Methodological issues for ecosystem service accounting in SEEA-EEA – some reflections building on EU experience and a recent CICES survey

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Introduction

This brief paper reviews some methodological questions that relate to key elements required for implementing ecosystem service accounts under the SEEA EEA framework. Part a) briefly discusses three points that seem to us of particular importance in the practical application of the concept of 'final ecosystem services' and the development of ecosystem service classification(s).

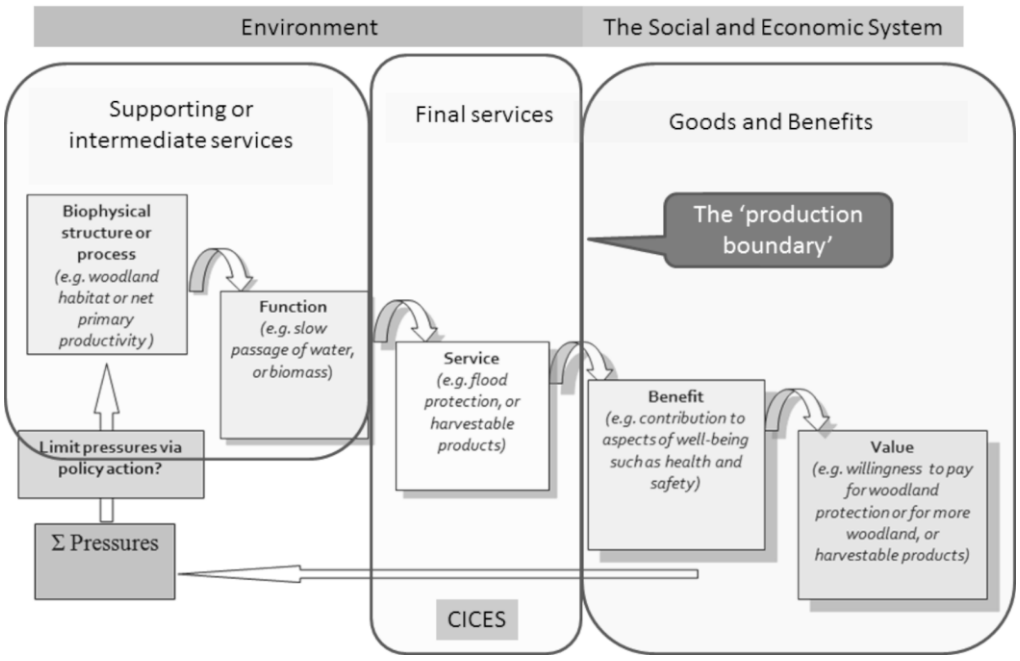
Part b) presents some issues that have emerged from the consultation on CICES this year and provides a reflection on how the feedback has been considered so far in the ongoing revision process of CICES. This is only an extract from a comprehensive review paper that is still to be finalised and represents current thinking. We would like to expose these issues for feedback by London Group members as part of the review process. The next steps will be a methodological comparison with the ES classification systems sponsored by USEPA (FEGS and NESCS) and discussion at an expert workshop in Wageningen on 17-18 November. The review paper and a proposal for CICES V5.0 are expected to be finalised by the end of 2016.

a) Methodological questions in implementing ecosystem service accounts

1) The environment-economy boundary

Defining the environment-economy boundary is a critical element in the SEEA framework and also in other contexts that aim to analyse the benefits that human society derives from ecosystems and their services. The key conceptual model that underpins the development of CICES and also analytical work in the context of the EU 'MAES process' (Mapping and Assessment of Ecosystems and their Services) is the ecosystem services cascade model – see figure 1 below.

This model seeks to show how ecosystem services bridge the biophysical and socio-economic sphere and is considered a very helpful conceptual model by EU partners in the EU MAES process. How does this compare to the environment-economy concept in SEEA-EEA? Can it be considered an appropriate representation of the environment-economy boundary concept in the SEEA context? If not, in what way would it have to be adjusted to fit the SEEA-EEA principles?



