Session IPS195

"Broadening the scope of GDP – a stocktaking on including ecological developments"

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Draft as of 15/04/2019

Abstract:

Gross Domestic Product (GDP) is the most prominent indicator of the System of National Accounts (SNA), which is widely used for policy and administrative purposes. GDP in real terms (i.e. price adjusted) has been accepted since some decades as a measure for economic growth. At the same time GDP often is considered as an indicator for societal progress and well-being. However, as highlighted by the famous Stiglitz-Sen-Fitoussi-report of 2009, such an interpretation of GDP is biased and can be misleading, given that most social and environmental cost are not covered, or even worse, their repair adds to GDP. In the case of environment the key words in this context are ecosystem services, depletion and degradation and as a practical example the repercussions of the global climate change could be mentioned. This paper therefore looks at the conceptual as well as empirical pros and cons of broadening the concept of GDP by including ecological developments.

Keywords: National accounts, Environment, Ecosystems, Well-Being.

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[1] The views expressed in this paper are those of the author. They do not necessarily reflect the views of the German Federal Statistical Office.

0. Introduction

Nature is the foundation of human life. Air and water are indispensable requirements to survive, as well as food. But natural resources are also important for our economies. The production and consumption of goods and services depends on one hand on extracting minerals and other resources from nature and on the other hand on returns of waste to nature.

For many economic decisions the yardstick mostly used is economic growth measured by gross domestic product, i.e. goods and services available to human societies. Looking at the GDP growth rates seems to suggest that unlimited economic progress is possible. Opposed to this it has been realized since some time, that the world and its resources are limited. At the same time the idea of inexhaustible resources and free goods is questioned as well as an unlimited growth of GDP.

This leads to the question, whether we can continue like today or whether there is aneed to consider a more sustainable development. Sustainability looks at both, the present as well as at the future. Sustainability means a good life for the present generation without destroying the resources for future generations. The issue of sustainability is further increasing by the worldwide population growth. According to United Nations forecast there will be over 10 billion people living on earth in 2055, which is around 2,3 billion more than today, representing a population increase of more than 30 % in just 25 years. Particularly affected by this population growth is Africa with + 2,3 bn and Asia with + 0,6 bn people. Sustainability is the core element in the resolution “Transforming our world: the 2030 Agenda for sustainable development” adopted by the General Assembly of the United Nations (UN, 2016).

This paper briefly presents the economic and environmental accounting as well as the ecosystem approach and selected measurement issues. In addition, proposals on how to disseminate and combine data on ecosystems are discussed, with the aim to attract more attention to the important functions of the environmental assets. Furthermore the question is addressed whether official statistics should embark on producing and publishing data on ecosystems.

1. Economic and environmental accounts

Economic well-being and development is focused by national accounts, for which the worldwide System of National Accounts (SNA) provides the conceptual basis since 1953, following a macro-economic logic. To be able to portray the whole economy in a systematic and comprehensive way, a distinction is made between type of institutional unit and type of economic occurrence. For the latter a distinction is made between flows (e.g. cheese produced during a month) and stocks (e.g. bread available at the end of a month). The starting point of the flow accounts is to look at the generation of income and to compile gross domestic product (GDP) by adding the value added created through production of goods and services by resident units during a certain period. This is followed by the distribution of income to the factors of production, i.e. labor and capital, and subsequently the redistribution between different household groups, mainly through taxes and social contribution on one hand and transfers as well as social benefits on the other. The resulting disposable income is either used for consumption or saving, which in turn may be used for investment purposes, either directly or via loans and other financial instruments. In this context the production boundary needs to be mentioned, since it defines the scope of production activities to be included and hence what is covered by GDP. Excluded for instance is housework for the own household, although in most cases these activities add substantially to well-being. Excluded furthermore are natural processes not under the control of resident economic units. Most social and environmental costs coming along with economic growth are not deducted, or even worse, the repair activities increase GDP.

For many years a purely economic viewpoint has been criticized repeatedly as being too narrow. Particularly the publication of the report of the Club of Rome on the limits to growth (Meadows, D., 1972) initiated discussions at various levels of societies all over the world. From these discussions the idea of a more comprehensive approach emerged. Different strands and indicators were proposed. Developing a so-called green GDP, i.e. an environmentally adjusted GDP, was an immediate approach. The 1987 report of the Brundtland Commission "Our Common Future" (World Commission on Environment and Development, 1987) focused on the links between economic, societal and environmental development.

