CONTRIBUTION TO THE SEEA EXPERIMENTAL ECOSYSTEM ACCOUNTING

Pablo Campos

Research Professor
Spanish National Award on Environment (2002)

Spanish National Council for Scientific Research (CSIC)
E-mail: pablo.campos@csic.es

1. Introduction

The aim of this contribution is to offer an alternative accounting proposal to measure ecosystem total income based on the total economic value concept and the simulated exchange value approach in the framework of the SEEA Experimental Ecosystem Accounting consultation process. The total income concept is defined beyond the SNA flow and asset boundaries on the basis of Hicks (1939) and Krutilla (1967), respectively, commercial income and environmental income.

The Tables A6a and A6b show a simplified net value added and capital gain indicators for illustrating the main challenges we need to agree for being able to incorporate market and environmental (non-market) economic values in real measurement of total income and capital accounts of ecosystems at any scale.

2. Ecosystem total economic value

The economic valuations of an ecosystem have the ultimate aim of estimating the Hicks-Krutilla total income (Hicks, 1939; Krutilla, 1967), and to achieve this objective it is required to, in advance, value the stocks and movements of natural capital and manufactured capital in the accounting period. Thus, there exists a widespread consensus among environmental economists that the total economic value of the ecosystem is a framework of the theory of suitable economic value (Pearce, 2007; CBD, 2009, Bateman *et al*., 2010, and TEEB, 2010). The total economic value includes all the sources that motivate individuals and/or institutional entities to attribute economic value to scarce goods and services that are consumed and/or appropriated. The clearer motivations of why people attribute an economic value to *final and intermediate* environmental goods and services are due to their *current active use.* Another reason why people assign economic value to known scarce sources is the motivation of ensuring the option of their future use. This *option value* emerges when the current generations are worried about the future supply of particular services for which they prefer to not put the persistence and/or provision of the desired service at risk. The option value is manifested in the availability of the current generations to include an additional management cost of the ecosystem as a way to ensure that in the future the preferred capital endowment is reached. The payment is justified, either due to avoiding the degradation of the supply of services of the ecosystem that originate from its current management, or because they prefer to have a future supply that is equal or superior to the current services. People and institutional entities also can give economic value to *passive use* (existence value) to try to mitigate habitat loss and the extinction of threatened species. The concept of *existence value* of an ecosystem has led to a lively controversy, which is not yet fully resolved, over the

difficulty of the valuation of the unique concept of passive use[1]. The economic science that underlies an existence value is based on the observation that humans spend economic resources on an individual or collective level in an attempt to prevent non-replaceable ecosystems, biological varieties, and *unique* cultural values from disappearing forever (once they disappear they cannot be reproduced). This behavior occurs even in situations when the passive user only knows these unique assets are threatened by readings, conversations with other people and audiovisual mediums, and without the requirement of the foresight of the future active use they still express the willingness to pay for the possibility of their future existence (Krutilla, 1967; Pearce, 2007).

The economic values of both active and passive uses which made up the utilitarian exchange total economic value are additives, although they can appear errors and/or double-counting in the application and inconsistency of the value of services, unless you have taken into account the criteria of *double counting* and of *exchange value* of environmental services measurements.

Some analysts attribute "intrinsic worth" to nature other than human species to be confronted this non economic value with utilitarian exchange total economic value. This is to say that *intrinsic worth* is a non utilitarian value that support that everything in nature has an *absolute worth*. Opposite, TEV concept assumes that only human species has an *end in itself*, and from this it follows that to those other nature things different of human beings, might become to receive from people a mere *relative worth* (a price), but they do not have by their-self an intrinsic economic value.

