Treatment of multiple economic values connected to ecosystems – theoretical aspects

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based on the 2024 London Group paper "Treatment of monetary values connected to ecosystem services"

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Background

UNCEEA and UNSC

The UN Committee of Experts in Environmental-Economic Accounting, at its 19th meeting (25-26 June 2024):

> "Highlighted the need to advance the research agenda on valuation for SEEA EA, taking into account country experiences and different approaches to monetary values connected to ecosystems and their services and building on the work being carried out in the London Group"[1].

With this phrasing, the UNCEEA for the first time acknowledged the "different approaches to monetary values connected ecosystems and their services" and the work being carried out in the London Group in this respect. This was a major step ahead in the direction of leaving behind the objective of establishing the prices of the ecosystem services, to be used in accounting, which is the explicit aim of a couple of SEEA EA chapters. It is worth recalling also that the chapters of the SEEA EA on monetary valuation, after long and intense debating, were left out of the International Statistical Standard, which results in a somewhat ambiguous status of these chapters: in fact, the Commission "recognized that, Chapters 8-11 of the SEEA Ecosystem Accounting describe internationally recognized statistical principles and recommendations for the valuation of ecosystem services and assets in a context that is coherent with the concepts of System of National Accounts for countries which are undertaking valuation of ecosystem services and/or assets, and requested the Committee [i.e. UNCEEA] to promptly resolve the outstanding methodological aspects in chapters 8-11 as identified in the research agenda"[2].

IPBES

IPBES's *Methodological assessment of the diverse values and valuation of nature* [3] is of the utmost relevance for how official statisticians should approach the issue. Almost all of the 10 key messages (KM) contained in the *Summary for Policymakers* of this document, approved at the 9th session of the IPBES Plenary in July 2022 (IPBES-9, are of interest here. Let us recall some passages (emphasis added):

- KM 1: The causes of the global biodiversity crisis and the opportunities to address them are tightly linked to the ways in which nature is valued in political and economic decisions at all levels. … the unsustainable use of nature … **emanating from** predominant political and economic **decisions based on a narrow set of values (e.g., prioritizing nature's values as traded in markets)**.
- KM 2 … **most policymaking approaches have prioritized a narrow set of values** … and have often ignored values associated with indigenous peoples' and local communities' world-views.
- KM3 The diversity of nature's values in policymaking can be advanced by **considering a typology of nature's values that encompasses the richness of people's relationships with nature**
- KM4 Valuation processes can be tailored to equitably **take into account the values of nature of multiple stakeholders in different decision-making contexts**.
- KM5 **More than 50 valuation methods and approaches**, originating from diverse disciplines
- and knowledge systems, are available to date to assess nature's values; **choosing appropriate and complementary methods** requires assessing trade-offs between their relevance, robustness and resource requirements
- KM6 … scientific documentation shows that **less than 5 per cent of published valuation studies report its uptake in policy decisions**.

It is important to note that the first three KM deal with values in the broadest possible sense, and the following three refer to valuation without any restriction to the establishment of monetary values. Indeed valuation is defined in IPBES glossary as "the process of documenting the existence of values, identifying when and where and by whom they are expressed, that in turn allows characterizing values".

Among the background messages, B7 deals specifically with valuation as understood in ecosystem accounting: "B7 Standardization procedures in valuation can help increase the uptake of ecosystem accounting into national policies, **with due consideration to the ongoing challenges of implementation in decision-making, linking accounting to diverse valuation perspectives and the challenges of measurement and valuation**". Ongoing challenges in advancing implementation include: (i) the need to move beyond the compilation of accounts to the use of accounting data in applications and decision-making processes; **(ii) the need to build links to the discussions of diverse value perspectives**; and (iii) the need for **further research on several aspects** of measurement and valuation, especially the exchange values of ecosystem services (established but incomplete). B10 states that "Different economic nature valuation initiatives can complement one another to inform policy decisions", but quotes only TEEB, SEEA–EA and the "inclusive/comprehensive wealth" proposal of the Dasgupta Review. We hope the ongoing work may help broaden the perspective as for the complementarity between different valuations.

IPBES authors also framed the question of purposes of monetary valuation in their broad view of valuation by connecting monetary accounting to cost-benefit based decision-making, and clearly pointing out that "some values are simply 'incommensurable', being neither comparable nor compatible with others" [4], as well as highlighting that "Sustainability transformation studies document a critical need to shift from individualism, materialism and economic profit to other

principles such as care, unity, equity, reciprocity and justice. Such a value shift implies systematic incorporation not only of 'what' values, but 'whose' are considered in decision-making. Traditional environmental decision-making ignores this contestation by purporting to separate 'facts' from 'values', biasing approaches to quantitative costs and benefits (e.g. hectares, dollars)" [5].

London Group

The LG discussed issues relating to the multiplicity of monetary values associated to ecosystem services (ES) and alternative approaches to the treatment of these values in several occasions, starting at least with the 2020 meeting ([6] to [14][14]). The LG debate highlighted the need for clarifications, among other, on the following aspects:

- Reasons why policy needs monetary values of ES, and whether the need for such information is connected to different types of policies or particular ways to take policy decisions;
- Theoretical criticism raised in the global consultations not tackled nor countered appropriately[1];
- Interpretation and communication issues (e.g. possible divergence between total monetary value changes and changes in ecological value, consequent to a change in physical ES flows, depending of the latter's cause).

Starting from LG work, a "pluralistic" approach was proposed in an article included in the *Oneecosystem* issue dedicated to Monetary valuation for ecosystem accounting [15]. This proposal, radically departing from the pricing approach of the SEEA EA, is based on the idea that the monetary values "connected to" or "dependent on" ES must not necessarily be interpreted as exchange values of the respective ES, but that these values can be dealt with "for what they actually measure", on the basis of their own direct meaning, which is determined by the methods that provide them.

On occasion of the 30th meeting of the London Group, held in Washington in 2024, an Issue Papers on "Monetary values connected to ecosystem services" was presented. The following tasks had been assigned to it:

"Chapters 8 to 11 of the SEEA EA, which are not part of the international statistical standard, state that ecosystem services should be valued based on exchange values. Since for most ecosystem services there are no observed market transactions, the values have to be estimated. A number of valuation methods are used for such an estimation[2]. These methods provide values that, according to SEEA EA, constitute the monetary valuation of ecosystem services (ES). ***Under a different approach****, discussed at length in the London Group, this interpretation is contested, and* ***these values are seen as the values of goods and services that are connected to (depending upon) ecosystem services but not as these services'***

[1] All responses to the GC on the SEEA EA can be accessed through the website dedicated to the SEEA EEA revision process: https://seea.un.org/content/seea-experimental-ecosystem-accounting-revision. From the same page also the documents produced by Working group 5 on valuation and accounting treatments can be accessed.

[2] We may recall here, among other works presented in the London Group, that he feasibility of calculating different values related to a single ecosystem service using a basket of methods, in order to bring in connected elements of production (e.g soil fertility and pollination for crop production services) and to explore aggregation possibilities, has been analysed by Statistics Estonia and a team of experts from Tallinn University of Technology and in several cases also from Statistics Netherlands. References [1] to [7].

exchange values. *Issues with their use, for which recommendations and solutions are required, include the following:*

- Multiple approaches for individual services: formulating a typology of methods, accounting for a multiplicity of values connected to the same service

- Issues with the aggregation of monetary values across services and/or ecosystem assets

- Communication of (multiple) monetary values from different approaches".

In the Washington meeting, two requests have been made to the authors of the Issue Paper: a) to better structure and strengthen the conceptual and theoretical part of the paper, and b) to work on practical examples (case studies) as proof-of-concept. To better answer these requests, we split the work into two parts. **The present paper tries and responds to the first request, while the paper "Empirical insights into the multiple economic values of ecosystems: applications and reflections" responds to the second.**

Introduction

We added emphasis to parts of the text quoted above from the 2024 LG Call for papers, in order to emphasyse that **the aim of the issue paper,** of which the present one is an update as for the theoretical part, **is not to repeat a discussion** that the LG had several times already, **on the merits and limitations of the use of monetary values made in SEEA EA** chapters 8-11, i.e. of the search for the "exchange values of ES", in a "pricing" perspective.

Nevertheless, the discourse about the limitations of the pricing approach is a fundamental background to the development of a "plural monetary values" approach coherent with the broader plural values *à la IPBES*. Therefore the present introduction, with its subsections on "plural values, utilitarianism and official statistics", and on "Economics and accounting", provides some important preliminary qualifications of the proposal, that go beyond the technicalities which are the main object of the present article. Moreover, annex A proposes, as a further reference and background reading helping to further put our discourse in the context of current developments, a paper which gained wide support in the context of the European Task Force on Ecosystem Accounting. Indeed, even if the present article focusses on monetary values, we consider it essential to take a much broader perspective than the one defined by monetary values. Considering a multiplicity of monetary values that may "live together", able to describe several different parts of the ecosystems-economy interaction story, is an important step, but not a final one. In the future, it will be necessary to consider and integrate more non-monetary indicators in the picture.

