**Sustainability Accounting, Management and Policy Journal; 2015**
**Vol. 6 Issue: 3, pp.315-339 doi: 10.1108/SAMPJ-04-2014-0020**

# Reflections on natural capital accounting at the national level: Advances in the system of environmental-economic accounting

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## 1. Introduction

Natural capital and its increasing scarcity have been at the heart of concerns over sustainability for well over 40 years (Meadows *et al.*, 1972; MA, 2005; Rockström *et al.*, 2009). As the key drivers of natural capital's scarcity are economic growth and the related increasing consumption of growing populations, there has long been discussion that the measure of economic growth, gross domestic product (GDP), has inappropriately become the most widely adopted measure of progress (Kennedy, 1968; Costanza *et al.*, 2009; Stiglitz *et al.*, 2010).

Alternative measures of progress that incorporate a range of non-economic factors, including natural capital, have been developed for many years. High-profile examples include the Human Development Index (HDI; UNDP, 2014) and the Genuine Progress Indicator (GPI; Cobb *et al.*, 1995). Many build from the pioneering work of Nordhaus and Tobin in the early 1970s (Nordhaus and Tobin, 1972). Nonetheless, however widely publicized or recognized, these alternative measures have not displaced GDP as the focal indicator for economic and development policy. Costanza reinforces this reality in making the case that "the chance to dethrone GDP is now in sight" (Costanza *et al.*, 2014).

This paper presents some reflections on the relative lack of "success" in displacing GDP as the leading measure of progress, well-being and/or economic welfare in policy circles. It does so by reflecting on the role of accounting frameworks in the measurement of GDP and from this position discusses the potential of extending these frameworks via natural capital accounting. Such extension would help to mainstream the discussion of environmental factors in economic and development policy through an integrated measurement framework, perhaps replacing some aspects of the broader measures of progress that have developed. At the same time, the paper is not intended to provide a fulsome critical review of different measures of progress.

In terms of accounting perspective, the paper does not cover the various ways in which the broad body of accounting knowledge and research has tackled the question of natural capital and sustainability (Gray, 1990; Bebbington and Larrinaga, 2014). Further, this paper does not aim to critique the bodies of work that may be generally considered as green, environmental or wealth accounting that have emerged from the economics profession (Hamilton and Clemens, 1999; Dasgupta, 2009; Mäler *et al.*, 2009; Barbier, 2013). Instead, the reflections on accounting come from the perspective of the System of National Accounts (SNA), i.e. the United Nations accounting-based standard system of macro-economic statistics that underpins the derivation of GDP.

As a long-time national accountant, the author has spent the past four years working on the United Nations-led project to establish international statistical standards that extend the SNA and integrate environmental information within an accounting framework. The standards were adopted by the United Nations Statistical Commission in 2012, and while work continues to implement and further

advance this area of accounting, substantial and meaningful progress will only be possible by expanding the awareness of these developments and seeking input from a broad range of disciplines. The goal of this paper is thus to raise awareness of the potential of accounting generally, but national accounting specifically, to contribute to the measurement of progress.

The paper is structured as follows. Section 2 describes the role of accounting in the measurement of GDP and points to the potential benefits that arise from taking an accounting approach. Section 3 summarizes the development of international statistical standards on natural capital accounting over the past 20 years that have emerged from extensions to the SNA. A key message of this section is that the development process has tended to be quite separate from developments in the academic literature over this time.

Section 4 provides an overview of the current state of play by describing the content of the System of Environmental-Economic Accounting 2012 (SEEA 2012) – the body of work recently released under the auspices of the United Nations Statistical Commission. Section 5 reviews the developments in the SEEA 2012, noting limitations and areas of required research. Section 6 concludes with reference to current initiatives and the role of accounting.

## 2. Measures of progress, GDP and accounting

Since the 1930s, the assessment of countries' progress has most commonly been linked to growth in the measure of economic activity known as GDP. The measurement of GDP has been progressively refined since the early 1950s, with its conceptual basis set out in a measurement framework known as the SNA. The latest version of the SNA was adopted by the United Nations Statistical Commission in 2008 (European Commission and International Monetary Fund, 2009).

The SNA enshrines a focus on economic capital, i.e. those physical entities or intellectual products that provide ongoing inputs to production and the generation of income, as defined from an economic accounting perspective. In its accounting approach, the SNA excludes the direct measurement of human and social capital, and has a coverage of environmental or natural capital that is essentially limited to the extraction of resources. Indeed, natural processes are explicitly excluded from the definition of production that sets the measurement boundary for GDP (European Commission and International Monetary Fund, 2009, 6.24).

