Do we need natural capital accounts for measuring the performance of societies towards sustainable development, and if so, which ones?

Walter Radermacher (1) and Anton Steurer (2)

Abstract: The past 20 years have seen substantial progress in relation to measuring sustainable development both in the policy field and in the statistical measurement field. However, there has been little progress with regard to the fundamental economic theory. This aspect cannot be ignored when considering what sorts of natural capital accounts could be useful for policy making in the domain of sustainable development. This paper presents some conceptual and practical limitations in the valuation of natural assets and environmental services. The authors conclude that a ‘narrow’ capital approach (i.e. monetising natural capital and adding it up to a total for wealth with the aim of making statements about past performance of societies) is not adequate for monitoring sustainable development. However, this approach can still be useful for assessment in specific cases at a smaller scale. Correspondingly, great care is needed when using the term ‘natural capital’ and associated monetary valuation outside of the scientific debate as it raises expectations that cannot be fulfilled and as it carries unintended but powerful connotations. Instead, the focus should be on establishing an integrated information system about the state and condition of the different components of nature, and the services derived from these components. Such a system could provide indicators for monitoring sustainability and for modelling the consequences of policy options.

JEL Codes: Q01, Q56, Q57

Keywords: natural capital, sustainable development, policy cycle, valuation of natural resources

(1) Walter Radermacher, Director-General, Eurostat.
(2) Anton Steurer, Head of Unit ‘Environmental statistics and accounts; sustainable development’, Eurostat
1. Introduction

As humanity approaches the limits of the planet, there is an increased need to know more about where these limits are and for information that helps manage society’s use of nature, as well as the need for information about natural assets. In the past 20 years, substantial progress has been seen in relation to measuring sustainable development both in the policy field and in the statistical measurement field. A major advance in statistics was the adoption as an international statistical standard of the System of Environmental-Economic Accounting (SEEA) — Central Framework by the United Nations Statistical Commission at its 43rd Session in 2012 (United Nations et al. (2014)). However, there has been little progress with regard to fundamental economic theory where the same old ideas are put forward to policy makers and statisticians.

The conceptual foundations of statistics are not a mere academic question. Statistics used for decision making must be fit for purpose (see Lehtonen (2015)). It is thus essential to understand the stage or stages in the policy cycle for which natural capital accounts would be made (e.g. problem analysis, identifying and assessing measures, target setting or monitoring). This aspect determines key requirements such as reliability and the frequency which the accounts have to fulfil to be of use. In particular, the monitoring of performance requires much higher data quality than, e.g., the assessment of policy options.

The use of statistics for decision making faces potential trade-offs between statistical measurability, scientific soundness and political relevance (see Figure 1). The construction of information systems has to cope with these conflicting goals (Radermacher (2005)).

This paper discusses, in particular, the question of natural capital, which is increasingly at the centre of the policy debate in the context of sustainable development. Relevant questions are: what do we mean by ‘natural capital’, how could we measure it in physical terms and could we attach monetary values to it? The ultimate question is, to what extent the resulting statistics meet the expectations and needs of policymakers?
2. What do we mean by natural capital and by natural capital accounts?

The term ‘capital’ has very different meanings. In classical and neo-classical economics, capital is one of the factors of production (along with land and labour) and is produced, i.e. a stock of accumulated goods devoted to the production of other goods thus being able to generate income. In this meaning, capital excludes natural resources and human, social or institutional capital. Wider economic meanings of the term are broadly associated to stocks of goods or stores of value. Many in the general public would interpret ‘capital’ as money, government bonds, buildings or machinery for production.

The System of National Accounts 2008 (European Commission et al. (2009)) defines an asset as ‘a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time’. The System distinguishes between financial and non-financial assets. Financial assets are generally matched by financial liabilities. Non-financial assets are further divided into produced and non-produced assets. The category of non-produced non-financial assets includes items such as natural resources, licenses or goodwill. Natural capital is the extension of the economic notion of (produced) capital to the natural environment, i.e. the ‘stock’ of natural (eco-) systems that yields a flow of valuable (ecosystem) goods or services into the future.

Many somewhat different definitions of natural capital can be found. It is useful to look at a few of them. The outcome document of the UN Conference on Sustainable Development (Rio+20) in 2012 (see UNCSOD (2012)) does not mention natural capital. Indeed, it does not contain the term ‘capital’ at all whereas the term ‘sustainable development’ occurs several hundred times. According to the Natural Capital Declaration, which was launched at the UN Conference on Sustainable Development, natural capital comprises Earth’s natural assets (soil, air, water, flora and fauna), and the ecosystem services resulting from them, which make human life possible.

