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Accounting Units for Ecosystem Accounts

Paper prepared by Alessandra Alfieri, Daniel Clarke, and Ivo Havinga
United Nations Statistics Division

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I. Introduction and review of current approaches

1. The purpose of this paper is to put forward a proposal on accounting units for SEEA Experimental Ecosystem Accounts. This proposal builds on the Discussion Note prepared by the authors in collaboration with Jean-Louis Weber for the *Expert Meeting on Ecosystem Accounts* held from 11-13 May, 2011, in Copenhagen, Denmark.[1]

2. The accounting unit is a conceptual and operational construct for the compilation of national accounts of the environment using a system's approach. The accounting unit is the entity about which information is sought, for which statistics (particularly stock and flow data) are compiled, and which provides the basis for aggregation to regional, national and global levels.

3. The accounting units are defined according to various types of criteria. The selection of criteria depends on the analytical and policy purpose of the statistics and the practicalities of data collection and compilation. In the context of ecosystem accounts, the accounting unit must support an 'ecosystem approach' to measurement. According to the Convention on Biological Diversity (CBD), and ecosystem approach is a strategy for "integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on the levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems."[2]

4. This CBD definition of the ecosystem approach contains important elements that warrant reflection in the national accounts for the environment. Foremost, it is a management based policy approach with a focus on the conservation and sustainable use of land and natural resources. Equally important is that it is theoretically grounded on scientific methodologies. And finally, this approach places the management of the environment in the perspective of the interrelationship with humanity.

5. For accounting purposes, the accounting unit for the environment should be a unit that can perform autonomous processes and functions necessary to maintain capacity and produce a range of ecosystem services and to interact in its own right with other environmental accounting units. This accounting unit can be meaningfully constructed as the sum of functional (land cover) units, of which the latter represent the smallest geographical production areas. The accounting units can be aggregated meaningfully to regional, national and global levels. At the different levels of aggregation, a broader set of ecosystems services may be identified, which collectively comprise the full set of ecosystem services.

6. The question of units for environmental accounting has been addressed in the United Nations International Recommendations for Water Statistics (IRWS)[3]. In IRWS, units in the environment for water accounts are defined as the spaces or areas that contain inland water bodies, such as a lake, river, or aquifer. These units are recognized for their

[1] http://unstats.un.org/unsd/envaccounting/seearev/meetingMay2011/lod.htm
[2] http://www.cbd.int/ecosystem/
[3] http://unstats.un.org/unsd/envaccounting/irws/irwswebversion.pdf

multiple functions for production, i.e. not only for providing water as a good to the economy, but also for transport routes or recreational purposes, as sinks for emissions, habitat for species, and so on.

7. According to IRWS, an inland water body could also be further split into separate units. For example, a river basin may be divided into sub-basins. Drawing boundaries for these accounting units may require a wide range of considerations, including hydrological, ecological, and social and economic factors, that all play a role in defining the shape of the unit from the perspective of ecosystem services and from the perspective of management. IRWS provides some general guidance on balancing these considerations, including for special cases such as wetlands. However, recommendations for ecosystem accounts need to go further in defining a specific set of rules that can be applied consistently for identifying precise spatial units, and not only for inland water bodies but for the entire national territory.

8. Vardon et al. (2011) suggested utilizing, where available, the cadastre of land ownership. Each unit in the cadastre, representing a separately owned parcel of land, can be linked through the associated register to a household, enterprise, or government entity owner, and thus the primary economic activities associated with it (as well as any other information that can be linked with that unique economic unit).

9. For statistical purposes, foremost, environmental accounting units need to represent an identifiable geographic space. The cadastre, or other location-reference information source, will be useful for integrating economic and social data with environmental information, simply by overlaying the geographic information systems. However, the appropriateness of using the cadastre itself for delineating units in the environment will vary depending on the environment and types of land uses. Although land use and ecological functions are often linked from an economic perspective, it is doubtful that the cadastre can reliably represent, or proxy, a functional unit from an ecological perspective.

10. An approach that uses observable biophysical characteristics as a starting point for delineating the geographical space as the accounting unit seems more promising. This approach delineates spaces according to relative homogeneity in terms of the dominant characteristics of land cover for the functional units and the aggregation of the functional land cover units in landscape units as accounting units. This approach considers the ecosystem as the functional land cover unit and the landscape as the accounting unit. With the introduction of the landscape perspective, both the horizontal and the vertical interactions between the components of the functional land cover units in the landscape, such as the flows of groundwater, are recognised as an integral part of the ecosystem approach to management of land and the natural resources

11. The European Environmental Agency project on Simplified Ecosystem Capital Accounts (SECA) has experimented with compiling accounts for landscapes in Europe delineating the European environment into statistical units through a series of steps beginning with sampling of land cover types. Mapping of land cover functional units are derived from determining dominant land cover types. The dominant land cover is observed from remote sensing images and using a probability-based calculation, called

CORILIS[4], to account for interactions between proximate areas (essentially a method of smoothing). Further integration of information on river basins, slope and altitude are applied to arrive at a map of "social-ecological landscape units" (SELU), each classified as low-land, high-land, mountain, or coastal, and with an associated dominant land cover functional class.[5]

12. The SELUs are meant to approximate the concept of "socio-ecological systems" or ecological production landscapes inclusive of the interrelationships between natural processes of ecosystems and human activities.