Plural values, utilitarianism, and official statistics

As the IPBES reports underline, diverse value perspectives are dominant in different scientific and human communities. Official statistics should in principle not embrace any particular perspective but aim at supplying evidence that is relevant under as many perspectives as possible, reconciling them as much as possible in broader, pluralistic and multidisciplinary statistical frameworks.

The dominant metaphor to frame human-nature relations, to which official statistics adhered through the SEEA EA, is the Ecosystem Services framework. As Gòmez-Baggethun and others wrote back in 2010:

> "The origins of the modern history of ecosystem services are to be found in the late 1970s. It starts with the utilitarian framing of beneficial ecosystem functions as services in order to increase public interest in biodiversity conservation (Westman, 1977, Ehrlich & Ehrlich, 1981, De Groot, 1987). It then continues in the 1990s with the mainstreaming of ecosystem services in the literature (Costanza & Daly, 1992, Perrings et al., 1992, Daily, 1997), and with increased interest on methods to estimate their economic value (Costanza et al., 1997). The Millennium Ecosystem Assessment (MA, 2003) contributed much to putting ecosystem services firmly on the policy agenda, and since its release the literature on ecosystem services has grown exponentially (Fisher et al., 2009)"[16][3].

This exponential growth continued, and one important effect on official statistics was the SEEA EEA revision. The process started in 2017 and culminated in the 2021 UNSC discussion on the new SEEA EA. The SEEA EA expressly adheres to the Ecosystem Services framework, and the representation of ecosystem services' "physical flows" (chapters 6 and 7) was accepted by all, as it is compatible with the SEEA CF representation of man-nature physical relationship through Environmentally Extended Supply and Use tables. As is well-known, the confrontation around chapters 8-11 ended, on the contrary, with their exclusion from the realm of International Statistical Standards. This was an important halt to the official legitimation of the utilitarian framing, as the pricing of ecosystem services and assets pursued by those chapters is the spearhead of utilitarianism applied to nature.

Meanwhile, the concept of 'nature's contributions to people' (NCP) [17] emerged as an attempt to encompass a larger set of perspectives than the utilitarian one, contested by many experts and at odds with the non-anthropocentric worldviews prevailing in first-nations, custodians-of-the-Earth, Amerindian, Aboriginal and forest peoples' cultures, as well as in Taoist philosophies (wu wei, naturalness, balance with the Way) and in Hindu and Buddhist visions of universal interdependence, as well as in the Shinto religion which attributes various deities to nature. The moral and practical teachings of these worldviews are more and more perceived as a fundamental contribution to facing the global ecological crisis. With the NCP concept "a new set of metaphors to frame human-nature relations" has been introduced, "aiming to overcome the limitations of the ES framework and to provide a fresh discourse for the assessments to be developed by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES)"[18][19][4].

It is hard to figure whether and how an accounting system may overcome the limits of utilitarianism. This paper does not deal with going beyond the utilitarian framing in general terms but deals solely with monetary values. However, it does this in a way different from that of the SEEA EA, and in particular, of SEEA EA Chapters 8-11 which promote the pricing of ecosystem services and assets. Pricing requires heavily relying on heroic, unrealistic assumptions that often are not even empirical falsifiable. A more aseptic and objective representation of the economic aspects of the ecosystems-

[3] For the works referenced in this quotation, see the original article.

[4] Muradian and Gómez-Baggethun also argue (in 2021) that the NCP concept would be "perpetuating, under a new jargon, the most problematic tenets of the ES framework and utilitarian environmentalism in general". It however seems to us that the 2022 report on values goes well beyond this limitation.

humans interaction, such as the one we provide by understanding the values connected to ecosystem services for what they actually measure and not as prices of something else (differently from what happens in the pricing approach), is suited for use beyond strictly utilitarian approaches to the humans-nature relationship, and therefore more appropriate than pricing for official statistics.

Economics and accounting

A plethora of methods is used in economics, especially in context-specific applications (e.g. projects' evaluation), to determine monetary values aimed at representing the economic importance of ecosystem services (ES), for use in policy decisions. In the neoclassical theory, decision-making is the result of calculus, considered a synonym of rationality. Calculus requires that everything is made numerically comparable with everything else, i.e. that everything is priced (or at least that preferences are non-cyclically ordered, but let us leave this aside as purely theoretical and of no practical relevance here). The question to which pricing responds, for "goods and services" that are not produced nor marketed such as ESs, is "how much *would* this be paid, *if* it *was* exchanged in a market?". In such an approach, the judgement of markets, as expressed by prices, is taken as the measure of all things. However, by the very definition of ecosystem service, no ES is ever produced or exchanged *per se* (ES are simply used for free). In between the ES and exchange there is **always** use or appropriation of the ES. Therefore, prices and exchange values of ecosystem services must be **made up** not just in a practical sense but also in a conceptual sense. The practical problem is solved by taking something else's price or value as price or value of the ES (imputation[5]). This often requires assumptions on the institutional aspects of "appropriation" which contradict the actual conditions (to which accounting should stick)[20].

In line with the *calcolemus*[6] approach to decision-making, the SEEA EA proposes, in chapter 9, an interpretation of some of these monetary values (namely, those derived by several, but not all, specific methods) as "exchange values of ES" (prices) and deems them fit for use in satellite environmental accounting and for comparison of ES's and derived ecosystem assets' values with national accounting figures. Understanding what is actually taken as a price and what kind of information it actually provides is the main aim of this paper. But let us put this practical aspect aside for the moment, and concentrate on the conceptual aspect, which is usually neglected (this is because pragmatic procedures are enough for practicing: as long as they deliver a result there is no need for them to respond to logic. For the same reason, there is even no need that the pragmatic choices be coherent with the conceptualization, as the SEEA EA itself proves).

The conceptual background of pricing is a view of the nature-society-economy relationship that is known as the capital(s) approach, an approach grounded in the neoclassical economics and based on qualifying ecosystems either as economic agents able to generate economic output of their own,

[5] This is the name used in national accounting for the operation of taking some values as a proxy for other, unobserved, values.

[6] Leibinz was convinced he could develop a universal mathematical language, thanks to which different opinions would not need to be discussed, but the truth could be calculated instead: "Quo facto, quando orientur controversiae, non magis disputatione opus erit inter duos philosophos, quam inter duos computistas. Sufficiet enim calamos in manus sumere sedereque ad abacos, et sibi mutuo (accito si placet amico) dicere: calculemus!"[21]. Pricing valuation and cost-benefit decision-making are in this line of thought.

or as capital assets that confer capital services (the ecosystem services themselves) to proper economic agents.

The first qualification, which is latent or taken for granted in SEEA EA chapters 8-11, is logically unsustainable, simply because ecosystems lack the basic characteristics that define economic agents, such as autonomous decision capacity on whether to engage or not in transactions, and ES lack the basic characteristics that define products, such as having production costs behind them and the third party condition being satisfied[7],[8]. The deviation of the conceptualisation of nature as a producer from the purpose and realm of national accounting is patent: the main purpose of national accounting is to measure the result of human labour and ingenuity, within the limits of the third-party principle. In practical terms, when the right to use the ecosystem service itself, as pure as possible, is marketed – e.g. when land is rented for agricultural use and its crop provisioning power is the main object of the transaction between landlord and farmer – there is no production, but only a transfer of income. To the owner of the land / seller of the ecosystem service, the service is provided for free by nature, and the buyer would be better off by not paying for it and getting it for free directly from nature exactly as much as the owner is better off by having it paid for.

The second qualification (ecosystems confer capital services to proper economic agents) is equivalent to the first if ecosystems' marginal contributions to income/output can be isolated and considered as if they were autonomous outputs of the natural capital asset/agent, which are then used as inputs in production. ES are thus dealt with as arguments (independent variables) in production functions. In the neoclassical theory there is indeed no distinction between net output and income or between unitary value of output and price (these are important distinctions in other economic schools' approaches and in the SNA, where not all individual income is considered net output at the societal level). This is reflected in the econometric estimations of production functions. These are assumed to have derivatives for all arguments, i.e. marginal contributions can be assigned and calculated for the "natural capital" input, i.e. its "capital services", i.e. ecosystem services. However, if this marginal contribution is conceptualised as a rent (implicit, resource rent), as we think it should, and if all rents, being income depending on property or on market distortions, should be considered distributional transactions, as we think they should, then they should enter the prices and the incomes but not the measures of social output. The contribution is not of nature itself to output, but of the *ownership* or of the *use* of nature to individual incomes. This depends on the arrangements surrounding the access to ESs (enforcement of property rights) - which include the way the ones of better quality (providing competitive edge to their owners or users) – and on the structure of the markets on which the products derived are sold[9].

[7] Without such agency, the transfer of whatever material or immaterial thing from ecosystems to the anthroposphere, just like the discharge of residuals from the latter to the former, cannot be called "exchange". Exchange value only comes into being if both parties in the trade have agency. Monetary accounting is accounting in pure exchange value.