3. Ecosystem private and public total incomes

The economic flows and stocks of and ecosystem are made up of *scarce goods and services* for which a person and/or an institutional entity are willing to pay a sum of money (numerarie) to access its use and/or property. The economic goods and services are classified in commercial and environmental, the latter being separated in public environmental and private environmental. Economic commercial goods and services are composed of *scarce goods and services* for which a person and/or institutional entity is willing to pay a sum of money to ensure their access to its use and/or property, and the person/institutional entity usually gains access by a payment of a sum of money through a *market transaction*. The Economic environmental goods and services generated by the ecosystem are formed by the scarce goods and services that are usually non-commercial that a person or institutional entity owns and self-consumes and that are non-proprietary with free access to their use and ownership, and for which people are willing to pay a sum of money to unsure their consumption and/or exclusive ownership.

The ecosystems produce natural goods and services depending on circumstances of *demand*, *location* and *property rights*, among others, which are *economic*, or the same goods and services are *non-economic* or *free* in other places and circumstances. That is to say, they are non-economic when the owner of the ecosystem does not find a person and/or institutional entity willing to pay a sum of money for its consumption and/or appropriation. The natural production of acorns, grass and pine nut that livestock, game species and people do not consume are considered free environmental goods, and therefore in these cases they are non-economic natural goods. Also the natural forestry water which is regularly consumed in excess

[1] Or non-use, as it is called by others, although this form of reference to passive use is nominally inconsistent with the theory of the consumer.

over natural grasslands by woody vegetation and the flow of natural forestry water that reaches the rivers without reservoirs are considered free environmental goods.

The flows and stocks of economic goods and services of an ecosystem depending on the way in which they are produced, they can be classified as natural resources (NRs) and manufactured resources (MRs). Among the NRs are natural fixed capital (FC_N), which are composed of *land* (FCl), *biological resources* (FCbr) and other natural (FCo_N); *natural raw materials* (RM_N); *natural work in progress* (WP_N); and *natural services used* (SS_N). The MRs can be grouped into *manufactured fixed capital* (FC_M), which are composed of constructions (FCco), equipments and machinery (FCe), plantations (FCp) and other manufactured (FCo_M); *manufactured raw materials* (RM_M); *manufactured work in progress* (WP_M); *manufactured services* (SS_M); and *labor costs* (LC), formed by employees (LCe) and self-employed (LCne). Thus, the *Hicks-Krutilla total income* (TI) extended to the economic environmental values of the ecosystem can be expressed by the equation [1]:

$$TI = F(NR, MR) = F(RM, SS, LC, WP, FC) \quad [1]$$

The equation [1] contains all the information needed to estimate the Hicks-Krutilla total income for any scale of territory (nation, region, natural ecosystem, vegetation, etc.). The ecosystem *production account registers and* organizes the information of *economic activities* to estimate the *net valued added* (NVA) in the accounting year. The economic resources that remain in the territorial economic unit for more than a year are organized in a capital balance account (including fixed capital and work in progress accounts) in order to measure the ecosystem *capital gain* (CG). The measurement of total income (TI) is resolved with the aggregation of both *net valued added* (NVA) and *capital gains* (CG) (Eisner, 1989, p. 17 and BEA, 2010, p. 18):

$$TI = NVA + CG \quad [2]$$

The science of economics is developing methods of environmental valuation that simulate the quantities and prices associated with the production and consumption of economic environmental goods and services, that have in some cases a comparable consistency to the criteria of valuation of the SNA[2]. They need the information of supply and demand to come reach an estimate of the partial equilibrium price that corresponds to the amount of supply of environmental goods or services that they want to assess. Thus, the total amount consumed/produced multiplied by its marginal price offers a total environmental economic value consistent with the commercial value of market goods and services of the SNA (Campos and Caparrós, 2011). In recent years there has been progress towards improving the techniques of environmental valuation based on individual preferences both revealed and stated by the population, but it is worth noting the few occasions in which they have tried to consistently use these techniques in green national accounting.

Tables A6a and A6b present the summarized estimation of total income as illustrative aim. The rows show, for each of the private and public activities carried out in the columns, the total

[2] Clearly, the principle of the SNA which states that theoretically one should only include market goods and services is not met in practice. In the majority of countries a significant part of economic activity of the governmental is free to citizens, and certainly in this case there is not a market price, nor any measured supply of the offered goods and services provided for free. The government simply decides to "attribute" the free public supply of goods and services that are consumed by citizens in a specific period of time an imputed market value equal to the cost of its production.

output and total cost, by distinguishing between the commercial SNA and the non-SNA items. The columns represent the private and public predominantly activities that have complete production and capital accounts, and therefore their total income and capital can be estimated.

