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Issue paper on Definition Classification of Socio-Ecological Landscape Unit (SELU)

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Based upon

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Introduction

1. The statistical units analysed and surveyed in the SNA consider nature only from the perspectiveof future benefits that they can obtain from it and ignore those values which are either free contributions to human well-being and/or vital for ecosystem functioning and renewal.It is therefore necessary to define specific statistical units for ecosystem accounting to address this gap.
2. Considering the various scales at which ecosystem services generation and use can be described, SELUs are an important level at whichintegration can take place and multifunctional ecosystems can bewell described. This leads to a hierarchy of scales for ecosystems which can be listed from small to large as:
    - Land cover basic objects (grass, tree etc…) and land cover types (herbaceous crops, tree covered area etc…)which are a bridge from land cover to land use classification; they are best usedto support the collection of quantitative statistics;
    - Land cover functional units (medium to large fields, rain-fed herbaceous cropland, agriculture associations and mosaics, or forest tree cover etc…) which capture and characterise the spatial distribution (“horizontal patterns”) of land cover types; LCFUs provide a good proxy to describe (or map) the spatial distribution of provisioning ecosystem services.
    - Socio-ecological landscape units (SELU) which characterise LCFU’s context as well as their spatial interactions within broader geographical entities; SELUs are characterized by their dominant landscape type and geo-climatic characteristics; SELUs support the description of a range of systemic ecosystem services (regulating and socio-cultural) as well as their relation to the provisioning services delivered by their component LCFU.

- River (sub-)basinsdefined at a scale which fits the description of important services linked to water such as water regulation and protection against floods; river basins (or catchments) are statistical units appropriate for reporting; for this reason the limits of river basins and their altitude classes are part of the SELU definition; also, the river hydrological network within a sub-basin is considered as a SELU per se.
- Biogeographical regions, climatic zones, oceans.
- Global ecosystem.

Statistical units in economic and ecosystem accounts

3. The SNA records **economic assets** which are defined as "*a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another. All assets in the SNA are economic assets*". *(SNA2008, 10.8).*The SEEA expands the scope of assets beyond the boundaries of the SNA and will address all land and ecosystems, even though ownership rights are often not established and no direct economic benefits are usually derived from them.

4. In the SEEA assets such as land, soil, water, timber and other biological resources are shared between units of the economy and (environmental accounting) units of the ecosystems. From the economic perspective, the units are production units (i.e. establishments) and institutional units. All the economic units are defined by or in relation to property rights. From the environment perspective, the equivalent units are elementary land cover functional units and socio-ecological units as systems. Because they are not defined by legal or economic principles, the ecosystem units necessary for accounting must be defined according to scientific analysis and the existence of information sources allowing empirical measurements and accounts computation.

5. In contrast to products and assets in the economy, which can be quantified individually bya certain metric and described by standard accounting balances, the theoretical functional and socio-ecological units need to be defined and represented as statistical units with clearly defined boundaries, characteristics and properties. For inland ecosystems, land cover units are used as the building block to produce such representations necessary for mirroring economic categories and producing integrated economic-environmental accounts.

6. When analysing a relatively small land area in isolation, it is not possible to understand the complete behaviour of the ecosystem, since the systemdepends to a large part on the neighbouring units and on the multiple interactions of the common structures such as river basins or geographical zones (mountain, coast, low and high lands). There is thus a need to observe these units as part of a landscape which reflects the concept of the socio-ecological system (SES). For accounting purposes, these landscape complexes could be seen as analogous to the 'enterprises' of the SNA and are in this proposal called the socio-ecological landscape units (SELU). Indeed, in analogy with the SNA, SELU are the entities which are "using assets" (land, soil resources,biological resources, water resources) in order to produce the various services of the ecosystem.The SELU are not merely an aggregation of

smaller land cover functional units, rather they areelementary socio-ecological system statistical units that represent the complete behaviour of the ecosystem.

Concept of Socio-Ecological Systems and empirical definition of SELU

7. The idea of socio-ecological systems (SES's) relates to the comprehension that it is impossible to understand nature without society, and society without nature. SES's are complex adaptive systems.Many broadly equivalent definitions exist such as this one: *"A social-ecological system consists of a bio-geo-physical unit and its associated social actors and institutions. Social-ecological systems are complex and adaptive and delimited by spatial or functional boundaries surrounding particular ecosystems and their problem context."*(Glaser et al. 2008). SES is a powerful concept which generates important research in the context of resilience and adaptation issues (e.g. with respect to climate change). To be considered in accounting though, SESneeds translation into a statistical category. This leads to the proposal of defining a proxy unit of SES for observation, statistical collection and economic-environmental accounting associo-ecological landscape unit (SELU).

8. In the economic accounts, institutional units own assets which are distributed between establishments toproduce commodities in workshops grouped in particular locations. Institutional units are the nerve centres where trade-offs between development options are made and decisions taken. By analogy, socio-ecological systems "own" assets (land with the various elements it supports) which are grouped into natural production units (land cover units, similar to establishments) depending on thecomplex entities or systems with whichthey interact. The behaviour of institutional units is shaped by ownership rights (to buy, own, sell, borrow…) while socio-ecological landscape units are shaped by the geography (relief and climate) and the legacy of land use. Both units have multiple activities or run multiple processes. The establishments are generally specialised in a limited number of products, asare the land cover units with respect to ecosystem services. The assets of both institutional and socio-ecological units determine their capacity fordelivering services.