The concept of natural capital features prominently in the European Union’s seventh Environment Action Programme to 2020 ‘Living well, within the limits of our planet’ (European Parliament and Council (2013)). The first priority of the 7th EAP is ‘to protect, conserve and enhance the Union’s natural capital’. The 7th EAP defines natural capital as the Union’s biodiversity, including ecosystems that provide essential goods and services, from fertile soil and multi-functional forests to productive land and seas, from good quality fresh water and clean air to pollination and climate regulation and protection against natural disasters. The programme also includes under its terms marine, coastal and fresh waters, land and forests, as well as air.

Neither the international System of National Accounts 2008 nor the SEEA Central Framework of 2012 defines natural capital. The term is not defined in the SEEA Experimental Ecosystem Accounting handbook completed in 2013 either. The SEEA Central Framework does define environmental assets, however. Environmental assets are the naturally occurring living and non-living components of the Earth, together constituting the biophysical environment, which may provide benefits to humanity. In the SEEA Central Framework, environmental assets are viewed in terms of the individual components that make up the environment, and are classified as follows:

1. Mineral and energy resources (oil, gas, coal, metallic and non-metallic mineral resources)
2. Land
3. Soil resources
4. Timber resources (cultivated and natural)
5. Aquatic resources (cultivated and natural)
6. Biological resources other than timber and aquatic resources (livestock, orchards, crops and wild animals)
7. Water resources (surface, groundwater and soil water resources)
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In principle, for the assets listed above, monetary as well as physical asset accounts can be made. These accounts would describe the opening and closing stocks as well as the changes in these assets. For the aforementioned assets one can assume that they can be quantified (‘counted’) in physical terms and that their quantitative ‘depletion’ can in principle be calculated with relevance for economic accounts and decision making. However, for a number of these assets, producing reliable monetary estimates is very difficult. This is not only for practical reasons but also for conceptual ones, as we will see in the next sections. Even physical accounts are difficult to make in a number of cases, especially when qualitative changes (i.e. ‘degradation’) prevail. For example, the extent or quality of certain assets is not well known (e.g. ground water, soil or oil and gas in the ground).

Commonly, natural capital is used to refer to all types of environmental assets as defined in the SEEA Central Framework, but including also ecosystem assets not covered by the components above. Often the term natural capital incorporates broad notions of a range of assets that supply a broad set of services, including ecosystem services. For example, a forest would be seen as an ecosystem that not only provides timber but also sequesters carbon (thus protecting the climate), cleans the air, filters water, mitigates water runoff (and thus provides flood protection), or provides recreation. Finally, ‘planetary’ systems (mainly the sea and the atmosphere) could be added:

(8) Ecosystems
(9) Planetary systems

For these ecosystem and planetary assets, making accounts becomes even more challenging. The basis for monetary valuation becomes very limited and the meaning of aggregate results becomes at least unclear. Physical data about the extent, status and capacity of some types of ecosystems are still limited. A few countries are experimenting with producing natural capital accounts, trying to compile the easier accounts first (see e.g. UK ONS (2014) or Australian Bureau of Statistics (2013) and (2015)).

The various assets listed above have very different characteristics. This matters for several reasons. First, there is the central question about accounting at the right level of aggregation. Secondly, we must address the heterogeneity of the types of natural assets. In this latter sense, two characteristics may be particularly relevant for the long-term temporal perspective that is at the heart of the idea of sustainable development. The first is whether an asset is used up by using it (‘non-renewable’) or not (‘renewable’ or permanently able to deliver a level of service). Many important natural assets are of the second type (e.g. climate, water, soil). The second key feature is that of interdependence or complexity. Often, ‘non-renewable’ assets are simple systems (e.g. natural gas fields or fossil ground water in a desert) but this does not mean that their extent or quality is well known. Complex interdependent systems pose additional challenges for predicting the impacts of human actions. Non-linear behaviour, tipping points, etc., suggest that risk considerations are more important than efficiency here. And, most importantly, even if all of these points could be solved, it would still not be clear how natural capital, say in Brazil, could be statistically accounted as a factor input for production of economic goods, say in France.

To sum up, the very compelling idea — for some — of using the notion of ‘capital’ in a broader sense, thus referring to the essential role of other production factors than produced capital for the long-term economic success of societies, seems to be faced with substantial obstacles, when it comes to its realisation. This could be seen as a minor problem, as long as the basic theoretical idea is good. However, as soon as we are in the aforementioned triangle of evidence based decision making, a theory without the possibility of real life application remains without relevance.
3. Capital accounts and measuring sustainable development

In Europe, the main discussion about frameworks for measuring sustainable development was in the period 2000–2005. After 2005, the focus shifted to measuring sustainable development with indicators. The capital approach was one of the frameworks discussed, in two very different senses. We can call them the ‘mainstream economic’ (or narrow) capital approach and the ‘framework’ (or wide) capital approach.