The focus on economic capital allows a comprehensive and internally consistent accounting for all market-based flows of income, but it does not permit a broader assessment of the sustainable generation of that income or recognition of other benefits that contribute to well-being which are generated from the omitted forms of capital. The idea that there is a direct connection between overall well-being and multiple forms of capital – such as economic, natural, social and human capital – has been established for many years in economics (Pearce and Atkinson, 1993; Asheim and Weitzman, 2001; Dasgupta, 2009) and provides the basis for the involvement of accounting in this field.

Given these seemingly obvious limitations about the scope and basis of GDP, what is it about GDP that has made it so enduring? There are many reasons but, in the view of the author, an often overlooked one is that GDP is forged from an accounting framework with all of the internal checks and balances that an accounting system contains. The majority of alternative indicators of progress do not have these internal checks and balances, even in cases where they incorporate indicators of capital and income.

There are four key features of the national accounts system that provide GDP's robustness. First, there is a defined production boundary that determines those goods and services considered to be produced within the economy and thus sets the size of GDP. Second, there is the adoption of supply

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**doi: 10.1108/SAMPJ-04-2014-0020**

and use principles such that there must be a balance between the total goods and services supplied (through production and imports) and the total goods and services used (by other businesses, government, households, for investment or exported). Third, there is a close relationship between the production boundary and the asset boundary such that changes to the production boundary or the asset boundary often imply changes in the other. For example, expanding production to include unpaid household work would also require that equipment used to support this work (fridges, washing machines, etc.) would be considered assets, whereas, at present, they are considered consumption items. Fourth, changes in assets over an accounting period must reconcile with the opening and closing balance sheets.

While these may be fairly standard accounting principles and relationships, this combination of features permits GDP to be measured equivalently in three ways – in terms of production, incomes or expenditures. Further, the alignment of income and asset measurement through the careful definition of measurement boundaries supports consistent recording and analysis of changes in the asset base and changes in GDP and income. Combined, these features provide a degree of robustness not found in most other indicators of progress.

In contrast, measures such as the GPI or the HDI bring together a range of indicators from the economic, social and environmental domains and then weight together the different indicators in some way. While clearly providing aggregate indicators with a broader, and more appropriate, scope in measuring progress, there are concerns about how these indicators are constructed (for a short summary, see Bartelmus, 2014).

From an accounting perspective, the major concern is how the component themes and indicators "beyond GDP" are selected. Most measures that go beyond GDP tend to work bottom-up in the sense of adding in indicators of those themes that would seem most appropriate in a broader conceptualization of progress or welfare. (See e.g. the construction of the GPI which uses household consumption expenditure from the national accounts and adjusts for 24 different social and environmental components; Cobb *et al.*, 1995).

GDP, on the other hand, is defined top-down by first determining a concept of production and including any good or service consistent with that concept. This is not to say that the definition of production is correct, immutable or completely objective, but the approach does confer a level of stability over the scope of GDP in the face of changing circumstance that is unusual in the indicator space. Further, the adoption of the same, agreed-upon definition of GDP in all countries provides a very strong comparative framework.

Some of these features are ones that other indicator frameworks are taking on. The HDI is now regularly compiled for all countries following an agreed-upon methodology (UNDP, 2014), and recently, estimates of the GPI have been released for a larger number of countries (Kubiszewski *et al.*, 2013).

However, the important lesson here is that GDP should not be viewed as an indicator that simply weights together a diverse selection of goods and services. If that were the case, then GDP would have been toppled or amended many years ago. It is not hard to think of things that might be included or excluded. GDP, however narrowly defined in scope, draws tremendous strength from its accounting roots, in particular the fundamental links between income, production and assets. It is in understanding these roots and the potential to extend or amend them that there exists potential to derive more robust alternative measures of well-being and progress.

One area in which the potential of accounting-based approaches has been explored is known as wealth accounting. This area of research emerged from initial work by Solow (1974) and Hartwick (1977) in the 1970s concerning the economics of using natural resources (which was based on initial work of Lindahl (1933) on the definition of income). The work has broadened to consider other

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forms of capital under the general logic that there is a strong relationship between the sustainability of a country's consumption and its use of capital. Dasgupta (2009) provides a thorough exposition of the concepts and relationships.

The wealth accounting theory has been actively applied in recent years in two different but similarly founded works. First, in the development of measures of genuine savings and national wealth by the World Bank (2011). Second, in the work on the development of the Inclusive Wealth Index (UNU-IHDP and UNEP, 2012).

