efforts of develop approaches to Integrated Environmental and Economic Accounting, which are currently seeking to integrate current thinking about ecosystem services into the revision of the framework first published in 2003 (SEEA, 2003)[1].

This proposal has been built on an examination of the kinds of links can be made between classifications of ecosystem services and three existing UN standard classifications:

- International Standard Industrial Classification of All Economic Activities (ISIC V4).
- Central Products Classification (CPC);
- Classification of Individual Consumption by Purpose (COICOP) [2]; and,

It was found that for some types of ecosystem output a 'read-across' can be achieved between international classifications and that a basis probably exists to propose a new standard in this important new area.

The proposal made here has been informed by two sources. First, the discussions that took place at two international workshops on CICES hosted by the EEA in Copenhagen, December 2008 and 2009. Second, an e-forum organised on behalf of the EEA which ran from November 2009 to January 2010, which was designed to enable a wider international audience to comment on the issues relating to the CICES concept. Over 150 people registered for the forum; participants were invited members from the international community.

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[1] The revision was undertaken under the joint responsibility of the United Nations, Eurostat, IMF, OECD and the World Bank. Much of the work was done by the London Group on Environmental Accounting.

[2] Note there is a cross tabulation of COP and COCIP at http://unstats.un.org/unsd/cr/registry/regso.asp?Ci=7&Lg=1

2. Contexts and Constraints

The development of the CICES proposal has taken note of the considerable body of work that exists in relation to the classification of products and activities, and the development of typologies for ecosystem services. Any new standard classification of ecosystem services would have to both be consistent with accepted categorisations and conceptualisations and allow the easy translation of statistical information between different applications. The boundary conditions[3] in which the current work is set are described in Figure 1.

To develop accounts that are able to link our understandings of changes in ecosystem structures and processes to their economic consequences, there has to be some cross-tabulation of ecosystem services and land cover on the one hand and ecosystem services and classifications of products etc. on the other. The ambition is eventually to construct the classification in the 'CICES box' shown in Figure 1, that links land cover to products via services.

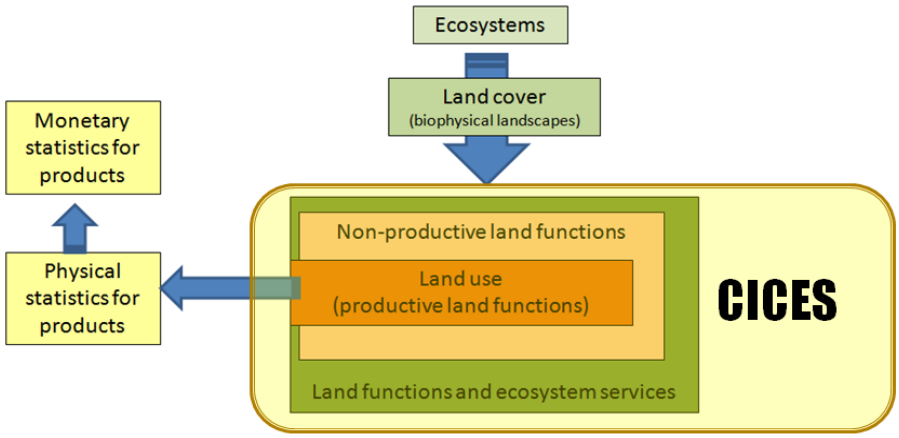

Figure 1: Conceptual framework for development of a common classification of ecosystem services

3. Classification of Ecosystem Services

The need for CICES arises because despite recent efforts, there is no accepted definition or classification of ecosystem services. While much of the current debate and usage has been framed around the ideas of the Millennium Ecosystem Assessment (MA), it is clear that other initiatives have approached these problems differently and suggested alternative ways of looking at the world.

[3] This framework has to be referenced as FAO & EEA, Land Cover and Land Use Classifications in the SEEA Revision, UNCEEA/4/11, Fourth Meeting of the UN Committee of Experts on Environmental-Economic Accounting, 24 - 26 June 2009, New York.

The Millennium Ecosystem Assessment defined ecosystem services simply as 'the benefits people obtain from ecosystems' (MA, 2005) and identified four main types of services:

- **Provisioning Services:** which cover material or energetic outputs from ecosystems, including food, water and other resources;
- **Regulating Services:** which cover factors that affect the ambient biotic and abiotic environment, such as flood and disease control;
- **Cultural Services:** which cover non-material (intellectual/cognitive/symbolic) uses, such as spiritual, recreational, and cultural benefits; and,
- **Supporting Services**, such as nutrient cycling and primary productivity, that maintain the conditions for life on Earth.

For ease of understanding, the MA considers all these benefits together as 'ecosystem services' because it is sometimes difficult to determine whether a benefit provided by an ecosystem is, in fact, a 'good' or a 'service'.

The MA-definition of a service has the advantage of being simple. However, its simplicity also leaves room for confusion and different interpretations. The TEEB-study[4], for example, states that there is a distinction between service and benefit. These authors argue that most services, like food, have multiple benefits; for food they include health, pleasure and sometimes even to cultural identity. Moreover, many benefits are the result of combining natural and human capital and so attributing them entirely to ecosystems

Table 1: Ecosystem Service-classification suggested through the TEEB Initiative (after De Groot et al., Ch1 in TEEB Assessment Report, in prep.)