These and other discussions led to a revision of the SNA-1968 and the inclusion of stock or asset accounts. Both, the former SNA-1993 as well as the present SNA-2008 provide that land, mineral and energy resources (if economically exploitable), non-cultivated biological resources and water resources as well as other natural resources (like radio spectra) are conceptually to be shown in the asset accounts and national balance sheet. Depletion of subsoil assets (due to physical extraction) as well as of other natural resource (forests, fish stocks in open seas) beyond sustainable levels of extraction are addressed by the other-changes-in asset-accounts (SNA- 2008, chapter 12). This important step forward implies that GDP, the most-quoted income measure, is not affected by this treatment. In addition, it has to be kept in mind that the SNA represents a worldwide recommended conceptual frame, which at the national level needs data sources and resources to implement. Such inputs will best be made available if the data can be used to address issues, which are high on the political agenda.

At the same time, research activities increased fostering integrated environmental and economic accounts. Briefly, this led to the publication of a corresponding handbook in 1993. This handbook was updated in 2003 and ultimately revised and published as System of Environmental-Economic Accounting 2012 - Central framework, which in March 2012 was adopted as an international statistical standard (SEEA-CF, 2012).

In general terms, the SEEA-2012-CF highlights the relationship between economy and environment by looking at “natural inputs” from the environment to the economy, e.g. mineral resources, timber, water or energy. On the other hand “residuals” flowing from the economy to the environment, e.g. solid waste, air emissions, return flows of water are considered as well (SEEA-CF, 2012, p. 13). These flows usually are compiled in physical terms using a supply-use framework known from national accounts. In addition to such flows, the methodology for compiling environmental assets are covered, where the focus is on individual components like mineral and energy resources, timber, water resources and land, both, in physical and value terms. As a third item, certain environmental activities, like protection expenditures, are included in the SEEA-2012-CF.

However, accounting for degradation and other measurement topics associated with ecosystems are not covered in the SEEA-central framework (SEEA-CF, 2012, p. ix). Excluded as well are oceans and the atmosphere, due to their magnitude. Full valuation of assets and flows related to natural resources and land beyond the valuation included in the SNA remains an outstanding issue (SEEA-CF, 2012, p. viii). Basically the SEEA-2012-CF focusses on the material benefits from the direct use of environmental assets or natural inputs for the economy by enterprises and households. By contrast, this does not cover the non-material benefits from the indirect use of environmental assets, like benefits from ecosystems services (SEEA-CF, 2012, p.13).

2. Ecosystem services and assets

2.1 Conceptual approach

A more comprehensive and growing approach to look at the role of nature for sustainable economic growth and human well-being is based on the concept of ecosystem services and assets[2]. In general terms the idea is that ecosystems (ES) provide benefits to humanity free of charge, which have a fundamental importance for human well-being, health, livelihood and survival. (MA, 2005; TEEB, 2010). Often-quoted ES-examples are cleaning of air and water, wild food and crops, natural medicines, but also pollination, climate regulation, filtration of pollutants by wetlands, recreation facilities, soil formation and photosynthesis or biodiversity (MA 2005, TEEB 2010, p. 7). The amount of benefits provided to human societies usually depends on the type and quality of the ecosystem considered and hence may vary from one region to another. The spatial perspective therefore is a fundamental element of the ES-concept.

The ES-approach goes a step further and looks at the natural processes from an economic viewpoint. Like in the SNA, a distinction is made between flows, which are measured over a period of time and stocks, which are captured at a certain point in time:

- The benefits provided by ecosystems to human societies are interpreted as services, in this case ecosystem services. The natural processes from which the ES services are resulting are looked at as a kind of production activity.[3]
- On the other hand, the ecosystem capacity is considered as an asset, sometimes called natural capital. The ES capacity may be negatively or positively affected by human activities (in addition to natural incidents)[4].

In this sense ES can be considered flows of value to human societies as a result of the state and quantity of natural capital (TEEB, 2010, p. 7).

The degradation of ecosystems (by human activity) undermine ecosystem functioning and resilience and thus threaten the ability of ecosystems to continuously supply the flow of ecosystem services (de Groot, R., 2012 p.50). Those threats become evident when looking at pollution of air, water or soil, deforestation, climate change and global warming. In this context the question is how to portray degradation of ecosystems. Conceptually ES-

[2] The experimental methodology for ecosystem accounting has been published separately (SEEA-CF, 2012).
[3] However in the case of economic services their production is adjusted to demand, which seems different for ES-services.
[4] A difference to economic capital, like machinery, seems to be that the latter has a certain limited service life after which it is useless.

degradation is defined as the decline in an ecosystem asset over an accounting period, which is due to economic and other human activities (SEEA-CF, 2012). A question could be raised with regard to how such a change in the ES-asset impacts on the provision of ES-services.

