

Common International Classification of Ecosystem Services (CICES): Consultation on Version 4, August-December 2012

Report to the European Environment Agency



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We thank those who have provided comments on the CICES website and via e-mail exchange. The views and interpretations presented here, however, are solely those of the authors, and although prepared as a briefing document for the European Environment Agency, do not necessarily represent their position.

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(Download at www.cices.eu or www.nottingham.ac.uk/cem)

Executive Summary

1. This Report documents the development of a Common International Classification of Ecosystem Services (CICES), following the most recent round of consultation between August and December 2012.
2. We confirm the need to **frame the** Common International Classification of Ecosystem Services (**CICES**) **around human needs**, and recommend that CICES is regarded primarily as a way of describing ecosystem outputs as they directly contribute to human well-being, so that discussions about appropriate assessment frameworks (economic, social, aesthetic and moral) can take place.
 - We recommend that ecosystem outputs are regarded as things fundamentally dependent on living processes, and so abiotic outputs from nature are not regarded as an ecosystem service for the purposes of CICES.
3. While there has been some discussion about what constituted '**final services**', the proposition that CICES should be confined initially to the ecosystem outputs directly consumed or used by a beneficiary was widely supported. **We recommend that this approach is maintained in the further development of the classification for accounting and other purposes.**
 - It should be recognised, however, that the CICES classification nevertheless provides a framework in which information about supporting or intermediate services can be nested and referenced, and this may be particularly useful in a mapping context. We suggest therefore that CICES should be explored through the development of experimental accounts, especially in the context of using accounts to check the integrity of underlying ecological assets.
4. The consultations confirmed the importance of making a **clear distinction between final ecosystem services, ecosystem goods or products and ecosystem benefit**, and recommend the following definitions as the basis for CICES:
 - Final ecosystem services are the contributions that ecosystems make to human well-being. These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people. A fundamental characteristic is that they ***retain a connection to the underlying ecosystem functions, processes and structures that generate them.***
 - Ecosystem goods and benefits are things that people create or derive from final ecosystem services. These final outputs from ecosystems have been turned into products or experiences that are not functionally connected to the systems from which they were derived. Goods and benefits can be referred to collectively as 'products'.
 - Human well-being is that which arises from adequate access to the basic materials for a good life needed to sustain freedom of choice and action, health, good social relations and security. The state of well-being is dependent on the aggregated output of ecosystem goods and benefits, the provision of which can ***change*** the status of well-being.
5. To emphasise the contribution of the CICES services to human well-being, we recommend that **further work is done on cross-referencing these services to standard product and activity classifications**, and to classifications of beneficiaries to facilitate the valuation process and help identify the ways different types of capital combine to support human well-being. This

recommendation does not have immediate consequences for the proposed structure of CICES but indicates the different roles that it might fulfil in enabling the translation between, and integration of, different assessment approaches.

6. As an outcome of the CICES consultation, **we therefore propose a more comprehensive framing of the concept of ecosystem services than that implied by the SEEA2012.** We suggest that in the forthcoming work on experimental ecosystem accounts there is a focus on the nature of the production boundary and a discussion of the concept of 'natural' within the Central Framework so that convergence between the systems might be achieved. At this stage however, we recommend that the concept of 'natural' is not used to define the boundary of the classification but rather the notion of **connection between the services and the underpinning ecological structures and processes**. Services are connected to underlying ecological structures and processes; products and benefits are not.
7. **On the basis of these findings we recommend modifying the structure of CICES at the 3-digit level as shown in Table 1. We also recommend, however, that CICES is presented in Volume II at the full, 4-digit level, because this better captures the richness of the material provided by the consultees. It will also make the testing of the classification more rigorous.** The full classification and the examples of services are provided in the attached spreadsheet.
8. The hierarchical structure of CICES has been designed so that the categories at each level are non-overlapping and without redundancy. The categories at the lower levels also inherit the properties or characteristics of the levels above. As a result, CICES can be regarded as a classification *sensu stricto*. We recommend the following definitional structure:
 - a. **Provisioning services:** all nutritional, material and energetic outputs from living systems. In the proposed structure a distinction is made between provisioning outputs arising from biological materials (biomass) and water. The consultation confirmed the classification of water as problematic, because it was regarded by some as primarily an abiotic, mineral output. The majority argued, however, that it should be included; convention and wider usage of the notion of an ecosystem services also suggests that it is appropriate to do so. In addition, water bodies of all scales host communities of species that provide ecosystem services themselves.
 - b. **Regulating and maintenance:** covers all the ways in which living organisms can mediate or moderate the ambient environment that affects human performance. It therefore covers the degradation of wastes and toxic substances by exploiting living processes; by reconnecting waste streams to living processes it is in this sense the opposite of provision. Regulation and maintenance also covers the mediation of flows in solids, liquids and gases that affect people's performance as well as the ways living organisms can regulate the physico-chemical and biological environment of people.
 - c. **Cultural Services:** covers all the non-material, and normally non-consumptive, outputs of ecosystems that affect physical and mental states of people. The consultation suggested that this area was particular problematic in terms of the different terminologies used by the wider community, which often does not make a distinction between services and benefits; the term recreation is, for example, particularly problematic in this respect. We also note that all services, whether they be provisioning or regulating can have a cultural

Table 1: CICES V4.3 at the 'three digit level'

Section	Division	Group	
Provisioning	Nutrition	Biomass	
		Water	
	Materials	Biomass, Fibre	
		Water	
	Energy	Biomass-based energy sources	
		Mechanical energy	
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	
		Mediation by ecosystems	
	Mediation of flows	Mass flows	
		Liquid flows	
		Gaseous / air flows	
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	
		Pest and disease control	
		Soil formation and composition	
		Water conditions	
		Atmospheric composition and climate regulation	
	Cultural	Physical and intellectual interactions with ecosystems and land-/seascapes [environmental settings]	Physical and experiential interactions
			Intellectual and representational interactions
Spiritual, symbolic and other interactions with ecosystems and land-/seascapes [environmental settings]		Spiritual and/or emblematic	
		Other cultural outputs	

dimension. However, it is valuable to retain the section for Cultural, and to make the category distinct.

We recommend therefore that cultural services are primarily regarded as the physical settings, locations or situations that give rise to changes in the physical or mental states of people, and whose character are fundamentally dependent on living processes; they can involve individual species, habitats and whole ecosystems. The settings can be semi-natural as well as natural settings (i.e. can include cultural landscapes) providing they are dependent on *in situ* living processes. In the classification we make the distinction between settings that support interactions that are used for physical activities such as hiking and angling, and intellectual or mental interactions involving analytical, symbolic and representational activities. Spiritual and religious settings are also recognised. The classification also covers the 'existence' and 'bequest' constructs that may arise from people's beliefs or understandings.

9. In the present structure of CICES we recommend that further details about the location and types of ecosystems are included by users at the class and class-type level. Thus it is at this level where users could identify whether a particular service is arising from a terrestrial, freshwater or marine ecosystem, for example, or in the case of cultural services whether the setting is a formal (designated) or informal (non-designated) species or location.
10. We note that our recommendation that CICES should be restricted to the outputs of ecosystems dependent on living processes is not supported by all members of the scientific community, who sometimes regard abiotic outputs as services. **In order to continue the dialogue and to account for human exploitation of other natural resources, we propose defining a separate but complementary classification that covers abiotic outputs. Both would retain the same underlying logic.**
 - Given that the experimental ecosystem accounts being developed through the System of Economic and Environmental Accounts (SEEA) process are mainly concerned with outputs dependent on living processes, the initial effort should be on the part of CICES that emphasises biodiversity, but the long term goal should be a combined classification that integrates outputs across ecosystems and from other natural resources.

1. Introduction

This Report documents the development of a Common International Classification of Ecosystem Services (CICES). It provides:

1. A summary and discussion of the issues identified in terms of the structure and potential application of CICES V4.3 in relation to its use for accounting, mapping and wider use in ecosystem assessments;
2. Background analysis relevant to the review of the UN document on SEEA Vol. II; and,
3. Recommendations on how the structure of CICES might be modified in relation to the issues identified by the consultees.

The purpose of the Report is to provide the European Environment Agency (EEA) with an overview of the issues and options that have emerged from the consultation on CICES between August and December 2012, as well as providing feedback to those who have made comments on the latest proposals.

The context for the latest phase of work is set out in Part 2, which gives a brief history of the development of CICES and the need for the most recent round of consultation. In Part 3, we summarise the major positions taken in the debate and conclude in Part 4 with our recommendations on the development of the structure of the Classification. The classification presented here should be referred to as CICES V4.3.