	Main service-types
	PROVISIONING SERVICES
1	**Food** (e.g. fish, game, fruit)
2	**Water** (e.g. for drinking, irrigation, cooling)
3	**Raw Materials** (e.g. fibre, timber, fuel wood, fodder, fertilizer)
4	**Genetic resources** (e.g. for crop-improvement and medicinal purposes)
5	**Medicinal resources** (e.g. biochemical products, models & test-organisms)
6	**Ornamental resources** (e.g. artisan work, decorative plants, pet animals, fashion)
	REGULATING SERVICES
7	**Air quality regulation** (e.g. capturing (fine)dust, chemicals, etc)
8	**Climate regulation** (incl. C-sequestration, influence of veg. on rainfall, etc.)
9	**Moderation of extreme events** (e.g. storm protection and flood prevention)
10	**Regulation of water flows** (e.g. natural drainage, irrigation and drought prevention)
11	**Waste treatment** (esp. water purification)
12	**Erosion prevention**
13	**Maintenance of soil fertility** (incl. soil formation)
14	**Pollination**
15	**Biological control** (e.g. seed dispersal, pest and disease control)
	HABITAT SERVICES
16	**Maintenance of life cycles of migratory species** (incl. nursery service)
17	**Maintenance of genetic diversity** (esp. gene pool protection)
	CULTURAL SERVICES
18	**Aesthetic information**
19	**Opportunities for recreation & tourism**
20	**Inspiration for culture, art and design**
21	**Spiritual experience**
22	**Information for cognitive development**

would be misleading. Thus the TEEB-study suggests that ecosystem services should be defined as 'the direct and indirect ***contributions*** of ecosystems to human well-being'[5] (de Groot el al., in prep).

The typology of ecosystem goods and services that was developed as the basis for the TEEB study is shown in Table 1; this classification was based on the earlier work of Costanza et al. (1997), De Groot et al. (2002), MA (2005) and Daily et al. (2008), and is shown here because it is indicative of recent international discussions. It differs from the earlier MA classification in that it includes a new general group of 'Habitat Services'.

The TEEB typology, like the MA before it, was designed mainly to assist in making assessments and valuations of ecosystem goods and services, rather than as a framework that could link to other classification systems that are used in economic and environmental accounting. Nevertheless, an understanding of their structure is necessary because they embody many of the key concepts that any proposed standard would have to be built if it is to be accepted and used. In the later sections of this proposal we document how these frameworks can be developed. Before this is done, however, we must consider how natural capital is treated in SEEA2003.

4. Classifying natural capital in the SEEA2003

According to the SEEA2003[6], natural capital is generally considered to comprise three principal categories: natural resource stocks, land and ecosystems (see page 5 of SEEA, 2003). All are considered as essential for long-term sustainable development, and are significant in terms of the 'functions' or uses that they support either as part of the formal economy or outside it. Within SEEA2003, the three broad types of functions are identified, namely:

- **Resource functions** which cover natural resources drawn into the economy to be converted into goods and services for the benefit of humankind. Examples are mineral deposits, timber from natural forests, and deep sea fish;
- **Sink functions** which absorb the unwanted by-products of production and consumption; exhaust gases from combustion or chemical processing, water used to clean products or people, discarded packaging and goods no longer wanted. These waste products are vented into the air, water (including sea water) or are buried in landfill sites. These three destinations are often referred to as sinks; and,
- **Service functions** which provide the habitat for all living beings including mankind. Some aspects of habitat are essential, such as air to breathe and water to drink. These are called survival functions. If the quantity and quality of survival functions are diminished, biodiversity of species is threatened, not excluding the human species. Other service functions are not essential but improve the quality of life, for example by providing a pleasing landscape for leisure pursuits. These are called amenity functions and affect mankind only (or at least are the only ones measurable to us in human terms).

[5] Such a definition was also confirmed at an international expert workshop held at the EEA in 2008

[6] http://unstats.un.org/unsd/envAccounting/seea2003.pdf

Table 2: Read-across between SEEA2003 concept and ecosystem service categories

SEEA 2003	Translation	MA categories	Notes
Resource functions	Food, fibre and energy	**Provisioning**	**Include all material and energetic outputs from ecosystems**
Sink functions	Waste assimilation	**Regulating**	**Include all factors that control or modify biotic or aboitic 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. This broad category could also include the maintenance of habitats and populations, although TEEB suggests they are distinct services.**
Service functions	Environmental quality (air, water, hazard etc.)~ 'survival functions'		
	Amenity functions	**Cultural**	**Include all nom-material uses of ecosystem outputs that have symbolic, cultural or intellectual significance**

Although the terminology used in the SEEA differs from that used in contemporary debates about ecosystem services, these 'functional groups' clearly capture many of the important contributions that ecosystems make to human well-being. In fact, given the broad categorisation of services used in such studies as the MA and TEEB, it is possible to develop a simple 'read-across' to the functional breakdown used in the SEEA (Table 2).

A number of features are apparent in the cross-tabulation shown in Table 2 which have implications for developing a classification of goods and services that might link to the SEEA:

- **Resource Functions and Provisioning Services:** The SEEA group of 'resource functions' corresponds almost directly to notion of provisioning services used in the MA and elsewhere. In the ecosystem services literature, provisioning services are commonly understood to be the material and energetic outputs from ecosystems, which generally enter the economy when turned into other types of goods and or services through other forms of capital (human, cultural etc.). The notion of 'provisioning' also covers subsistence uses of the material and energetic outputs as well as those that enter 'the market', but this broader understanding does not undermine the equivalence with the SEEA. However, there is a major difference between the two categorisations in relation to their treatment of resources linked to **biodiversity** and **geodiversity.**

  If ecosystems are defined as the interaction between living organisms and their abiotic environment then it is generally argued that *ecosystem services have to be traceable back to some living process* (i.e. **dependent** on biodiversity) (cf. Fisher and Turner, 2008). Thus the notion of 'provisioning services', if strictly applied, would exclude many minerals and things like wind, snow or salt (i.e. elements of 'geodiversity'), and is a somewhat narrower concept than the SEEA grouping of 'resource functions'. It is clear, however, that not all commentators agree, and some (e.g. Brown et al., 2007) do regard non-renewable resources, such as rocks, minerals and fossil fuels as ecosystem goods.