Potschin & Haines-Young 2016 Routledge Handbook of Ecosystem Services

Figure 1: The ecosystem services cascade model

2) The ecological production function concept

This is a key conceptual construct in SEEA-EEA (see also Obst et al., 2015) that is meant to ensure that only contributions from ecosystems are measured that are not already in the economic realm. It assumes that bio-physical models and data are available that allow separating out the contributions of ecosystems from the human input (e.g. labour, energy) to joint production process. It is particularly discussed in the context of provisioning services but is likely to be relevant to other types of ecosystem services as well. Two concerns have arisen in considering its application in a European context, related to its conceptual premise and its practical application.

Conceptually, it appears very difficult, if not impossible, to allocate a percentage 'contribution' to individual elements of one system if they are all required for that system to function. Figure 2 shows a couple of examples where intuitively or on the basis of established research the concept does not appear to work. The examples shown relate to the functioning of a car (which parts contribute which share to its speed or energy?) and to long-standing insight into the agronomic production process (the so-called 'Liebig law') – do fertilisers and water both contribute 30% of total crop output when they could both be the one limiting factor, if reduced to [close to] zero ?

In practical terms, a review of ecosystem service accounting approaches in Europe shows that it appears difficult to find the data that are required for identifying the share of different production factors. As illustration, table 2 lists the ecosystem services and associated measurement units that are proposed for implementation in phase 2 of the EU KIP INCA project.

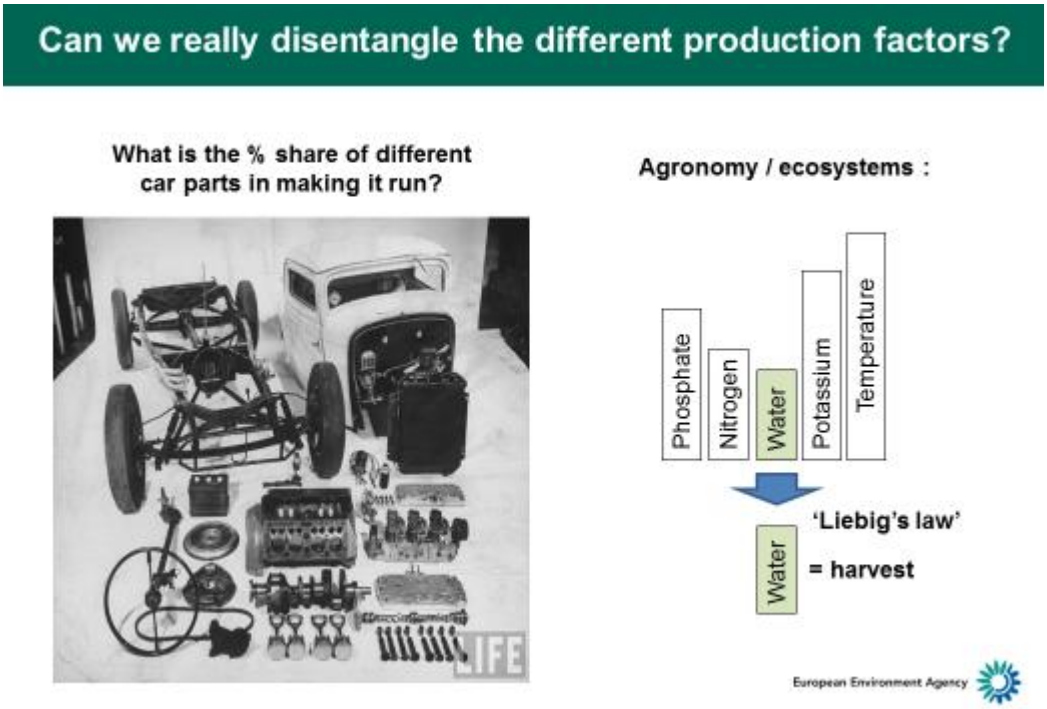


Figure 2: Reflections on the production function concept

Nevertheless, the question of attributing a production share to different components or stages in economic production processes must have been tackled in economic analysis or accounting contexts before. It would be useful to understand what conventions are applied in such cases. Where is that documented or explained?

There is also output from bio-physical research (e.g. on the energy input-output ratio in different farming systems) or environmental impact assessment (e.g. life-cycle assessment approaches) that potentially allows developing proxy approaches for estimating the total contribution from 'nature'. These would not necessarily represent 'reality' (due the complexity of real-life systems and data gaps, and given the conceptual concerns expressed as such) but could be a basis for developing rules of thumb (or even more elaborated conventions) to be applied for estimating the 'contribution of nature'.