Another approach reflecting the potential of accounting-based approaches to go beyond GDP has been developed in the System of Environmental-Economic Accounting (SEEA), and it is this approach that is the focus of this paper. Unlike the wealth accounting approach, the application of accounting principles in the SEEA is not applied only in relation to the value of the various forms of capital and the associated income and consumption. The SEEA also applies accounting principles to the organization of environmental information in physical terms (e.g. flows of water, energy and emissions) to support the development of more coherent data on the environment and facilitate the integration of those data with economic information. The scope and approach of the SEEA are explained through Sections 3 and 4.

A key motivation for developing the accounting extensions of the SEEA is that by extending the standard economic accounting framework, it will facilitate mainstreaming environmental information within regular discussions on economic and development policy. Thus, rather than setting up alternative and competing measures, the intent is to work within the current accounting constructs and establish complementary measures to GDP that enable a broader story to be conveyed. Whether such an approach will be more persuasive and successful in broadening the discussion is yet to be fully tested, but it should be recognized as a different way forward.

Of course, in the absence of definitive accounting approaches that cover all aspects of progress, the compilation of broad indicators such as the HDI and GPI adds immeasurably to the public discussion of these important issues. It is simply noted here that accounting-based approaches have certain features that suggest moving beyond GDP in measurement terms is not only a case of replacing one broad indicator for another.

## 3. Background to the development of international standards in natural capital accounting

The potential and need to better integrate measures relating to natural capital within the national accounts framework emerged through the 1970s and 80s (Bartelmus, 1987; Ahmad *et al.*, 1989). Consistent with a request from the first United Nations Conference on Environment and Development held in Rio de Janeiro in 1992 (United Nations, 1993a), the United Nations Statistical Division led the drafting of the first international document on environmental-economic accounting (United Nations, 1993b). This document, Integrated Environmental and Economic Accounting, became known as the System of Environmental-Economic Accounting or SEEA. It was an interim document prepared by the world's official statistics community to propose ways in which the SNA might be extended to better take natural capital into consideration.

Since that initial work in 1993, work on environmental-economic accounting (now more widely referred to as "natural capital accounting") has continued steadily within the auspices of the official statistics community. Countries such as The Netherlands (Statistics Netherlands, 2013), Canada (Statistics Canada, 2014), Australia (Australian Bureau of Statistics, 2012) and Denmark (Statistics Denmark, 2013) are among the leaders in the field, but many other countries, both developed and developing, have experience in the development of various environmental-economic accounts.

Key developments since 1993 have included:

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- The establishment of the London Group of Experts on Environmental-Economic Accounting largely comprising technical level representatives from national and international statistical offices and which has now met 20 times.
- A guidance document released in 2000 titled *Integrated Environmental and Economic Accounting – An Operational Manual* (United Nations, 2000).
- An update to the 1993 SEEA released in 2003, the *SEEA-2003* (European Commission and International Monetary Fund, 2003).
- The establishment of an overarching UN body for this field of work in 2005 – the United Nations Committee of Experts on Environmental-Economic Accounting (UNCEEA) – under the auspices of the United National Statistical Commission and given the task of progressing international efforts in this area.
- Adoption of the SEEA 2012 Central Framework (United Nations and European Union, 2014) as the international statistical standard in the area of environmental-economic accounting. This adoption places work in this area on a par, at least conceptually, with the long-standing SNA[1].
- Release of SEEA 2012 Experimental Ecosystem Accounting (United Nations *et al.*, 2013) as a synthesis of approaches to the measurement of ecosystems through a national accounting lens.

Over the past 20 years, there has been an important broadening of focus in SEEA-related work. Through the 1980s and early 1990s, the primary focus was on extensions and adjustments to GDP, for example measures of depletion and degradation-adjusted GDP, and recording environmental expenditures. Discussion considered the range of ways in which depletion and degradation might be estimated, valued and, subsequently, incorporated within the structure of the standard national accounts and its various measures of production, income, saving and wealth.

Through the 1990s, this specific focus started to broaden to consider ways in which accounting approaches and structure may be useful in the organization of physical information on environmental stocks and flows such as water, energy and waste. This direction built on work to model the economy in physical terms (Meadows *et al.*, 1972). This broadening of the SEEA discussion reflected a recognition that accounting principles could be applied without reference to monetary units.

This broader application of accounting, which has been expanded further in recent years through the development of ecosystem accounting, confronts the common conception that adoption of accounting approaches necessarily relies on valuation (in monetary terms) of nature. Certainly there are questions that cannot be answered unless valuation is undertaken, for example adjusting measures of GDP, but there are some important advantages of applying accounting principles in the organization of data in physical terms (see Section 4).