*Thus in developing CICES a key decision to be made is whether the classification should (a) **restrictive** in the classification and only define something as a service if it were dependent on 'biodiversity'; OR (b) **inclusive** and cover non-living outputs from natural systems as services, in which case we could have subcategories of each service group that were 'dependent on biodiversity' or 'dependent on geodiversity'. Given the content of the current ecosystems service literature our initial proposal was that CICES should be restricted to those outputs dependent on biodiversity; our consultation suggested that most people felt that both biotic and abiotic elements outputs should be covered.*

- **Sink Functions and Regulating Services:** It is clear from Table 2 that the SEEA group of 'sink functions' correspond to only a subset of ecosystem outputs conventionally referred to as 'regulating services' by the MA and others. While the broad class of regulating services includes the capacity of ecosystems to absorb or process waste products it also takes in those contributions ecosystems make to human well-being by controlling the ambient environment (e.g. global and local scale climate regulation). In the SEEA these benefits of natural capital are covered in the 'service function' group, which includes the maintenance of 'environmental quality' in relation to air, water characteristics, and the protection against hazards.

  Thus in developing CICES, if we are to retain the broad classifications used in the SEEA and ecosystem services literature, some split within the regulating service group is needed to group services that broadly correspond to sink functions environmental quality functions in the SEEA so that an unambiguous correspondence between the various groupings can be established.

- **Service Functions and Cultural Services:** Table 2 suggests that there is a broad correspondence between the 'amenity functions' described in the SEEA and the idea of cultural services, as used in the wider ecosystem services literature. Both refer to natural capital or ecosystem outputs that have symbolic, cultural or intellectual significance for people. The main problem that seems to arise in developing a read-across between the groupings is the choice of the term 'service function' in the SEEA, which given current usage in the wider research and policy literatures may lead confusion.

  It is not the purpose of this document to suggest modifications to SEEA terminology. Nevertheless, if this categorisation of 'service functions' is to be maintained then the implication for CICES is that any grouping of cultural ecosystem services has to be constructed so that 'amenity functions' can be split out from those functions relating to environmental quality.

5. Designing a Common International Classification for Ecosystem Services.

To make assessment of ecosystem services consistent and compatible with the SEEA, the conceptual framework has to be clear and well defined. Much of the focus of recent debates has been to understand more clearly the nature of the contributions that ecosystem make, and in particular how to quantify them unambiguously. Figure 2 illustrates how the 'pathway' from ecosystems (left main box) to human wellbeing (right box) might be seen.

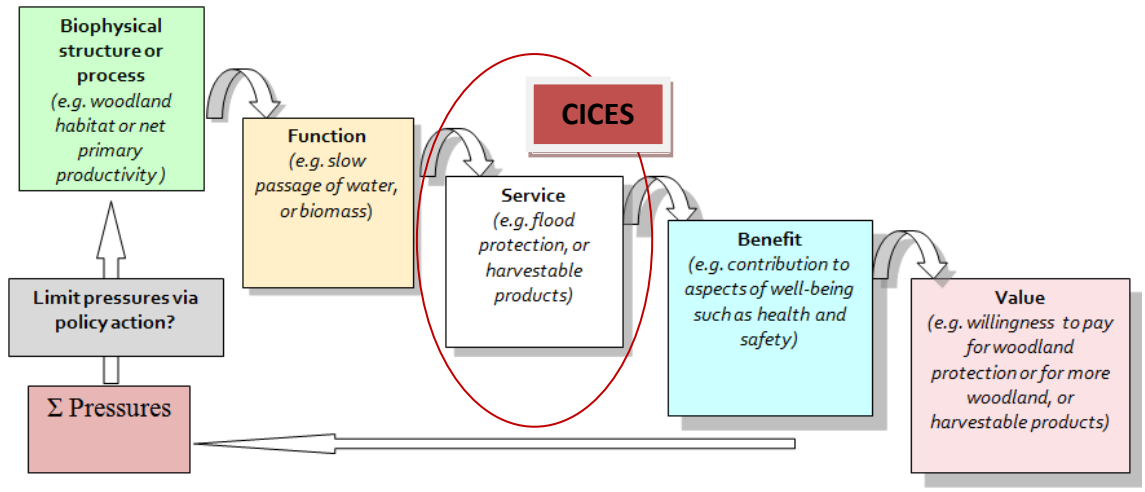

Figure 2: Defining ecosystem functions, services and benefits, and the context for CICES (after Haines-Young and Potschin, 2010; modified de Groot et al. 2009).

The key features of the 'production chain' shown in Figure 2 are:

- **That it is important to distinguish between ecosystem structure, process, and function:** Ecosystems are composed of physical, biological and chemical components such as soils, water, plant and animal species and nutrients. Interactions among and within these components allow the ecosystem to perform certain functions. Ecosystem functions, in turn determine the capacity of the system to provide services and benefits to human users.

