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Ecosystem services SNA and non-SNA benefits

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1. Introduction

The first question explored here is whether and to what extent the theoretical frameworks behind ecosystem services classification systems match the theoretical framework behind the SEEA-EEA. By answering this question, it is possible to start clarifying conceptual notions and to attempt to provide some consistent definitions. This paper first describes the conceptual framework on the accounting side, and then the conceptual frameworks on the ecosystem services classification side. Based on the former, there seem to be gaps in clarity in the definitions of SNA and non-SNA benefits (SEEA-EEA), and in environmental assets (SEEA-CF): a fundamental motivation of this paper is to highlight this issue and to offer a draft possible solution. After attempting to combine the accounting and formal ecosystem services classification frameworks together, we propose a set of tables for discussion and feedback.

2. The accounting framework and the ecosystem service cascade model

The SEEA-CF in principle makes it possible to track and manage natural resources as individual components. However excessive exploitation of resources can irreversibly damage not only an environmental asset, including the natural resource itself, but also damage the larger ecosystem in which that resource resides or functions. For example, excessive timber removal can cripple a forest ecosystem's capacity to regenerate. The SEEA-CF can report cubic meters of timber year after year, but the SEEA-CF cannot report the damage that propagates as the forest ecosystem tree cover is removed – damage to the hydro-geological equilibrium, to carbon sequestration and accumulation in biomass and soil, and to the visual appeal of the area for recreation activities. In the same way, pollutant accounts in the SEEA-CF report data linked to specific economic activities, but the accounts do not provide information about how pollutant loads will affect the ecosystem, or whether the ecosystem remains capable of removing and absorbing them without irreversible degradation. The SEEA-CF can provide some additional valuable information to the SNA, but not enough information to support a retroactive analysis of sustainable management of natural resources, or to infer correlations that could inform forward planning.

The SEEA-Experimental Ecosystem Accounts (SEEA-EEA, UNSD et al., 2014b) were developed to fill this important gap. Its theoretical framework will be more complex than the SEEA-CF. The SEEA-EEA has to deal with many factors not conventionally measured in economics, those beyond the accounting measures that the SEEA-CF itself extends beyond SNA measures. Ecology – a multifaceted family of natural sciences, spatial analysis, and conservation planning – will play a major role, since accounts will only be correct if what is biophysically assessed is properly measured. The SEEA EEA must include asset

and flow accounts: ecosystems and the flows of ecosystem services that they generate. Figure 1 shows an adapted version of the SEEA-EEA theoretical framework (UNSD et al. 2014b) that depicts the relationship between environmental and economic assets.

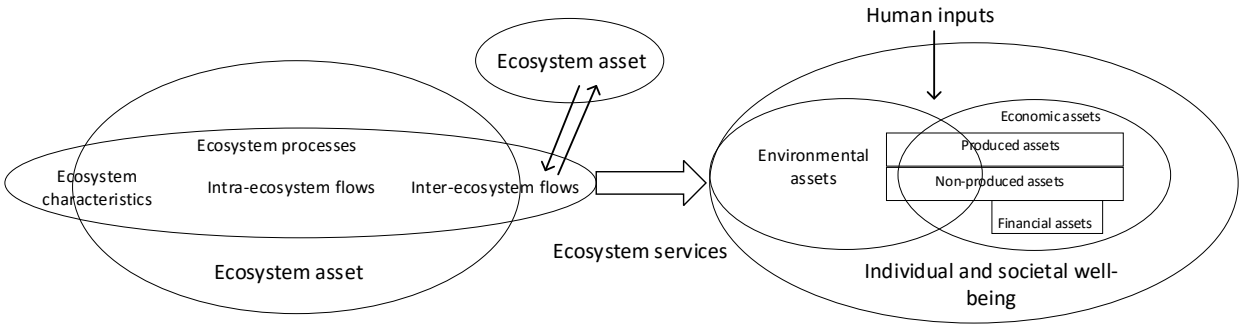

Figure 1- Stylized model of flows related to ecosystem services (adapted from UNSD et al., 2014a and UNSD et al. 2014b)