9. Within SELU, the land cover accounts make visible the main changes occurring. In doing so, theysummarise interactions between the economy and nature and their impacts on ecosystems' state and theircapacity for delivering services. These impacts come from pressures such as urban sprawl and the development of infrastructures (through converting agriculture and natural land), the intensification and industrialisation of agriculture (through converting family farming and mosaic landscapes), the extension of agriculture in general (through converting forests and marginal land), the drainage of wetlands (although in many regions most of it has been done so far), deforestation (for timber production and/or agriculture development), and afforestation (to reverse the effects of deforestation and desertification).

10. In practice, socio-ecological landscape units will be mapped regarding topography and dominant land cover types. Topography will consider first the boundaries of river basins which are natural frontiers in general and which channel a particular socio-ecosystem: the rivers network. Then the topographic relief itself is representedas three basic classes: lowland, highlands (hills and plateaux) and mountains. These three relief categories are not purely physical (altitude and slope) asthey are correlated to climate and phenology (the way plants reproduce and grow). For example, in the

Northern hemisphere the phenology of lower altitudes at high latitudes corresponds to the phenology of high altitude at lower latitudes. The three categories will be therefore translated into norms by climatic regions, with the purpose of having comparable categories of SELU.

11. The physical units are then combined with the map of dominant land cover types in order to produce the map and directory of SELU.

12. Coasts are ecosystems of a particular kind, so an additional breakdown is then done in order to map separately the subset of SELU adjacent to the sea. Coastal areas are specific socio-ecological systems which need to be addressed in an integrated way with other terrestrial ecosystems, because they provide economic resources like sea grass and algae beds and important habitats for many marine species. The functioning of the marine plant and animal life have to be understood in relation to impacts from aspects like the inland pollution transferred to the sea by rivers, the development of infrastructures on the coast line which modify the streams in the sea, the damming of rivers which reduce sediment inputs, and overfishing. These coastal zones are described as mosaics of both terrestrial and aquatic ecosystems comprising seashore, tidal flats, coral reefs, and seaweed/ grass beds, with an emphasis on the aquatic ecosystems[1].

13. Lastly, the hydrologic network is a specific system which links all the land units within a catchment. The subdivisions of the hydrologic network (river reaches) have from this perspective a status equivalent to land cover units. The principles of such analyses are those presented in the (unnecessarily provocative?) accounts of the SEEA Water.

Classification of socio-ecological landscape unit

14. A socio-ecological landscape unit undertakes the production of goods and services in its own right based on its autonomous character, function and processes. A SELU's productivity is determined by its environmental assets derived through socio-economic and bio-physical interactions and common structures such as slope, altitude and climate.

15. SELU are classified according to their characteristics of relief (belonging to a river basin and altitude and slope characteristic - mountain, highland, lowland), position (proximity to the sea), dynamism of exchanges (the rivers networks vs. more static land objects) and lastly dominant land cover type.

16. The dominant land cover type is assessed regarding the influence that the various land cover functional units have on their own space as well as on their neighbourhood because of their size and/or number in a particular area.

17. The dominant land cover types units are presented usingthe same classification as the land cover functional units since they are a generalisation of LCFUs (see note on land cover classification).

18. These aspects combined underpin theSELU classification which is presented in Table 1:

1*Cf. Satoyama-Satoumi* Ecosystems and Human Well-being: Socio-ecological Production Landscapes of Japan – Summary for Decision Makers. United NationsUniversity, Tokyo, Japan, 2010

Table 1Classification of Socio-Ecological Landscape Units

1	**Mountainecosystemlandscapes**
1.1	Urban and associated developed areas
1.2	Broad pattern agriculture
1.3	Agriculture associations and mosaics
1.4	Pastures and natural grassland
1.5	Forest tree cover
1.6	Otherdominant **n**atural land cover
1.7	Composite land cover (no dominant land cover)
2.	**Highland ecosystemlandcapes**
2.1	Urban and associated developed areas
2.2	Broad pattern agriculture
2.3	Agriculture associations and mosaics
2.4	Pastures and natural grassland
2.5	Forest tree cover
2.6	Other dominant natural land cover
2.7	Composite land cover (no dominant land cover)
3.	**Lowlandecosystems (inland) landscapes**
3.1	Urban and associated developed areas
3.2	Broad pattern agriculture
3.3	Agriculture associations and mosaics
3.4	Pastures and natural grassland
3.5	Forest tree cover
3.6	Other dominant natural land cover
3.7	Composite land cover (no dominant land cover)
4.	**Coastallandscapes**
4.1	Urban and associated developed areas
4.2	Broad pattern agriculture
4.3	Agriculture associations and mosaics
4.4	Pastures and natural grassland
4.5	Forest tree cover
4.6	Other dominant natural land cover
4.7	Composite land cover (no dominant land cover)
5.	**River systems**

19. In order to make possible the identification of a dominant land cover type, the analysis is carried out with a limited number of land cover classes, including a broad class of “Other”. In a second step, it is possible to assign an additional attribute to the SELU. One possibility is to subdivide this class mentioned previously with a dual indexing, e.g. other dominant natural land cover/open wetlands. Another possibility is to record the sub-dominant character of “Composite land cover (no dominant land cover)”.