2.2 Scope of ES-services

Regarding the distinction of ecosystems services a categorization into various broad types usually is applied:

- provisioning services, i.e. ES providing air, water, food or timber
- regulating services, i.e. ES providing flood control, pollination or water regulation
- cultural services, i.e. ES offering recreational or cultural benefits

A more detailed overview of what is covered in these categories of ES is provided by the table 2 in Costanza et al., 2017, p. 7). A revised version V5.1 of the classification of ecosystem services has been adopted recently (Haines-Young, R., et al. 2017), but the above mentioned three major sections are kept. It has to be mentioned in this context, that there is not a one-to-one relation, but that an ecosystem can provide different services at the same time, a service bundle or basket. As an example, a forest can provide timber (provisioning service), clean the air from carbon (regulating service) and provide the landscape for hiking (cultural service).

An interesting question in this regard is whether abiotic natural processes are included as well, or whether there is a limitation to biotic resources. From a holistic viewpoint it seems not advisable to omit resources like water or wind. On the other hand excluding abiotic resources from ES may give a more focused picture, although it lacks a comprehensive assessment (Brouwer, R., et al, 2013, p. 52).

A further issue concerns the question whether ES services can be negative, i.e. produce so-called dis-services. Looking at nature as a self-regulating and self-balancing system, it seems obvious, that natural processes exist, which result in damages for the welfare of human societies. Practical examples are hurricanes/tycoons, earthquakes, pests etc. Some compare them to negative externalities, which in economic accounts are not covered and hence could be neglected as well (Obst et al., 2016). But the point could be made that ignoring ES disservices "would limit our understanding of the relationship between changes in ecosystem assets and production ...". By referring to Sumarga and Hein (2014) the conclusion is that accounting for only the flows of positive services would imply quite a different interpretation compared to the net effect within the ecosystem asset (particularly if one part of the ES asset generates disservices and another part services). On the other hand, the question could be raised, whether ES-disservices are reflected by certain economic activities already, possibly leading to double counting. From a pragmatic point of view it would seem useful to focus on the most important aspects of ES.

2.3 Separate or Holistic Environmental Methodology?

At first glance an astonishing point seems that environmental accounting is split in two separate parts, including separate methodologies, classifications and indicators. On one hand the SEEA-2012-CF mainly covers energy, water and material benefits supplied by nature entering the economy as well as certain residuals returned to nature from production and consumption. On the other hand, the SEEA-2012-EEA focuses on the non-material benefits of nature. Such a division of methodology is completely acceptable when developing methods and sources as well as testing is the primary goal. Differing priorities at local, regional and national level may be a further reason. But taking into account the decades spent by researchers to work on the different environmental topics, the question could be raised, why not have a single conceptual basis for environmental accounting. The idea is to draft a common, more generic methodology, possibly supplemented by technical handbooks looking at the different ecological areas. As a primary goal such a unified single methodology could strive for elaborating a holistic indicator reflecting the ecological situation in one headline figure. Similar to GDP as a holistic indicator for the economic situation, such a single key indicator would make environmental issues much more visible. This in turn should attract the attention of people and broaden the perspective of progress. In addition, more detailed data could be provided for research and for evidence-based decision making.

Obviously the development of a comprehensive indicator portraying the ecological situation (in a certain region) cannot be considered an easy task. A big obstacle is that the physical measurement units for the different environmental items vary a lot: Land usually is measured in square-km, timber in cubic meters or minerals in tons. To overcome this obstacle, one solution could be to put the focus on the development over time, and to combine the growth rates by type of natural resource with weights to derive a single measure. Another theoretical solution, putting the focus on the level, seems to elaborate a single metric so that the specific resource-related measures can be added. Is it completely impossible to develop such a single metric at the physical level or is valuation the only option?

3. Measurement issues of ES

3.1 Physical Data

To be able to implement the concept of ES-services and ES-assets source data are needed, possibly supplemented by estimations. Such data may for instance be provided by so-called land cover surveys, showing the spatial area by type in square-km. A usual classification is to distinguish between sea, coastal areas, land etc. A more refined classification of land coverage types is given by the Land Cover Classification System of the FAO (in SEEA-EEA, 2012, table 2.1):

- Urban and associated developed areas
- Medium to large fields of rain-fed herbaceous cropland
- Medium to large fields of irrigated herbaceous cropland
- Permanent crops, agriculture plantations
- Agriculture associations and mosaics
- Pasture and natural grassland
- Forest tree cover
- Shrupland, bushland, heathland
- Sparsely vegetated areas
- Natural vegetation associations and mosaics
- Barren land
- Permanent snow and glaciers
- Open wetlands
- Inland water bodies
- Coastal water bodies
- Sea

As a result of such a land cover survey data may be derived showing the land by type of coverage in physical terms (square-km)[5]. This table could be combined with the condition of each land type to be able to determine the impact of human activities on ES-assets between two reporting dates. Furthermore, measures may be developed showing by each area the distance to crucial tipping points as well as whether this is narrowing or widening (in physical terms); including an aggregation to the national level.