2. The Development of CICES and the Need for Consultation

2.1 Purpose and History of CICES, and the need for consultation

The concept of ecosystem services is an attractive one because it potentially helps us describe some of the ways that humans are linked to, and depend on, nature. It is also challenging, because the connections between people and nature are complex and different specialist groups look at them in different ways. For example, some need to describe ecosystem services so that they can be mapped or valued economically. Others are more interested in how human impact on ecosystems changes their capacity to deliver services, so that appropriate policies can be developed. All these concerns imply the need for some kind of accounting system for natural capital. **The Common International Classification of Ecosystem Services (CICES)** has been developed to help negotiate the different perspectives that have evolved around the ecosystem service concept and assist in the exchange of information about them.

The first draft of CICES was tabled at an expert meeting hosted by the European Environment Agency (EEA) in December 2009. There then followed two rounds of consultation with the international community in 2010 and 2011 to develop it further (Versions 2 and 3). Much of the subsequent work focussed around meetings organised by the EEA that involved the technical experts linked with the UNSD initiative to revise the System of Economic and Environmental Accounts (SEEA). However, the wider relevance of CICES for the ecosystem service assessment and valuation was always noted, and the development of the current set of proposals was also informed by recent efforts in the EU to develop a consistent classification of ecosystem services for ecosystem mapping¹, in the EU process on the 'Mapping and Assessment of Ecosystems and their Services'

¹ See [Ecosystem Assessment Topic on the CIRCABC website](#)

(MAES). Ecosystem services cannot be valued, mapped or included in accounts if they cannot be described and measured. CICES has therefore been designed to help provide the clarity that is needed in all these applications.

The most recent round of consultation was prompted by the tabling of Version 3 of CICES at the expert meeting on ecosystem accounts organised by the UNSD in December 2011 in London. This was followed up with discussions at the Seventh Meeting of the UN Committee of Experts on Environmental-Economic Accounting Rio de Janeiro, 11-13 June 2012. In the response to the paper tabled at Rio it was noted that 'in general, the conceptual alignment is well developed and hence significant change to this version of CICES is not expected'. However, further consultation with relevant experts was felt to be necessary to clarify some remaining issues from the accounting perspective. The EEA also identified that some further consultation was required to ensure that CICES remained at the core of EU efforts to develop a consistent classification of ecosystem services for ecosystem mapping.

The current situation is that Volume 1 of the SEEA Central Framework has been published. It was adopted by the United Nations Statistical Commission, at its 43rd Session in 2012, as the first international standard for environmental-economic accounting. During the process leading up to the release of the Central Framework it became clear that there were some issues (including CICES) that could not be advanced and agreed to at the level of an internationally agreed standard, and it was decided that these were best dealt with in Volume 2, which was entitled *Experimental Ecosystem Accounting*. Consultation on this material is open into mid-January 2013, and so it is partly in response to this invitation that the current Report has been prepared.

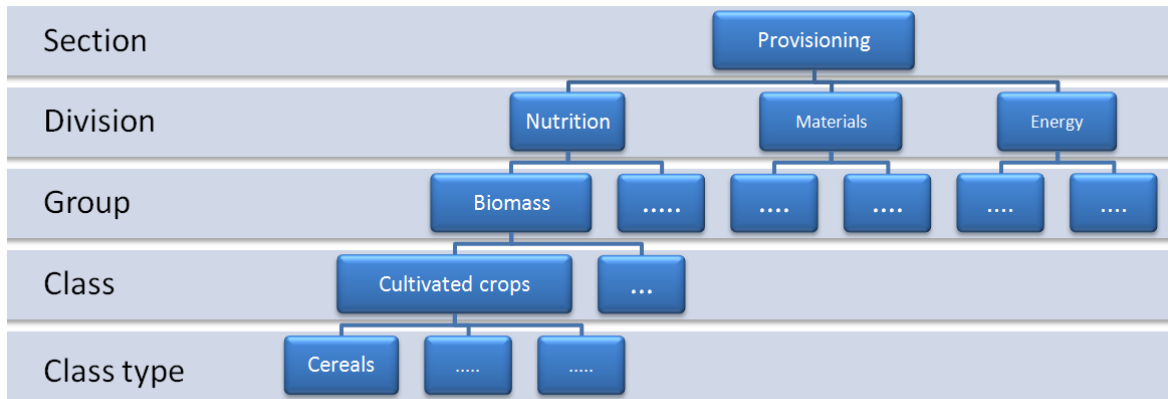
The material that has informed this Report (CICES Version 4) has been gathered from comments received in the CICES website (www.cices.eu) up to 21st September 2012, and additional e-mail communication from the wider community that was passed to the authors and coordinators at the EEA. It has also been supported by response documents provided by the UNSD and the EEA². The briefing document used for the consultation exercise is provided in Appendix 1. A summary of the major issues identified in comments received is provided in Appendix 2.

2.2 Structure of CICES

If people are to use environmental accounts and have confidence in them, then the way of describing ecosystem services must echo broader understandings in the research and practitioner communities. Thus a consideration for the design of CICES is that it should, wherever possible, have resonance with the other widely used frameworks that people use in discussing ecosystem services, especially in terms of the terminology adopted. This is not to say that terminology cannot evolve, but the idea was that wherever possible familiar or accepted terms and concepts should be used.

² Both can be found in the resources section of the CICES website at www.cices.eu

Figure 1: Illustration of proposed hierarchical structure of CICES V4.3



Note in earlier versions of CICES (V1-V3) the nomenclature of the levels was different; in descending order they were: Theme (now Section), Service Class (Division), Service Group (Group), Service Type (Class), and Sub-types (Class types). The current nomenclature reflects advice from the UN Statistical Division based on their best practice guidelines.

Thus CICES took as its starting point the typology of ecosystem services suggested in the Millennium Ecosystem Assessment (MA, 2005), and refined it to reflect some of the key issues that have been discussed in the wider research literature. It is, for example, more explicitly hierarchical in structure (see accompanying spreadsheet, CICES V4.3). At the highest level are the three familiar categories used in the MA: provisioning, regulating and maintenance, and cultural. Below these major 'Sections' in the classification are nested a series of 'Divisions', 'Groups' and 'Classes'.

Figure 1 illustrates the hierarchical structure of CICES for Provisioning Services. The hierarchical structure was proposed as a way of handling some of the challenges that arise in relation to the different spatial and thematic scales used in different applications. Accounts, like more general assessments, have to be based on a well-defined and credible metrics which are often specific to particular geographical situations or ecosystem types. For the purposes of reporting or comparison these may need to be aggregated and generalised. The hierarchical structure allows users to go down to the most appropriate level of detail required by their application, but then group or combine results when making comparisons or more generalised reports.

Thus in CICES, as we move successively from Section, through Division, Group and Class the description of the service is progressively more specific and there may be many service types nested within these broader categories. This feature enables an application at national scale in a particular geographical region, to aggregate and prepare accounts on all the nutritional services within, say, the 'Cultivated crops'. In another geographical area, a similar and comparable report at that level could be made even though the mix of sub-elements within that aggregation would be different.

There is therefore 'dependency' in the CICES hierarchy in the sense that the characteristics used to define services at the lower levels are inherited from the Sections, Divisions and Groups above them. There is also a sense of 'taxonomy' in that elements within the same Group or Class are conceptually more similar to each other, in terms of the ways they are used by people, than they are to services elsewhere in the system. As such, CICES can therefore be regarded as a classification rather than an arbitrary nomenclature. At the class level the system is designed to open so that people can add

services and nest them within the broader categories. These upper levels are however, regarded as *exclusive* in the sense that they cover the range of things that need to be considered albeit in a generalised way. The definitions of the levels will be discussed in Part 4 of this document.