  The building blocks of ecosystem functions are the interactions between structure and processes, which may be physical (e.g. infiltration of water, sediment movement), chemical (e.g. reduction, oxidation) or biological (e.g. photosynthesis, denitrification), whereby 'biodiversity' is more or less involved in them all, although the precise detail of the relationship is often unclear or limited.

- **That it is important to distinguish between ecosystem functions and services:** For many years, the terms "function" and "service" have been used inter-changeably by some authors, creating a confusion that still exists today despite ongoing efforts to formalize definitions and nomenclatures (e.g., Daily, 1997, Boyd and Banzhaf 2007; Fisher et al. 2009, Granek et al., 2009). The capacity to deliver a service exists independently of whether anyone wants or needs that service. According to the cascade model (Figure 2), that capacity only becomes a service if some beneficiary can be clearly identified, and clearly a service flood protection may depend on a number of functional properties of an ecosystem. Thus it is useful to distinguish these two elements in the production chain.

  Whatever wording is chosen, however, it has to be acknowledged that the mix of structures – processes – function is what generates the services that ultimately provide benefits to people. Thus, services are best seen as the 'useful things' ecosystems 'do' for people in relation to enhancing human well-being directly or

indirectly, and that we should strive to be clear about what we label as a service and how it is to be measured and valued.

- **That it is useful to distinguish between services and benefits:** Another contested issue that emerges from recent debates is the distinction between services and benefits which, some claim, is crucial for economic valuation and for accounting purposes (Boyd and Banzhaf, 2007; Mäler et al., 2009). It has been argued that a clear distinction between ecological phenomena (functions), their direct and indirect contribution to human welfare (services), and the welfare gains they generate (benefits) is necessary to avoid the problem of 'double counting'. It is argued that valuation should ***only*** be applied to the thing directly consumed or used by a beneficiary because the value of the ecological structures and processes that contribute to it are already wrapped up in this estimate (Boyd and Banzhaf, 2007; Wallace, 2008; Fisher and Turner, 2008; Balmford et al., 2008). Thus for the economic valuation of services one must look at the contributions that these 'final services' make to benefits, and when aggregating values across the different components of human well-being avoid adding up the value of direct and indirect contributions to the same benefits. The recent classifications emphasise the importance of provisioning, regulating and cultural components of the MA as the focus for valuation studies, and subsume the value of supporting services in the assessment of these final products.

Given this background, CICES aims to describe the links between ecological structures and processes and the benefits that flow from them. It is intended to provide a ***bridge*** between the biophysical components of ecosystems and the various products, activities and benefits that are wholly or partly dependent on them (Figure 1). **Since its aim is to identify the 'final products' of ecosystems, CICES aims deals *only* with provisioning, regulating and cultural outputs.**

In developing the CICES proposal, we have considered the adequacy of the other classifications that are being used, and have identified an important structural problem that is associated with many of them. Namely, that they tend to have a 'flat structure' which makes them inflexible and unbalanced in terms of the way they describe the different types of ecosystem outputs. The nature of this structural problem can be illustrated by reference to the classification proposed in TEEB (Table 1).

The TEEB classification is essentially a one-dimensional list of categories. Although they are grouped in to four broad types (provisioning, regulating, habitat and cultural) these headings are essentially descriptors rather than categories that can be used operationally. The problem with a one-dimensional listing such as this is that it is difficult to make such a structure comprehensive. Each time a new service is identified the list has to be updated. Moreover, it is also apparent that the scope of the different categories also varies enormously. Thus under provisioning, 'ornamental resources' appears to have the same status as 'food production' as an ecosystem output, when in reality the latter is probably of more widespread significance. Similarly under regulating, the very specific service of 'pollination' is identified and given the same status as 'climate regulation', which includes the contribution that ecosystems make to global carbon sequestration and the influence of vegetation on temperature and rainfall patterns.

To overcome the structural problem that is apparent in many existing classifications, it is proposed that CICES should use categories that are both as generic as possible, and linked in a nested hierarchy to accommodate different scales of concern or thematic content. The aim should be to develop a structure into which new and specific elements can be fitted without disrupting the general structure of the classification. A hierarchical classification would also enable summaries of service output at different levels of generality to be constructed, a feature that is difficult to accomplish with a simple listing.

6. Draft Standard Classification of Ecosystem Services (CICES)

On the basis of the considerations outlined above, a draft classification of ecosystem services can be proposed (Table 3 and Table 4). The aim of this classification is to develop a flexible structure that broadly links the categories of ecosystem service that are being discussed in on-going international initiatives such as TEEB, and the functional groupings considered in the SEEA.

In proposing this structure for CICES the aim is not to suggest a schema that *replaces* existing typologies, but to provide a standard that allows the translation *between* different systems. The development of this draft standard has also taken account of the need to link service classes to groupings used in the various product and activity classifications.

Table 3: Draft classification of ecosystem goods and services for CICES

SEEA 2003function	CICES Theme	CICES Class	TEEB Categories			
resource	Provisioning	**Food & Beverages**	Food	Water		
resource		**Materials**	Raw Materials	Genetic resources	Medicinal resources	Ornamental resources
resource		**Energy**				
sink	Regulating and Maintenance	**Regulation of waste assimilation processes**	Air purification	Waste treatment (esp. water purification)		
service		**Regulation against hazards**	Disturbance prevention or moderation	Regulation of water flows	Erosion prevention	
service		**Regulation of biophysical conditions**	Climate regulation (incl. C-sequestration)	Maintaining soil fertility		
service		**Regulation of biotic environment**	Gene pool protection	Lifecycle maintenance	Pollination	Biological control
service	Cultural	**Symbolic**	Information for cognitive development			
service		**Intellectual and Experiential**	Aesthetic information	Inspiration for culture, art and design	Spiritual experience	Recreation & tourism

The proposed structure of CICES is shown in Table 3, in the column labelled 'CICES Class'. Nine categories are proposed, three for the provisioning service, four for regulating services and two for cultural services. The relationship between these classes and the SEEA functional groupings is indicated by the coding in the first column of the Table.