By definition an activity whose ordinary most important output is environmental is called an environmental activity. It should be noted that an environmental activity can supply own account commercial gross fixed capital formation and generate commercial costs. Thus, an environmental activity could generate a mixed environmental and commercial total income, and this mixed total income could be separated into environmental income and commercial income depending on the activity. Another distinct feature is that a commercial activity can generate a mixed joint private and public total income, which can be separated into private income and public income depending on the activity. In other words, the total income of the ecosystem can be classified, by the criterion of ownership, in public and private, and, by the criterion of the market, in commercial and environmental (Campos and Caparrós, 2006). When valuation is done at producer prices, the Hicks-Krutilla total income is also called total social income.

The *total output* of the ecosystem is classified, on the one hand, in total *commercial* output and total *environmental output*, and, on the other hand, in total *private* output and total *public* output. The total *commercial* output is estimated by the sum of total *private commercial* output and the total *public commercial* output. The later consists of the own account public commercial gross fixed capital formation generated by the government management spending associated with the total output of the ecosystem.

The *private environmental goods and services auto-consumption final output* generated in an ecosystem consists of all the flows of *scarce goods and services* for what a non-industrial private ecosystem owner is *willing* to pay a sum of money (numerarie) to guarantee its use by holding exclusive property of the ecosystem. The final private amenity consumption is not traded as a flow, but requires that its capital value is internalized by the potential market transaction of land (Campos et al., 2009).

The total *public environmental output* generated in an ecosystem consists of all the flows of non-commercial *scarce goods* and *services* not usually traded to which a consumer and/or institutional entity non-owner has free access, and for which the person and/or institutional entity is willing to pay a sum of money (numerarie) to guarantee their consumption and/or exclusive ownership.

The *private total output* results by adding the *private commercial total output* and the *private environmental total output*, and, equally, the *public total output* is estimated by the sum of the *commercial* and *environmental* public outputs.

Also the total cost, in the same way as the total output, can be disaggregated into commercial and environmental, and, also, into private and public. The private total cost coincides with the private commercial total cost, and the public total cost is the aggregation of public commercial total cost derived from governmental public spending in the ecosystem and the environmental total cost.

The disaggregated estimation of government spending on the public management of the ecosystem allows its full integration into the ecosystem accounts system in a way that is consistent with the concepts of commercial output and costs of the conventional SNA. The contribution of government spending in the ecosystems and the commercial output, as well as

the environmental output, and, also, to the private and public outputs, could be estimated by market values and the simulated exchange value approach. These measurement are achieved by building comprehensive private and public accounts, and, as the sum of both, we obtain the social accounts of the ecosystems (Campos and Caparrós, 2006; Campos and Caparrós, 2011).

4. Recommendation

The scientific communities, governmental specialized agencies and governments have stated concerns on building the gap to melt private and public incomes in an sole accounting tools, as recently stated the European Commission (2011), will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020. We need to follow the criterion of don`t let the best be enemy of the good. Nowadays scientific techniques to emerge partial equilibrium marginal environmental prices are enough robust tools as the conventional criteria that make possible more than six decades ago to worldwide governments agree in the first United Nations System of National Accounts.

The appendixes tables A6a and A6b illustrate that at any scale of vegetation, landscape, farm, region, nation and the world it is possible to extend de production and capital boundaries of conventional SNA to measure the well established definition of Hicks-Krutilla total income.

The current draft on SEEA Experimental Ecosystem Account could increase their "experimental" aim incorporating the public environmental goods public expenditures and capital gain into the measurement of ecosystem services, being this mythological note to serve this aim.