[8] A service meets the third-party criterion when "another person could have performed the task and obtained the same outcome". In this case the person is the one who benefits from the ES. Think of somebody else performing the task of enjoying nature in your place – the outcome for you is not the same. This means, the ES per se cannot be exchanged; only the right to use it can.

[9] "The rent of land, therefore, considered as the price paid for the use of the land, is naturally a monopoly price. It is not at all proportioned to what the landlord may have laid out upon the improvement of the land, or to what he can afford to take; but to what the farmer can afford to give"[22].

Nature provides resources, among which ES, on which labour is applied. Although local labour productivity depends on local quality and quantity of natural resources their differentials end up in distributional effects. Income from property and market distortions should be netted out from measures of societal output, as they are a loss for the buyer of the "capital service" and an equal gain for the owner (forget about transaction costs).

If individual income/exchange value and output/use value are kept distinct as in the classical economists' tradition, and societal output is recognised as different from the mere aggregation of economic agents' incomes gross of rent – a distinction embodied in several SNA editions – it is possible to allocate to economic agents (institutional sectors, kinds of activities, individuals) not only the positive but also the negative contributions to net current incomes of natural capital's ownership. **This information is no doubt interesting**, as it tells who gains and who loses (and how much) from the current allocation of property rights, whether governments enforce and monetize collective ownership, etc..

The contributions of nature to individual incomes can be reconducted to the specific chunks of nature (the specific resources or ESs) that contribute to them. The same is not possible for societal output, for this is the result of human efforts only, applied to nature. The fact that these results depend, among other things, on how nature is generous, does not imply that this generosity can be measured in terms of its contributions to individual incomes, because, as said, income transfers based on property rights depend primarily on institutional circumstances, not on human labour (not even indirectly).

For those who own or use their services, ecosystems are assets to the extent they are appropriated and can provide a reserve of exchange value or contribute to providing them with a stream of income. To the same extent, however they are a sort of liability for the rest of society.

Let us now turn to the practical aspect of the pricing problem. This is not entirely solved by the coherent application of the natural capital approach. The SEEA EA tried, with chapters 8-11, to develop the pricing approach into an international statistical standard conceptually based on the ecosystems=natural capital conceptualisation described above. However, where there are no exclusive ownership rights on the use of ESs, nor does the selective access to ES provide a recognisable competitive edge for derived products (e.g. because their use in production is non-rival, or because there is plenty of it so that no monopoly power can be installed on it - think e.g. of the oxygen provision ecosystem service), no observable nor implicit rent exist, that can be taken as positive ESs' price. In these cases, the neoclassical approach, coherently applied, has no prices to provide for ESs. It would be logical at this point to accept that the value of ecosystem services is something radically different from the income they provide to their economic owners, and that the contribution of ecosystems' use values to economic activities needs to be conceptualised in a completely different way. But this is unacceptable in an approach whose declared objective is to "make nature count" by subjugating nature to economic calculus. So, the approach is kept alive by constructing a "protective belt" around it, i.e. by devising other ways of making up prices, on the basis of no, or quite feeble, justifications that sometimes even contradict the core theoretical

framework[10]. This is where values "connected to ecosystem services", further than actual or implicit rents, come into the picture. While the procedures on which they rely contradict the neoclassical framework, **in a non-pricing perspective**, **these values may provide quite interesting pieces of information, able to tell something about the importance of ecosystem services for the economy and society.**

Non-pricing-consistent accounting of ES and their connected values

The general model of the physical representation of ecosystem services in SUTs of the SEEA EA, follows the schemes of SEEA CF chapter 3. These allow identifying actual activities, **and therefore actual monetary (exchange) values**, accounted for in National Accounts, **dependent** from specific ES: of output which would not arise in their absence, of wages that would not be paid, of taxes that would not be paid, or subsidies that would not be obtained. Some of these values (output by product) can be read in usual SNA Supply monetary tables. To the extent that the "contribution of ecosystems to economic benefits" is not a separable, marginal, additive component of total output's values of economic activities, but a precondition of their existence, the whole value of the dependent output is a good measure of the importance for the economic process of having ecosystems in sufficient quantity and quality[11]. For instance, in satellite accounts for tourism, it could be specified which parts of the outputs of the tourism industry depend on Ecosystem Services (and even which ones, provided by which Ecosystem type), excluding those parts that depend on Museums and Aqua parks. Wild mushrooms ecosystem service would not exist at all without the provisioning ecosystem service, but their market value tends to equalise the costs of producing (i.e. gathering them and bringing them to the marketplace), and if any premium beyond that is embodied in their prices, this depends on exclusive knowledge of the good places (a monopoly power) as much as from the mushrooms actually being there. A building that would be at risk of being swept away by a landslide, if no trees were there to maintain the overhanging hillslope stable, would lose much – if not all – of its value if the forest would disappear; nevertheless, this is not what determines the level of the market value of the building, but the characteristics of the building itself, as the ES sustaining it is taken for granted. Some further disaggregation by product (CPA) and/or by kind of activity (ISIC) may be necessary for better identification of the specific dependencies from specific ES, but the model provides a neat way to read the economic importance of ES and their contribution to economic activity.

[10] The concept of "protective belt" is due to the philosopher Imre Lakatos, who explained how scientific research programs near to collapse increasingly rely on additional hypotheses, making the core theory less and less relevant [23].

[11] This corresponds to a theory of production different from the neoclassical one. As explained above, in the latter the value of the output is exhausted by the shares the various "contributors" appropriate of it, and in turn the value of the output can be expressed as the result of the sum of the respective contributions, so that in ideal conditions each "contributor" gets a share of the output exactly equal to its marginal contribution, i.e. to the importance it has in relation to its scarcity. Leontievian analysis assumes fixed coefficients (production functions are L-shaped, not derivable, elasticity of substitution is null); Georgescu-Roegen's Flow-Fund Theory of Production does not limit the result of production activity to the desired products' market value, but incorporates a physical dimension comprising initial and final stocks as fundamental descriptors of the economic process, considered per se and not per their reflection in economic value; the physiocrats assumed all value coming from nature, Ricardo used a labour-value theory in which rent did not enter the price of the product, and Marx clarified that all wealth (consisting in use values) derives indeed from nature but only labour, which must be applied to nature, "contributes" value (this may perhaps be extended to "dead labour" embodied in produced capital, but surely not to nature).

Some other dependent values (or connected elements playing together in production, in a different role, but contributing to the same output) will be read in the usual SNA monetary use tables, as the examples above point to components of Value Added, i.e. to the values of factors of production used in production, or to transfers affecting the distribution between producers and government of the VA.

Of course, we can read in the use table also the values of the products that would not be demanded to the rest of the economy if production was not possible because of a shortage in ES (e.g. due to disasters following their disappearance; think especially of regulation). Leontievian applications are just one step ahead.

All this does not require inventing anything, but only keeping the physical ES SUTs, as described in chapter 7 of the SEEA EA, at the core of the representation of the dependence of the economy from ecosystems. Annex C describes a neat example of how monetary value can be dealt with coherently with a non-pricing approach that starts from recognising this dependence.

The way forward on monetary values

While acknowledging the criticisms to monetisation of ES in general, we also do not want to overlook that:

- A relevant and urgent policy demand for information on the economic importance of ecosystem services exists;
- some NSOs and international organisations already compile accounts based on very disparate (conceptionally and methodologically) estimated values;
- the tools proposed to practitioners for the calculation of biophysical flows of ES often include monetary valuation modules, as if valuation/pricing was undisputed.

In such a situation, there is clearly a need to **open the exploration of a perspective**, different from the pricing one, based on the recognition of the various values that are “connected to” or “dependent on” ecosystem services properly said and to provide guidance on the correct use and interpretation of these values. This is what the present article aims at.

The further exploration of the pricing perspective is of course a legitimate effort, which will surely continue to be pursued in other international fora, and presumably also in the LG. But, for us, this approach has deployed its full potential and shown all of its limits, so **we want to shift the focus on** what we think is a more legitimate and useful **approach, alternative to pricing** and more in line with a sound understanding of the SNA and satellite accounting and with a broad plural values perspective. It is not our intention to compare the two approaches, but to promote understanding, implementation and further development of the emerging one.

Multiple approaches for individual services: formulating a basic typology of values

How we proceed

The final aim of our research program is to develop a reasonable set of monetary values, free from the constraints of the pricing logic, able to capture as many facets of the economic importance of ecosystems and their services as possible.

Our point of departure is in recognising that the connected/dependent values reflect a range of different meanings. This entails that the values we are confronted with are no longer seen as the results of *methods* for establishing something else (the supposed exchange values of ES), but with values of specific transactions, having their own meaning. The objective stated above can only be achieved by understanding the different kinds of information provided by the different monetary values that can be observed or estimated. Understanding, in statistics, means, as a first step, defining and classifying.

We therefore carry out an exam of the various values, considering them one by one, and characterise them with reference to a set of criteria such as observability, actual/hypothetical nature, public/private nature of the items to which the values refer.