To show how the grouping of services relates to other international classifications of ecosystem goods and services, the relationship between the CICES Classes and those of TEEB is shown on the right-hand side of Table 3. The Table suggests that it is relatively easy to nest the TEEB categories into the nine classes proposed as the basis for CICES. The important feature to note, however, is that in naming the latter an effort has been made to use a generic terminology that can identify groupings that can progressively be refined according to the interests of the user. Thus potentially, the TEEB categories 'raw materials', 'genetic', 'medicinal' and 'ornamental' resources could be sub-classes of the CICES materials group.

The main discontinuity with the suggested TEEB classification is in the treatment of so-called 'habitat services'. The importance of ecosystems in maintaining the gene-pool and life systems is mentioned in the current SEEA, and included within the 'Service Function'. While TEEB chooses to identify them as a distinct service grouping at the highest level, the draft classification presented here suggests they are part of the regulating and maintenance theme. It is suggested that they form a sub-class that captures aspects of natural capital that are important for the regulation of the 'biotic' environment (e.g. pest and disease control, pollination, gene-pool protection etc.).

The full structure for proposed for CICES is given in Table 4. This Table describes the structure of the classification to the 'type' level. The categories are defined as follows:

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 coal 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 these 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.*

Table 4: CICES Structure to Type Level for Provisioning Theme

Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Nutrition	**Terrestrial plant and animal foodstuffs**	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 foodstuffs	Commercial fishing (wild populations)	eg. by fishery	
		Subsistence fishing	eg. by fishery	
		Aquaculture	eg. by fishery	
		Harvesting fresh water plants for food	eg. by resource	Water cress
	Marine plant and animal foodstuffs	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. (include but EXCLUDE subsurface assets)
Energy	**Renewable biofuels**	Plant based resources	eg. by resource	Wood fuel, energy crops, peat etc.
		Animal based resources	eg. by resource	Dung, fat, oils
	Renewable abiotic	Wind	eg. by resource	EXCLUDE subsurface assets such as oil, coal
		Hydro	eg. by resource	
		Solar	eg. by resource	
		Tidal	eg. by resource	
		Thermal	eg. by resource	

Table 4, cont. CICES Structure to Type Level for Regulation and Maintenance Theme

Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
Regulation of wastes	Bioremediation	Remediation using plants	eg. by method (*in situ* and *ex situ*)	Phytoaccumulation, phytodegredation, phytostabilisation, rhizodegradation,
		Remediation using micro-organisms		In situ (Bioremediation), ex situ (composting), bioreactors
	Dilution and sequestration	Dilution	eg. by method (*in situ* and *ex situ*)	Wastewater treatment
		Filtration		Filtration of particulates and aerosols
		Sequestration and absorption		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	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	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	Pollination	eg. by process	By plants and animals
		Seed dispersal	eg. by process	By plants and animals
	Pest and disease	Biological control mechanisms	eg. by process	By plants and animals, control of pathogens
	Gene pool protection	Maintaining nursery populations	eg. by process	Habitat refuges

Table4, cont CICES Structure to Type Level for Cultural Theme

Service Class	Service Group	Service Type	Sub-types	Examples and indicative benefits
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.

Regulating and Maintenance

Includes all the ways in which ecosystems control or modify biotic or aboitic 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 soild, 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*

7. Cross Tabulating Ecosystem Services with Existing Standard Classifications

It is apparent that many classifications of ecosystem services are possible and in seeking to justify the use of any one of them, the test must be whether it is 'fit for purpose'. In proposing the draft shown in Table 3 and Table 4 the initial constraint has been that it is both consistent with the SEEA framework and compatible with developing international approaches to describing ecosystem services. Given that the proposed classification broadly meets this criterion, a more severe test is whether it can also be linked to other types of product and activity classification that are key constituents of integrated environmental and economic accounting. As noted at the outset, the ultimate aim in developing CICES is to provide a framework for linking data on the ecosystem structure and dynamics of ecosystems and information on economic performance.

The suitability of the ecosystem services classification proposed for CICES was tested by attempting to cross-tabulate them with the classes defined in the following three UN standard statistical classifications, namely the:

- International Standard Industrial Classification of All Economic Activities (ISIC V4);
- Central Products Classification (CPC, V2); and,
- Classification of Individual Consumption by Purpose (COICOP).