The basic idea of the mainstream economic approach is to measure whether (national) wealth is non-declining. To determine this, all types of assets (human, natural, economic…) need to be monetised and added up. Key features of the application of this approach are its national focus (i.e. it ignores cross-border effects) and the assumption of substitutability. Hence the approach works best for simple cases such as natural gas or crude oil reserves where the proceeds of extracting the natural resource are invested in the education of people and other forms of capital. The approach is of little use for natural assets such as the climate system or biodiversity.

The basic idea of the capital approach as an organising framework is that the asset base secures the future, so indicator systems must cover all main areas of assets in a wide sense (human, cultural, natural…). The approach recognises that monetisation at the scales involved is neither possible nor meaningful. Capital stocks and changes in stocks are measured with physical indicators (often proxies), e.g. human capital is described using the number of university graduates etc. This is a useful pragmatic approach for organising information but is not further discussed here.

In 2009–2012 a UNECE task force worked on statistical frameworks for sustainable development. The final result was adopted by the Conference of European Statisticians in 2013 (UNECE (2013)). The result seems to be a compromise acceptable to all and presents alternative ways to present sustainable development indicators including the capital approach as organising framework and the so-called policy approach. The UNECE report does not advocate the narrow capital approach.

To mitigate some of the flaws of the narrow capital approach, the concept of critical natural capital (3) has been introduced already in the 1990s. Critical natural capital is that part of the natural capital that delivers ecosystem services that cannot be substituted by other types of capital. Examples are freshwater resources, climate regulation and fertile soils (Millennium Ecosystem Assessment (2005)).

The mainstream economic capital approach is called ‘narrow’ as it has a very limited focus in applying standard neo-classical capital theory to the wide set of assets listed above. Many of these assets have characteristics that are not compatible with neo-classical theory. Nonetheless, the approach has been applied e.g. by the World Bank (e.g. World Bank (2006) and World Bank (2011), by Costanza et al. (1997) and in the Stern review report (Stern (2007))). The main achievement of the reports has been one of raising awareness (4). The relatively large monetary numbers support the view that the issues at stake are important. Some of the criticism these reports received has therefore been that the numbers are exaggerated and alarmist.

However, the more fundamental issue is that the values are neither necessarily reliable nor meaningful. Regarding the quality of the estimates, the reports have received criticism at many levels, including the assumptions used, the use of scientific data, the omission of key assets and the economic valuation (discount rates, cost and price estimates etc.).

(3) For a summary overview see Brand (2009).
(4) This is a key reason put forward by the WAVES initiative (https://www.wavespartnership.org/en): that ignoring the value of natural capital is likely to lead to decisions that endanger the poor.
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This reflects the basic problems involved in such exercises:

- There is a massive lack of knowledge about the state and functioning of the phenomena at stake in physical terms (e.g. extent and characteristics, tipping points, etc.) (5). The classic example is ecosystems. Soil is another example where much more and more systematic knowledge is needed (see, for example, Dominati, Patterson and Mackay (2010)).

- The valuation of these phenomena is both conceptually and practically very difficult. Some elements can be valued relatively easily, for others this is nearly impossible which makes any estimate incomplete.

These issues have led to the formulation of a ‘monetisation possibility frontier’ (O’Connor and Steurer (1999)), which uses two main dimensions (see Figure 2). Valuation works well for phenomena where both issues of scale and complexity, and cultural and ethical issues play no significant role. Valuation becomes problematic where the physical or temporal scales of the phenomenon, its interdependencies with other phenomena and the scientific uncertainties are large, and where ethical issues are important (issues of distributional fairness across space and time, existence value and heritage).

Figure 2: A stylised map of the ‘Monetisation possibility frontier’

Beyond the ‘monetisation possibility frontier’, valuation adds an extra layer of complication and uncertainty and increases the error margins in the results. Furthermore, it creates a paradox and conflicts with basic economic thinking, when at a larger scale the functioning of markets is assumed to be replaceable by technical-statistical experiments. In such a situation it is better to rely on management and monitoring purposes for the physical data, and concentrate scarce resources on reducing the error margins in this area.

(5) This point is also made nicely in an article in The Economist (2002). The article underlines the importance of thinking in ecosystems rather than components and lays out a vision of an environmental data revolution based on remote sensing. The vision is still valid and advances have been made towards it but we are still largely ‘flying blind’.
4. Why is the ‘narrow’ capital approach not meaningful for (most) natural capital?