13. The EEA SECA project utilized eight core categories (derived from CORINE Land Cover) for mapping of ecosystem units for Europe. These categories of land cover classes used in EEA SECA are presented below. It should be noted that these categories are coherent with the SEEA Land Cover Types presented in Table 2.

Table 1: Dominant Land Cover Classes used in EEA SECA

1	Artificial surfaces
2A	Arable land & permanent crops
2B	Pastures & mosaic farmland
3A	Forests and transitional woodland
3B	Natural grassland, healthland, sclerophylous vegetation
3C	Open space with little or no vegetation
4	Wetlands
5	Water bodies
	No dominance

II. Recommendations for SEEA Ecosystem Accounts

14. The importance of well defined accounting units is well understood in economic accounting. Accounting units serve as a tool for measuring the activity of the economy in an unduplicated and exhaustive manner. They therefore constitute the basis, or "counting units", upon which economic statistical systems are constructed. In the System of National Accounts, or SNA (UN, 2008), accounting units are defined as economic entities that are capable in their own right of owning assets, incurring liabilities and engaging in economic activities and in transactions with other entities. In other words, the accounting units in economic accounting theory are defined according to *capacities* for autonomous economic behaviors or functions.

15. The same approach can be applied for ecosystem accounts by defining the basic

[4] See Annex to EEA (2006) Land Accounts for Europe 1990-2000: Towards integrated land and ecosystem accounting, EEA Report No. 11/2006

[5] Including the possible class of "no dominance"

functions associated with an ecosystem. In economic accounting, the basic functions are related to the three core activities recognized by the SNA: production, consumption, and accumulation. Functions of ecosystems can be articulated in a similar way:

- *Production* of ecosystem services that represent a flow of value to humanity ;
- *Consumption* of energy and other inputs for the supporting functions that allow ecosystems to sustain themselves and ultimately provide ecosystem services;
- *Accumulation* or the holding of structure or material components of ecosystems.

16. A functional unit in ecosystem accounts can be defined according to its capacity to perform all three of these behaviors. In practice, it is necessary to identify a set of simple rules based on observable traits that reasonably approximate capacities for the three functions in order to have a mutually exclusive database of accounting units. This is the experience of the SNA, in which rules used for delineating in practice varies by institutional sector.

17. The SNA states that households, for example, are effectively the group of persons who (i) share the same living accommodation, (ii) who pool some, or all, of their income and wealth and (iii) who consume certain types of goods and services collectively. (UN, ibid). It is important to note here that the three above rules do not constitute the definition of households, but rather are the rules used to identify the households as accounting units in practice.

18. The same approach is applicable for ecosystem accounting. A definitive rule or set of rules can be applied in order to identify the units in line with the conceptual identity of autonomous capacity for production, consumption and accumulation. It is proposed here that those rules be the observable continuous (after smoothing) dominant land cover type coupled with relevant considerations pertaining to the broader landscape.

19. It is recommended that the statistical criteria in identifying accounting units in the environment are simple and are based on biophysical features that could reasonably approximate the definition of ecosystems as functional units as proposed above. The accounting unit about which we want to collect information in ecosystem accounts is a spatial area, which provides the space to produce ecosystem services and to maintain the capacity of the ecosystem to produce these services in the future.

20. In the current draft Chapter 5 on asset accounts in the revised SEEA, the classification shown in Table 2 is proposed for land cover types. The SEEA land cover types classification was developed in consultations involving EEA and the Food and Agriculture Organisation of the United Nations (FAO) and is based on LCCS 3, a standard classification system for the basic objects (such as trees) that underpin land cover types. Utilizing the SEEA land cover types classification implies that the ecosystem functional units will be defined by the information consistent with data used for the purpose of land cover (change) accounting. This approach has the advantage of establishing a direct link with other accounts in the SEEA Central Framework at the basic level of the accounting units.

Table 2: Land Cover Types

Code	Category
01	Artificial surfaces (including urban and associated areas)
02	Herbaceous crop
03	Woody crops
04	Multiple or layered crops
05	Grassland
06	Tree covered area
07	Mangroves
08	Shrub covered area
09	Shrubs and/or herbaceous vegetation, aquatic or regularly flooded
10	Sparsely natural vegetated areas
11	Terrestrial barren land
12	Permanent snow and glaciers
13	Inland water bodies
14	Coastal water bodies and inter-tidal areas

21. The units for ecosystem accounting should also incorporate, in addition to the dominant land cover classes, the characteristics of slope and altitude (mountain, highland, lowland and coastal). This can be accomplished by simply adding categories of altitude and coastal zones as an additional dimension to the classification.