Table 5: Cross tabulation of proposed CICES classes with ISIC V4 sections

Level	Code	ISIC Section	Food & Beverages	Materials	Energy	Regulation of wastes	Regulation of flows	Regulation of abiotic physical environment	Regulation of biotic environment	Symbolic	Experiential
0	A	Agriculture, forestry and fishing	x	x					x		x
0	B	Mining and quarrying			x						
0	C	*Manufacturing*									
0	D	*Electricity, gas, steam and air conditioning supply*									
0	E	Water supply; sewerage, waste management and remediation activities				x		x			
0	F	Construction		x							
0	G	Wholesale and retail trade; repair of motor vehicles and motorcycles			x						
0	H	Transportation and storage									x
0	I	Accommodation and food service activities	x								x
0	J	Information and communication									x
0	K	Financial and insurance activities									x
0	L	*Real estate activities*									
0	M	Professional, scientific and technical activities									x
0	N	Administrative and support service activities								x	x
0	O	*Public administration and defence; compulsory social security*									
0	P	Education									x
0	Q	*Human health and social work activities*									
0	R	Arts, entertainment and recreation									x
0	S	Other service activities									x
0	T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	x	x	x						
0	U	*Activities of extraterritorial organizations and bodies*									

The cross tabulation exercise was undertaken to determine whether a clear rational for defining the potential links could be established and what any attempt to link them might mean in terms of future work.

ISIC V4

The cross-tabulation of the proposed CICES classes with the ISIC V4 at the most general, section level is shown in Table 5. ISIC provides a comprehensive framework within which economic data can be collected and reported in a format that is designed for purposes of economic analysis, decision-taking and policy-making. It covers economic activities within the production boundary of the System of National Accounts, as well as activities that lie outside this boundary that relate to the subsistence activities of households.

To the extent that many of provisioning and cultural ecosystem services support economic activities it should be possible to establish how the various classes might be linked. Table 5 shows how in general terms this can be achieved. The Table was developed by looking at the detailed activities below the section level within the ISIC classification and marking up a cross link at the section level if at least one of the subclasses could be related to one of the propose CICES classes. The principle is

Table 6: Coding of ISIC classes according to proposed CICES classes for two ISIC sections

Level	Code	ISIC Section and Division	Food & Beverages	Materials	Energy	Regulation of wastes	Regulation of flows	Regulation of abiotic physical environment	Regulation of biotic environment	Symbolic	Experiential
0	A	Agriculture, forestry and fishing	x	x					x		x
1	1	Crop and animal production, hunting and related service activities	x	x					x		x
1	2	Forestry and logging	x	x	x						x
1	3	Fishing and aquaculture	x	x							
0	B	Mining and quarrying			x						
1	5	Mining of coal and lignite									
1	6	Extraction of crude petroleum and natural gas									
1	7	Mining of metal ores									
1	8	Other mining and quarrying			x						

illustrated in Table 6, by the more detailed view of two levels in the ISIC hierarchy, dealing with 'Agriculture, Forestry and Fishing' (ISIC Section A) and 'Mining and Quarrying' (ISIC Section B).

Table 6 illustrates a number of other features, namely:

- How the ISIC classes can potentially be coded according to the ecosystem services that underpin them; the coding system uses the three blocks of services (provisioning, regulating and cultural) and within them indicates the existence of a link by a binary code ('blank, or 0' =no link or 'x or 1' = link).
- However, depending on the geographical context in which the particular products are being considered, the coding system could take note of the scale at which the ecosystem service is operating (global, national/regional or local). Given the structure of ISIC, this coding would relate to the nature of the market and so primarily relate to economic activities. Subsistence activities and their links to ecosystem services (which are mostly local in character) would be covered in ISIC Division T, 'Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use'.
- That while the main links between activities and services is through provisioning and regulating services, some links are apparent via the regulating group. Thus 'Support activities to agriculture and post-harvest crop activities' (ISIC Division 16) includes such activities as 'pest control' and 'maintenance of land to keep it in good condition for agricultural use' which broadly can be classified as having links to the ecosystem service category 'regulation of the biotic environment' (or potentially 'regulation of biophysical conditions' or 'hazard regulation'). In Table 5 further links to regulating services were found in ISIC Divisions E, 'Water supply; sewerage, waste management and remediation activities' (via for example, 'purification of water for water supply purposes' and 'treatment of non-hazardous wastes').
- That if we define ecosystem services as outputs from ecosystems that depend on the interaction of biotic and abiotic factors, then there would be no linkage to activities within the mining and quarrying division that depend only on mineral elements (peat extraction would be included since there latter is an organic material). Using the same criteria of dependence on biodiversity, no links to services were also found for ISIC divisions C, D, L, O, Q and U (see Table 5), although this could be revised if biotic and abiotic ecosystem outputs are included in the classification..

CPC V2

The cross-tabulation of the proposed CICES classes with the CPC V2 at its most general level is shown in Table 7. The classification of products seeks to capture the different types of output that are within the production boundary of the System of National Accounts in ways that are helpful to decision makers.

Table 7: Cross tabulation of proposed CICES classes with COP V2 classes

Level	Code	CPC Description	Food & Beverages	Materials	Energy	Regulation of wastes	Regulation of flows	Regulation of abiotic physical environment	Regulation of biotic environment	Symbolic	Experiential
1	0	Agriculture, forestry and fishery products	x	x	x				x	x	x
1	1	Products of agriculture, horticulture and market gardening	x	x	x				x	x	x
1	2	Live animals and animal products (excluding meat)	x	x	x				x	x	x
1	3	Forestry and logging products		x	x					x	x
1	4	Fish and other fishing products	x		x						
1	1	Ores and minerals; electricity, gas and water	x	x	x						
1	2	Food products, beverages and tobacco; textiles, apparel and leather products	x	x							
1	3	Other transportable goods, except metal products, machinery and equipment		x							
1	*4*	*Metal products, machinery and equipment*									
1	5	Constructions and construction services		x							
1	6	Distributive trade services; accommodation, food and beverage serving services; transport services; and electricity, gas and water distribution services									x
1	*7*	*Financial and related services; real estate services; and rental and leasing services*									
1	8	Business and production services									x
1	9	Community, social and personal services					x	x	x		x