To estimate ES-services by land coverage type a further step is required, since each land cover type may provide different ES-services at the same time. For instance a forest may provide timber and wild fruits (provisioning-services) and at the same time hiking opportunities (cultural service). If this is systematically estimated by type of land cover and type of service, the physical flows of ES can be assessed and presented in the following cross-table / matrix (SEEA- EEA, 2012, table 2.2), :

[5] Since in national statistical systems this will be limited to the territory of each country, a solution is needed with regard to open seas.

Type of ecosystem services (by CICES)	Type of LCEU Forest tree cover	Agricultural land[a]	Urban and associated developed areas	Open wetlands	...
Provisioning services	For example, tonnes of timber	For example, tonnes of wheat			
Regulating services	For example, tonnes of CO_2 stored/ released	For example, tonnes of CO_2 stored/ released	For example, tonnes of CO_2 stored/ released	For example, tonnes of phosphorus absorbed	
Cultural services	For example, number of visitors and hikers		For example, hectares of parkland	For example, hectares of habitat for ducks	

a Medium to large fields of rain-fed herbaceous cropland.

However, an aggregation of the different ES-services in physical terms is complicated due to the different physical measures used. A proposal mentioned to overcome this difficulty is to use weights for the different ES-services (like in price statistics) and combine them with the physical measures transformed to index numbers. This allows compiling growth rates for total ES-services provided as well as for the basket of ES-services provided by each land cover type.

3.2 Monetary Data

The advantage of compiling data in monetary unit is that a comparison with other monetary data is enabled, which may be useful for analytical purposes as well as political discussion. Unfortunately in practice monetary values for ES-assets and ES-services are missing in most cases. This requires looking for substitutes, i.e. imputed or hypothetical prices. To be as near as possible to economic accounting standards, such prices are compiled in line national accounts valuation principles.

In economics a value usually consists of two elements, a quantity of a product and the respective market price, i.e. when buyers and sellers are willing to exchange the product. This exchange value guarantees consistency between the records of both parties and therefore is a cornerstone of national accounts. But market prices are not always available, so that in certain cases alternative valuation methods are accepted as proxy. But there are only few exceptions to using market prices as valuation basis for products in national accounts:

- the market prices of similar items is applied for instance in the case of dwellings used by their owners (based on market rents for comparable rented dwellings)
- the costs of production are used for government services, which reflect the market prices for the inputs used, i.e. labor and capital.

Market prices for environmental products can be available, particularly when these are used as inputs for production, e.g. mineral resources. But also for certain ES-services market prices do exist, for instance in the case of provisioning services such as crops, fish or water, i.e. products which are consumed by people. Non-consumptive ES-services, like the spiritual or cultural importance of a landscape, are rarely valued in monetary terms (TEEB, 2010, p.7). An exception to this is a recent study to estimate the value of nature-based (short-distance) recreation in Europe for 2012, based on the potential visits of the population for recreational purposes by type and in a regional breakdown. Monetary values are obtained by applying the so-called zonal travel cost method (TCM), based on travel expenses by car (Vallecillo, S. et al., 2019).

In the case of ecosystem services researchers need to be innovative to develop a satisfactory valuation. As can be seen from annex 1, which is a copy from recent conference paper, 11 different valuation methods are presented including an assessment on their suitability (Obst, C., 2018). In addition, researchers still have different opinions concerning the fitness of certain ecosystem services valuation methods. This concerns for instance the use of shadow pricing methods, of preference-based methods and of restoration costs (Droste, N. et al 2017). This does not imply that these methods do not provide useful information in certain (regional) circumstances, but it raises questions with regard to the comparability of such valuations over space, nations and time. Therefore it has been proposed to consider monetary valuation of ecosystem services as a communication tool particularly for decision making. “Values in monetary units will never in themselves provide easy answers to difficult decisions, and should always be seen as additional information, complementing quantitative and qualitative assessments, to help decision makers by giving approximations of the value of ecosystem services involved in the trade-off analysis. (De Groot, R., et al., 2012).

For ecosystem assets one could argue that their value ought to be included in the national balance sheet, by extending the present asset category "natural resources" already included in the national accounts methodology (SNA-2008, table 13.2), which covers:

- land (without buildings and improvements; valued at current market price)
- mineral and energy reserves (at net present value of expected future returns, NPV)
- non-cultivated biological resources (valued at NPV).
- water resources (valued at NPV)
- other natural resources (like radio spectra).