The definitions of the specific monetary values provided by specific studies and applications are implicit in the calculation methods. We explore the characteristics of these methods by asking what kind of situation the practitioners take as a reference for their calculation. It is actual or hypothetical? Is a value directly calculated or is a unit value applied to a quantity? If a unit value is used, does it represent a benefit or a cost? How is it calculated? To which quantity is it applied?

The situations taken as reference for the calculation of monetary values are scenarios. Scenarios are static mental experiments, simulations that may, but do not necessarily, correspond to the actual situation. For example, in some scenarios, an ecosystem service which in fact exists is assumed not to exist. In most of these scenarios, also economic activities, transaction, assets... - in short: monetary values - which in fact exist, are thought not to, because without the ecosystem service they would not, as the ES is an indispensable support and *raison d'être* for them. In some scenarios, however, economic activities, transaction, assets... values, which in fact do not exist may be assumed to exist because they substitute (i.e. provide a similar use value, or avoid a damage, etc.) the ecosystem service.

Scenarios are static, not dynamic. So, even if we use the words "appears/disappears" or "is gained/is lost", what we really mean is "exists/does not exist in the hypothetical scenario", when the latter is different from the actual situation. The latter is a scenario of its own, where observables occur.

The scenario-based characterisation of connected monetary values is useful in order to assess:

- the possible use of the values in satellite accounting (representation of the connected/dependent values in relation to SNA accounting tables),
- aggregation possibilities (homogeneous groups of values that can be summed among them with no need for further assumptions),

- communication options (how to present the result in an appropriate way) and
- policymaking use potential (how to use the values in decision processes).

Ours is an open research program: the theory may offer "solutions" of a general nature, ways of reasoning, applications to abstract, stylised methods for the calculation of monetary values connected to ecosystem services. "Open" means that each time a new application is considered, the emerging need for refinement and development of the reference framework is tackled without prejudice. It is remarkable, by the way, how varied the applications that can be found in the literature and thought of are, revealing how far from exhaustive the methods listed in the SEEA EA are. This is better illustrated by the many examples included in the article "Empirical insights into the multiple economic values of ecosystems: applications and reflections".

Criteria

Under the "connected values" approach, a number of challenges arise, some of which are peculiar to it. In general, the values may be characterised by considering the answers to questions such as:

a. is the value estimated directly from statistics on observable transactions or is it derived from observable transactions through modelling?
b. is the situation, to which the estimated value refers, an actual or an hypothetical one?
c. in case the situation is hypothetical, is there a logical reason to consider that the value actually represents the price that the ES would have, if it was sold and bought on a market?
d. may the value be aggregated with other values, especially those obtained through different methods, as they reflect the same economic concept and situation?
e. does the value deal with private or public goods and services?
f. If a unit value is applied to a physical quantity, how does that quantity relate to the ecosystem service?

In this section we will exemplify the analysis of the many kinds of monetary values connected to ES by referring to the methods described in SEEA EA Chapter 9, and in particular to those considered the most valid for imputation.

a. Statistics vs. modelling

As for the first question:

- the SEEA EA itself provides some practical of examples of values that are directly observable: (i) when "managers of [a] wetland are able to charge the water company that abstracts the water for municipal uses" (9.28); (ii) "land rental prices in agriculture where markets exist to rent land for crop production or grazing" (9.28); (iii) "payments for ecosystem services (PES) may provide a direct measure of the value of ecosystem services [when] there is clear evidence that the scheme does target a specific service" (9.31); (iv) "observed prices from emission trading systems which may be used to estimate prices for global climate regulation services based on carbon retention" (9.32). In all of these cases, like all possible others of the kind, transactions exist (otherwise the "prices" would not be observable) the flows are recorded with their own meaning in national accounts: Rent on land (ii) is currently recorded in the allocation of primary income account (SNA 2008 7.109),

and the same should probably be the case for the rent paid to extract the water natural resource (i); PES (iii) are transfers recorded in the secondary distribution of income account (SNA 2008 8.10); government ETS (iv) schemes have complex recording in NA but are basically taxes, while in voluntary schemes some companies pay others for an image-improvement service (intermediate flow, usually of imported services). The most important thing is that **none of the values above is a price paid to the ecosystem for its services**, and therefore there is no need to conceptualise them as "value of" these ES. Observed price only reflect the actual capacity of the ecosystem's owners or managers to extract some property income from those who base their economic activity on the ES. As the SEEA EA itself points out referring to the "low" values often observed, "it is fundamental to recognise that this result is most likely a reflection of the existing institutional arrangements and is a result that is well-understood in the economic literature" (9.29).

- the SEEA EA also describes three "methods where the price for the ecosystem service is embodied in a market transaction" and must be derived by modelling:
    - in the "residual value and resource rent method", the values are obtained by "deducting the cost of all other inputs, including labour, produced assets and intermediate inputs" (9.36);
    - in the "productivity change method", "the marginal product (contribution) of the ecosystem service is estimated as the change in the value of production consequent upon a marginal change in the supply of the ecosystem service" (9.38);
    - in the "hedonic pricing method" the target of the estimate is "the differential premium on property values or rental values (or other composite goods) that arises from the effect of an ecosystem characteristic (e.g., clean air, local parks) on those values" (9.40).

  In principle, these three methods can be interpreted as providing implicit prices (paid to those economic units which become economic owners of ES by embodying them in their output), or simply as connected values, i.e. as components of companies' turnover. The existence of a differential in prices of produced goods and services is, again, a consequence of institutional arrangements which allow establishing quasi-monopoly rights on chunks or functions of ecosystems, by simply using their services (while others are not allowed or do not have the means to do so). By definition, these methods can only be applied to ES that "contribute to" productive activities. A point needing clarification is whether any ES that does *not* contribute to some productive activity exists. E.g. the flood protection is considered in the SEEA EA as providing non-SNA benefits (6.18), but where this service is present, there must be by definition some user, i.e. for instance some dwelling activity with actually paid or imputed rents, i.e. at least some economic activity, whose respective total value is a value *dependent* upon the ES, which hides within it *connected* residual, marginal and hedonic values.
- "similar goods and services" are connected to ES by their being similar, and therefore supposedly possible substitutes of ES. They are observable as unitary values, but when applied to ES physical flows the resulting value is the hypothetical (and therefore non observable) value of an equivalent quantity of substitutes. How much more value in

cultivated mushrooms will satisfy the needs of those who now collect them in the forest, and how much of pigs meat in replacement of boars'? This kind of question of course abstracts from the need to replace also the cultural ES that the forest supplies to mushroom gatherers and boar hunters jointly with the satisfaction of the catch. The corresponding values are recorded in standard national accounts;

- "revealed expenditures in related goods and services" is by definition observable, being "revealed". In particular:
    - "averting behaviour" accounts for money spent "on preventing or mitigating the negative effects and damages caused by adverse environmental impacts" (9.45). Such expenses are partially captured (namely, for the "preventing" part) in environmental protection expenditure accounts;
    - "travel costs" "include data on the expenditures incurred by households or individuals to reach a recreational site, entrance fees and may include the opportunity cost of time to travel and visit the site" (9.47). All but the opportunity cost are values recorded in standard national accounts as households expenditure on certain products, which are the output of certain, well specified, economic activities that depend upon the existence of tourism. All of these flows are recorded in tourism satellite accounts. As for the opportunity cost of time, it is yet another connected value[12].
- Values of "expected expenditures", insofar as they refer to actual transactions of goods and services, are similar, under the observability aspect, to value of "similar goods and services". In particular:
    - "replacement costs" may be observable as unitary values, and are hypothetical connected values when applied to ES quantities[13];
    - "avoided damage costs" are also hypothetical if calculated as unitary costs and applied to ES quantities: "similar to replacement costs, the focus will generally be on services provided by ecosystems that are lost if the ecosystem were not present or was in sufficiently poor condition such that the services were not available" (9.52). However, if the value of assets and/or of current activities' outputs that are at risk are known – and they may be, as they are included in standard NA – they correspond to actual, observed values that qualify for representation in a system of values connected/dependent from ES.

[12] Please note that this value can be calculated for any human activity, including sleep and working itself. It highlights that not only when working one earns monetary value, but also doing something else, like visiting nature. In valuation/pricing, this form of leisure is not seen as one very reason for working and earning money, as to be able to spend some in travelling, but as another form of production, and leisure itself becomes another form of work. Whatever the price (the opportunity cost) assigned to it, the output – and hence its value – i.e. the time spent in producing the enjoyment of nature, will tautologically be the same as the input – and hence its value – i.e. the time spent in using the enjoyment of nature. This value, under the valuation/pricing approach is recorded as a sort of value added, where this strange kind of working time has the same hourly price as when one goes to work.

[13] The use of replacement cost in the SEEA EA is not the same as in SNA. For a discussion of this difference, see Annex B. From now on, we will reserve the term "replacement" to the restoration of the ES, and use the more appropriate term "substitution" for what the SEEA EA calls "replacement".

- “simulated exchange values” are definitely non-observed and hypothetical. They “estimate the price **and the quantity** that would prevail if the ecosystem service were to be traded in a hypothetical market” (9.55, emphasis added).