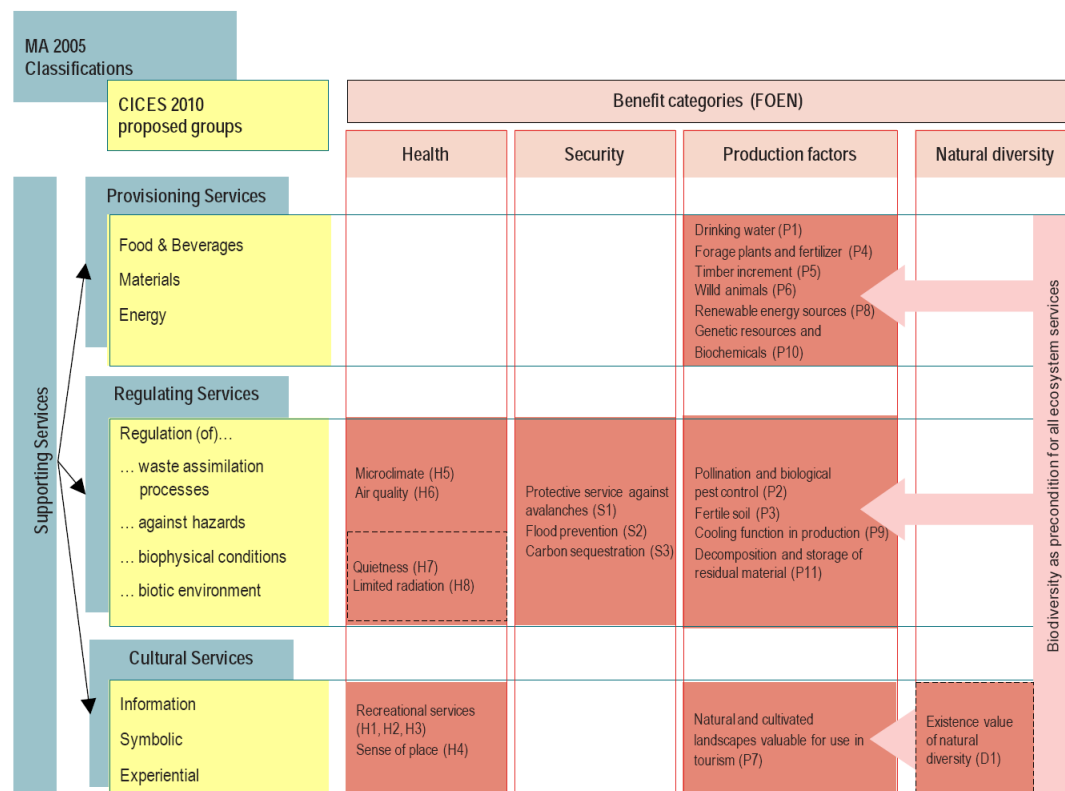
2.3 CICES: Applications

The proposal for CICES V4.1 suggested that for mapping and assessment purposes the ‘class-type’ level may be most appropriate, whereas for accounting information at the level of Classes or even Groups may be sufficient. However, there is no restriction about how these different levels might be used in different sorts of application. This issue should be explored in future work, including that on experimental ecosystem accounts that now follows the publication of the *Central Framework* of the SEEA2012. Nevertheless, despite the developmental nature of the classification several applications of earlier versions of the Classification have been described that may serve as a guide to what levels of detail are needed by users.

An illustration of a non-accounting application of CICES has been provided by the study from the Swiss Federal Office for the Environment (FOEN) (Staub et al., 2011), which aimed to develop

Figure 2: 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 FECS “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 FECS P1 can also be assigned to this CICES class.



concrete proposals for operationalising an ‘Inventory of Final Ecosystem Goods and Services’ (FEGS). Figure 2, 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 these metrics 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 both supply and demand issues related to ecosystem services, in the sense that the suite of indicators proposed measured use as well as output. In the Swiss study it was 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.

In addition to other studies that have used the earlier version of CICES as a framework for their assessment of biodiversity (e.g. Houdet, 2012) and the dynamics of ecosystem services supply and demand (Kroll et al., 2012), other work has sought to develop the structure of CICES as a more general mapping tool. The EU MAES working group have, for example³, considered the structure of the classification as a mapping framework in Europe; it was established by DG Environment in March 2012. Further more specific changes have been proposed for Belgium⁴.

Other recent published work to reference CICES has commented on its structure and usefulness for other types of application (e.g. Armstrong et al., 2012; Kandziora et al., 2012). We will deal with these remarks later, in relation to the other modifications to the structure that others have suggested. The purpose of noting these other applications is to emphasise that while CICES was developed initially with an accounting purpose in mind, it is necessary to consider these other perspectives so that consistent approaches can be developed.

³ http://www.eccb2012.org/userfiles//MAESWorkingPaper_v8_3.pdf

⁴ Document on CICES website at: www.CICES.eu

3. Issues explored during the 2012 consultation

As a framework for our recommendations on the revision of CICES V4 it is useful to present two alternative proposals received during the consultation process. Table 1 shows the structure down to the Group level proposed by the EEA, generated through their internal review process. Table 2 provides the response made by the Editorial Board of the SEEA Experimental Ecosystem Accounts. This was proposed following a discussion of the proposals for CICES V4.

The features of each and the differences between them will be discussed in the sections that follow, as a back drop to our recommendations for the revision of CICES.

Table 1: Proposal for structure of CICES V4 made by EEA (December 2012), now revised

Section	Division	Group
Provisioning	Nutrition	Terrestrial biota
		Freshwater biota
		Marine biota
		Freshwater for drinking
	Non-nutritional biotic materials	Fodder and fibres from all biota
		Chemicals and other substances from all biota
		Genetic materials from all biota
		Freshwater for non-drinking purposes
	Energy	Energy from all biota
Regulation and Maintenance	Remediation	Bioremediation
		Accumulation/storage, dilution and filtration (in biota and ecosystems)
	Regulation and maintenance of ecosystems	Land and soil regulation
		Freshwater regulation
		Marine regulation
	Regulation and maintenance of biological processes	Lifecycle maintenance, habitat and gene pool protection
		Pest and disease control (incl. invasive alien species)
Cultural	Physical or experiential use of ecosystems and land-/seascape - (environmental settings)	Recreation
		Information and knowledge
	Intellectual representations of ecosystems and land-/seascape- (environmental settings)	Spiritual & symbolic
		Other cultural meaning

Table 2: Proposal for structure of CICES made in SEEA Experimental Ecosystem Accounting Consultation Draft (October 2012)

<i>CICES for ecosystem accounting the SEEA Experimental Ecosystem Accounts</i>		
<i>Section (1-digit)</i>	<i>Division(2-digit)</i>	<i>Group (3-digit)</i>
Provisioning	Water	Water
	Materials	Uncultivated terrestrial plants and animals for food
		Uncultivated freshwater plants and animals for food
		Uncultivated marine plants, algae and animals for food
		Nutrients and natural feed for cultivated biological resources
		Plant and animal fibres and structures
		Chemicals from plants and animals
Energy	Biomass based energy	
Other provisioning services	Other provisioning services, n.e.c.	
Regulating	Remediation and regulation of biophysical environment	Bioremediation
		Dilution, filtration and sequestration of pollutants
	Flow regulation	Air flow regulation
		Water flow regulation
		Mass flow regulation
	Regulation of physico-chemical environment	Atmospheric regulation
		Water cycle regulation
		Pedogenesis and soil cycle regulation
		Noise regulation
	Regulation of biotic environment	Lifecycle maintenance, habitat and gene pool protection
		Pest and disease control (incl. invasive alien species)
	Cultural	Physical or experiential use of ecosystems [environmental setting]
Information and knowledge		
Intellectual representations of ecosystems [of environmental settings]		Spiritual & symbolic
		Non-use

<i>Lists of abiotic services for the SEEA Experimental Ecosystem Accounts</i>		
<i>Section (1-digit)</i>	<i>Division(2-digit)</i>	<i>Group (3-digit)</i>
Abiotic Services	Abiotic materials	Non-metallic mineral resources
		Metallic mineral resources
	Abiotic energy	Abiotic non-renewable energy resources
		Abiotic renewable energy resources
	Space	Space for human habitat and infrastructure
	Other environmental services, n.e.c.	Other abiotic services, n.e.c.

3.1 Final and Supporting Services

Many of the points made in the consultation involve consideration of the concept of final services and so it is useful to clarify their role in CICES.

A key early decision in designing CICES was to exclude the so-called supporting services from the classification and focus only on the provisioning, regulating and cultural components. The reason for this was that if ecosystem and economic accounts are to be linked, then an essential step is to identify and describe the 'final outputs' from ecosystems that people use and value, so as to avoid the problem of 'double counting'.

It has been widely argued that valuation of ecosystem services should only be applied to the things 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. When aggregating values across the different components of human well-being we must avoid adding up the value of direct and indirect contributions to the same benefits made by the underpinning ecological functions.

Exclusion of supporting or intermediate services, as some people call them, does not imply that they are unimportant or can be overlooked. In fact, there is no reason why fully developed environmental and economic accounts cannot also record changes in underlying ecological structures, processes and functions, and systems like CICES may well be extended to cover them. However, given that service may depend on many underlying functions and that those same functions may support a number of different services, it was decided to focus the design of CICES on the interface between ecosystems and society, namely the so-called 'final services'.

While there was some discussion about what constituted 'final services', the proposition that CICES should be confined initially to the ecosystem outputs directly consumed or used by a beneficiary was widely supported, as is illustrated in the responses summarised in Table 1 & 2. We recommend that this approach is maintained in the further development of the classification. It should be recognised, however, that the CICES classification nevertheless provides a framework in which information about supporting or intermediate services can be nested and referenced, and this may be particularly useful in a mapping context. The approach should be explored through the development of experimental accounts, especially in the context of using accounts to check the integrity of underlying ecological assets.