The main elements of the ‘scientific DNA’ of the ‘narrow’ capital approach are as follows:

1. A micro-economic view (i.e. the basic mainstream axiomatic setting in economics), in which the complexity of decisions is reduced to a one-dimensional choice that should be ‘optimal’ in terms of the most efficient allocation of scarce resources (‘efficiency only’).

2. It is assumed that all relevant components are valued, the impact of the choices is gradual (marginal), irreversibility doesn’t exist and property rights of all commodities and capital goods are clear. In this world, the efficient allocation of scarce resources (financial, natural, labour etc.) is achieved through the invisible hand of the market.

3. For the most efficient choice between short-term consumption and long-term investments, the concept of ‘capital’ is introduced. The Hicksian income definition where income equals the net returns from capital fits here.

4. Sustainable development in this sense is nothing more than another term for the Hicksian income concept (See for example El Serafy (2013) or World Bank (2006)), which balances short term and long term interests. In a pure application this approach would lead to what is called ‘weak sustainability’, allowing unlimited substitution between all forms of capital (including natural). An assumption limiting the substitution of natural capital leads to a ‘strong sustainability’ concept.

At the macro-economic level, this conceptual frame is transposed to (macro-) economic-environmental accounting without any adaptations to the larger scale. If all interactions between stocks (all capital goods, assets, liabilities) and flows (activities like production, consumption including their internal/external effects on capital) are taken into account, the closing balance sheet in comparison to the opening balance sheet will tell us whether we have performed sustainably.

The global financial crisis has already indicated some limitations of this approach. Even ignoring natural capital, the balance sheet at the macro-economic scale, based on market values, will not tell us much about sustainability. Indeed, the crisis has triggered some work that emphasises the dynamic and systems nature of the economy, which works much like an ecosystem with interdependencies, thresholds and tipping points. The crisis has also shown that unrealistic model assumptions can generate unrealistic results (Colander et al. (2009)) (or even dangerously misleading results that result in massively sub-optimal decisions). Applying the same logic to natural capital does not seem wise. Or in the words of Reinhard Selten: ‘it is better to make many empirically supported ad hoc assumptions than to rely on a few unrealistic principles of great generality and elegance’ (Selten (1991)). Herman Daly in the early 1990s (Daly (1992)) underlined that this ambition and focus on efficiency only is an example for a fallacy of misplaced concreteness, since the underlying assumptions are altogether not fulfilled in reality. In his view, three dimensions are relevant for the decision process (*):

1. Scale: When changes are not marginal, where is the turning point in the behaviour of systems, beyond which risks might explode? He explains this with the Plimsoll line of a boat. One can put more and more weight into a boat, without any increase of risk. If however the maximum weight is achieved, further loading would very quickly lead to a catastrophe.

2. Distribution: The use of natural goods and services leads very often to questions related to the (unclear) property rights of public goods. The oceans, global atmosphere, rainforests, ecosystems could be seen as global public

(*) These principles are described in different words in an article by Daly et al. (2000). This includes that fundamental steps in valuation are the identification of possible alternatives and of the impacts for each alternative, and that political decisions are about incremental and not revolutionary changes.
goods. Their use and degradation is first and foremost a difficult point for political negotiations at international level.

(3) Allocation: Once the problems of scale and distribution are solved, one might internalise externalities by the establishment of market mechanisms (taxes, trading schemes of politically defined limited pollution rights) in the most efficient way. This is the moment where economic efficiency comes in.

Global climate policy in principle follows this sequence: First, setting of global turning points for temperature increase (‘2 degrees’) and corresponding thresholds for greenhouse gas emissions; second, distribution of these global aggregates to national targets; and third, creation of market and other mechanisms.

The framework for the decisions of individuals is set in a system (scientific, political) that is external to markets. For the setting of these frames other mechanisms and tools are more necessary than market tools. Markets do their work within these frames and find an efficient allocation of scarce resources. What scarcity concretely means, was prepared in a step-by-step procedure that incorporates knowledge and assessment of natural sciences (i.e. scale) and political choices concerning fairness of distributions.

This is not a surprising result, neither theoretically (the conditions for the operation of a system cannot be set by the system itself) nor practically (market conditions such as tax and social insurance and legal frameworks are the prerogative of politics; they follow their own political logic).

While (or because) the political decision making process follows its own logic, economic theory and economic models do of course play a role in this process. In the example of climate policy, the decision makers will try to predict what the economic (and other) impacts of their decisions (or indecision) might be.