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Table A6a. Grassland ecosystem social total income

Class	Private	Public[3]	Social
1. Total output (TO)	290 + X	30 + X	320 + X
1.1 Intermediate output (non-SNA)	80[4]	X	80 + X
1.2 Final output	210+X	30 +X	240 + X
1.2.1 SNA	200[5]	X[6]	200 + X
1.2.2 Non-SNA	10[7]	30[8]	40 + X
2. Total cost (TC)	165+ X	20 + X	185 + X
2.1 Intermediate consumption	105	20+ X	125 + X
2.1.1 Own intermediate consumption (non-SNA)	*80*[9]		80 + X
2.1.2 Bought intermediate consumption (SNA)	*X*	*20*[10]	20X
2.1.3 Work in progress used (non-SNA)	25[11]	X[12]	25 +X
2.2 Labor cost	50 + X	X	50 + X
2.2.1 Employee labor cost (SNA)	50	X[13]	50 + X
2.2.2 Self-employed labor cost (non-SNA)	X[14]		X
2.3 Consumption of fixed capital (SNA)	10	X[15]	10 + X
3. Net operating margin (1 – 2)	125 + X	10 + X	135 + X
3.1 Natural net operating margin	90	30	120
3.2 Manufactured net operating margin	35	– 20	15
4. Net value added at producer prices	175 + X	10 + X	185 + X
5. Capital gain[16] (non-SNA)	X	– 15[17]	– 15 + X
5.1 Capital revaluation	5	– 15	

[3] It is assumed that public environmental gods and services are value by the simulate exchange value approach.
[4] Imputed market value of natural grass consumed by own livestock grazing.
[5] Total livestock products and hunting fess received by the landowner from sold the hunting positions.
[6] Example: government own account gross fixed capital formation on infrastructures employed to supply free access landscape recreation, landscape conservation and threatened biodiversity.
[7] Game gross work in progress formation (game animal yield both births and net natural growth).
[8] Whole society (consumers) marginal price willingness to pay for avoiding to increase the number of threatened biological species by continuing with the current government wilderness preservation program in the relevant area where the farm is included.
[9] Grazing forage units consumed by own livestock.
[10] Raw materials and services bought by the government and used in the accounting year to produce the species preservation public total output.
[11] Imputed market hunting resource rent.
[12] Example: Carbon dioxide withdrawals because timber cut in the accounting year.
[13] Example: government as employer of dependent workers to supply free services to the public and government own account durable goods used for public goods and services supply.
[14] Example: Family work could be objectively estimated as residual positive value under an assumed criterion for labor marginal productivity.
[15] Example: consumption of fixed capital on equipment and machinery used in the production of the public goods and services.
[16] Example: private fixed capital goods and work in progress revaluation net of destructions and adjusted by consumption of fixed capital to avoid double counting.
[17] Example: government fixed capital goods and work in progress revaluation net of destructions and adjusted by consumption of fixed capital to avoid double counting

5.1.1 Natural capital revaluation	15[18]	– 15[19]	0
5.1.2 Manufactured capital revaluation	– 10[20]		– 10
5.2 Capital destruction (less)			
5.2 Consumption of fixed capital	10		10
6. Total income (4 + 5)	190 + X	– 5 + X	185 + X
6.1 Labour income	50		50
6.2 Capital income	140	–5	135
6.2.1 Natural resource rent	105	15	120
6.2 .2 Manufactured capital income	35	–20	15

X: Attribute could be present.

[18] Increased value of the accounting year opening inventory game animals that the still continue in the closing inventory.

[19] Public economic environmental services revaluation (it includes degradation).

[20] Manufactured capital revaluation equals consumption of fixed capital on the basis of assuming constant prices.