In the ecological-economic foundation of TEEB (2010) it is possible to find one of the early versions of the cascade model, proposed by Haines-Young and Potschin (2010), and used in a variety of applications (Potschin et al., 2016). The diagram makes a distinction between ecological structures, processes created or generated by living organisms, and the benefits that people eventually derive from ecosystem services. The presence of ecological structures has the functional capacity to provide services that humans find useful. The cascade model represents the theoretical basis of the Common International Classification for Ecosystem Services (CICES), proposed by the European Environment Agency, which has become an important frame of reference for ecosystem services research (Maes et al., 2014). The purpose of the cascade framework is to show the pathway of ecosystem services, from ecological structures to human well-being. Using concepts from systems ecology (biomass, information, and interaction), it is possible to add a deeper ecological perspective to the cascade model (La Notte et al., 2017b). Because the tile levels of the cascade are not 'equal' in complexity or dependency, it is not enough to establish a causal sequence among the elements of the cascade. The inherent complexity of each stage can also be represented, with larger tiles representing higher systemic complexity (Figure 2).

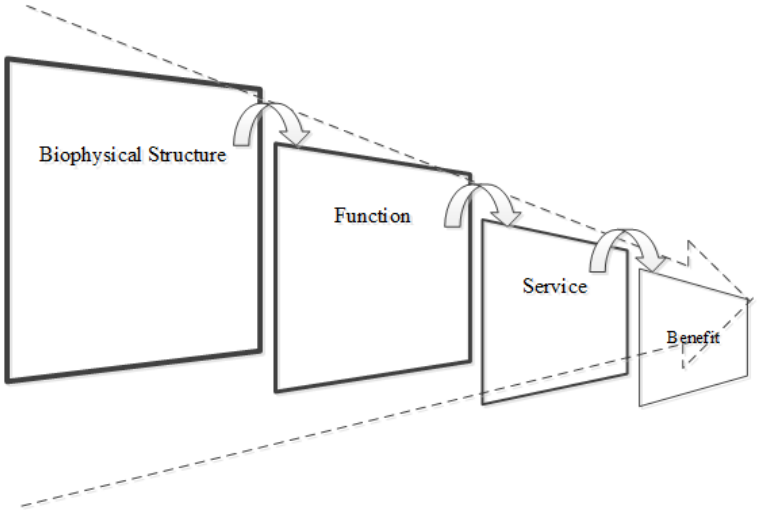

Figure 2- The 'telescopic' cascade model based on system ecology categories (source: La Notte et al., 2017)

On the one hand, biophysical structure and function remain linked to the ecosystem perspective. Processes that take place at a deep systemic and holistic level, such as nitrogen and carbon cycling, primary production, and so on, are considered to be background and intermediate processes that occur on very large scales – creating or maintaining the ecosystem. On the other hand, "final" ecosystem services can be identified as usually countable individual flows, where from an economic perspective each flow occurs on a smaller, human, scale. From systems ecology, interaction and information are complex processes that take place at higher hierarchical levels (i.e., refer to Function and Service in Figure 4) and may not be directly perceived by humans, whereas mass and biomass for direct use and consumption are less complex elements that are more easily perceived by humans. Table 2 reflects an attempt to establish which step of the cascade the typologies of SEEA accounts (i.e. both the CF and the EEA) may refer to.

Important work on classification of the links between natural and human systems has been undertaken at the US-Environmental Protection Agency (EPA), where two classification systems were developed. We consider in particular the National Ecosystem Services Classification System (NESCS) that comprises four classifications – Environment, Ecological End-Products (EEPs), Uses, and Users. The NESCS begins with Environment classes and classifies the actual physical elements from natural products and processes that people use or appreciate (EEPs), and offers the flexibility of separately classifying Uses from Users. In fact, in the NESCS, different Users may employ the same Use, or any particular User may employ the same EEP to different Uses (Figure 3).

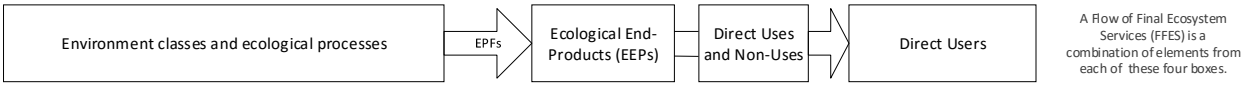

Figure 3 – The four-part classification structure of the NESCS (adapted from USEPA, 2015)

The NESCS is built to be able to identify and classify any relevant flow of final ecosystem services that may enter any User's utility function (Industry, Household, or Government). The ecological side in the two classification systems is about the same: ecological production functions (EPFs) describe processes by which one or multiple ecological end-products are generated, but there is no attempt to classify the myriad ecological processes necessary to generate any EEP. EPFs are embraced as offering the ability to characterize and gauge ecological "production" dynamics for EEPs – so that people know what intermediate ecological processes to protect in order to have the ES they desire. Processes take place at the ecosystem level.