As a conclusion for this letter, in a connected/dependent values perspective, all economic activities and assets that depend on an ES are potentially relevant, and their values may be worth reporting in dedicated monetary tables representing the economic importance of these ES. E.g. the asset value of a building which would not survive a flood, and its stream of capital services’ output, both as total dependent value (see next section) and as, e.g., connected “hedonic value”.

b., c. Actual and hypothetical values

As for the second and third questions, in the article by Femia and Capriolo mentioned above, a typology is proposed, for the same values just discussed under the first bullet point, based on the questions above. We reproduce here their summary table and refer the reader to the full article for details.

In this table, only the methods that in the SEEA EA are deemed most acceptable for valuation are listed, so that many connected values that can be found in existing applications are missing, as well as further relevant values which can be thought of. Examples are the figures included in the South-African Biodiversity Economy account (see below), as well as “indirect” and “total” measures of the economy’s dependence from ES. The estimate of this kind of “second-order” connected values would require the use of input-output techniques and would be based on the estimates of the directly connected values. We will not further elaborate on this, given that the main need at the moment is to have clarity on the basic concepts.

Table 1.

Conceptual framing of the main SEEA EA methods for determining monetary values connected to ESs

Actual situation for the ES		Hypothetical situation for the service	Hypothetical situation for related economic activities	Method
The ES exists…	…and it is traded	No need for		Directly observable prices
	and it is not traded (but directly embodied in products)	the right to use the ES is traded on its own	no change, as long as the right to use is given to the same unit which already benefits from the service. Otherwise income shifts between units	Residual, Resource rent, Hedonic pricing, Prices from similar markets, Simulated Exchange Value (also based on Stated preference)
		The ES disappears	Some economic activity appears or grows	Replacement costs, Restoration costs, Opportunity costs of alternative uses, Shadow project costs
			Some economic activity disappears or shrinks	Avoided damage costs, Travel costs, Productivity change (decrease in ES input)
The ES does not exist…		…but it appears	Some economic activity appears or grows	Productivity change (increase in ES input case), Averting behaviour

d. Issues with the aggregation of monetary values across services and/or ecosystem assets

When different values are assumed to reflect the same meaning of "exchange value of ES" - this is the axiom at the basis of valuation/pricing - they can, by definition, be aggregated across ES, ecosystem assets, ecosystems, Ecosystem Accounting Areas… Also, having that meaning, they can be actualised and used for the calculation of the respective asset values. Furthermore, the aggregates thus derived can be compared with national accounting aggregates (e.g. ecosystem output vs economic output), or even further aggregated with other monetary aggregates (e.g. Net Ecosystem Product as a complement to GDP).

Additivity of the different values is no longer granted under the "connected/dependent values" approach, as these values may be e.g. of some actual expense in one case, and of some hypothetical saving in another case: these two cases reflect different concepts and scenarios, that cannot be unified and have no common basis for aggregation, even if both expressed in monetary terms.

ES contribute to the economy in various ways, represented by different monetary figures. For instance, the actual expenditure in nature education [16], ,reflects the cost society is paying for the specific purpose to maintain and use the service, while the travel costs consider the economic costs (for the users) and benefits (for the producers of the goods and services purchased for travelling), associated with accessing the ecosystem for educational purposes. These values are connected to the ES in the sense that they would not exist without the ES. WTP captures what is commonly known as the welfare value of the ES, which is the actual volume of transactions that would appear in case of perfect price discrimination (in a partial equilibrium theoretical setting which may not be the most appropriate one when large transactions are involved and the budget constraint cannot be assumed as given). In this example, values calculated with the expenditure transfer approach, expenditure-based approach and travel cost may be considered to be additive, to the extent these methods are used to quantify different aspects of the service, i.e. different expenditures/costs, referring to the same scenario/ecosystem service flow. The values derived with exchange values (revealed preferences) and welfare-based methods, however, cannot be summed up, as these might overlap in some regards but also because the focus and logic of these methods are different. But both methods provide important information: exchange-value-based methods show what society actually pays in monetary terms for the service, while WTP reflects people's appreciation of the ES, given their budget constraint.

Aggregation between different values is still possible under the "connected values" approach, but only within more limited sets of values, characterised by reference to a common concept/scenario. With reference to the table drawn from Femia and Capriolo (2022) and reproduced above, values estimated with methods belonging to the same cell in the last column should be in principle suitable for aggregation among them, as they refer to homogeneous concepts and scenarios, while those belonging to different cells should remain separate in official statistics presentations, as they refer to different concepts and scenarios.

One consequence of the limited possibility of aggregation is the impossibility of connecting values to ecosystem assets through actualisation of the sum of diverse ES values, unless all of these refer to the same basic concept/scenario. Even in this case, the meaning of the derived actualised value will not be that of a capital value for the asset, but of the actualised value of a stream of connected/dependent values. E.g. if the stream of future replacement costs for an ES is computed, their actual value will represent the present value of the business opportunity represented by replacement as well as the cost that society will incur for replacement.

A good reason not to add different values even when it is technically legitimate, is the loss of visibility of missing and minor elements in the overall picture. For example, an Estonian study [20] considering three services (rainfall infiltration, timber provisioning and compost producing services), showed that exchange-based values dominate the total and obfuscate other values connected to them.

Another study [21] has brought out the trade-off aspect, i.e. that in some cases values cannot be added across services' because the services themselves are alternative. In the case of the forest ecosystem, the timber supply service competes with other forest ecosystem services, so it is not additive. If the supply service is fully realized, then the remaining services of the forest ecosystem

disappear or decrease; forest ecosystem cannot provide all these services simultaneously. Wood, the main provisioning service of the forest ecosystem, competes with regulatory and cultural services.

e. Private and public goods and services

Monetary exchange values appear and disappear all of the time in the economic reality, depending on the institutional settings surrounding goods and services. An unproductive piece of land may become a gold mine's worth for its owner, if the municipality decides that the area can be developed. The institution of an integral reserve natural park in a forest, may destroy the commercial value of nearby sawmills, along with the wood provision ES of that forest. In the first case we have a private good emerging, at the expenses of the public goods connected to the ecological functions of soil. Vice-versa, in the second case, the public benefits from the forest are no longer sacrificed to the private appropriation of the wood provisioning service.

Similar assumptions, of changing institutional arrangements around one or several ES, are implicit in some valuation methods [20]. Especially contingent valuation implies setting the mind of the people involved in the experiments in a market situation, while the actual situation is usually a non-market one. This has serious implications for the figure's relevance and meaning, as research show that people's behavior may radically differ in the two cases [24][14].

f. Quantities valued

When a unit value is applied to a physical quantity to obtain an estimate of a value connected to an ES, differently from pricing, this quantity needs not be the quantity of the ES. In certain cases, unit values can be applied to "stocks of ecosystem services", rather than to flows thereof, such as e.g. the standing timber resulting from the accumulation through time of the wood provision ES (which is defined as net increment as for the Forests Available for Wood Supply). In other cases, they can be applied to entities that are related to ecosystem services, or represent quantities thereof, but are not ES, such as e.g. emission permits actually bought and sold on the market, or the stock of emission permits held by the private sector in an economy.

Clearly, the meaning of the connected values estimated, and the hypotheses embodied in their estimation, changes radically depending on the quantity to which unit values are applied.

A reference scheme

The following scheme displays the semantics of the applied connected ecosystem services monetary values framework and provides a general reference characterisation/classification of the values, based on the scenarios that are assumed in their calculation, i.e. on the methods used for their computation.

[14] Also see https://en.ilsole24ore.com/art/what-money-cannot-buy-AHuDKko?refresh_ce for an exposition and a confutation of Michael Sandel's arguments

In the first column (1) we have the cases where the service exists in the scenario, including all the values based on direct or indirect observations and those whose "appearance" or "disappearance" in the scenario depends on institutional, rather than on physical/ecological, changes; in the second (2) we have values based on hypothetical scenarios where "the service does not exist" ("would disappear": risk of loss)[15]. "The service does not exist in the scenario" is always related to counterfactuals that "appear" or "disappear" in the economic world. These values are therefore not related to economic activities, transactions, economic flows or stocks that do exist in reality but only in the hypothetical scenarios in which their value becomes visible.

In the rows, we have, at the first level: (A) actual situations, where the connected value exists (as an actual economic value), are observable and directly referred to ES or "stocks" thereof. Since these depend on the ES existence, they are not related to an hypothetical scenario; (B) hypothetical scenarios where connected values appear, connected mostly to the case of decrease in the availability of the ES (latent economic potential of ecosystem degradation), and (C) hypothetical scenarios where connected economic values, not directly referred to ES actually exist but would disappear (risk of loss) in case of ES's loss.