Table A6b. Forest ecosystem total income at producer prices

Class	Private	Public[21]	Social
1. Total output (TO)	204 + X	30+ X	234 + X
1.1 Intermediate output (non-SNA)	X[22]	X[23]	X
1.2 Final output	204 +X	30 +X	234 + X
1.2.1 SNA	200[24] + X[25]	X[26]	200 + X
1.2.2 Non-SNA	4[27] + X[28]	30[29] + X[30]	34 + X
2. Total cost (TC)	205 + X	45	250 + X
2.1 Intermediate consumption	145 + X	45	190 + X
2.1.1 Own intermediate consumption (non-SNA)	*X*[31]	*45*[32]	45
2.1.2 Bought intermediate consumption (SNA)	*40*[33]	*X*[34]	40 + X
2.1.3 Work in progress used (non-SNA)	105[35]	X	105 + X
2.2 Labor cost	50 + X	X	50 + X
2.2.1 Employee labor cost (SNA)	50	X[36]	50 + X
2.2.2 Self-employed labor cost (non-SNA)	X[37]		X
2.3 Consumption of fixed capital (SNA)	10	X[38]	10 + X
3. Net operating margin[39] (1 – 2)	– 1 + X	– 15 + X	– 16+ X
3.1 Natural net operating margin	4[40]	– 15	– 11
3.2 Manufactured net operating margin	– 5		– 5

[21] It is assumed that public environmental gods and services are value by the simulate exchange value approach.
[22] Example: forage units supply consumed by livestock grazing.
[23] Example: regulated natural water yield consumption by forest vegetation in excess over grassland in a context of natural water scarcity.
[24] Wood cut.
[25] Example: livestock products.
[26] Example: government own account gross fixed capital formation on infrastructures employed to supply free access landscape recreation, landscape conservation and threatened biodiversity.
[27] Timber net natural growth (NNG) in the accounting year. NNG is from gross natural growth (GNG): NNG = r*GNG = 0.05*80 = 4. GNG exclude pure discounting effect revaluation of standing timber originated by having shorter the discounting period.
[28] Example: private amenity.
[29] Gross carbon captured in the accounting year.
[30] Example: partial equilibrium marginal price times quantity for `public recreation, landscape conservation, threatened biodiversity and regulated natural water yield final output.
[31] Example: forage units consumed by livestock grazing.
[32] Joint timber harvest carbon withdrawals as atmospheric heat filter input consumption.
[33] Fuel bought by the landowner and used in the accounting year to cut the wood.
[34] Raw materials and services bought by the government and used in the accounting year to produce the public total output.
[35] Timber cut in the accounting year at its resource rent price (standing price less accounting year silvicultural manufactured total cost).
[36] Example: government as employer of dependent workers to supply free services to the public and government own account durable goods used for public goods and services supply.
[37] Example: Family work could be objectively estimated as residual positive value under an assumed criterion for labor marginal productivity.
[38] Example: consumption of fixed capital on equipment and machinery used in the production of the public goods and services.
[39] Net operating margin is the operating benefit at producer prices.
[40] Wood natural net operating margin is estimated from wood net natural growth.

4. Net value added at producer prices	49	– 15	34
5. Capital gain[41] (non-SNA)	33 + X	– 15	18 + X
5.1 Capital revaluation	23	– 15	8
5.1.1 Natural capital revaluation	33[42]	– 15[43]	18
5.1.2 Manufactured capital revaluation	– 10[44]		– 10
5.2 Capital destruction (less)			
5.3 Consumption of fixed capital [45]	10	X[46]	10
6. Total income (4 + 5)	82 + X	– 30 + X	52 + X
6.1 Labour income	50		50
6.2 Capital income	32	– 30	2
6.2.1 Natural resource rent	37	– 30	5
6.2 .2 Manufactured capital income	– 5		– 5

[41] Capital gain is measured from capital revaluation less capital destructions and adjusted by consumption of fixed capital in the accounting year for avoiding double counting.

[42] Wood natural capital revaluation is measured from opening standing wood revaluation because discounting is a period sorter at the end of the accounting year (Wr) less net natural growth (NNG) value of the accounting year for avoiding double counting.

[43] Public economic environmental services revaluation (it includes degradation).

[44] Manufactured capital revaluation equals consumption of fixed capital on the basis of assuming constant prices.

[45] It is considered to avoid double counting.

[46] Example: government manufactured fixed capital consumption on supply public goods and services.