On the whole, the development of natural capital accounting as described in the SEEA has taken place outside of academia and has reflected a process managed by the international official statistical community. Over the 20 years from the release of the 1993 SEEA, there has been relatively little academic literature which debates accounting alternatives from a national accounting perspective. Exceptions include Harrison (1993), Vanoli (1995), de Haan and Keuning (1996), Nordhaus and Kekkelenberg (1999), Peskin and de Los Angeles (2001), Vardon *et al.* (2007) and Edens and Hein (2013). Instead, the development and debate of the work is reflected in documents published by various international agencies (particularly the United Nations Statistics Division [UNSD] and the Statistical Office of the European Communities [Eurostat]) and in documents presented to the meetings of the London Group and UNCEEA. Essentially, the academic literature

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does not reflect the substantial thinking and debate that has taken place over the past 20 years in national accounting and SEEA circles.

It would be wrong to conclude that these documents and papers were not subject to peer review or were reports of consultants engaged only on specific topics. Indeed the process of finalizing the SEEA Central Framework involved well over 100 experts through multiple rounds of consultation and review over five years. At the same time, by and large, the technical content of the SEEA 2012 Central Framework may be best described as a codification of literature and thinking developed before 2000. The document has thus tended to clarify the language and make choices about the technical approach to natural capital accounting. Significantly, by making these choices and reflecting an agreed-upon position, it has provided a stronger foundation for governments and international agencies to support work in natural capital accounting and in turn form a basis for further research and extension.

Unfortunately, the effect of discussion on the SEEA residing largely within the international statistical community has meant that awareness of the work outside of that community has been limited. This has both reduced the discussion within the SEEA community of other developments taking place outside and meant that some of the positive developments taking place in the SEEA were not influencing other thinking. However, since 2012, this dynamic has changed significantly, and while it is still early days, the breadth of connections is increasingly rapidly. Section 6 provides a description of the nature and direction of some of these connections.

The changed dynamic has been driven by two things. First, the adoption of the SEEA Central Framework and the process leading up to its release provided a platform for the international statistical community to promote its approach. This platform was reinforced by the SEEA's joint publication by six international agencies (United Nations, European Commission, Food and Agricultural Organization of the United Nations, International Monetary Fund, Organisation for Economic Cooperation and Development and the World Bank) and the timing of adoption, just ahead of the Rio 2012 conference on sustainable development.

Second, in framing the scope of the SEEA Central Framework, the members of the UNCEEA determined that some technical aspects of natural capital accounting were unlikely to get broad-based support, particularly the valuation of environmental degradation (as distinct from valuing the depletion of individual resources such as timber and fish resources). They, therefore, split the drafting of technical material in two – the SEEA Central Framework on the one hand and a second volume that became known as the SEEA Experimental Ecosystem Accounting.

In this second volume, a variety of issues were brought together, and, without the requirement to develop an international statistical standard, a broader framing of natural capital accounting in a national accounts context was undertaken. The timing of the work was especially important in this context, as it was possible for the SEEA discussion on ecosystem accounting to take into consideration the emerging work on ecosystem services and ecological economics. The advances in these areas – which gained momentum after 2000 – provided a ready-made academic community interested in inter-disciplinary work and who were also making connections between the environment and the economy.

These two factors, combined with the increasing recognition of declining natural capital, have meant that:

- the thinking outlined in SEEA Experimental Ecosystem Accounting has benefited from substantial input from many non-statistical, non-national accounting experts, including economists, ecologists and geographers;
- the process for developing and advancing SEEA Experimental Ecosystem Accounting has provided a platform for these experts to engage; and

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- there is the opportunity for national accounting-based approaches to be considered in other approaches and projects on natural capital assessment.

A product of this broader engagement has been an increase in the number of academic papers and related writing from the existing SEEA community admittedly from a low base. The papers by Edens and Hein (2013) and Obst and Vardon (2014) are examples of this direction. In many ways this paper is aimed at establishing further connections in this important area of work and reflects the inter-disciplinary dynamic that must be nurtured.

## 4. The SEEA 2012

In light of this short history of natural capital accounting as developed through the channel of official statistics and national accounting, this section briefly summarizes the key elements of the approach described in the SEEA 2012. The SEEA 2012 comprises three volumes:

- the SEEA 2012 Central Framework;
- SEEA 2012 Experimental Ecosystem Accounting; and
- SEEA 2012 Applications and Extensions (United Nations, 2014).

