

Do we need natural capital accounts¹, and if so, which ones?

Walter Radermacher, Anton Steurer, Eurostat

Paper for HLEG meeting, 22-23 Sept. 2014 in Rome, Session 1: Do we need capital accounts for other types of capital than economic capital (e.g. human capital, natural capital, social capital)?

1. Introduction

This paper is to facilitate the HLEG's discussion about whether, and if so what sorts of natural capital accounts could be useful for policy making, and which of them could be feasible to produce. Some key points the paper addresses include:

- As humanity approaches the limits of the planet, the need will increase for knowing more about where these limits are and for information that helps managing society's use of nature, and so will the need for information about natural assets.
- To determine whether natural capital accounts are useful or not we need to specify what they describe (which components of nature, data in physical quantities or monetary data).
- It is essential to understand the stage or stages in the policy cycle for which the natural capital accounts would be made (e.g. problem analysis, identifying and assessing measures, target setting or monitoring) as this determines key requirements such as reliability and frequency which the accounts would 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 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.
- Monetary valuation will play a role in the assessment of individual policies and individual projects rather than in target setting or monitoring. Even for the early stages of the policy cycle, getting monetary estimates that are fit for purpose is not easy for many natural assets. Monetary asset accounts (balance sheets) that would be fit for the purpose of monitoring "sustainability" are completely unrealistic for many key natural assets.
- A key challenge for the future is to set up an integrated information system which will in all likelihood be in physical rather than monetary units.

It is also helpful to keep in mind the issue of the potential trade-offs between statistical measurability, scientific soundness and political relevance. The construction of information systems has to cope with these conflicting goals.²

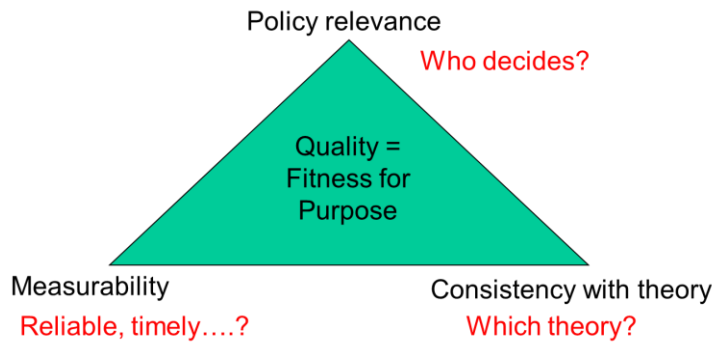
Looking at figure 1 and considering the main advances made in the past 20 years in relation to measuring sustainable development, it is clear that substantial progress has been made in the policy field and in the statistical measurement field. A major advance in statistics was the adoption as an international statistical standard of the System of Environmental-Economic Accounting (SEEA) – Central Framework by the United Nations Statistical Commission at its 43rd Session in 2012.³ However, there has been little progress with regard to the fundamental economic theory where the same old ideas are put forward to policy makers and statisticians.

¹ We use 'natural capital accounts' as a collective term for structured information about natural capital in a wide sense. For detail see section 2.

² W. Radermacher: The Reduction of Complexity by Means of Indicators – Case Studies in the Environmental Domain, in Statistics, knowledge and policy: key indicators to inform policy making, OECD 2005

³ See <http://unstats.un.org/unsd/envaccounting/seearev/>

Figure 1: fundamental aspects of quality in statistics used as evidence for decision making



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.

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 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 or other assets.

The System of National Accounts 2008⁴ 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 document⁵ of the UN Conference on Sustainable Development (Rio+20) in 2012 does not mention natural capital. Indeed, it does not contain the term "capital" at all whereas the term "sustainable development" occurs several 100 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 Environmental Action Programme to 2020 'Living well, within the limits of our planet'.⁶ The first priority of the

⁴ See <http://unstats.un.org/unsd/nationalaccount/sna2008.asp>

⁵ <http://www.uncsd2012.org/content/documents/727The%20Future%20We%20Want%2019%20June%201230pm.pdf>

⁶ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386>

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 includes under the term also 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, 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)

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 above mentioned 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, making reliable monetary estimates is difficult. 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. Including these elements would add:

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 making natural capital accounts, trying to compile the easier accounts first.⁷

The various assets listed above have very different characteristics. 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 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. As soon as we are however in the above-mentioned triangle of evidence based decision making, a theory without the possibility of real life application remains without relevance.