However in practice it is often observed that the implementation is difficult and therefore such data on assets of natural resources are often missing. This leads to the question whether an extension of natural resources assets to cover ecosystem assets is realistic. The main issue is that most economic assets are not actively traded during an accounting period, like dwellings, factories or large customer-tailored software. This holds also in the case of ES-assets, so that alternative valuation approaches are needed. One possibility is to compile the net present value (NPV) of future flows of income for each type of ES-asset, a valuation method considered fully in line with national accounts principles for asset valuation (Obst, C., 2018). This method in practice often represents a big challenge due to limitations and uncertainties of the NPV-ingredients, like particularly

- the choice of discount rate
- the expected asset life.

If it can be assumed that ecosystem assets tend to exist almost eternally, a realistic estimation of the expected asset life is extremely difficult. In addition, the application of any discount rate for such a long period will heavily influence and probably even dominate the results.

Insofar the conclusion drawn in a paper would seem understandable: “Note that expressing values in monetary units can be a time and resource intensive exercise and often quantitative insights expressed in bio-physical units are sufficient to communicate benefits (e.g. number of people benefitting from clean water provision). Valuation should therefore only be done where it is needed.” (De Groote et al. 2012, last page).

4. Disseminating and combining ecosystem data

4.1 Separate ES-figures

As soon as reliable data on ecosystem services (and assets as well) become available, either in quantity or in value terms, the question of how to publish them has to be addressed. The immediate proposal possibly is to disseminate them as stand-alone data and showing their development over time and space. More precisely two different data sets could be available for publication:

- the current amount of ES services provided to human societies,
- the available stock (and state) of ES-assets.

In the first case, the importance of ES-services for human well-being is stressed, whereas the second case highlights the potential available for present and future generations. at human activities have an influence on environment.

Such a dissemination strategy could be extended by combining ES-figures with other data and thereby presenting them in a context. An example is to publish data on ES-services alongside with GDP development. In this case the focus is on the relative importance of both economy and ecology for human well-being. In addition, if data on ES-assets could include the negative impact of human activities and are provided alongside with GDP, the message tends to be that economic progress has been achieved on the account of the environment.

4.2 Integration of ES-data and well-being indicators

Various indicators and indicator sets have been developed during the last decades, which differ in certain respects. The following parts look at some of them to find out whether data on ES could be included. The indicators and data sets have been chosen deliberately to show the range, but are far from being exhaustive. Several other indicators are available at international level, like Genuine Saving Index, Ecological Footprint or World Happiness Index. But also at national level numerous activities to foster the idea of measuring social progress in a broader sense were and are carried out, both by statistical offices and by academic researchers and research institutes (cf. Durand, M., 2015, annex 1)[6].

4.2.1 Human Development Index

A well-known metrics at world level is the human development index (HDI) published annually by the United Nations Development Program (UNDP). The HDI is a composite indicator combining three pieces of information to grasp societal progress. Since the revision in 2009 these are (UNDP, 2018):

- health, measured by life expectancy at birth,
- knowledge, measured by mean years and expected years of schooling and
- living standard, measured by GNI per capita (at purchasing power parities, PPP).

To aggregate them each of three indicators is assigned the same weight and a geometric mean is compiled. In addition, an inequality-adjusted HDI is presented as well, comprising data on inequality in different domains. Therefore the question could be raised, whether it is not possible to compile and publish an environmentally-adjusted HDI as well?

4.2.2 How's life Indicators

On the occasion of its 50th anniversary the Organisation for Economic Cooperation and Development (OECD) in 2011 published the How's Life data set, a dashboard of wellbeing indicators. The most recent report "How's life 2017" covers 25 indicators, highlighting 11 dimensions of current and future well-being (OECD, 2018). "It includes dimensions that have a claim to be considered as universal – that is, relevant to people living in all societies

[6] For Germany for instance: W³-Indicators of the German Federal Parliament (Deutscher Bundestag, 2013), Prosperity Quintet (Denkwerkzukunft, 2014) or KfW-Sustainability Indicator (KfW, 2014) .

(Durand, M., 2015,p.8)”. For the indicators used to measure how is life this implies flexibility to reflect specific country conditions. The selection of the concrete OECD-indicators has been driven by a number of crucial criteria, e.g. capture well-being achievements at the individual or household level, measure well-being outcomes rather than inputs, enable disaggregation by different household groups. The How’s Life data, in addition to figures and tables, are presented in a summary form using a kind of traffic light icons. Furthermore, the Better-Life-Index is an interactive web-tool so that users can set their own weights on the 11 dimensions and hence compare the well-being results using different weights. Environmental quality is reflected by two indicators, which are water quality and air quality. The question could be raised whether there is an obstacle to include ES-data in this dashboard.