Overall, it seems that more work has to go into finding a convincing approach for applying the ecological production function concept in an SEEA-EEA context (if all can be convinced). However, even if it is possible to develop standard assumptions for the contribution of nature in different contexts it would seem advisable to keep these rules as simple as possible - as the investment priority would seem to be to expand the existing set of ecosystem services that can be calculated rather than improving existing ecosystem service calculations forever (if a harvest approach with some deduction for human input would suffice).

Table 1: Ecosystem services accounts to be developed in the EU KIP-INCA project

Service	Physical unit
Provisioning services	
Crops	Harvest (ton per ha)
Timber	Timber growth and harvest (ton per ha)
Marine fish	Catch (ton per fishing zone)
Water	Water abstraction for public, industrial and agricultural use (m3 per unit area)
Livestock	Amount of animal feed (grass) provided
Regulating services	
Pollination	Share of the crop harvest pollinated (ton per ha)
Erosion control (soil protection)	Avoided erosion in ton/ha/year compared to bare soil
Water purification	Removal of in-stream nitrogen (ton per km river)
Air filtration	Deposition of air pollutants (ton per ha)
Carbon sequestration (in vegetation and soil)	C sequestration in ton/ha/year
Flood control	Land area protected
Cultural services	
Recreation	Number of visits in ecosystems (person-days) / ha, include budget for surveys in some countries
Tourism	Number of overnight stays generated per ha/year

3) Statistical aggregation - needs and purpose

In the development of CICES it was assumed that aggregation is an important function for an accounting approach (it also makes great sense in many other analytical contexts). Hence CICES is built on a hierarchical structure that allows horizontal aggregation from lower level categories to groups and sections.

In the recent informal CICES consultation there was feedback that explored this issue; with some suggesting that the ability to sum up 'horizontally' and 'vertically' across categories would be helpful. The latter does not appear possible at first reflection (as one compares 'apples with oranges'). However, it could be possible to give this issue further attention. A potential technical solution could be to add virtual tags or classifiers to each cell at class type level. With the right software tool it would then be possible to sum up different categories independent of the location of the cell.

Feedback would be appreciated on whether this issue is sufficiently important to merit further investment to develop such tagging to allow flexible aggregation.

b) Extract from discussion document on revision of CICES

Prepared for discussion at the London Group meeting, Oslo, Sept. 2016

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1. Principles underpinning the revision

1.1. In designing CICES it is assumed that we seek to build a multi-purpose classification that can be used for mapping and assessment work as well as natural capital accounting. The assumption is made because the 2016 CICES survey found that users were involved in a range of applications; the most frequent was mapping and ecosystem assessment, followed by valuation, indicator development, stakeholder engagement, modelling and ecosystem accounting.

1.2. The goal of building a multipurpose classification clearly assumes that the requirements of the different purposes are compatible. Although the requirement for quantification of service metrics is common to many of the types of application citied, any future guidelines for CICES should explain the extent to which it can be readily used for different types of applications (and in particular ecosystems accounting including valuation) without amendment, or whether modifications are necessary.

1.3. It is proposed that CICES V5.0 continues to be based on the conceptual framework of the 'cascade model' which views ecosystem services as being at the interface between people and nature; they are features or outputs of ecological systems that are dependent on (or still connected to) living structures and processes ('biodiversity' *sensu lato*) but which provide the opportunity for deriving some human benefit. These services are regarded as 'final' in the sense that they are outputs of ecosystems that are directly consumed or used by people (see Section 5 for further discussion).

1.4. Thus CICES V5.0 is built on the principle that a classification of ecosystem services needs to describe the contribution that ecosystems make to human well-being, defined in terms of **'what ecosystems do that is actually or potentially useful for humans'**. Thus the definition of a service needs to highlight the ecological outcomes that particular ecosystem characteristics or processes generate, that can ultimately benefit people.

1.4.1. Accounting deals with the present, so that ecosystem accounts would document the ways in which ecosystems are currently useful to people and how this has changed over time. In contrast, for planning purposes the identification potential future uses of ecosystems is often a key concern. It should be noted that CICES is intended as a framework that can be employed to identify both actual and potential use. While the CICES categories might be common to both types of application, they will be used (and potentially quantified) in different ways in relation to information about, for example, beneficiaries or drivers of change.