So there are six main kinds of 'value categories' in the table, but only four main blocks of cells can be populated: 1A – reality: actual flows and reserves of exchange value that can be directly or indirectly observed; 1B – institutional change: "privatisation" of the (whole) ES; 2B – adaptation: the loss of the ES sparkles "alternative" or "reparatory" economic activities; 2C – cost of inaction: what we lost or risk losing. Of course, all figures in 1A could also be placed in 2C. The difference is that 2C figures are either historical estimates of damages actually suffered (no-longer-existing values) or prospective forecasts that would not make sense out of the "loss of ES" hypothesis, differently from 1A cases. These four main cases can be further articulated according to the specific characteristics (additional scenario hypothesis, e.g. concerning "what is exactly put in place instead of the ecosystem service" in the "ecosystem service does not exist" hypothesis) of the methods used to derive the connected value. Moreover, not all four cases are relevant for all ecosystem services, according to the empirical analysis of case studies described in the next section.

The first main row of the table, "Connected monetary value/ transaction/asset exists in the scenario" has four sub-cases:

i. "ES are traded as private usage right to use": this is the case of rent on land as in the national accounts, PES (if PES is not a given as a subsidy but as a payment measured on a physical quantity of the ES actually provided), the volume of actual transactions in tradable emission permits;

ii. "ES are potentially traded as private usage right to use": some ecosystem services are to a certain extent institutionally dealt with as a private kind of asset. This is the case of the actual

[15] In principle, three kinds of scenario can be defined as for the existence of the ecosystem service: it exist both in the reality and in the scenario; it exists in the reality, but not in the scenario ("is lost"); it does not exist in the reality, but it does in the scenario ("appears"). The latter case did not show up in the applications we considered, so we did not include it in the scheme. Framing the economic aspects of ecosystem services' enhancement, however, would also be very interesting: when ecosystem services are gained, and their unmet demand is satisfied, new economic opportunities arise and some existing activities are threatened (e.g., how much air filtration devices manufacturing would be an unnecessary cost to society if more natural air filtration was available?).

stock value of potentially-for-sale actually tradeable emission permits, and to that of all the standing timber that is potential wood supply. These quantities differ from the total quantity of the respective ecosystem services "measured" by the non-monetary indicators of SEEA chapters 6-7.

iii. "the ES is used as an input for producing other goods or services[16]": Resource rent, Residual value, Hedonic pricing... fit in the "ES exists" column, but they are embodied in other transactions' values, not directly observable as actual transactions. Even if they look for the price at which the ES would be traded on its own, which is not the current situation (so from this institutional point of view the scenario is hypothetical), they intend to capture a share of existing monetary flows that is supposed to represent the contribution of the ES to its users' income.

iv. "Other (transactions recorded in SEEA CF and/or SNA that are related to ecosystem services)". Under this category fall empirically observable transactions or asset values that depend from or are related to the ecosystem service, which can be found e.g.in: production and value added of industries that heavily depend on ecosystem services, actual biodiversity protection expenses from EPEA, taxes linked to ecosystems use (from ETEA) or earmarked for use for ecosystems' protection, subsidies, some EGSS items... . Also actual historically borne observable travel costs are connected monetary value/ transaction that exist in the reality scenario. Of course, all Ai and some Aii cases could be placed here as well, but this is a residual category.

As said, all the connected values belonging to these "reality" values would of course disappear if the ES disappears, but we do not need to make this hypothesis to calculate them, unlike other connected values whose existence is conceptually linked to the ecosystem service *not* being available, such as e.g. those of substitutive activities. These are placed in the second main row, while the third main row we have the connected values that exist in reality but need, in order to be estimated, the hypothesis that an ecosystem service that supports them is not available (anymore), such as the damages that the loss of the ecosystem service would cause.

The second main row of the table is for the cases where a connected monetary value does is not observable in reality, but is hypothesised to exist in a hypothetical scenario. In comparative static terms, "Connected monetary value/ transaction would appear in the scenario". We identified three types of these cases, so we have the following three sub-rows:

i. "Economic activity that avoids the need for the ES, or substitutes it with something else". E.g. technologies are put in place to abate carbon emissions to zero, and economic activities exist which provide those technologies (cars retrofits are an example). Actual historical expenses on retrofits are values included in row 4. above. Prospective estimates of the cost of further abating carbon emissions belong here[17]. The global climate regulation ES would not be necessary in such a scenario, and this is why we use the second column for these cases. Another example is hand pollination as a substitute for pollinators. This latter example points to a kind of values that would exist in an economy adapted to be disappearance of some ES,

[16] This is a way to appropriate ecosystem services and get an income from that, if there is rivalry in their use. If there is none, probably there is no edge for the user who produces goods or services by using the ecosystem service to charge more than its costs of production. E.g. all production activities use oxygen for free, and no one would be able to charge more its clients for that.

[17] It is important to keep in mind that every monetary cost is the dual expression of some economic activity's output value. In this block of rows the emphasis is on the emerging activities.

important to consider for a society resigned to their perspective loss, and which sees business and employment opportunities in it.

Figure 1. **Semantics of the applied connected ecosystem services monetary values framework**

REFERENCE SCHEME FOR THE CLASSIFICATION OF VALUES CONNECTED TO ECOSYSTEM SERVICES ACCORDING TO THE FEATURES OF THE CALCULATION SCENARIO				
			Ecosystem service in scenario	
			Ecosystem service exists	Ecosystem service does dot exist hypothesis
Connected monetary value (transaction/asset, etc.) in scenario	exists (scenario coincides with reality)	Ecosystem services are traded as private usage rights	Rent of the land, directly observable prices applied to actually traded volumes, observed value of actually observed transactions in tradable permits	
		Ecosystem services are potentially traded as private usage rights	Directly observable prices applied to potentially for sale permits of using the ES	
		ES is used for producing other goods or services	Resource rent, Residual value, Hedonic pricing	
		Other (outside or inside of SEEA-EA, within SEEA CF, other satelllie accounts or SNA)	Travel cost method, effective carbon rates	
	"would appear" (does not exist in reality, does in the scenario)	Economic activity that avoids the need for the ES		Abatement costs, substitution costs, averting behaviour
		ES restoration as economic activity*		Restoration costs
		Marketisation of the ES (with or without perfect price discrimination)	Prices applied to quantities of ES not actually traded or tradable under current institutional arrangements, WTP for maintaining ES	
	"would disappear" (exists in reality, is lost in the scenario)	Existing economic activies can no longer thrive, and/or assets are damaged («other negative changes in value») because of the lack of the ES		Social cost of lacking ES, expected damages

* Restoration costs usually refer to the restoration of whole ecosystems. It is however possible to think about the restoration of a single ES, that leaves the rest unchanged. E.g. if an area is made suitable (e.g. reclaimed from venoms) for wild animals and/or these are reintroduced in the area. Pollinators could be one case

ii. "ES restoration as an economic activity". When ecosystems are lost, and all of its ES with them, there sometimes is the possibility to put in place human actions (economic activities) that locally reverse the ticking of the clock, and help nature to recover. Planting trees and purifying the water from the nutrients that cause oceans' eutrophication are actions that have costs which, when quantified ex-ante in relation to the "ES is lost" hypothesis, provide hypothetical connected values.

iii. "Marketisation" of the ES" (with or without perfect price discrimination). When a payment for a well-specified, existing, quantity of ecosystem services is done to the owner of the supplying ecosystem, where there was no payment before, an institutional arrangement arises, that recognises economic ownership and monopoly rights on the use of the function of nature represented by the ES. The value of actually paid PESs belongs to row 4 of block 1, and this is recorded under "subsidies" in the national accounts if paid by government units. However, if the unitary "price" used for the PES is applied to the whole existing flow of the ES, we get an estimate of how much would ecosystems' owners earn by cashing it. A common good becomes private and property income flows appear. A similar kind of hypothesis underlies questions such as "if you had to pay for this ES, how much would you like to?", with the only difference that the aggregation of willingness to pay across individual gives a measure of the whole area under the demand curve, i.e. what the ecosystem (service) owners would get in the case of prefect price discrimination. These mental experiments do not need that existing ES be imagined to disappear, so they are found under the first column.

The third main row of the table, for each service, is the "Connected monetary value/transaction/asset would disappear" scenario. This reflects a hypothetical situation in which existing economic activities can no longer thrive, and/or assets cannot stand in their current state (are damaged: «other negative changes in value of assets» in the SNA) because of the lack/disappearance of the ES. This row is not split further. We allocate here all value based on emerging economic and "social" cost kind of estimations, even if these are often based on the value of activities that try and restore the damaged values (repair works after a flood, additional healthcare needs of air pollution…), which would suggest allocation in the second block of rows, because the emphasis is on the damage suffered and the objective of the estimations is to quantify it independently from any hypothesis that the reconstruction costs be actually sustained by someone (and, certainly, that the deceased could be restored to life). But it is clear that, not differently from war destruction, even ecological catastrophes are economic opportunities for some, and social costs for others. As said above, all figures in the 1A block could also be placed in 2C, as they would be lost under the "ES does not exist (anymore)" scenario, or the C row could be dealt with as a fifth sub-case of A, the only one where the activities exist and their quantification requires the explicit hypothesis of the ES disappearing.