4.2.3 National Welfare Index / Index of Sustainable Economic Welfare

The conceptual basis of the German National Welfare Index (NWI) is the Index of Sustainable Economic Welfare (ISEW) developed by Nordhaus and Tobin and the defensive cost approach (Nordhaus, W.D., Tobin, J., 1972). The German National Welfare Index (NWI) has been elaborated by two academic research institutes on behalf of the Federal Environment Agency in 2009 (Diefenbacher, H., Zieschank, R., et al. 2009) and updated later-on. The NWI is a single monetary indicator, which starts from inequality adjusted private consumption expenditure to which certain beneficial items are added and from which a couple of detrimental items are deducted.[7] In the present version the following items enter (Diefenbacher, H., et al., 2016):

Inequality adjusted private consumption expenditure
+ Value of housework
+ Value of voluntary work
+ Public expenditure on health care and education
+/- Costs and benefits of durable consumer goods
- Costs of travel between home and workplace
- Costs of traffic accidents
- Costs of crime
- Costs of alcohol, tobacco and drug abuse
- Compensatory social expenditures due to environmental impact
- Damage costs of water pollution ("reminder value")
- Damage costs of soil degradation ("reminder value")
- Damage costs of air pollution
- Damage costs of noise
+/- Net value of loss/increase of ecosystem (biotope area) ("reminder value")
+/- Net value of loss/increase of agricultural areas
- Replacement costs due to the consumption of non-renewable energy resources
- Damage costs of GHG emissions

[7] A similar approach is followed by the "Genuine Saving Indicator” published by the Worldbank: Starting from net saving, education expenditure is added and deducted are depletion of energy resources, minerals and forests as well as CO_2damages and particulate pollution damages (Hamilton, K. et al. 2014)

- Costs of the use of nuclear energy

= National Welfare Index

Conceptually as well as politically an interesting feature is that national welfare can be increased by less inequality, by more private consumption, by more beneficial items, but also by a reduction of the detrimental/defensive costs. Given that the majority of indicators are environmental ones, it would seem difficult to argue that ES-data cannot be included.

5. Official Statistics on Ecosystems ?

The fundamental principles of official statistics, endorsed by the General Assembly of the United Nations in March 2014, acknowledge the importance of nature for societies by asking for data on the environmental situation, alongside with figures on the economic, demographic and social situation. "To this end, official statistics that meet the test of practical utility are to be compiled and made available on an impartial basis by official statistical agencies to honour citizens' entitlement to public information." (UN, 2014, principle 1)

The challenging point for official statistics is to meet the test of practical utility mentioned in principle one. Obviously such a test may be based on different criteria. To assess the practical utility in this paper the five criteria developed for statistical products in the European Statistics Code of Practice are used deliberately (Eurostat et al, 2017). These are relevance, accuracy and reliability, timelines and punctuality, coherence and comparability as well as accessibility and clarity.

- Relevance:

  Relevance means to meet the needs of users. The main reason for this seems that resources are needed for producing official statistics with high quality. But since the users differ, possibly their needs do as well. In the case of ecological data the general public may be interested in obtaining one or few key-figures on the environmental situation, whereas researchers maybe more interested in detailed data and time series. Furthermore the needs of stakeholders at the political and government levels are important, so that official statistics should offer inputs to address political agendas both, at the national and international level. At the international level this concerns for instance the UN-Agenda 2030 or the Paris Climate Agreement. Against the background of the growing world population, information on the environment with regard to tipping-points would seem particularly useful as well.

- Accuracy and Reliability

Accuracy may be translated as a good portray of the reality and reliability as giving very similar results when repeatedly compiled. If comprehensive data sources are available for compiling physical data on natural resources and returns to nature there seems no major obstacle that these are produced and disseminated by statistical offices. The situation for value data seems a bit different. On one hand different valuation methods are proposed, for which it is unclear if they produce reliable results. On the other hand in case of some methods their suitability assessments diverge. Insofar it seems that further research is needed. And for statistical offices the advice could be to follow a more cautious approach concerning value data. Possibly they could be published not as official statistics but as so-called experimental data, compiled in close connection and with the support of specialized researchers.