20. Table 2 lists possible additional indexations of SELUonce defined at the aggregated level.

Table 2 Optional classification for sub-dominant classes of SELU

Other dominant natural land cover	
Optional: sub-dominantnaturalcharacteristics	
	Shrubland, bushland, heathland
	Sparse vegetation and bare land
	Permanent snow and glaciers
	Open wetlands
	Water bodies
Composite land cover (no dominant land cover)	
Optional: sub-dominantcharacteristics	
	Built up and associated areas
	Agriculture
	Natural and semi-natural land cover

21. For reporting purposes, the SELU can be grouped into reporting units: river basins, coastal zones, mountain areas, as well administrative units, where appropriate.

Main applications of accounting by SELU: Ecosystem physical flow and asset balances and physical composite indicator of ecosystem potential?,productivity and health

22. The physical accounts of SELU integrate quantitative and qualitative dimensions of ecosystems, in particular productivity and health. Health refers to vigour, integrity and resilience (see David J. Rapport). Vigour refers to sustainable productivity (primary production): productivity decline is an indicator of stress;quick decline often preludes an ecological flip. Accounts by SELU are physical balances (stocks and flows) of environmental assets for land cover, soil resources, biological resources and water resources and semi-quantitative counts of distress symptoms (dependency from artificial inputs such as chemicals, disease prevalence of human or wildlife populations e.g. bird flu).

23. The physical balances of the main assets give a first level of information on the state of ecosystem capital, particularly whether the stocks have beendepleted over the accounting period or maintained. Accounting for land cover change at the level of land cover units or by administrative entities provides quantitative measurements, which are not always sufficient for establishing a diagnosis. A particular difficulty results from unclear baselines, in particular when long term change happens at a moderate pace. The same land (and other assets) accounts can be more clearly interpreted if their results are understood as symptoms of the possible dysfunction of complex ecosystems, in particular if the results are considered in conjunction with the multiple flows for the environmental assets. This type of multi-criteria analysis provides quantitative-qualitative information from whicha first set of ecosystem health indexes can be computed and interpreted at the SELU level.

24. In addition, other health symptoms are recorded regarding the capacity and performance of the system. This information, which is not summarized in physical capital balances, includes the conditions of the species within a system (e.g. recurrent diseases or intoxication from pesticides) and the dependency of the ecosystem from artificial inputs. Some of these symptoms can be observed at the level of individual land cover functional units. Others require an auscultation of (or “diagnostic listening

to") the SELU, in particular, when complex issues such as biodiversity healthor losses of wellbeing are involved.

25. The quantitative-qualitative indices extracted from the ecosystem accounts are used to make a diagnosis of ecosystems' health as represented by land units and their biophysical and socio-economic properties. The approach is to use accounts to evaluate multiple symptoms simultaneously, similar to the doctor's check list for the annual preventative medical check-up. In the accounts, they will be used to adjust the regular accounting items for foreseeable risk factors (e.g. occurrence of droughts, decline of biodiversity…).

Diagnosis of ecosystem health – measurement of ecosystem health

26. The diagnosis of the SELUs by particular land cover weighted by the basic assets balances produces a composite indicator of ecosystem health in physical terms as a measure of capacity and performance of the ecosystem. The approach and methodology will be detailed at a later stage.

Accounting for the stress factors

27. For each SELU, the health diagnosis can be connected to the stress factors which are responsible forthe observed state: pressure from human activities and natural disturbances. According to Rapport (op. cit), these include pressures related to over harvesting, force feeding, artificial introduction of species, deposition of residuals, or/and system restructuring (e.g. fragmentation by roads, dams…).

28. Most pressures are conventionally recorded by institutional sectors in the SEEA flow and asset accounts. Ecosystem accounts will further contribute toassessing these pressures from the point of view of their impacts on ecosystems. The assessment of stress factors follows the DPSIR framework used for environmental reporting. In the case of ecosystem capital accounts, "S", the ecosystem state is the starting point. Pressures are identified in respect to their effect on ecosystem state observed at the level of land cover functional units and SELU.

Questions for discussion

1. Is the structure of ecosystem statistical units for accounting adequate to support experimental applications?
2. The simplified SELU experimental format is based on the fact that land cover, relief and river basins limits and main rivers are available at the global scale. Is this acceptable in the first instance for developing applications, in particular as no other solution exists presently?
3. How can variants of the proposed format or different formats addressing the same purpose of mapping socio-ecological systems be cross referenced and used in national applications?
4. The SELU definition presented here starts from land. How can SELU equivalents for sea and atmosphere be approached in ways which take account of the many interactions between these macro-level ecosystem types?