3.2 Distinguishing Final Ecosystem Services, Goods and Benefits

The importance of making a distinction between final ecosystem services and benefits to human well-being has been reflected in the consultation on CICES as well as the debates in the wider literature. In the SEEA Central Framework ecosystem services are seen as 'the contributions of ecosystems to benefits used in economic and other human activity' (SEEA, 2012, para 2.20). For CICES final ecosystem services were defined as the *contributions* that ecosystems make to human well-being. In both cases services are 'final' in that they are the outputs of ecosystems that most directly affect the well-being of people. Both definitions capture the idea that services lead to changes in human well being, by virtue of the benefits they generate. **In the context of CICES, the key point is that it is as a classification of services and not benefits.**

The distinction between services and benefits has been important in developing the terminology for CICES; the difficulty has been that during the consultations many people used terms referring to services and benefits interchangeably, or drew the boundary between them differently. An example of this is 'recreation' which some argue is a cultural ecosystem service. Others suggest that it is the physical and cultural setting of characteristics of the ecosystem that is the service which enables a benefit called 'recreation' to be gained. Another example is provided in proposals for experimental ecosystem accounts, where agriculturally produced crops are regarded as benefits and nutrient input the service; most other classification systems identify crops as a provisioning service from agricultural ecosystems, and nutrient cycling as a supporting or intermediate service. These differences can be seen by inspecting Tables 1 and 2 which differ significantly in what they regard final services to be in the Provisioning Section of the classification. While the EEA framework puts crops under outputs from terrestrial biota, Table 2 regards them as products and proposes that the final service should be 'nutrients and natural feed for cultivated biological resources'.

Part of the problem of making the distinction between services and benefits is identifying what it is that changes human well-being. While the highly influential Millennium Ecosystem Assessment (MA, 2005) regards goods and services as synonymous, others (e.g. Bateman et al., 2011) have argued that it is important to distinguish between them, and that goods like benefits are the things that can be valued; fundamentally they are the things 'produced' from the final service that then affect well-being. They argue that the distinction between service and good is necessary because we need to account for the fact that a single ecosystem outputs or final service (e.g. trees) can be used to create a range of different goods (e.g. timber for construction; wood for fuel). The benefits that arise from these goods can also vary from place to place and may in turn depend on the combination of a number of different kinds of ecosystem goods (e.g. shelter may depend on timber for construction as well as other natural products, such as thatch from reeds).

We will return to the importance of making these kinds of distinctions later in the Report, because it has particular bearing on the scope of any classification of ecosystem services. **At this stage it is sufficient to note that as a result of the consultations we note the importance of making a clear distinction between final ecosystem services, ecosystem goods or products and ecosystem benefit, and recommend the following definitions as the basis for CICES:**

- **Final ecosystem services** are the *contributions* that ecosystems make to human well-being. These services are final in that they are the outputs of ecosystems (whether natural, semi-natural or artificial) that most directly affect the well-being of people. A fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them.
- **Ecosystem goods and benefits** are things that people create or derive from final ecosystem services. These final outputs from ecosystems have been turned into products or experiences that are no longer *functionally connected* to the systems from which they were derived. Goods and benefits can be referred to collectively as 'products'.
- **Human well-being arises from** adequate access to the basic materials for a good life needed to sustain freedom of choice and action, health, good social relations and security. The state of well being is partly dependent on the aggregated output of ecosystem goods and benefits.

3.3 The place of biodiversity and abiotic outputs from ecosystems

The importance of living (biotic) processes and the contribution they make to human well-being is, for many, the core of the argument about ecosystem services. To emphasise this many would argue that the role of biodiversity is so fundamental that **only** those outputs from ecosystems that depend on living processes should be regarded as ecosystem services. The conceptual problem that this poses is that ecosystems are composed of biotic and abiotic elements which also interact with geophysical processes. These processes provide a number of abiotic outputs that benefit people and these also need to be discussed in some way. Such outputs include, for example, energy sources such as wind and waves, fossil energy sources ultimately derived from biotic processes such as coal oil and gas, and or natural materials like sand and salt.

The approach adopted in the CICES classification is to focus on the original definition of the ecosystem concept and hence to accept only as ecosystem services those outputs that are dependent at least in part on ecosystem processes in the biological sense. The tension between extending service classifications to include natural abiotic outputs from ecosystems or just those dependent on living processes is highlighted by the recent publications of Armstrong et al. (2012) and Kandzoria et al. (2012). Both refer to CICES in their separate discussions of the frameworks they use to analyse ecosystem services, and both conclude that abiotic outputs should be included. Elsewhere others have proposed classifications of atmospheric ecosystem services (e.g. Thornes et al. 2010).

The problem of how to handle biotic and abiotic ecosystem outputs is illustrated most starkly by the different comments received on the place of water in the proposed CICES classification. The difficulty comes about because water is an abiotic mineral whose availability is controlled by a range of different biotic and abiotic factors. Despite the abiotic character of water, it is however essential to nutrition and it is important to recognise in any classification the mediating effect of living processes on its quantity and quality. The options identified for classifying water during the consultation were as follows:

- i. If we restrict the notion of an ecosystem services to the contribution that *living* (biotic) processes make to human well-being, then the focus in relation to water must be on how effective living processes are in controlling the quantity and quality of water, rather than the availability of water *per se*. Under this option 'water-related' services would best be situated entirely under the regulating services rather than in the provisioning section.
- ii. If we recognise that the ecosystem service concept also covers abiotic ecosystem outputs then the contribution that water makes in both nutritional and material terms should be identified, and it should therefore be included in the provisioning section of the classification, as well as under regulating. If water is treated in this way then it would seem consistent to regard other abiotic outputs from ecosystems as services, and include those in the classification where it is appropriate to do so.

Our review of the comments received in relation to these different positions suggests that there is no simple way forward, other than to compromise in the case of water and include it within the classification.

Even if one takes the position that only outputs dependent on biotic processes are 'ecosystem services' one has to recognise that these other abiotic outputs are provided by nature and have to be handled in some way. In the feedback received from the EEA and the members of the Editorial Board

of the SEEA Experimental Ecosystem Accounts it was argued that CICES should exclude abiotic ecosystem outputs and that the focus should be only on those outputs that are fundamentally dependent on biodiversity. However, the discussions also acknowledged that similar classification approach would be useful for abiotic outputs, and indeed could be developed alongside one based on living processes. This has now been developed further, and a provisional proposal is provided in the accompanying spreadsheet.

We note, however, that our recommendation that CICES should be restricted to the outputs of ecosystems dependent on living processes will not be supported by all members of the scientific community. **In order to continue the dialogue and to account for human exploitation of other natural resources, we suggest that the complementary classification that covers abiotic outputs attempts to apply the same underlying logic described in section 4.**

Given that the experimental ecosystem accounts being developed through the System of Economic and Environmental Accounts (SEEA) process are mainly concerned with outputs dependent on living processes, the initial effort should be on the part of CICES that emphasises biodiversity, but the goal should be a combined classification that integrates outputs across ecosystems and from other natural resources.

3.4 The anthropocentric focus

The ecosystem service concept has been criticised because it seems to promote a utilitarian view that commodifies nature, rather than valuing it for its intrinsic properties. CICES has also been criticised in the responses because it seems to formalise this perspective. Some argue that documenting the way people consume or use the outputs from ecosystems, the system can imply a separation between nature and economy.

While it is the case that CICES takes an anthropocentric perspective, in that it describes the way humans rather than any other organisms, use and value nature, it does not follow that people and nature are separate or that only human values count, or even that economic values trump all. These are all important philosophical questions and the development of CICES has not taken place without paying them some regard. However, the design of a classification system is probably not the right framework around which these fundamental issues can be resolved.

CICES has a more pragmatic and modest set of aims, namely to describe what people mean when they refer to particular types of ecosystem service so that information can be more easily exchanged and insights compared. It is for this reason that we suggest that it can be useful in building integrated environmental and economic accounts. Nevertheless, as argued in the section on the production boundary, in designing CICES we do not assume that nature and society are somehow separate. Indeed the focus on 'final services' is used to emphasise just how close these reciprocal relationships are. Moreover, there is no intention that in describing ecosystem service we only focus on natural or semi-natural ecosystems. Many ecosystems have been highly influenced by human action, and to overlook them would make the exercise a narrow one. Biotic processes go on all around us and it is important to describe just how they contribute to human well-being, and how human actions can interfere with them. Finally, the attempt to document these contributions (so that integration with economic accounting can be achieved) must not be taken to imply that only economic valuation counts. Economic valuation may be important in some situations and not in others, and beyond accounting there is nothing in the design of CICES that would prevent it

supporting social, moral or aesthetic forms of assessment. Indeed physical accounting (i.e. physical measurements of service outputs) may even be sufficient in many decision making contexts.