1.4.2. It should also be noted that that the notion of 'what ecosystems do' covers the characteristics *and* behaviours of ecosystems that make them useful to people. Given that many characteristics and processes may be needed to enable this potential utility to be realised, services are in a sense aggregates of a number of properties that together give rise to a useful output. The identification of the functional characteristics of ecosystems in the cascade model provides a way of specifying what this set of characteristics and behaviours are.

1.5. The emphasis or focus on 'what ecosystems do' is intended to make explicit the properties or behaviours of ecosystems that are actually or potentially useful to people, such as generating fibre (say wood) with characteristics that make it suitable (or not) for construction timber. Thus CICES provides a list of things that 'ecosystems do', based on our understanding of them, that is initially independent of identifying any specific beneficiary or benefit. Although the identification of benefits and beneficiaries is necessary for accounting purposes, the entry-point for many other applications is via the things that 'ecosystems do'. While accounting and mapping applications should enable people to identify 'ecosystem output-use-user' combinations, for CICES the identification of such combinations is not regarded as a prerequisite for specifying service types/categories.

1.6. CICES seeks to describe 'what ecosystems do' in biophysical terms, keeping in mind the benefits/uses that are ultimately supported by the ecosystem; recognising a 'useful ecological outcome' depends fundamentally on knowing what the potential uses and beneficiaries are. The danger of mixing ideas about biophysical outcomes and uses is that there may be a blurring of the service/benefit divide as has happened in the classification of cultural services in V4.3, where the properties of ecosystems that made them culturally useful or significant were mixed with the activities or practices that were associated with them. Thus, for example, while particular types of ecosystem provide better or worse opportunities for observing wildlife, it is useful to distinguish this from the cultural practice (benefit) of observing wildlife itself, which depends on a range of other things besides the properties of ecosystems. The advantage of being clearer about ecological outcome and use is that if it can be handled in a consistent and logical way, it may be easier for users to visualise what the service actually is. This is especially important when working with non-technical or lay audiences who may have a more limited understanding of ecological structures, processes and functions.

2. Structure of the Classification

2.1. While the hierarchical structure of CICES was generally seen as useful, both in communicating the characteristics of the different categories and in allowing users to group and split categories in ways appropriate to their application, the role of the division/group level was questioned.

2.2. There was a proposal (UK), for example, that these two upper levels might be merged and presented as follows:

Table 1: Option for Collapsing the Division/Group Distinction

Section	Division/Group
Provisioning	Biomass
	Water
	Energy[1]
Regulation and Maintenance	Mediation of wastes
	Mediation of flows
	Maintenance of physical, chemical and biological conditions
Cultural	Physical and experiential interactions with natural environment
	Intellectual and representative interactions with natural environment
	Spiritual, symbolic and other interactions with natural environment

Notes: [1] The energy category in this proposal did not include biomass-based energy

2.2.1. This proposal (Table 1) has the advantage of simplification, especially in the area of cultural services, where the four-level system seemed to impose a set of distinctions that were difficult to operationalise. Each of the new Division/Group categories also makes sense in terms of a reporting category, and as noted in the feedback the removal of implied uses such as 'nutrition' at the upper level emphasises the biophysical characteristics more clearly. However, it seems to introduce some uncertainty about where biomass-based energy would sit (note the UK proposal did not include biomass-based energy).

2.2.2. A review of the CICES application literature identified through the 2016 Survey found that use has been made of the upper levels in the classification. Kulczyk et al. (2014), for example, used the Division level to report on different dimensions of tourism and recreation, while Helfenstein and Kienast (2014) used the hierarchical structure in a flexible way to construct reporting categories for their analysis of ecosystem service state and trends at regional to national levels in Switzerland. Thus there may be a trade-off between the simplicity a three level classification would offer, and flexibility in terms of reporting and analysis. Given that both the logic and hierarchal structure of V4.3 were highlighted as the two most frequently cited merits of the system, we have therefore not reduced the number of levels in the draft proposal for V5.0.