The CICES, the FEGS-CS, and the NESCS are currently being considered by experts working on the SEEA-EEA as possible reference classifications for ecosystem services to be named in ecosystem services supply and use tables. A NESCS-like framework is being used provisionally for NCA work by a multi-agency, international, NGO, and private-sector team in the US exploring NCA accounting structures and attempting to match existing data to fill elements of those pilot accounts.

Having described the theoretical frameworks from both the accounting and the ecosystem-services sides, we now attempt to combine where the three models currently considered by the experts working on SEEA-EEA are placed, compared with an accounting framework (Figure 4).

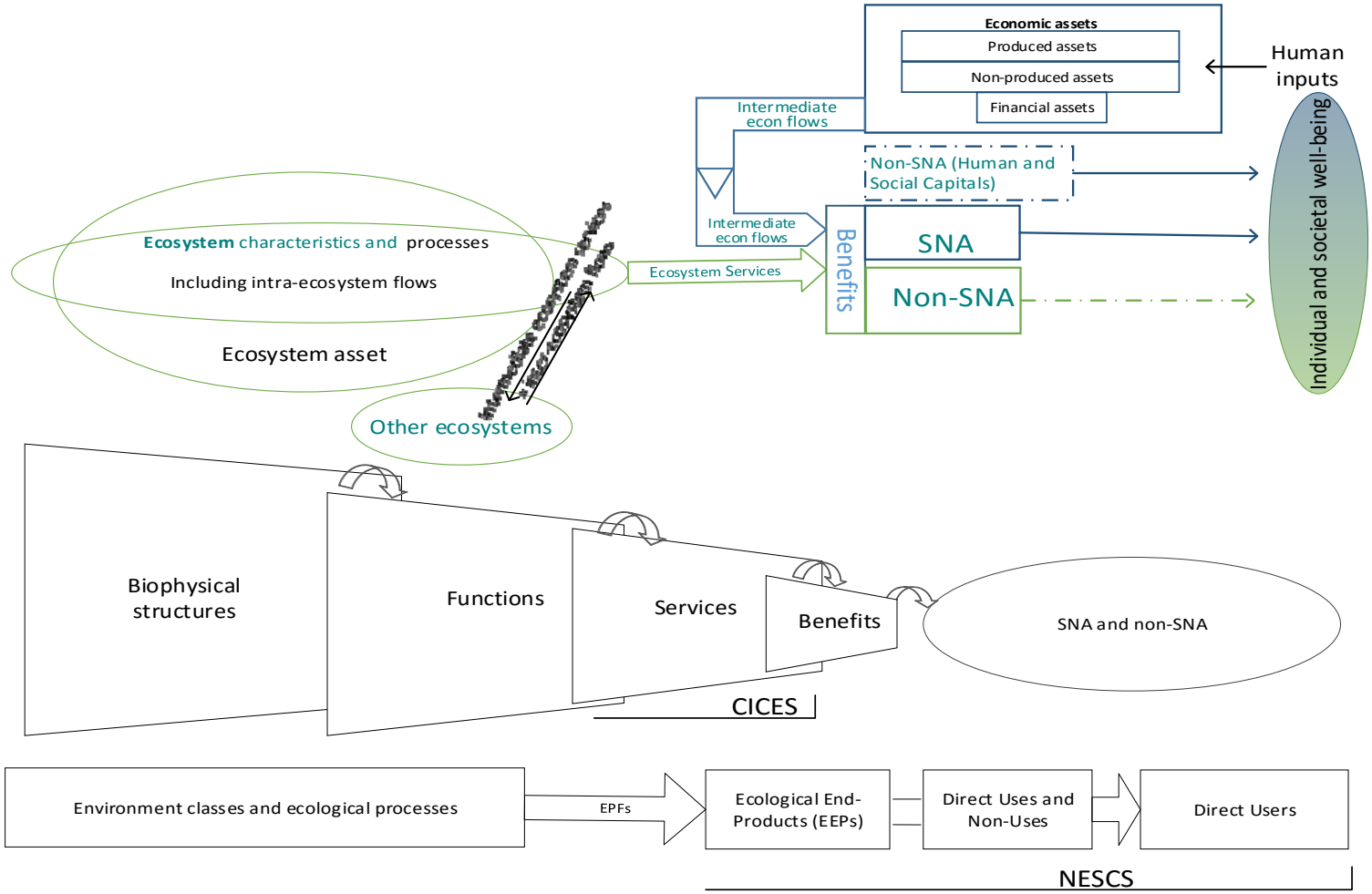

Figure 4 –Comparison between the SEEA-EEA theoretical framework and ecosystem services classification frameworks

Figure 4 highlights that the cascade model does not explicitly depict the economic component, whereas NESCS explicitly includes and develops it.