22. Rivers are landscape features of a particular type. In the case of rivers, the units can be decomposed into drains and segments. Similarly, units for coastal areas will be of particular interest and have particular characteristics from the perspective of ecosystem functional capacity. Again the delineation can be established based on the identification of river (drainage) basins and by simply indicating the areas of contiguous land cover dominance and common river basin that are adjacent to the sea

23. Why is the use of dominant land cover classes, coupled with further specifications to account for altitude, river basins and coastal areas, coherent with the conceptual identity of autonomous capacity for production, consumption and accumulation? The answer is that land cover characteristics are inevitably linked to the types of ecosystem services (and capacities for delivering these services) within a given spatial area. Forests (or tree-covered areas), for example, can be associated with a certain set of ecosystem service capacities that are different from other land cover types, like grasslands or urban areas. Some of the ecosystem service capacities will be common to multiple land cover types, but clear distinctions are observable. Particularly at the broad (e.g. national) scale, it is useful to assume that forest ecosystems within the territory will generally have similar ecological functions and behaviours as compared to (e.g.) grassland ecosystems.

24. In order to apply this approach it is necessary to determine the appropriate aggregation of the SEEA land cover type classification for identifying dominant land cover classes. Potentially, a relatively small number (high aggregation) of land cover classes are appropriate in order to reasonably determine land cover dominance for a given area at a reasonable scale for national ecosystem accounts and in concordance with the

definition of the space as a functional unit. It may be that a smaller number of aggregated classes - say 6 or 7 core classes – is sufficient (and also more manageable) to delineate spatial areas in a way that is fit for purpose.

25. Of course, further disaggregation of the land cover types is also possible, and the use of a highly aggregated set of classes only affects the identification of the units, without any information loss in terms of producing the actual statistics related to land cover and land cover change.

26. For the purpose of identifying accounting units, use of fewer (rather than more detailed) classes has several advantages. First, it makes the exercise more manageable at the national level. Second, fewer categories are more likely to have distinct and autonomous functional capacity in line with the conceptual basis for the units (distinction among ecosystem services are more substantial when comparing forests *vis a vis* grasslands as compared to deciduous *vis a vis* coniferous forests). Third, fewer classes generally means more limited cases without dominance, thus improving the certainty with which the no dominance class can be meaningfully analysed.

27. It should be possible to organize the functional units into *'sectors'*, as is done for the institutional units of the economic accounts. The institutional sectors in the SNA group the accounting units according to common economic objectives, functions, and behavior.[6]

28. As has been argued above, the land cover features used to identify the accounting units will generally be related to ecosystem functions and behaviors. Therefore, the combination of dominant land cover classes and indicators related to altitude/slope used to delineate units may be applied for sectoring the accounting units. In other words, the aggregated classification of land cover types used, organized according to altitude (mountain, highland, lowland and coastal), would also serve as the list of sectors that can be used for organizing the accounts in aggregate tables.

29. In some cases the level of detail of location reference for relevant economic, social or demographic data will not match the level needed for linking to functional ecosystem units. An example is economic data that is available only as an aggregate for a large administrative region overlapping with multiple functional ecosystem units. For such cases there are a number of modelling possibilities (essentially a form of reverse-sampling) so that the information can be integrated with the ecosystem units. Of course, the reverse is also possible, e.g. for cases where the ecosystem units cover a much larger geographic area than the existing administrative units or other location reference used for economic and social statistics.

30. The rationale for the independent identification of units of the environment (i.e. rather than using a cadastre or existing administrative zones), followed by an *ex post* linkage with existing statistics through geographic referencing, is that they represent the functional capacity of the environment from the perspective of ecosystem services. This capacity will often be linked to economic and social activities. However, the approach

[6] There are five institutional sectors in the SNA: non-financial corporations, financial corporations, general government, households, and non-profit institutions serving households (NPISHs).

retains a biophysical-based perspective to more realistically reflect actual ecological functioning capacities.

31. This paper provides an initial proposal on the fundamental rules by which the functional ecosystem unit and the landscape accounting units could be defined for SEEA ecosystem accounts with consistency across countries and for diverse environments. It is expected that once the principal rules have been established and agreed upon, the technical and practical details can be further elaborated based on the existing experience in the use of GIS and remote sensing as applied to environmental monitoring.

Question for discussion:

Does this proposal reflect the appropriate scale for units for national accounting for the environment? Are units at multiple scales needed, for example in terms of an autonomous functional unit and a broader landscape unit?

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