The approach to cross tabulation with the proposed CICES classes is similar to that outlined for the ISIC, with links indicated at the higher levels in the classification hierarchy if one of the products in the sub-classes is found to be dependent upon a particular type of ecosystem service. As with the earlier cross-tabulation, links are mainly exist through the provisioning and cultural services, although some regulating services form the basis of products, most notably in the context of regulation of the biotic environment. Thus within the CPC, 'seed production' and the production of 'reproductive material of animals' would both form part of the biotic regulation category in CICES (maintenance of life cycles). A wider range of regulating services is linked within the 'Community, social

and personal services' grouping of the CPC, by virtue of the services provided as part 'Sewage and waste collection, treatment and disposal and other environmental protection services'.

As with ISIC some classes have no links to ecosystem services. These largely concern manufacturing related to 'metal products, machinery and equipment' and 'financial services'. It is proposed that the CPC links to the main CICES ecosystem service categorise could be coded in the same way as for ISIC; similar coding for scale could also be added.

COICOP

The cross tabulations of the classification of Consumption by Individual Purpose and the CPC already exist, and so in principle once a cross-tabulation of CPC with the finalised CICES classes is made, then links to COICOP can also be established.

Table 8 suggests a tentative cross tabulation, using the same approach as that outlined for ISIC and CPC.

Table 8: Cross tabulation of proposed CICES classes with COICOP classes

Level	Code	CICOP Description	Food & Beverages	Materials	Energy	Regulation of wastes	Regulation of flows	Regulation of abiotic physical environment	Regulation of biotic environment	Symbolic	Experiential
1	1	Food and non-alcoholic beverages	x								
1	2	Alcoholic beverages, tobacco and narcotics	x							x	
1	3	Clothing and footwear		x							
1	4	Housing, water, electricity, gas and other fuels		x	x						
1	5	Furnishings, household equipment and routine household maintenance		x							
1	6	Health		x							
1	7	Transport			x						
1	8	Communication									
1	9	Recreation and culture								x	x
1	10	Education									x
1	11	Restaurants and hotels									x
1	12	Miscellaneous goods and services									
1	13	Individual consumption expenditure of non-profit institutions serving households (NPISHs)		x		x	x	x	x		x
1	14	Individual consumption expenditure of general government		x							x

8. Issues arising

The cross-tabulations of product and activity classes with the proposed CICES classes is tentative at this stage, and the links identified would clearly have to be refined and discussed before the new classification of ecosystem services was used. Before such an exercise is undertaken, however, more fundamental questions arise about the acceptability of the structures proposed for CICES, and what modifications might be considered if a final standard is to be produced. **It is the purpose of this document to lay out some of the issues and stimulate such a discussion.**

An feature of the cross tabulations suggested here is that the product and activity classes could potentially be linked to more than one ecosystem service group at the higher levels in the classification, although this could probably be resolved as more detailed sub-classes are defined. One approach to the more detailed classification of services within CICES is shown in Table 4.

The merit of the cross tabulation of CICES groups with these international standard classifications for products and activities is that it assists in identifying the 'final outputs' of ecosystems, and thus potentially helps overcome the problem of 'double counting' in valuation studies. The linkages to activity and product classifications certainly helps to define the 'concrete outcomes' sought by the EPA in its 2009 report (EPA, 2009). **In this context the exclusion of non-renewable, mineral outputs from the classicisation of services needs to be confirmed**[7].

Although cross tabulation of services, products and activities seems possible, it is also apparent that since the products and activities depend on the combination of natural and human capitals, the 'links' are complex. Cross-tabulation implies the need to develop some method of weighting to indicate the relative strengths of the different kinds of capital input to each product and activity. This could be achieved by constructing some kind of 'production function'. These production functions would have to be tailored to the particular application, but would seem to be vital if the aim of better understanding the links between economy and environment is to be achieved. They may also need to take account of the scale at which a given ecosystem service operates.

In reviewing the suitability of the proposed CICES classes it should be remembered that an additional constraint is that they should also be amenable to cross tabulation with land cover and land use classifications, such as those used by the EEA for its land and ecosystem accounting, or the FAO in its statistical work, *and* be sensitive to land cover and land use changes (see Gong et al., 2009; Weber 2009 and Gong and Weber, 2009). An examination of the extent to which the proposed CICES classes can be linked to classifications of land cover and land use has been considered in parallel to this study. The preliminary results presented in here suggest that at the CICES class level, cross tabulation between service classes and land cover and cover change data may be undertaken in a robust way.

[7] They could, for example, be included as a sub-class of the CICES 'materials' category, which at its highest level could split biotic and abiotic materials.

9. Conclusions and Recommendations

In order to develop CICES this document was circulated to participants attending an international workshop hosted by the EEA in Copenhagen between 2nd and 3rd December 2009. It was also posted for comment on an e-forum (www.cices.eu) opened in November 2009, designed to enable a wider international audience to comment on the issues relating to the CICES concept. By 6th December 2009 over 120 people had registered for the e-forum, and summaries of the first two weeks for discussion were prepared and circulated.

On the basis of the work undertaken here, and the comments received from the workshop participants and e-forum a number of conclusions and recommendations emerge that might shape for future work:

- There is general support for the development of CICES. It was accepted that CICES should not attempt to replace other classifications but aim to provide a framework that would enable the translation between different classifications and the linking of different sources of information about economy and environment.