A very important feature characterising different scenarios is the quantity to which unitary values are applied: if applied to actually traded quantities of private usage rights on ESs, we have observable values (1Ai); if applied to quantities "in stock", that could be traded under the current institutional arrangements, we have the value of existing assets (1Aii); if applied to quantities of ES that are not subject to alienable property rights, we have values that may appear under a "marketisation" hypothesis (1Biii), or potential costs connected to losing the ES (2Bi and 2Bii).

Conclusion: developing a dashboard of values for policy and communication

The connected/dependent values approach aims at providing policy and the public with a more complete picture of the economic importance of ecosystems and their services than the reductive or distortive one that can be provided through pricing.

Champions of monetary valuation refer wide and large to the need of "overcoming the economic invisibility" of ecosystems. The objective of protecting ecosystems, however, is not served by including ecosystems' contributions on the ledger and applying the cost-benefit logic. Indeed, the values actually estimated often are disappointingly low and do not support ecosystems' protection. Indeed, the SEEA EA itself warns that "the resulting prices may provide accounting entries for the value of ecosystem services that might be considered low, i.e., where the monetary value of the contribution of the ecosystem is negligible. It is fundamental to recognise that this result is most likely a reflection of the existing institutional arrangements and is a result that is well-understood in the economic literature. For example, it is well documented that the resource rents for natural resources that are extracted in open-access contexts will tend to zero (Hartwick & Olewiler, 1998)" (9.29). Still "the resulting prices should still be applied in ecosystem accounting since the core intent to show accounting entries that reflect the established market context and hence support analysis of the prices relative to those of other services and assets. " (9.30). This is especially the case of the values provided by the methods preferred – for their coherence with the SNA - in the valuation/pricing accounting perspective (rents and residual values).

The risk is then that valuation, notwithstanding good intentions, may turn out to be counterproductive in a nature protection perspective, as it conceptually introduces the exchangeability of ecosystems.

So, from the acknowledgement that the established market context – even after the accounts are "well done" – is not favourable to ecosystem protection – some support for the

connected/dependent values approach arises in the SEEA EA itself. “To the extent that the recorded values are considered “low”, there may then be an interest in estimating complementary values on the basis of alternative institutional contexts and market settings” (9.30). Unfortunately, the whole reflection on these complementary values is confined to chapter 12 of the SEEA EA, which was assigned no status at all by the UNSC.

Also note that the “low values” result is often obtained even by including substantial chunks of so-called non-SNA benefit into the picture. The Estonian results on people’s willingness to pay for ecosystems’ conservation or enhancement are paradigmatic in this sense.

In conclusion, it seems that in order to overcome the economic invisibility of ecosystems, the best official statistics can do is to display **a dashboard of values** that may, in their multiplicity, reveal several aspects of the importance for the economy from ecosystem services. This may include the full value of goods, services and assets whose existence depends from ES, including actual current outputs and potential losses; the actual distributive and financial transactions connected to ownership rights on ES; values appearing in activity accounts of SEEA CF ch, 4; people’s willingness to bear additional costs for protecting nature. Most importantly, these monetary indicators of economic importance, may be presented side-by-side with non-monetary indicators such as e.g. the number of people who benefit from existing ES, who would need more, who were historically hit by their lack, etc. Such measures, along with the physical measures of actual ES flows would provide a much broader and accurate picture of how societies depend on thriving ecosystems.

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Annex A. Monetary values and ecosystem services

A general framework for the European feasibility study.

Position paper

Drafted by Italy, revised on the basis of the inputs from Estonia, Austria, Spain, France, Germany, Netherlands, Norway.

The position paper can be downloaded from the following webpage of Eurostat's TF https://circabc.europa.eu/ui/group/922b4700-1c83-4099-b550-763badab3ec0/library/a12ee52f-0b95-41d2-9e3c-d1c885bf4ad5/details

Annex B. Current cost accounting (Replacement cost)

The use of replacement cost in this paper is the same as in SEEA EA. But, it can be argued that the interpretation in SEEA EA is not the same as in SNA. In the SNA the replacement cost is only relevant for goods in inventories and in the fixed capital stock. Replacement cost is not related to services, therefore we need to apply replacement on the ecosystem providing the service rather than on the ES. Replacement cost, according to SNA, is the cost of replacing goods taken out of the inventory in the same period. This is a way of accounting for the current social costs (current production costs) of replacing the same kind of goods in the period the goods are used rather than accounting for the historic costs of these goods if acquired in a previous period. This is the SNA principle of current cost accounting (2008SNA para. 1.65).

Objects in the inventory and the capital stock might not be produced anymore therefore might have disappeared from the market as new items. In such a case it is not possible to capture the price change of new objects between years and use it to revalue the same kind of objects that are still in the capital stock. In this case the replacement cost relates to the price that would make an enterprise produce and provide the object for sale on the market. The growth in market prices of new objects no longer produced is estimated by the growth in market prices of substitutes produced by the same enterprises (industry) or by the growth in the corresponding production costs. This is thought to best capture the development of the replacement costs for object no longer produced but still in the stocks.

Furthermore, in the SNA replacement cost refers to the same product: timber is replaced by timber of the same tree species and dimension, raw petroleum by raw petroleum of the same quality etc. Differently from the SEEA EA, replacement does not refer to a close substitute or a good that can be used to replace the main functions of the item no longer produced. Replacement cost is the current cost of producing a new item of the very same

good. To support this understanding of replacement cost we refer to Keynes who in the second paragraph of the first part of chapter 11 in his magnum opus 'General theory...' writes the following:

> "Over against the prospective yield of the investment we have the *supply price* of the capital-asset, meaning by this, not the market-price at which an asset of the type in question can actually be purchased in the market, but the price which would just induce a manufacturer newly to produce an additional unit of such assets, *i.e.* what is sometimes called its *replacement cost*.' (italics in the original text)

Observe that Keynes by replacement cost does not refer to the market price of existing goods. The reason is that the market price is influenced by other factors besides the original production costs determining the supply price charged by the producer. Such factors include taxes and subsidies decided by the government.

Translating this into ecosystem accounting means that the disappearance of an ecosystem service like pollination and substituting it by hiring beehives from a beekeeper or using labour equipped with small brushes cannot be accounted as replacement of the same pollinating service. Replacement means providing exactly the same ES which only can be done by restoring the ecosystem so it can provide the service that has disappeared. Looking on the issue from this point of view the replacement cost of ES is different than the cost of hiring beehives or using labour. The replacement costs in the context of EA, understood as in the SNA, actually would mean restoration costs.

Annex C. The South-African biodiversity economy satellite accounts

More specific "connected monetary values" may be represented in an integrated way with national accounts following the logic of SEEA CF chapter 4 (activity or "thematic" accounts).

One example of how to follow this logic is provided by the South-African biodiversity economy satellite accounts[13]. In their effort to "measuring the benefits of biodiversity for the economy", the authoritative authors of the study[14] very appropriately remind that "Satellite accounts are linked to, but distinct from, the central system of the SNA 2008. Broadly speaking, there are two types of satellite accounts:

1. The first type involves some rearrangement of central classifications and the possible introduction of complementary elements – these are referred to thematic satellite accounts.

2. The second type of satellite analysis is mainly based on concepts that are alternatives to those of the SNA 2008".

They then clarify that also "thematic satellite accounts typically use the framework of supply and use tables (SUTs) as a starting point" and that "the focus of the Biodiversity Economy Satellite Account is on the contributions of ecosystems and species to activities that fall inside the SNA production boundary. A large portion of "the environment" is already included within the SNA production boundary, and satellite accounts for environment-related sectors can help to highlight this".

After defining the biodiversity economy (BDE) in general ("economic activities that rely solely on intensively managed ecosystems and non-indigenous species" are excluded, so that there are links "with some but not all ecosystem services"), they go on specifcying two broad categories of BD-related activities: "those that contribute to conserving biodiversity and those that utilise biodiversity. [...] Within these two categories of biodiversity-related economic activity we identified further sub-categories as follows:

- **BDE Category A: Conserving Biodiversity, including economic activity in:**
  A1. Protecting and managing biodiversity assets
  A2. Restoring and maintaining ecological infrastructure
  A3. Research and professional services related to biodiversity
- **BDE Category B: Using Biodiversity, including economic activity that depends on:**
  B1. Non-consumptive use of biodiversity
  B2. Extractive use of biodiversity"

Although the BDE satellite account has "links and overlaps with environmental activities as defined in Chapter 4 of the SEEA Central Framework", these do not exhaust the thematic account, which is therefore able to provide additional information, putting monetary values in the forefront, but not considering them as *the value of* biodiversity ES. These values are additive and can be compared to the wider aggregates they belong to, but their share within the latter is the share of the (existing, actual) chunk of the economy *dependent on* biodiversity, not *of* biodiversity.

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Annex D. Integration of welfare values

The environmental valuation has come to be applied to the practice of evaluating the social gains and losses from environmental degradation or improvement. Economists practice valuation by applying welfare economics to environmental outcomes. Evaluation of benefits and costs often evokes strong objections, even when applied in the well defined context of welfare economics[25].