CICES explicitly considers the ecological production of Services, while NESCS classifies the relationship between EEPs and Use-User combinations. Specifically: services are the identified step in the cascade model that CICES treats as the object of classification, whereas Final Ecosystem Services in the NESCS connect the EEPs to specific Environments and to specific Beneficiaries/Users, through Use. As NESCS sub-classifies parts that together characterize flows of final ecosystem services – Ecological–End-Product—Use—User – it more closely approximates pathways of SNA and non-SNA benefits that reach humans (who are producers, consumers and living organisms). More specific allocation of benefits for accounting purposes follow the beneficiary perspective of NESCS (Table 3).

There is room to explore whether CICES and NESCS might be considered as complementary classifications that focus on different steps of the general chain described by the cascade model. In accounting terms: the flow of the services is tackled in a less anchored way by CICES (only some Services seem to connect to uses directly), while Ecological End-Products and their use for individual and societal well-being are broken out specifically by NESCS. NESCS does indeed fill an information gap that arises between the SEEA-CF and the SEEA-EEA, concerning benefits associated with ecosystem services from named ecosystem assets, where the flows are economic inputs (SNA) or flow directly to people (non-SNA).

In the following tables we attempt to fit:

- First column: CICES classification of ES;
- Second column: NESCS classification of EEPs (partial, for demonstration);
- First row: ISIC/NACE classification of economic activities;
- Second row: NESC use classification.

All of the classification elements used to name rows and columns in these tables are partial, for purposes of demonstration and discussion. What CICES or NESCS would name as candidates to fill cells in these tables is also only partially represented, again for demonstration and discussion. Full use of CICES or NESCS would require more rows and columns, and fill more cells.

Table 1 – Primary sector

		Agriculture					Forestry				Fishing		
		raw material for transformation	support of animal breeding	support of plant cultivation	protection of human property	support of subsistance	raw material for transformation	support of plant cultivation	protection of human property	support of subsistance	raw material for transformation	support of animal breeding	support of subsistance
ES (CICES)	**EEP (NESCS)**												
	SNA- benefits												
water retention/supply	*water*			irrigation [SNA]			timber [SNA]						
crop provision and crop pollination	*flora*	crops [SNA]											
animal husbandry/fisheries	*fauna*		livestock [SNA]								fisheries [SNA]		
-	*abiotic components*												
outdoor recreation	*- scapes*												
flood control	*complex ecological structure that regulates extreme events*				field protection [SNA]				wood protection [SNA]				
	Non SNA- benefits												
water retention/supply	*water*												
water purification	*cleaned water*			irrigation [non-SNA]								[non-SNA]	
air filtration	*clean air*												
habitat maintenance	*flora*					Conservation of existing conditions in nature [non-SNA]				Conservation of existing conditions in nature [non-			Conservation of existing conditions in nature [non-
habitat maintenance	*fauna*												
soil erosion	*soil*			fertile soil [non SNA]				fertile soil [non-SNA]					
outdoor recreation	*scapes*												
flood control	*regulation of extreme events*								wood protection [non-SNA]				
global climate regulation	*other end-products*					mitigation of CC effects [non-SNA]				mitigation of CC effects [non-SNA]			mitigation of CC effects [non-SNA]