In general terms, therefore, we recommend that CICES is regarded primarily as an attempt to describe ecosystem outputs as they directly affect human well-being, so that discussions about appropriate assessment frameworks (economic, social, aesthetic and moral) can take place. This position is consistent with that taken by the EEA in its response which stressed that for something to be a service there must be an 'active or passive human demand (want or need)'; it also follows from the ideas implicit in the definition of a final service proposed above, which suggest that only if some beneficiary can be identified can something be regarded as a service.

In the responses provided through the consultation it was suggested that there should be some place in the classification where the links between ecosystem services and other capital inputs, such as human labour or other energy or material sources, since these are often needed to produce a service, especially, for example, in the case of provisioning services. This is an important issue because an understanding of the way different forms of capital are combined as ecosystem outputs are transformed into benefits is a fundamental goal of the new ecosystem service paradigm. However, we suggest that such a modification to CICES is unnecessary because it is intended to support such analyses rather than subsume them in any classification structure. Such remarks do, however, indicate that some clarification is needed about the role of CICES in these wider debates.

CICES is intended as a classification of final services. In line with the SEEA, they are regarded as final in the sense that, these ecosystem outputs can be used by households, enterprises or government to produce benefits, often by combining these ecosystem goods and services with other forms of capital. **Thus CICES aims to describe one step in this 'production chain', and focuses on the things that can be turned into products that are valued in some way.** This position does not deny that other types of capital input may be needed to facilitate or manage some of the intermediate steps that give rise to this final service. However, to place values on these would be to open the door to double-counting. Although decisions about what constitutes the final service may be debateable, there are some conventions that we might usefully follow. It was for this reason that in the original CICES proposal the services recognised were cross-referenced to standard classifications of products and activities. This may not be possible for all services, but where a read-across can be made then it is useful as a way of emphasising the dependency of economic activity on the outputs from ecosystems (whether artificial, semi-natural or wholly natural).

An alternative and complementary approach would be to take what the US EPA has described as a 'beneficiary perspective'⁵. This involves identifying a set of beneficiary classes and using these to identify the ecosystems outputs or attributes they depend on for their well-being. While such an approach seems to offer a flexible approach to identifying services, for comparison between studies some system such as CICES would possibly still be needed to cross reference any assessments. The example application from the Swiss Federal Office for the Environment (FOEN) (Figure 2) also illustrates how a beneficiary focus can work and the role that CICES might play within it.

To emphasise the contribution of the CICES services to human well-being, we recommend that further work be done on cross-referencing these services to standard product and activity classifications, and to classifications of beneficiaries to facilitate the valuation process and help

⁵ Landers, pers comm. November 2012; see also:

<http://www.conference.ifas.ufl.edu/aces10/Presentations/Thursday/B/PM/Yes/0135%20P%20Ringold.pdf>

identify the ways different types of capital combine to support human well-being. This recommendation does not have immediate consequences for the proposed structure of CICES but indicates the kinds of role that it might fulfil in enabling the translation between and integration of different assessment approaches.

3.5 Final Ecosystem Services and the SEEA 'Production Boundary'

Given that a primary aim of CICES was to support the development of integrated environmental and economic accounting, it is important that its design should be consistent with the structure of the *Central Framework* of the SEEA (SEEA, 2012). A particularly important issue for the design of CICES is how it relates to the so-called 'production boundary'.

In the SEEA *Central Framework*, the 'production boundary' represents the interface between the economy and the environment (Figure 3). Within the economy activities that are carried out under the control and responsibility of 'economic units', which use labour, assets and goods and services to produce outputs of goods and services. These outputs are collectively known as 'products'. Within the SEEA 'the environment' is taken to include all living **and** non-living components that comprise the bio-physical environment, including all types of natural resources and the ecosystems within which they are located (SEEA, 2012, para. 2.10). The SEEA2012 goes on to describe flows from the environment to the economy as 'natural inputs', which include flows of minerals, timber, fish, and water etc.. In addition to the flow of inputs from the environment into the economy, the *Central Framework* identifies a contra-flow across the production boundary, namely that of 'residuals', which include solid wastes, air emissions, and the return flows of water to the environment.

Although the terminology may be different to that used in the ecosystem services literature, the conceptualisation shown in Figure 3 is broadly consistent with more general thinking about ecosystem services; to see the *similarities* it is useful to compare this diagram with Figure 4. If 'final' ecosystem services are the things that people directly use and value, then in this model they clearly define something equivalent to the SNA production boundary. These final services can represent inputs to the economy (in the form of provisioning services, e.g. timber), or services to the economy such as the assimilation and processing of waste (these would include some of the regulating services).

Figure 3: Physical flows and natural inputs, products and residuals (after SEEA2012)

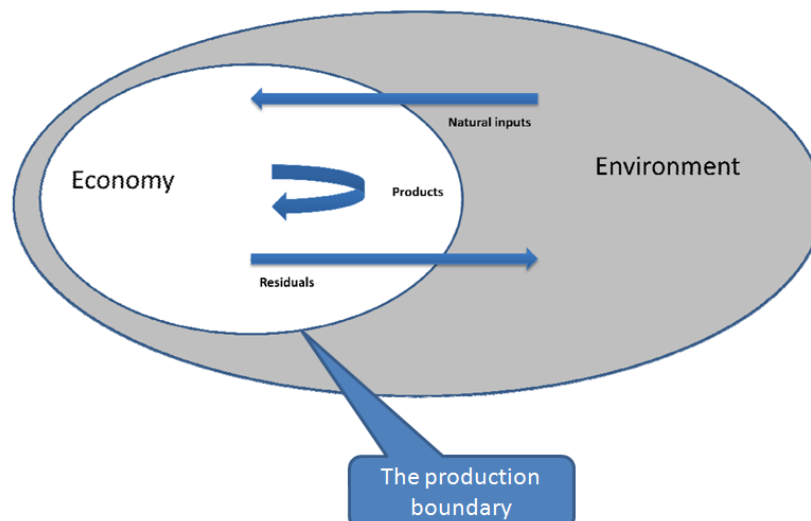
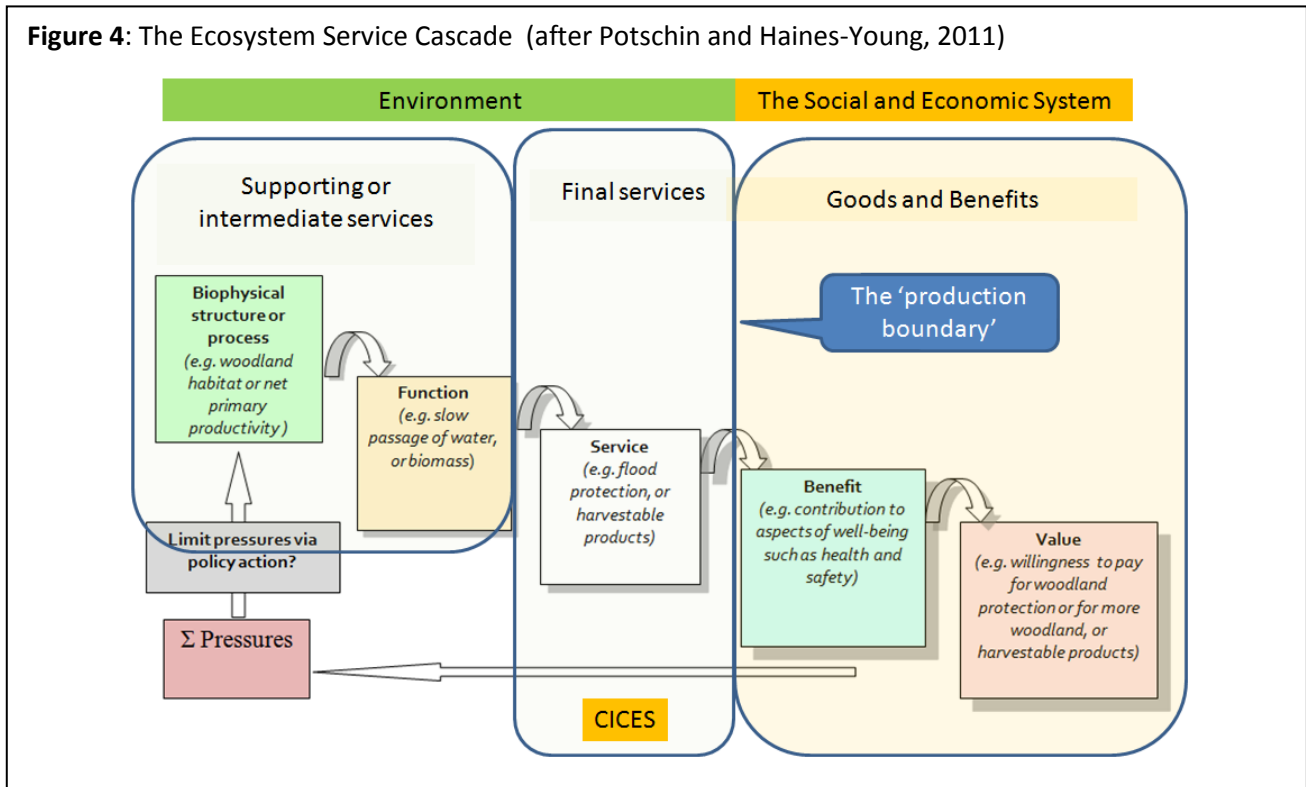