3. Capital accounts and the measurement of sustainable development

In Europe, the main discussion about frameworks for measuring sustainable development was in the period 2000-2005. After 2005, the focus shifted on measuring sustainable development with indicators. The capital approach was one of the frameworks discussed, in two very different meanings. 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 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 result⁸ was adopted by the Conference of European Statisticians in 2013. The result seems to be a compromise acceptable to all and presents alternative ways to present sustainable

⁷ See e.g. UK Office for National Statistics May 2014: UK Natural Capital – Initial and Partial Monetary Estimates, or the Australian Bureau of Statistics 2013: [Towards the Australian Environmental-Economic Accounts, 2013](#)

⁸ UNECE 2013: Conference of European Statisticians recommendations on measuring sustainable development

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 capital⁹ 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.¹⁰

The mainstream economic capital approach is called 'narrow' as it has a very limited focus of 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 Bank¹¹, by Costanza et al¹² and in the Stern review report.¹³ The main achievement of the reports has been one of awareness raising.¹⁴ 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 not necessarily reliable nor are they 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.). 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.).¹⁵ The classical example is ecosystems. Soil is another example where much more and more systematic knowledge is needed.¹⁶
- 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"¹⁷, which uses two main dimensions. 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).

⁹ For a summary overview see Brand, F. (2009). Critical natural capital revisited: Ecological resilience and sustainable development, *Ecological Economics*, 68, 605–612.

¹⁰ Millennium Ecosystem Assessment 2005

¹¹ E.g. Where is the [wealth of nations?](#) - Measuring capital for the 21st century, World Bank 2007 and [The Changing Wealth of Nations](#): Measuring Sustainable Development in the New Millennium, World Bank. 2011

¹² Costanza, R., D'Arge, R., de Groot, R. S., Farber, S., Grasso, M., Hannon, B. ... van den Belt, M. (1997). The value of the world's ecosystem services and natural capital, *Nature*, 387, 253-260.

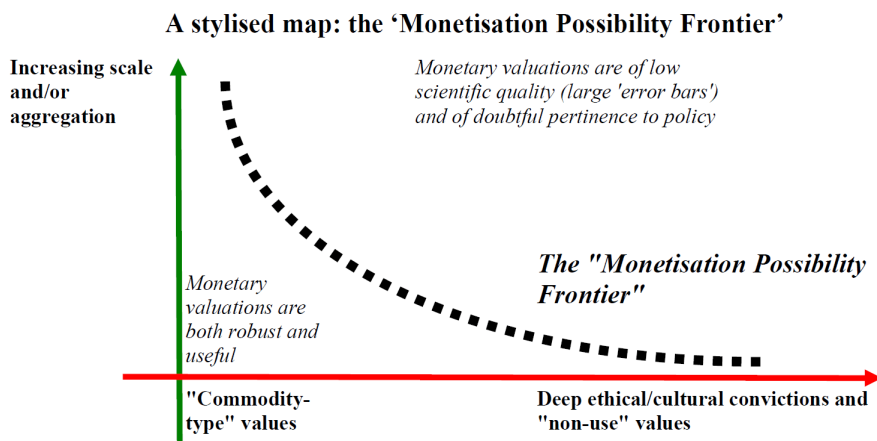
¹³ Nicholas Stern, *The Economics of Climate Change - The Stern Review*, 2007

¹⁴ This is a key reason put forward by the [WAVES](#) initiative: that ignoring the value of natural capital is likely to lead to decisions that endanger the poor.

¹⁵ This point is also made nicely in an article in *The Economist* (Flying blind, July 4th 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".