2.2.3. In preparing the draft and considering the initial feedback we have, however, considered the consequences of revising the provisioning services to make biomass, water and energy as categories at the Division level and sub-dividing by implied use (e.g. nutrition vs materials etc.). The change has little impact on the overall structure and mainly results in a reordering of rows at the class level. However, the uncertainty of where to place biomass-based energy sources would need to be balanced against the disadvantage in V4.3 of splitting water and biomass across the broader nutrition and material categories.

2.2.4. **On balance we propose retaining the four-level hierarchical structure of V4.3 at this stage and to explore other options in the future.** The discussion has been important because it has identified the need for guidance on how to handle ecosystem outputs that are apparently split across more than one class and hence fall in to different groups or divisions etc.

2.2.5. The example of an animal, such as reindeer, being used for food and materials illustrates this issue. The point here is that while the service 'wild animals and the outputs' is clearly an ecological outcome, if one part of the animal is used for nutrition and another part for fibre (and potentially a third part for energy), then the split between the two (or three) should possibly be within the same 'Group' and not spread across more than one Group. This is so that, if necessary, the measurement (in both physical and monetary terms) can be made of the ecological output, not of the final (processed) good (a skin).

2.2.6. An insight into how to address the issue might be found by making the distinction between how to *define* a service and how to *report* the contributions that ecosystems make. **CICES is primarily a way of defining services, and assumes that the broad properties at the Section, Division and group levels are inherited by the Classes; thus the splitting at the different hierarchical levels is simply a way of helping users 'key out' the different types of service.** When the services come to be reported, however, there is nothing to stop users grouping or aggregating them in different ways, and so if it is relevant to have a reporting category relating to 'wild animals and their outputs' combining the classes for food, material and energy (assuming the metrics can be summed), or using the set to define a set of monetary values that it is meaningful to lump together.

2.2.7. The point does however, suggest that further thought and clear guidance on the use of the hierarchical structure of CICES is needed, coupled with tools to help users combine classes in different ways for different reporting purposes. Three alternative approaches can be contemplated:

2.2.7.1. The Section-Division-Group-Class structure of CICES is regarded as a defining framework, with each level increasingly adding detail to expand the characterisation of the services inherited from the levels above. In this strategy CICES is regarded primarily as a *classification* system with exclusive, non-overlapping categories that span all things that are considered to be ecosystem services. Guidance would be needed to show how the CICES classes might then nest (and potentially be aggregated) into different reporting frameworks.

2.2.7.2. The hierarchical structure of CICES is modified and the Section-Division-Group structure be designed to label broad that categories of different types that can be used for aggregation and reporting purposes; the categories could denote broad 'uses' such as nutrition, or materials or general biophysical characteristics such as 'biomass' or 'water'. While a number of these labels were used in V4.3, the differentiation into types would need to be checked for conceptual consistency and relevance. Although classes could still be reordered to create other reporting frameworks, this approach does presume that an arrangement

at the Section-Division-Group can be found that covers the most common reporting requirements. A disadvantage is that it may not be possible to have nested categories at each level as in V4.3.

2.2.7.3. A final more hybrid option is to consider how using a flexible database structure a common set of classes could be arranged for a range of different purposes. It is possible that this could be achieved by tagging the basic classes in various ways that would enable customised 'user views' to be constructed rapidly. This technical option will be explored in further work.

3. The notion of potential final services

3.1. The revised version of CICES will continue to identify 'final ecosystem services'. These are seen as outputs or characteristics of ecosystem that contribute to well-being but are still *connected to* or *dependent upon* the ecological structures, processes and functions that underpin them. Although this definition is specific to CICES it is not conceptually at variance with other definitions such as those of Boyd and Banzaff (2007) who suggest that final ecosystem services are the directly consumed ecological components of ecosystems". We contend that such ecological components can only be identified if this connection to underlying structures and processes is active.

3.2. While the notion of final services is retained, experience since the release of V4.3 suggests that it is now acknowledged that what counts as a final service is often context dependent, and what might be final in one situation might play an underpinning role in another. This perspective is also supported by SEEA EEA technical guidance[1] and others[2].

3.3. Given the context dependency of 'final services' we therefore propose emphasising that the list of services provided in CICES should be regarded as ***potential* or *putative*** final services and that it is up to the person applying the classification to decide whether they play this role in a particular situation depending on the uses and beneficiaries involved.

3.4. To illustrate the problem we propose providing examples in the guidance on how to handle final and intermediate services.