- Timeliness and Punctuality

Timeliness concerns the interval between the end of a reporting period and the publication date, which should be as short as possible; punctuality concerns the respect of pre-announced publication dates. In digital societies timeliness is very important, because news need to be as topical as possible to attract attention and to serve as a basis for political debates and measures. A much appreciated but challenging timeliness goal consists in publishing environmental data one year after the end of reporting period. This implies to look at the statistical production processes and possibly streamline them for instance by employing satellite images instead of surveys or using company information on non-financial reporting like the standards on sustainability accounting (SASB-standards, 2018).

- Coherence and Comparability

Comparability of the data refers to the common methodological standards used over a reasonable period of time and across countries; coherence means that arithmetic and accounting identities are respected. Due to the fact that at the moment two separate international methodologies, namely the SEEA-2012-CF and the SEEA-2012-EEA, are used to produce environmental accounts, there is a risk of both double-counting and undercoverage. Therefore it would seem a useful idea to develop one (integrated) methodology for environmental accounting. From a dissemination point of view it would seem advantageous to have one single key-indicator being able to portray the ecological situation in one figure.

- Accessibility and clarity

Clarity refers mainly to the availability of metadata, whereas accessibility concerns the easiness of obtaining data and support. As in other statistical areas, environmental data produced by statistical offices should be published by them via a prss release, including a comment (link), so that further information can be obtained. Just disseminating the environmental data is an important first step. In addition, there is a need to produce and publish metadata in order to inform users about methods used including assumptions made and comments on limitations.

For the time being several countries, like the member-states of the European Union or Australia and Canada, regularly produce ecological data, mainly based on the SEEA-2012-CF. For the future relevance of official statistics it would seem useful to work on ecosystem data as well, at least in physical terms. This could be done in a stepwise parallel approach, i.e. working on national priorities and at the same time joining international efforts to make progress in the case of stated international priorities, like the Agenda 2030 or the Paris climate agreement.

6. Conclusion

The focus of this paper is on environmental accounting as well as the ecosystem approach, which are briefly presented on a conceptual basis. A question raised in this respect is, why not have one integrated methodology for environmental accounting instead of two separate ones. A couple of selected measurement issues are addressed as well, including the issue of compiling ecosystem data in physical and/or in value terms. In addition, different possibilities how to disseminate and combine data on ecosystems are presented, having the aim to attract more attention and broaden the perspective of progress. Finally an assessment on the basis of certain criteria is provided, regarding the question whether official statistics should embark on producing and publishing data on the environment including ecosystems. The recommendation is that by working on ecosystem data statistical offices their relevance is enhancing.

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Annex 1

SEEA EEA Technical Recommendations: Table 6.1: Summary of valuation techniques and their use in ecosystem accounting

Valuation technique	Description	Comments	Suitability for valuation of individual ecosystem services	Applicable for the following ecosystem services
Unit resource rent / Net factors of production	Prices determined by deducting costs of labour, produced assets and intermediate inputs from market price of outputs (benefits).	Estimates the average value of ecosystem service, not marginal. Estimates will be affected by the property rights and market structures surrounding production. For example, open access fisheries and markets for water supply often generate low or zero rents.	In principle, this method is **appropriate** but care is needed to ensure that the residual estimated through this approach is limited to the target ecosystem service.	Provisioning services involving harvest or abstraction (e.g. concerning timber, fish, crops, livestock, etc.) Potentially, also applicable to cultural services such as recreation provided by established businesses.
Production function, cost function and profit function methods	Prices obtained by determining the contribution of the ecosystem to a market based price using an assumed or estimated production, cost or profit function.	In principle, analogous to resource rent but generally can be better targeted to focus only on specific ecosystem services and models more able to take into account ecological connections. Can reveal marginal value of ecosystem service. However, more data intensive and require benefit transfers methods for higher level aggregates.	**Appropriate** provided the market based price being decomposed refers to a product rather than an asset – e.g. value of housing services rather than the value of a house.	Prices for all type of ecosystem services may be estimated using this technique provided an appropriate production or similar function can be defined. This will require that the ecosystem services are direct inputs to the production of existing marketed goods and services. It is likely to be of most relevance in the estimation of prices for provisioning services and for certain regulating services that are inputs to primary production, e.g. water regulation.
Payment for Ecosystem Services (PES) schemes	Prices are obtained from markets paying for specific regulating services (e.g. in relation to carbon sequestration)	Estimates will be affected by the type of market structures put in place for each PES (see SEEA EEA 5.88-94). Because payments are not typically conditional upon ecosystem service delivery, prices do not represent true consumer or producer surplus.	**Possibly appropriate** depending on the nature of the underlying institutional arrangements.	Given the most common focus of PES schemes, the price information will be most applicable to the valuation of regulating services, e.g. carbon sequestration.
Hedonic pricing	Prices are estimated by	Very data intensive approach and separating	**Appropriate in principle**, if an	Most commonly applied in the context