¹⁶ See, for example, Dominati, Patterson and Mackay "A framework for classifying and quantifying the natural capital and ecosystem services of soils", *Ecological Economics*, vol 69, No.9 (15 July 2010, pp.1858-1868).

¹⁷ O'Connor and Steurer: [The "Frontier of Monetisation" in Environmental Valuation](#), paper presented at the 6th meeting of the London Group on Environmental Accounting, Canberra November 1999



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 conflict with basic economic thinking, when at bigger scale the functioning of markets is assumed to be replaceable by technical-statistical experiments. In such a situation it is better to rely for management and monitoring purposes on the physical data, and concentrate scarce resources on reducing the error margins in this area.

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 (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 else than another term for the Hicksian income concept¹⁸, 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 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 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,

¹⁸ See for example El Serafy, S.: Herman Daly Festschrift: [Hicksian income, welfare, and the steady state](#), in The Encyclopedia of Earth, or see World Bank: [Where is the wealth of nations?](#), 2007

thresholds and tipping points. The crisis has also shown that unrealistic model assumptions can generate unrealistic results¹⁹ (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.²⁰

Herman Daly²¹ in the early 1990s 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 process²²:

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 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. Firstly, setting of global turning points for temperature increase (“2 degrees”) and corresponding thresholds for greenhouse gas emissions, secondly, distribution of these global aggregates to national targets, and thirdly, creation of market and other mechanisms.

The frame for the decision 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 necessary than market tools. Markets do their work within these frames and find 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 (= 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.

¹⁹ Colander et al: The financial crisis and the systemic failure of academic economics, Kiel working paper 1489, 2009

²⁰ R. Selten: Evolution, learning and economic behaviour, 1991

²¹ Herman Daly: Allocation, distribution, and scale: towards an economics that is efficient, just, and sustainable, 1992

²² These principles are described in different words in an article by Daily, G. C., Soderqvist, T., Aniyar, S., Arrow, K., Dasgupta, P., Ehrlich, P. R., ... Walker, B. (2000). Ecology – [the value of nature and the nature of value](#), Science, 289. 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.

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.²³

It is well known that such predictions carry large error bars 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 political level. However, it has been demonstrated that this promise cannot be fulfilled. The elegance and appeal of the mathematical model contrasts sharply with the manifold difficulties of linkage to 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 exception than principle. Qualitative degradation of natural systems cannot be easily quantified or even counted in inventory list. 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 last point is related 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-transparent) technocratic-scientific modelling of the outcome of such societal valuation can undermine and unduly limit the public debate²⁴.

This leads us to the conclusion that the capital approach remained an unfulfilled hope and promise for the monitoring of 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 to 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. What should we do?

The HLEG may want to consider to:

1. Clearly recognise that for monitoring sustainable development 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.

²³ See for example Bockermann, A., Meyer, B., Omann, I., Spangenberg, J. H.: Modelling sustainability - comparing an econometric (PANTA RHEI) and a systems dynamics model (SuE), in *Journal of Policy Modeling* 27 (2005) 189–210.

²⁴ See for example Merry, S. E.: [Measuring the World - Indicators, Human Rights, and Global Governance](#), in *Current Anthropology*, Vol. 52, No. S3., or Expert meeting on the Oxford Martin Commission's [Worldstat recommendation](#), 27 May 2014

2. Make it clear that 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.
3. Underline that scenario techniques and modelling the consequences of policy options provides valuable information for the choices that societies have to make on their way towards sustainable development.
4. State that 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 or increasing income the management of nature becomes ever more important whereas the establishment of good quality information systems takes a long time.
5. In the meantime, indicator approaches should be further improved.²⁵

²⁵ See e.g. Eurostat 2013: [Sustainable development in the European Union - 2013 monitoring report of the EU sustainable development strategy](#) or Eurostat 2013: [Smarter, greener, more inclusive? - Indicators to support the Europe 2020 strategy - 2013 edition](#)