- Given the complexity of resolving different potential user needs, the consensus is that the primary design focus for CICES should be the link it makes with environmental accounting and the revision of the SEEA.

- It was apparent from the comments received, however, that once the accounting requirements of a common classification have been met, the opportunities to 'fine tune' the schema to link with other areas of work dealing with ecosystem services should be explored.

- That while the hierarchical structure is appropriate but at more detailed levels a rule- or criteria-based approach should be developed to enable the system to be used a flexibly as possible, given that it is difficult to design a classification that could deal with all circumstances. A set of rules and criteria would allow users to nest particular or specific ecosystem outputs with the more general, higher level groups and classes. We recommend that this kind of structure is explored further in the next version of CICES.

- Although the initial intention of CICES was to provide a means of linking ecosystem services to product and activity classifications that form the basis of economic accounting in the SNA, the discussions emphasised that the classification ought also to help identify the impacts of human activities on services and the ecosystem services and functions that underpin them. ***We recommend that this 'two-way' interaction is emphasised in future accounts of the scope and purpose of CICES.***

References

Balmford, A., Rodrigues, A., Walpole, M. J., ten Brink, P., Kettunen, M., Braat, L., & de Groot, R., (2008) *Review of the Economics of Biodiversity Loss: Scoping the Science.* Brussels: European Commission.

Boyd, J. and Banzhaf, S. (2007) "What are ecosystem services? The need for standardized environmental accounting units." Ecological Economics 63(2-3) 616-626.

Brown, T. C., Bergstrom, J. C. and Loomis, J. B. (2007) Defining, valuing, and providing ecosystem goods and services. *Natural Resources Journal* **47**(2) 329-376.

Costanza, R. (2008) Ecosystem services: multiple classification systems are needed. Biological Conservation, 141, 350-352.

Costanza, R., D'Arge, R., DeGroot R., Farber, S., Grasso, M., Hannon B., Limburg, K., Naeem, S., O'Neill, R., Paruelo, J., Raskin, R., Sutton, P. and van den Belt, M. (1997) The Value of the World's Ecosystem Services and Natural Capital. Nature, 387, 253–260.

Daily, G. C. (1997) Introduction: What are Ecosystem Services? In: Daily, G.C. (Ed.) Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C., 1-10.

Daily, G.C. and. Matson, P.A. (2008) Ecosystem services: From theory to implementation. *PNAS* 105(28) 9455–9456

De Groot, R.S., Wilson, M.A. and Boumans, R.M.J. (2002) A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecological Economics, 41, 393–408.

De Groot, R.; Fisher, B.; Christie, M.; Aronson,J.; Braat, L.; Haines-Young, R.H; Gowdy, J.; Killeen, T.; Maltby, E.; Neuville,A.; Polasky, S.; Portela, R. and Ring, I. (in prep) Integrating the ecological and economic dimensions in biodiversity and ecosystem service valuation. Draft Chapter 1 of The Economics of Ecosystems and Biodiversity (TEEB) study.

EPA (2009) Valuing the Protection of Ecological Systems and Services: A Report of the EPA Science Advisory Board. United States Environmental Protection Agency Washington, DC 20460, EPA-SAB-09-012.

Fisher, B. and Turner, K. (2008) Ecosystem services: Classification for valuation. Biological Conservation, 141, 1167-1169.

Fisher, B., Turner, R. K. and Morling, P. (2009). "Defining and classifying ecosystem services for decision making." Ecological Economics 68(3) 643-653.

Gong, X., Marklund, L.G. and Tsuji, S. (2009) Land Use Classification. Paper presented to the 14th Meeting of the London Group on Environmental Accounting Canberra, 27 – 30 April 2009, LG/14/10.

Gong, X. and Weber, J.L (2009) Land Cover and Land Use Classifications in the SEEA Revision. Paper presented to the Fourth Meeting of the UNCEEA. 24 - 26 June 2009, UN Headquarters, New York, ESA/STAT/AC.189 and UNCEEA/4/11.

Granek, E.F., Polasky, S., Kappel, C.V., Reed, D.J., Stoms, D.M., Koch, E.W., Kennedy, C.J., Cramer, L.A., Hacker, S.D., Barbier, E.B., Aswani, S., Ruckelshaus, M., Perillo, G.M.E., Silliman, B.R., Muthiga, N., Bael, D., Wolanski, E. (2009) Ecosystem services as a common language for coastal ecosystem-based management. Conservation Biology (in press).

Haines-Young, R.H. and Potschin, M.P (2010) The links between biodiversity, ecosystem services and human well-being In: Raffaelli, D. & C. Frid (eds.) Ecosystem Ecology: a new synthesis. BES Ecological Reviews Series, CUP, Cambridge (in press).

MA [Millennium Ecosystem Assessment] (2005) Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Mäler, K. G., Aniyar, S. and Jansson, A. (2009) Accounting for Ecosystems. *Environmental & Resource Economics* 42(1) 39-51.

SEEA (2003) Handbook of National Accounting: Integrated Environmental and Economic Accounting 2003. United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, World Bank. http://unstats.un.org/unsd/envAccounting/seea2003.pdf

Wallace, K. (2008) Ecosystem services: Multiple classifications or confusion? Biological Conservation, 141, 353-354.

Weber, J.-L. (2009) Land Cover Classification for Land Cover Accounting. Paper presented to 14th Meeting of the London Group on Environmental Accounting, Canberra, 27 – 30 April 2009, Session 4 – Asset Accounting, Point 11 – Land classification, LG/14/9.