3.4.1. An example that can be used to illustrate context dependency is that of pollination. Some have suggested that this is an 'intermediate service' whose value is captured in, say, the crop harvest that is dependent upon it. For those who do not regard the crop itself as a final service (or end-product) delivered by the ago-ecosystem, then pollination would have to be seen as final, along with other ecological contributions such as nutrient cycling etc. It would be especially important to recognise it as such in situations where the contribution of natural pollinators was supplemented by artificial sources so that the level of nature's input could be assessed. However, in situations where pollination is provided entirely by natural means, or where we judge the crop itself to be the final service (because of the problem of disaggregating

[1] System of Environmental-Economic Accounting 2012 Experimental Ecosystem Accounting, para 3.47-3.51

[2] Obst, C (2016) Developing an international classification for ecosystem services for environmental-economic accounting. Unpublished Comment, par c.iii.

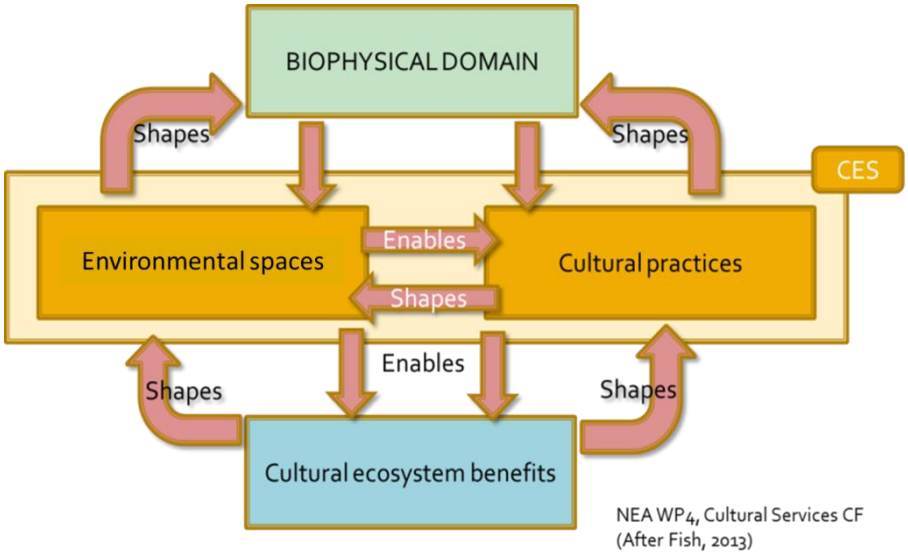
and allocating all the separate ecological inputs), then it would be correct to regard pollination to have an 'intermediate' status in this particular application context.

3.4.2. The discussion of this example in the feedback on the first draft of this document suggests that greater clarity about the notion of an 'intermediate service' is needed in future guidance. The situation where the outputs of one ecosystem contribute the outputs of another is different to that where different beneficiaries have different perspectives on an ecosystem output depending on the benefit they enjoy (sensu Boyd and Banzhaf). In the case of pollination it would be important to identify it as a 'final service' of urban gardens, for example, where it contributed to production of surrounding horticultural land.

4. Cultural services

4.1. The reorganisation of cultural services represents the major changes proposed. The changes have been introduced to emphasise that the service relates to the ecological characteristics and qualities of a space/environmental setting, rather than the cultural practice (walking, running) that generates the benefits. The service is defined in terms of the opportunity it offers to support these cultural practices.

Figure 1: Conceptual framing of cultural ecosystem services (CES) in the UK National Ecosystem Assessment Follow-on Project



4.2. Following the work on CES in the UK National Ecosystem Assessment Follow-on Project (NEAFO Project) (Figure 1), the dual role of 'cultural spaces' and 'cultural practices' in defining a cultural ecosystem services is recognised in the proposed revision, although in CICES it is the opportunity for specific cultural practices in a particular locale that is stressed rather than the practice itself. The opportunity arises because of the capacity/ability of a site to support or be suitable for particular cultural practices.

4.2.1. Note that this approach is also consistent with the way cultural services are represented in the SEEA-EEA (see para A3.24-3.26) where the ecosystems provide *the opportunity* for things such as recreation :

Figure 2: Representation of recreation in the SEEA-EEA