Figure 4: The Ecosystem Service Cascade (after Potschin and Haines-Young, 2011)



In terms of the *differences* between the conceptualisations in Figures 3 and 4, three features are apparent:

- i. In the 'ecosystem services cascade' represented by Figure 4, services can have *social* as well as *economic* value; social values can include cultural significance as well as moral and aesthetic worth for people; that ecosystems can provide a range of 'non-market goods'. Thus in contrast to Figure 3, the ecosystem services model implies more of a 'socio-economic boundary' rather than a narrower 'production boundary' (see SEEA, 2012, para 2.149). Nevertheless, while a listing of ecosystem services may be much longer than one simply drawn up from an economic perspective, it is clear that conceptually the two models are consistent in terms of how the environment relates socio-economic systems, and in particular how the flows (=ecosystem services) take place between them.
- ii. In the *Central Framework* the flows to and from the environment can be both biotic and abiotic. This would suggest that any classification of these exchanges across the production boundary (i.e. any full description of what the environment 'does' for the economy) would need to include **both** elements. This observation would seem to support the notion of a consistent and integrated classification of all types of ecosystem outputs, rather than one that emphasises the contribution of biodiversity alone; however, for the reasons set out above, we only consider biotic flows here.
- iii. In the *Central Framework* the term 'natural' is used to describe the various inputs from the environment. 'Natural' resources are taken to include all 'natural' biological resources such as timber and aquatic resources, mineral and energy resources, soil resources and water resources. As a comparison between Tables 1 and 2 shows, according to the SEEA model *cultivated biological resources* are excluded from what is taken to represent the 'environment' and regarded as part of the 'economy'. Instead nutrients are taken to be the final service provided by the ecosystem. The way the 'environment' is framed in the SEEA2012 is perhaps

one of the more problematic aspects for those working with ecosystem services, in that it implies that the environment only consists of structures and processes that exist without the intervention of human agency. Setting aside the problem that in many parts of the world few natural habitats or ecosystems exist (many being the result of current or historical human intervention or impact), even in explicitly cultivated ecosystems, such as the farmed landscape or plantation woodlands, the habitats can make a number of different contributions to human well-being, besides those for which they are or were cultivated. Most ecosystems, whether they are artificial, semi-natural or wholly natural are multi-functional and capable of delivering market and non-market benefits. Thus the water regulating or carbon sequestration services of plantation woodlands, for example, would not seem to be regarded as flows from the 'environment' in the SEEA model if we apply the term natural flows in a strict way, whereas they would under the more conventional ecosystem service paradigm.

It is perhaps the third point about 'natural' flows that is the most difficult to resolve, because conceptually it seems to narrow the scope of any proposed classification of ecosystem services for accounting purposes. The criterion of naturalness fundamentally changes perspectives on what an ecosystem is, and what kinds of service it provides. The problem clearly arises because we are looking at a chain of production that cannot easily be broken down into discrete steps, and which involves the progressive combination of different types of capital (e.g. natural, social, built intellectual and economic) at different points. ***In order not to close options at this stage, we therefore propose a more comprehensive framing of the concept of ecosystem services than that implied by the SEEA2012.***

It may well be that the differences between the more general ecosystem services paradigm and the SEEA2012 model can be resolved by looking more closely at the concept of 'natural flows'. The definition of flows in the *Central Framework* involves the idea of physical inputs that are 'moved from their location in the environment' directly or indirectly into production processes. For the ecosystem service paradigm it is not so much the physical movement but a ***change in the dependency on biotic processes***. Thus the transformation of an ecosystem service into a good represents more of a disconnection of the ecosystem output from the active ecosystem structures and processes that generated it (i.e. the underpinning supporting or intermediate services). Similarly the processing of 'residuals' by the environment represents an exploitation of biotic processes, when the flow of matter or energy moves the other way; in this case there is a reconnection to some set of underpinning services that can help society deal with these wastes. Thus the issue is perhaps not whether the ecosystem is 'natural', in the sense that it has not been engineered by human action, but whether the dominant processes that one is dealing with are economic or social ones (in which case we are 'within' the economy or society and are dealing with goods or products, and benefits contributed by the ecosystem), or whether biotic processes are the key factor (in which case we are dealing with ecosystem services, generated by underlying ecosystem structures, processes and functions).

We suggest that in the forthcoming work on experimental ecosystem accounts there is a focus on the nature of the production boundary and a discussion of the concept of 'natural' within the Central Framework so that convergence between the systems might be achieved. At this stage however, we recommend that the concept of 'natural' is not used to define the boundary of the classification but rather the notion of connection between the services and the underpinning ecological structures and processes.

3.6 Cultural ecosystem services

Many of those consulted pointed out the difficulty of defining and describing cultural ecosystem services. Indeed, one of the complexities recognised in recent debates is that, to some extent, all services have potentially a cultural component. There are, for example, important cultural dimensions to diet and hence what we regard as ‘provisioning service’. The situation is perhaps, analogous to the dependency of services on biodiversity, in that there is probably also a spectrum ranging from services that are wholly on cultural factors to others that are less so.

The inclusion of a section that explicitly highlights cultural services in CICES does not deny that cultural values are important across all the services. Indeed many of these cultural factors may be recognised in the values that people subsequently ascribe to these services. The purpose of distinguishing cultural services is to flag up the fact that there appears to be a set of non-material outputs from ecosystems that are important to people. These outputs are variously described as representing ‘spiritual’ significance, or ‘meaning’, or of encapsulating aspects of peoples ‘identity’.

In order to better distinguish between final services and benefits, the UK NEA⁶ classified cultural services in terms of ‘environmental settings’. These were conceived as locations or places which, at different scales, give rise to the cultural goods such as leisure, recreation and tourism, and religious, spiritual and health benefits (Figure 4). In general terms these environmental settings can be regarded as socio-ecological systems of some kind that are socially determined units in which nature and society are linked materially and culturally. To emphasise the ‘physicality’ of the things regarded as cultural services in CICES, we have proposed that the term ‘setting’ should be used in the titles at Division Level and carried through to the lower levels. The responses received (Table 1 and 2) tended to retain the terminology, but it was apparent that the terms referring to benefits (such as recreation) have not been entirely eliminated in terms of the revisions proposed. In the revisions we have made the problem has been addressed by modifying the terminology accordingly.

A further problem with emphasising the non-material aspects of cultural services, as a distinguishing feature, is that there is a potential ambiguity in the current structure of CICES. At present the services that contribute to hunting and angling (sport fishing), for example, would be classed as supporting a type of cultural practice. However, since they involve the extraction of biomass, they could equally well be placed in the provisioning sector either as a food if the quarry is eaten (e.g. in the Nutrition division in the class ‘Wild plants and animals and their products’) or as an ornamental service (in the class ‘biotic materials’) if they are treated more as trophies. ***One option that was suggested in our proposal or V4.1 was to change the location of the ‘extractive’ forms of cultural service and place them in the provisioning sector of the classification, but there has been little support for this modification. As a result in the structure proposed here, we retain ornamental in provisioning and the use of environmental settings for hunting and sport fishing, for example, in the physical experiential group of Cultural Services.***

On the basis of the comments received there is more support for a classification that differentiates the physical or experiential use of ecosystems and what they represent intellectually or symbolically. Thus in revising the classification of cultural ecosystem services, we recommend a structure that distinguishes at Division level: (a) the physical and intellectual interactions with environmental settings; and, (b) their spiritual or symbolic representation, with corresponding subdivisions at the lower levels.