Scenario techniques, including econometric modelling of alternative pathways to sustainability, could provide valuable evidence of sufficient quality for the choices that societies have to make on their way towards sustainable development. This approach would centre on methods for quantifying the opportunity costs associated with meeting specified targets or performance standards. These models should be closely synchronised with the available statistical database (See for example Bockermann et al. (2005)).

It is well known that such predictions carry large error margins and are subject to the same kinds of problems listed above for valuation. Nonetheless, for making the decision, even knowing the broad order of magnitude, is useful information.

However, trying to predict the economic impact of political decisions to help make these decisions is fundamentally different from setting up monetary accounts that should track whether we acted sustainably in the past. The former does not put a value on nature. It makes an estimate of the economic impact of a decision. The latter requires a much greater precision and comprehensiveness to be fit for the purpose of tracking development over time.

In summary, the ‘narrow’ capital approach seems to offer a nice, simple consistent theory for the integrated preparation of decision making at the political level. However, it has been demonstrated that this promise cannot be delivered. The elegance and appeal of the mathematical model contrasts sharply with the manifold difficulties of linkage with the real world: systems such as nature or societies don’t behave in the necessary smooth, linear manner; abrupt changes, complexity and nonlinearity are characteristic features. Causal chains in terms of one-to-one relationships between activities and observable impacts are more the exception than the rule. Qualitative degradation of natural systems cannot be easily quantified or even counted in inventory lists. Monetary valuation of non-market goods (and services) is, at least when applied to goods of non-marginal size, reflecting more the model parameters than societal values.

A final point relates to the role of science and scientific advice in democratic societies. Valuation as part of making choices between different options and directions is fundamental for the transparency and functioning of democratic decision making processes. However, too much reliance on (non-
transient) technocratic-scientific modelling for determining the outcome of such societal valuation can undermine and unduly limit the public debate (see for example Oxford Martin Commission (2014)).

This leads us to the conclusion that the capital approach remains an unfulfilled hope and promise for monitoring sustainable development. While valuation is useful for assessing an incremental change, the total value of all ecosystems of the planet has no meaning. Instead of helping decision makers progress towards sustainable development, this approach is an obstacle because it does not generate useful and impartial information while it distracts from and discredits those approaches which are feasible and helpful in reality.

5. Conclusions

To determine whether natural capital accounts are useful or not we need to specify what they describe (which components of nature) and how to measure them (data in physical quantities or monetary data). The authors are of the view that great care is needed when using the term ‘natural capital’ outside of the scientific debate as it raises expectations that cannot be fulfilled and as it carries unintended but powerful connotations for some (financial capital, substitutability of elements of nature…) which others may consider unethical. To varying degrees, these considerations would probably also apply to social, human and other similar forms of capital.

In our view, the ‘narrow’ capital approach (i.e. the monetisation of natural capital with the aim of making statements about past performance of societies) is not adequate for monitoring sustainable development. Monetary asset accounts (balance sheets) that would be fit for the purpose of monitoring ‘sustainability’ are completely unrealistic for many key natural assets. The simple idea of monetising ‘everything’ and then adding it up to a total for wealth — for the purpose of monitoring performance — is misleading policy makers rather than providing useful information.

However, the ‘narrow’ capital approach can still be useful for assessment in specific cases at a smaller scale, e.g. where countries deplete their sub-soil assets (such as oil and gas or diamonds), to determine the amounts that should be invested in other forms of assets. Monetary valuation will play a role in assessing individual policies and individual projects rather than in target setting or monitoring. Even at the early stages of the policy cycle (where low quality data sets can still be useful), getting monetary estimates that are fit for purpose is not easy for many natural assets.

What else can statisticians do to support policy-making decisions in the domain of sustainable development? Scenario techniques and modelling the consequences of policy options provide valuable information for the choices that societies have to make on their way towards sustainable development. Therefore, natural capital accounts in the sense of integrated information systems about the state and conditions of the various components of nature are a very useful tool as part of environmental-economic accounting that should be further developed, starting with the layers expressed in physical units. With increasing population and increasing income, the management of nature becomes even more important whereas the establishment of good quality information systems takes a long time. It is therefore appropriate to start investing in such integrated information systems now. In the meantime, indicator approaches should be further improved (see e.g. Eurostat (2013) or Eurostat (2015)).
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Acknowledgments

The authors would like to thank Arturo de la Fuente, Marleen De Smedt, Jukka Jalava, Joachim Recktenwald and John Verrinder (all from Eurostat) as well as two anonymous reviewers for their valuable contributions.

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