	decomposing the value of an asset (e.g. a house block including the dwelling and the land) into its characteristics and pricing each characteristic through regression analysis	out the effects of different characteristics may be difficult, unless there are large sample sizes.	individual service can be identified. Heavily used in the pricing of computers in the national accounts.	of decomposing house and land price information and hence will be relevant for those ecosystem services that impact on those prices. Examples include access to green space, amenity values and air filtration. A challenge is attributing the estimated prices to the location of supply.
Replacement cost	Prices reflect the estimated cost of replacing a specific ecosystem service using produced assets and associated inputs.	This method requires an understanding of the ecosystem function underpinning the supply of the service and an ability to find a comparable “produced” method of supplying the same service. Over-estimates value when no reasonable replacement is available.	**Appropriate** under the assumptions (i) that the estimation of the costs reflects the qualities of the ecosystem services being lost; (ii) that it is a least-cost treatment; and (iii) that it would be expected that society would replace the service if it was removed. (Assumption (iii) may be tested using stated preference methods and should take into account the potential scale issues in replacing the service.)	The idea of replacement cost assumes that a service can be replaced, i.e. that a man-made alternative can be developed. In general, this engineering type focus will mean that the method would be applied for various regulating services such as water regulation, water purification and air filtration.
Damage costs avoided	Prices are estimated in terms of the value of production losses or damages that would occur if the ecosystem services were reduced or lost due to ecosystem changes (e.g. as a result of pollution of waterways).	May be challenging to determine the value of the contribution/impact of an individual ecosystem service.	**Appropriate** under the assumptions (i) that the estimation of the damage costs reflects the specific ecosystem services being lost; (ii) that the services continued to be demanded; and (iii) that the estimated damage costs are lower than potential costs of abatement or replacement.	Similar to replacement costs, the focus will generally be on services provided by ecosystems that are lost due to human activity impacting on environmental condition, particularly through pollution. Regulating services are likely to be the most commonly estimated using this method.
Averting behaviour	Prices are estimated based on individual’s willingness to pay for improved or avoided health	Requires an understanding of individual preferences and may be difficult to link the activity of the individual to a specific	**Possibly appropriate** depending on the actual estimation techniques and also noting the method	

	outcomes.	ecosystem service.	relies on individuals being aware of the impacts arising from environmental changes.	
Restoration cost	Refers to the estimated cost to restore an ecosystem asset to an earlier, benchmark condition. Should be clearly distinguished from the replacement cost method.	The main issue here is that the costs relate to a basket of ecosystem services rather than a specific one. More often used as a means to estimate ecosystem degradation but there are issues in its application in this context also.	**Likely inappropriate** since it does not determine a price for an individual ecosystem service but may serve to inform valuation of a basket of services.	
Travel cost	Estimates reflect the price that consumers are willing to pay in relation to visits to recreational sites.	Key challenge here is determining the actual contribution of the ecosystem to the total estimated willingness to pay. There are also many applications of this method with varying assumptions and techniques being used with a common objective of estimating consumer surplus. Finally, some travel cost methods include a value of time taken by the household which would be considered outside the scope of the production boundary used for accounting purposes.	**Possibly appropriate** depending on the actual estimation techniques and whether the approach provides an exchange value, i.e. excludes consumer surplus. A distinction here is that the total of actual travel costs is not a measure of the value of the ecosystem services but it may be appropriate to use the demand profile associated with the travel cost (the estimation of this demand curve is referred to as use of the travel cost method).	This will relate to valuation of recreational ecosystem services.
Stated preference	Prices reflect willingness to pay from either contingent valuation studies or choice modelling.	These approaches are generally used to estimate consumer surplus and welfare effects, and non-use (bequest and existence) values. Within the range of techniques used there can be potential biases that should be taken into account.	**Inappropriate** since does not measure exchange values. However, while the direct values from stated preference methods are not exchange values, it is possible to estimate a demand curve from the information and this information may be used in forming exchange values for ecosystem services.	
Marginal	Prices are	This method can use	**Appropriate** since	In principle, may be

values from demand functions	estimated by utilising an appropriate demand function and setting the price as a point on that function using (i) observed behaviour to reflect supply (e.g. visits to parks) or (ii) modelling a supply function.	demand functions estimated through travel cost, stated preference, or averting behaviour methods. The use of supply functions has been termed the simulation exchange value approach (Campos & Caparros, 2011)	aims to directly measure exchange values. However, the creation of meaningful demand functions and estimating hypothetical markets may be challenging.	applied for many types of ecosystem services but most likely to be relevant in the estimation of values for regulating and cultural services.

Source: Obst, C., 2018