Table 2 – Secondary and part of the tertiary sector

		Mining and quarrying			Manufacturing			Construction		Transportation and storage		Accomodation and food service activities		
		raw material for transformation	protection of human property	support of subsistance	industrial process	protection of human property	support of subsistance	protection of human property	support of subsistance	protection of human property	support of subsistance	tourism	protection of human property	support of subsistance
ES (CICES)	**EEP (NESCS)**													
	SNA- benefits													
water retention/supply	*water*				cooling process [SNA]									
crop provision and crop pollination	*flora*													
animal husbandry/fisheries	*fauna*													
-	*abiotic components*	sub-soil assets[SNA]												
outdoor recreation	*- scapes*													
flood control	*complex ecological structure that regulates extreme events*		mine protection [SNA]			factory protection [SNA]		site protection [SNA]		site and infrastructure protection [SNA]			facility protection [SNA]	
	Non SNA- benefits													
water retention/supply	*water*											visitor attractor [non-SNA]		
water purification	*cleaned water*													
air filtration	*clean air*													
habitat maintenance	*flora*			Conservation of existing conditions in nature [non-SNA]			Conservation of existing conditions in nature [non-SNA]		Conservation of existing conditions in nature [non-SNA]		Conservation of existing conditions in nature [non-SNA]	visitor attractor [non-SNA]		Conservation of existing conditions in nature [non-SNA]
habitat maintenance	*fauna*											visitor attractor [non-SNA]		
soil erosion	*soil*													
outdoor recreation	*scapes*													
flood control	*regulation of extreme events*											visitor attractor [non-SNA]		
global climate regulation	*other end-products*			mitigation of CC effects [non-SNA]			mitigation of CC effects [non-SNA]		mitigation of CC effects [non-SNA]		mitigation of CC effects [non-SNA]			mitigation of CC effects [non-SNA]

Table 3 – Other sector (mainly tertiary)

		Electricity/gas supply		Water supply			Professional activities		Education		Other industries	
		protection of human property	support of subsistance	waste assimilation	protection of human property	support of subsistance	information , research	support of subsistance	science, education	support of subsistance	protection of human property	support of subsistance
ES (CICES)	**EEP (NESCS)**											
	SNA- benefits											
water retention/supply	*water*											
crop provision and crop pollination	*flora*											
animal husbandry/fisheries	*fauna*											
-	*abiotic components*											
outdoor recreation	*- scapes*											
flood control	*complex ecological structure that regulates extreme events*	facility protection [SNA]			facility protection [SNA]						property protection [SNA]	
	Non SNA- benefits											
water retention/supply	*water*											
water purification	*cleaned water*			cleaning cost reduction [non-SNA]								
air filtration	*clean air*											
habitat maintenance	*flora*		Conservation of existing conditions in nature [non-SNA]			Conservation of existing conditions in nature [non-SNA]	genetic heritage [non-SNA]		natural heritage [non-SNA]	Conservation of existing conditions in nature [non-SNA]		Conservation of existing conditions in nature [non-SNA]
habitat maintenance	*fauna*						genetic heritage [non-SNA]		natural heritage [non-SNA]			
soil erosion	*soil*						genetic heritage [non-SNA]		natural heritage [non-SNA]			
outdoor recreation	*scapes*											
flood control	*regulation of extreme events*											
global climate regulation	*other end-products*		mitigation of CC effects [non-SNA]			mitigation of CC effects [non-SNA]		mitigation of CC effects [non-SNA]		mitigation of CC effects [non-SNA]		mitigation of CC effects [non-SNA]

Table 4 - Households

		direct consumption	protection of human health	protection of human property	cultural/ spiritual	recreation	aesthetic appreciation	support of human life
ES (CICES)	**EEP (NESCS)**							
	SNA- benefits							
water retention/supply	*water*	own extraction [SNA]						
crop provision and crop pollination	*flora*	own extraction [SNA]						
animal husbandry/fisheries	*fauna*	own extraction [SNA]						
-	*abiotic components*							
outdoor recreation	*- scapes*							
flood control	*complex ecological structure that regulates extreme events*			house protection [SNA]				
	Non SNA- benefits							
water retention/supply	*water*				cultural heritage [non-SNA]	close-to-home attractor [non-SNA]	close-to-home attractor [non-SNA]	
water purification	*cleaned water*		health protection [non-SNA]					
air filtration	*clean air*		health protection [non-SNA]					
habitat maintenance	*flora*		long term health protection [non-SNA]					Conservation of existing conditions in nature [non-
habitat maintenance	*fauna*							
soil erosion	*soil*							
outdoor recreation	*scapes*		physical and mental health [non-SNA]		cultural heritage [non-SNA]	close-to-home attractor [non-SNA]	close-to-home attractor [non-SNA]	
flood control	*regulation of extreme events*							avoided deaths [non-SNA]
global climate regulation	*other end-products*							mitigation of CC effects [non-SNA]

Questions for the London Group

1. Could you please provide comments for all the Tables (1-4)?

2. How to consider HH extraction from Envt for own consumption? In SNA we have this item but theoretically it is outside of SNA measures.

3. For provisioning services: is it correct to separate the land management activities from the harvesting/logging/catching activities? What are the implications of this split?