When statisticians venture into the already complex field of welfare economics, they can expect even more questions and objections. Among the three major subcategories of ecosystem services—provisioning, regulating, and cultural services—the disparity between welfare economics and environmental and economic accounting approaches and methods is most pronounced for cultural services. In welfare economics, the criterion of something's value is its ability to create (or increase) the well-being of individuals. Everything that positively changes the welfare of individuals has value[26].

It is hardly disputed that ecosystem services in all three categories have a positive effect on well-being. So these ecosystem services have value anyway. And, according to welfare economics, the value can be quantified and measured[27]. Welfare economics uses a wide range of indirect and direct methods to do this, based on both real and hypothetical markets[28].

SEEA-EA (6.8.) also claims that: „The key concepts of the ecosystem accounting framework related to ecosystem services concern (i) the supply of ecosystem services to users; and (ii) the contribution of ecosystem services to benefits (i.e., the goods and services ultimately used and enjoyed by people and society)“. According to this definition of SEEA-EA, the object of ecosystem accounting is both input from ecosystem services to the production of goods and services, as well as services directly used by people and society. Therefore, there is no requirement that the services which are subject for accounting should enter the economic system or become part of the so-called conventional economy before improving people's welfare.

This conclusion is also confirmed by SEEA-EA (6.9) “ecosystem services are the contributions of ecosystems to the benefits that are used in economic and other human activity”. In this definition, use incorporates direct physical consumption, passive enjoyment and indirect receipt of services. Further, “ecosystem services encompass all forms of interaction between ecosystems and people including both in situ and remote interactions“. Such an interpretation allows the passive use of ecosystem services to be considered as ecosystem services, making the consumption of socio-psychological services, such as existence value, choice value and future value, also objects of ecosystem

accounting. Many cultural services inherently transfer value from the ecosystem to individuals, according to welfare economy, directly impacting their well-being, without participation in the economic system and real markets and without generating financial turnover.

Therefore, information on the values related to ecosystem services does not have to be limited to the real economy and real markets and real turnover, which is the object of classical accounting. At the same time, it is clear that the statistics and accounting of ecosystem services cannot completely ignore the principles and developed traditions of the respective field, which in terms of economic accounting are based on real markets and real turnover and prices. Thus, the key issue in accounting for ecosystem cultural services (and other non-market services) is how to reconcile a system based on real markets and prices with the results obtained using hypothetical markets and stated preferences methods (for example, contingent valuation).

Often, the use of hypothetical markets is the only way to find the connected monetary values to non-market ecosystem services. In order to still reflect the values obtained in hypothetical markets, they should be kept separate from the data obtained by conventional accounting methods. The use of satellite accounts offers good opportunities for this[26][18]. With this, it would be achieved that conventional accounting could stick to its traditional approach, and at the same time non-market ecosystem services, which play an important role as determinants of the welfare of individuals, would also have a representation of some related monetary value[19].

Statistics Estonia and Tallinn University of Technology has for example tested the integration of the financial monetary value of ecosystem services found using the contingent valuation method and based on original research[29], [30]. Statistics Estonia has discussed the methods applied and feasibility of inclusion of welfare values and respective additivity in earlier works in London Group of environmental accounting meetings in 2020, 2021 and 2022 ([3], [7], [8], [9] and [10].

The application and interpretation of the welfare values need further research from an accounting perspective.

[18] Although SEEA-EA does not directly recommend the use of additional satellite accounts in ecosystem services accounts. SEEA EA refers to satellite accounts in connection with data on tourism (9.48) and oceans (13.88).

[19] The comparability of market services and non-market services is especially important in decision-making processes where different scenarios of resource use compete.

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Annex E: Which of the estimates of connected/dependent values at hand are fit for use in official statistics at all?

This question was not raised in the paper, but in reality it should probably be the very first one in any discussion about monetary values, whether “of” or “connected to” ES. Indeed, the question is relevant to any possible use of the values, whether in the valuation/pricing perspective or in the connected/dependent values perspective.

Exclusion of a particular value from the set of values connected to/dependent from any specific ES may derive, in an official statistics context:

- from considerations on the intrinsic observability of the concept;
- from consideration of the scarce accuracy of the estimates provided. E,g. even if the total hedonic value of accommodations near a forest depending on several ES at once may be estimated reliably, this will hardly be the case for the contributions of the individual services;
- from lack of evidence of the connection/dependency[20].

[20] All in all… who said the value of accommodations near a forest should – ceteris paribus – necessarily be larger? Forests vicinity brings nuisance and danger as well as advantages and protection: insects, risk of fires, noise from lumberjacks working, birds waking you up early in the morning, fear of meeting bears and

It should be clear that any exclusion of values from the connected/dependent value line of research does automatically imply exclusion of the corresponding methods (for determining ES prices) from valuation/pricing, as imputation requires that stricter criteria are met.

The vice-versa, however, does not automatically apply, depending on the reason of the exclusion. If for instance welfare values can be excluded in an "exchange value" valuation/pricing perspective, this is not a-priori the case for the set of connected / dependent values. However, a reflection is necessary on their degree of observability.

Also in this sense, the connected/dependent values approach has greater inclusiveness potential.

Annex F. Communication of (multiple) monetary values from different approaches

Good communication of connected/dependent monetary values requires attention to the following aspects:

- the nature of the connection/dependency, which should always be well explained and clarified;
- the range of ES contributing to the value (when more than one ES contributes to a same benefit), which should be always reported in full, in order to avoid connecting to a single ES some value that in fact depends on the concomitant presence (joint contribution) of more than one ES. E.g., the hedonic value of accommodations near a forest usually depends on the cultural value of the nice view, the regulation value of flood mitigation, air cleaning and local climate regulation. A solution maybe to use a comprehensive name such as "differential premium due to regulatory and cultural ES from forests" (tentative denomination; an alternative, already in use, but in

boars… As far as economic accounting goes, all "benefit accounting" has shaky logical grounds, based on the exclusion of disservices – in the case of ecosystem accounting, of Ecosystem Disservices (see SEEA EA § 6.3.5) – and it would always be better to refer to observable transactions, without assuming – even for them! – that there are "benefits" attached to them in general, while the transactions reveal that someone perceives them as necessary to get a benefit – like for instance when profits from illegal drug dealing are accounted for in GDP.

The following text in the SEEA EA is particularly interesting, as for the asymmetry in considering ecosystem services and disservices: "although it is possible to record relevant physical flows and quantities such as the number of pests, or the number of people affected by malaria, none of these negative connections can be considered to reflect an exchange of positive quantities of a good or service and hence are not considered as transactions for accounting purposes. Further, the precise nature of the net connection at a societal level must recognise that different people may have different values with respect to the same ecosystem asset (e.g., trees that provide shade may also obstruct some people's view)" (6.67). This may seem unjustified, from the point of view of the economy, which "benefits" also from nature's disservices (e.g. combating pests). The more so in accounting that aims at being objective.

connection to a specific method is “resource rent”) and specify in a footnote the contributing ES;
- the observability of the values reported;
- the actual/hypothetical nature of the values reported;
- the position occupied in national accounts by the actual values reported;
- the fact that connected values may represent benefits supported by ecosystem services that may be lost (costs of inaction) as much as business opportunities that may arise. Examples are substitution costs, as well as SEV.
- the possibilities of aggregation with other values, as discussed in the previous subsection;
- the private or public nature of the goods and services connected/dependent on ES, to which the values directly refer.

All these aspects should not also be reflected as much as possible in the immediate presentations of the data, but their discussion should definitely appear in background documents accompanying the connected/dependent values published. Indeed, without links to basic data, semantics and analysis, the true meaning behind the single number could be meaningless and lacks true usability.

Questions to the London Group

- **Does the London Group endorse the general approach and perspective delineated in this paper?**
  - that **the multiple values perspective requires** going beyond the valuation/pricing approach of chapters 8-11 of the SEEA EA?
  - that pricing of ES must be limited to cases where actual rents are observable or implicit (resource) rents can be determined?
  - that **reporting systems** (accounts, **dashboards**, combined presentations…) **dedicated to the economic importance of ecosystems an their services should be developed, including monetary and non-monetary indicators**, in order to represent the ecological, social and economic costs of inaction and the benefits and opportunities of protecting ecosystems?
  - that several monetary values concerning **flows and stocks connected to ecosystem assets and their services**, some of which can be found within the SNA or satellite accounts (e.g. rents, economic efforts for biodiversity protection dealt with in SEEA activity accounts, actual exchange values dependent from ecosystems and their services like those of the South African Bioeconomy accounts), reflect different aspects of the economy’s dependence on ecosystems and their services,

and should therefore be kept distinct, even if included in dedicated reporting systems?

- that these systems may include, besides **backward-looking measures** (such as the ones found in SNA and satellite accounts), **forward-looking measures** (based on scenarios) of risks of ecosystems' degradation and opportunities of ecosystems' enhancement, as well as measures representing **welfare values (**such as e.g. results of willingness-to-pay surveys)?
- that appropriate **communication** of the different values is of fundamental importance and should be tailored on each figure's specific meaning?

- **Are the categorisations of economic values proposed in this paper useful to support such developments and correctly formulated?**