⁶ Based on Max-Neef’s ‘Human-Scale Development Matrix’

4. Recommendations for CICES V4.3

On the basis of these findings presented above, we recommend modifying the general structure of CICES as shown in Table 3. Table 4 provides a formal definition of the sections within the classification

The structure of CICES V4.3 at the '3-digit level' as shown in Table 3. We recommend, however, that CICES is presented in SEEA Volume II at the full, 4-digit level, because this better captures the richness of the material provided by the consultees. It will also make the testing of the classification more rigorous. The full classification and the examples of services under each category is provided in the accompanying spreadsheet, which can also be downloaded from the CICES website: www.cices.eu

Table 3: Recommended modifications for CICES V4.3

Section	Division	Group	
Provisioning	Nutrition	Biomass	
		Water	
	Materials	Biomass, Fibre	
		Water	
	Energy	Biomass-based energy sources	
		Mechanical energy	
Regulation & Maintenance	Mediation of waste, toxics and other nuisances	Mediation by biota	
		Mediation by ecosystems	
	Mediation of flows	Mass flows	
		Liquid flows	
		Gaseous / air flows	
	Maintenance of physical, chemical, biological conditions	Lifecycle maintenance, habitat and gene pool protection	
		Pest and disease control	
		Soil formation and composition	
		Water conditions	
		Atmospheric composition and climate regulation	
	Cultural	Physical and intellectual interactions with ecosystems and land-/seascapes	Physical and experiential interactions
			Intellectual and representative interactions
Spiritual, symbolic and other interactions with ecosystems and land-/seascapes		Spiritual and/or emblematic	
		Other cultural outputs	

Table 4: Definitions of the major sections within CICES V4.3

Provisioning	<p>All nutritional, material and energetic outputs from living systems. In the proposed structure a distinction is made between provisioning and material outputs arising from biological or organic materials (biomass) and water. Materials can include genetic structures.</p> <p>The Division for energy makes a distinction between biomass based energy sources, where the organic material is consumed (e.g. fuel wood) and power provided to people by animals.</p>
Regulating and Maintenance	<p>All the ways in which living organisms can mediate or moderate the ambient environment that affects human performance. It therefore covers the degradation of wastes and toxic substances by exploiting living processes.</p> <p>Regulation and maintenance also covers the mediation of flows in solids, liquids and gases that affect people's performance. as well as the ways living organisms can regulate the physico-chemical and biological environment of people.</p>
Cultural	<p>All the non-material, and normally non-consumptive, outputs of ecosystems that affect physical and mental states of people.</p> <p>Cultural services are primarily regarded as the physical settings, locations or situations that give rise to changes in the physical or mental states of people, and whose character are fundamentally dependent on living processes; they can involve individual species, habitats and whole ecosystems. The settings can be semi-natural as well as natural settings (i.e. can include cultural landscapes) providing they are dependent on <i>in situ</i> living processes. In the classification we make the distinction between settings that support interactions that are used for physical activities such as hiking and angling, and intellectual or mental interactions involving analytical, symbolic and representational activities. Spiritual and religious settings are also recognised. The classification also covers the 'existence' and 'bequest' constructs that may arise from people's beliefs or understandings.</p>

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Appendix 1: Consultation Document

Common International Classification of Ecosystem Services (CICES) version 4

Briefing Note, July 2012

Background

1. 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.
2. CICES V4 has a five level hierarchical structure (section – division – group – class – class type) (see Appendix 1). The more detailed class types makes the classification more user-friendly and provides greater clarification on what ecosystem services are included within each class. Using a five-level hierarchical structure is in line with United Nations Statistical Division (UNSD) best practice guidance as it allows the five level structure to be used for ecosystem mapping and assessment, while the first four levels can be employed for ecosystem accounting without reducing the utility of the classification for different users.
3. At the highest level are the three familiar sections of provisioning, regulating and maintenance, and cultural; below that are nested ten principle divisions 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/>).

Table 1: CICES basic structure and relationship of classes to TEEB classification

CICES Section	CICES Division	TEEB Categories			
Provisioning	Nutrition	Food			
	Water supply	Water			
	Materials	Raw materials	Genetic resources	Medicinal resources	Ornamental resources
	Energy				
Regulating and Maintenance	Regulation of bio-physical environment	Air purification	Waste treatment (esp. water purification)		

	Flow regulation	Disturbance prevention or moderation	Regulation of water flows	Erosion prevention	
	Regulation of physico-chemical 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 and tourism

4. Table 1 shows that it is relatively straightforward to cross-reference the TEEB categories with CICES. The labels 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 division'.
5. The structure for CICES below the division level is shown in Appendix 1⁷, with twenty two 'service groups' and fifty three 'service classes' being proposed. Box 1 provides the formal definitions of the service themes and classes and the rationale that underpins them. Definitions need to be developed for all the levels in the classification.

BOX1: Definitions

Provisioning	<p>Includes all material and biotic 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.</p> <p>Within the provisioning service section, four major divisions of services are recognised:</p> <ul style="list-style-type: none"> • Nutrition includes all ecosystem outputs that are used directly or indirectly for as foodstuffs (including potable water) • Water supply which includes that for human consumption • Materials (biotic) that are used in the manufacture of goods • Biotic renewable energy sources <p>Within the provisioning services groups, additional classes and class types may be recognised.</p>
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⁷ This table may also be downloaded as an Excel spread sheet from the CICES website :www.cices.eu

<p>Regulating and Maintenance</p>	<p>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.</p> <p>Within the regulating and maintenance division, four major groups of services are recognised:</p> <ul style="list-style-type: none"> • Regulation of bio-physical environment which covers 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 physic-chemical 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. <p>Within the regulation and maintenance classes, additional classes and class types may be recognised. The classification allows these to be distinguished by process and whether the processes operate 'in situ' or 'ex situ'.</p>
<p>Cultural</p>	<p>Includes all non-material ecosystem outputs that have symbolic, cultural or intellectual significance</p> <p>Within the cultural service division, two major groups of services are recognised:</p> <ul style="list-style-type: none"> • Symbolic • Intellectual and Experiential <p>Within the cultural classes, additional classes and class types may be recognised. The classification allows these to be distinguished using criteria such as whether it involves physical or intellectual activity.</p>

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

- a. **Abiotic outputs from ecosystems are not 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). According to this strict definition, abiotic ecosystem outputs such as salt, wind and snow, for example, would not be included.
- b. **The 'regulation and maintenance' section 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' section. It is proposed that they form a groups and classes that capture 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.

- c. **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 previous consultations on CICES suggested that the naming of the higher levels should be as generic and neutral as possible. Thus 'flow regulation' is suggested, for example, as opposed to 'hazard regulation'. The assumption is that users would then identify the specific services that they are dealing with as 'classes' and 'class types', 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.

Issues for Consultation on CICES V4

7. Respondents are invited to comment on any aspect of CICES, however, there are a number of areas where responses would be particularly welcome. **These mainly relate to revisions that have been made from versions 3 to 4 and proposals that have arisen during that process.** The questions set out in this document are intended merely as an aid to discussion and comments need not be confined to the issues raised.
8. The consensus from recent reviews and discussions was that CICES required amendment to:
 - a. Have a naming of the levels in the hierarchy that is consistent with other international classifications (i.e. Section, Division, Group, and Class); this has therefore changed the terminology used in Version 3.
 - b. More fully include ecosystem service associated with the marine environment; Version 4 makes these additions.

Question: Are these adjustments now sufficient to cover the marine sector?

- c. Exclude non-ecosystem based natural flows, i.e. renewable abiotic energy sources and abiotic materials. The renewable abiotic energy sources included wind, hydro, solar, tidal and thermal; and abiotic materials included mineral resources. These have been excluded from CICES version 4 and the UNSD has proposed combining these into a section called 'other environmental flows' because these could become a separate table in the SEEA Volume 2.

Question: Should abiotic energy and material be excluded from the classification or included? They could be included by having them as distinct categories in provisioning as in CICES Version 3. For accounting purposes it may make sense to exclude them, for mapping and assessment purposes the rationale is less clear.

- d. Water has been given its own division within provisioning services as it does not sit comfortably within either nutrition or materials and to reflect the water account component of ecosystem accounts. Three groups have been added along with new classes. Water supply also includes marine waters. Cooling water has been removed from water quality regulation to avoid double counting.

Question: Do you support this revision or have any suggestions for further improvement?

- e. In the 'biotic materials' group, it has also been proposed to remove ornamental resources and include cosmetic resources. Ornamental resources have been retained and cosmetic resources combined with medicinal. Do you support this revision or have any suggestions for further improvement?

Question: Do you support this revision or have any suggestions for further improvement?

- f. In the 'energy' group, abiotic renewables have been removed and 'renewable biofuels' renamed 'biomass based energy' to reflect wider use of biomass for energy (i.e. heat, power, fuels).

Question: Do you support this revision or have any suggestions for further improvement?

- g. It has also been proposed to change the group 'dilution and sequestration' to 'dilution, trapping and recycling' as the current title does not include all processes included in the group. The three classes would be replaced with two broader classes – 'geophysical' and 'biochemical' processes to ensure inclusion of processes such as remineralisation and decomposition.

Question: Do you support this revision or have any suggestions for further improvement?

Appendix 2: Summary of Responses from Consultation

The comments received on the CICES website were organised around a number of discussion topics. In reporting them we have retained the original numbering, although it was clear that there was some overlap in the points made and some issues are more easily dealt with by combining them. It is not possible here to report in detail how the comments were dealt with but rather give a general picture of the debate. Many of the key issues have been discussed in greater depth in the main text of this document. An updated spreadsheet showing the revised classification is attached. A comparison between Versions 4 and 4.1 in this spreadsheet shows what changes have been made.

Topic 1: Marine

The main adjustments to CICES V4 in the marine sector were an expansion of the classification to more fully include the biotic marine environment and to exclude ecosystem outputs from marine systems that were not dependent on living processes such as renewable abiotic energy sources and abiotic materials. Setting aside the debate about whether abiotic ecosystem outputs should be included (see Issue 4), no significant shortcoming in the classification was identified for provisioning, and regulating.

There was, however, some discussion about ‘transport services’ and a case was put for their inclusion. The argument echoes that of DeGroot (2006), who identified a so-called ‘carrier function’ for ecosystems, defined in terms of their ability to provide a suitable substrate or medium for human activities and infrastructure. Such services would, if abiotic services are excluded from CICES, also lie outside the classification, except in so far as organisms may regulate or mediate navigation, say, via their effect on sediment movement or water flow, but this is something that probably only applies to freshwater systems. At present these services are covered in ‘Flow regulation’. The same topic was identified in the exchanges about water (see Issue 3).

Topics 2 & 5: The place of abiotic energy sources and energy more generally.

The discussion points made here rehearsed many of the arguments for and against including abiotic services in the classification. It was suggested for example that by including abiotic ecosystem outputs there was a danger of making the system too broad. One respondent argued, for example, ‘From a scientific point of view one might want to make a complete-all-inclusive system in its own right, but with a view to the political task on our hands, which stems from the Biodiversity Convention, it might be wise to settle for less complexity and focus on the most important aspects’. This discussion thread was continued in the comments for water (Topic 3) and biotic materials (Topic 4); see below.

However, in terms of energy issues, assuming they are retained in the system, it was noted that there had been some applications in Belgium using the original classification and the respondent endorsed the present structure in conceptual terms.

Topic 3: Water

Much of the discussion focussed on the problem of classifying water because it is, as a number of contributors pointed out it an abiotic component of ecosystems. Thus one suggestion was that it should be moved entirely to a section covering abiotic services. However, living processes clearly play a role in regulating its quantity and quality, and so it was suggested that it should be eliminated from provisioning, and only referred to in the regulating section; in this case the service would be

the regulating capability or contribution that living organism make in the water cycle, say or via their capacity to purify. The options for water have been discussed in the main text of this document. At this stage we have retained water in the provisioning and regulating Divisions, mainly on the basis that this seems to be the convention, following the MA.

In the wider comment received on the general problem of abiotic ecosystem outputs it was noted in the discussion that the present situation largely reflects the historical development of the ecosystem service framework, and that we still need to work towards a 'coherent and robust' framework. It was also argued that the separation between biotic and abiotic is somewhat artificial; the general tone of the comments received was that some unified treatment was probably desirable.

Topic 4: Biotic materials

Some quite specific comments were made here. It was noted for example that dependency on fungi and micro-organisms, should be covered alongside plants and animals in nutrition, and that the term fibre should be generalised to materials. Finer resolution of the genetic category was also proposed.

Other comments suggested that the scope of the classification of biotic materials as intermediate service and final services needed to be clarified (e.g. should plant based fertilisers and fodder be identified in the classification?). These issues are discussed in terms of the concept of final service – see above- and the notion of products (goods) as distinct from services.

It was also suggested that the placing of ornamental is problematic in that use is essentially determined by culture. However the same could be said of all foods, but we would probably not to move these to the cultural service section. TEEB has it here, under provisioning. Perhaps it should go at class-type level as specific types of non-food vegetal and animal materials.

Topic 5: Regulating Services

There were a number of comments made about the structure of this Division. One contributor put expressed their concerns as follows:

1. We felt that this ES group and classes 'dilution and sequestration' is an odd case in the CICES list, as it is one of the few groups which are split up based on processes. We (CICES-Be) prefer not to split up ESS according to processes, but rather based on the type of service they provide.
2. Some of the division names in the regulation and maintenance are quite vague and very broad: We therefore propose on the level of division to replace the term 'regulation of the biophysical environment' by 'regulation of wastes, pollution and nutrients', and park here 4 ES groups: Soil pollution remediation, Water quality regulation, Air quality regulation and Noise regulation. The other group 'regulation of the physic-chemical environment' can then also be deleted and replaced by the more specific descriptor 'regulation of climate'.

It was subsequently endorsed by other contributors. The original contributor suggested four elements at the Group level, with corresponding classes:

- Regulation of wastes, pollution and nutrients: (Soil pollution remediation; Water quality regulation; Air quality regulation; Noise regulation)
- Water & mass flow regulation: (Water and soil stability; Protection against peak events)
- Regulation of climate : (Atmospheric regulation; Regional climate regulation; Local climate regulation)

- Regulation of biotic environment: (Regulation of agriculture, forest & fishery production; Regulation invasive species; Regulation human diseases)

Further discussion is probably needed at this point. The clearer distinction between regulation of the physical and biotic environment used in earlier versions of CICES may make the classification easier to use.

At a more detailed level, the point was made that if 'Regulation of biotic environment' includes 'the nursery functions that habitats have in the support of provisioning services' then there appears to be scope for double counting. One contributor asked: Is the nursery function of an ecosystem counted as a provisioning service (in the form of the animals that are eventually harvested) or as a regulating service (in the form of the maintenance of a harvested resource)? They argued that it cannot be both, and that the definition suggested in the revised classification seems to reintroduce the concept of supporting services, which have been explicitly excluded from CICES. Certainly clarification is needed. As example here would be the case of shrimp farming where wild seed are collected, bought and sold. This is not a direct nutritional use; it could be regarded as harvesting a genetic resource under biotic materials. Given the discussion on the nature of the production boundary above – the shrimp seed is more of an ecosystem good, and it is the mangrove in an appropriate functioning state that represents the final services.

An additional regulating service suggested was the stabilising effect of biodiversity on ecosystems that contributes to an improved 'ambient environment' for human performance. It was argued that support for this view can be found in Consensus Statement 2 in the recent summary review Nature article by Cardinale et al., 2012 ('Biodiversity loss and its impact on humanity'). The definition for the Regulating and Maintenance section of CICES is based on the assumption that it broadly describes the regulation for the human environment, and covers the state of bio-physical conditions as well as risk and hazards that arise by virtue of various natural processes.

'Trapping', under dilution and sequestration was thought to be ambiguous, in that for some the word is used in the context of hunting or harvesting animals. Nutrient trapping is, however, an established phrase in the scientific literature and so could be retained.

Topic 6: General

In the discussion a number of general comments were made as well as a number of specific ones. The broader issues are covered in the main part of this document. The more particular suggestions are summarised below.

At a practical level it was suggested that:

- a) For the purposes of illustration, the examples and indicative benefit sections might be illustrated with, example final ecosystem services, ecosystem goods and benefits, so that policy makers might better understand the relevance of this work for promoting sustainable use of agriculture/forest areas.
- b) Use of animals for transport (motive power) was identified as a gap;
- c) There were also some overlaps noted, especially in terms of the cultural services

Issue 7: Cultural Services

A new topic was added during the consultation, given the comments that were received.

It was suggested that the distinction between 'Symbolic' and 'Intellectual and Experiential' was not helpful and possibly inconsistent with the definition in Box 1 of the briefing document. To resolve the inconsistency it was recommended that the major distinction that perhaps should be made was between physical or experiential uses, and intellectual ones. Another commentator argued that perhaps 'Meaning' or 'Sense of Identity' was better than Symbolic because it conveyed more clearly what was intended.

A number of gaps were identified. For example one commentator observed that the cultural section seems limited given the definition of culture by UNESCO which includes identity, diversity, life satisfaction etc. Thus it was suggested that there should be reference to psychological services (health improvement: not the physiological effects), as well as a sociological one: socialisation. Echoing the remarks made about sense of identify, it was argued that another collectively enjoyed individual services are identity formation, the formation of a society's semiotic system (defining values and meaning), and environmental stability as a condition of individual life planning, which in turn is a condition of quality of life, and of development. The discussion on cultural services in the main text may help clarify these issues, which revolve around whether the classification is dealing with final ecosystem services, goods or benefits. We have modified the examples to help illustrate the approach and indicate where these topics might be located.