The third volume focuses on ways in which data organized following the accounting framework described in the SEEA Central Framework can be applied to the analysis of various policy questions and linked to other data sets. This volume is not discussed further in this paper.

The focus here is on a description of the accounting content of the first and second volumes that collectively provide a comprehensive approach to the integration of environmental information with information on the measurement of economic activity and wealth.

This section provides a summary of the main aspects of SEEA 2012, including the accounting principles that are applied and a description of the main type of accounts within scope, namely:

- physical flow accounts for substances such as water, energy and emissions;
- asset accounts for resources (such as mineral and energy resources, timber and fish stocks);
- accounts for measuring changes in land and ecosystems;
- accounting for environmental transactions (including environmental protection expenditure, environmental goods and services, environmental taxes and subsidies); and
- a sequence of accounts and accounting for depletion and degradation.

Further details in all of these areas of accounting are provided in the relevant SEEA 2012 volume.

### 4.1 Accounting principles [2]

To facilitate the integration of environmental and economic information, the SEEA uses as its base the accounting principles of the SNA. Among the key principles are quadruple entry accounting (whereby each transaction is recorded in the accounts of the supplier and consumer in both their real and financial accounts), recording on an accrual basis and valuation at transaction or exchange values.

The SEEA Central Framework describes how these principles can be applied in accounting for stocks and flows measured in physical quantities (e.g. tonnes of timber, cubic meters of water) by recognizing that there is an underlying physical reality to economic activity. In this context,

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accounting approaches provide a set of relationships between information on stocks and flows that can be applied in situations where data are not available in monetary units.

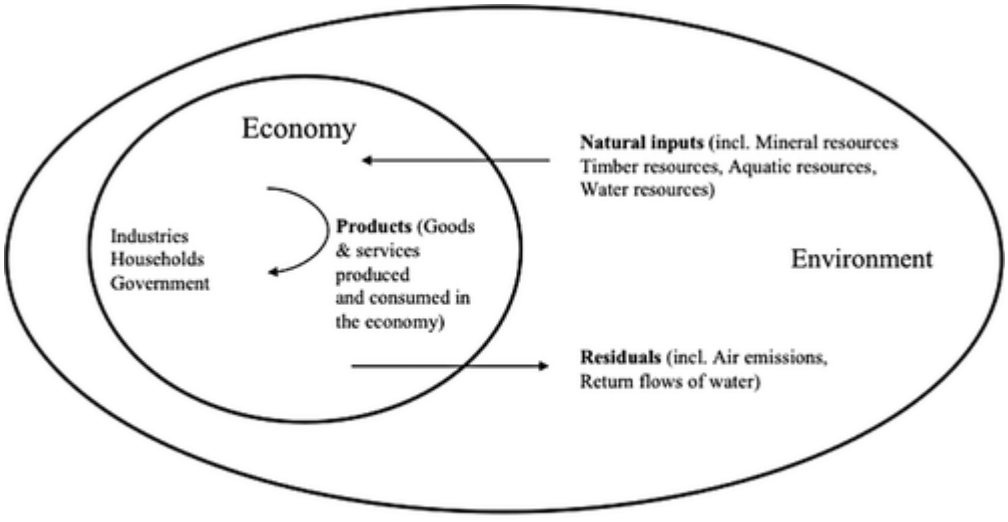
**4.2 Physical flow accounts** [3]

Physical flow accounts are the most well-developed of the SEEA accounts and have been implemented in many countries. For example, at least 33 countries are known to have implemented water accounts (Vardon *et al.*, 2012). Physical flow accounts are also common for flows of energy, greenhouse gas (GHG) emissions and waste. Each physical flow account is balanced by virtue of using a single measurement unit (e.g. tonnes, cubic meters, joules) and by ensuring that all flows between the economy and the environment, and within the economy, are constrained to satisfy the supply-use and input-output identities.

The supply–use identity requires that the total supply of a product or input is equal to the total use of the same product or input. For example, the total supply of timber resources from the environment must equal the total use of timber resources by the economy. The input–output identity requires that for each recorded input into an economic unit (e.g. inputs of water), there is a matching output from the economic unit (e.g. the return of water to the environment plus evaporation).

The scope of physical flow accounts is presented in Figure 1. Each physical flow account considers, as appropriate, the flows of the relevant substance from the environment to the economy (natural inputs), within the economy (flows of products) and from the economy to the environment (residuals). Accounts for water and energy track all of these types of flows. Accounts for GHG emissions focus only on residual flows.

**Figure 1.** Physical flows of natural inputs, products and residuals




**Source:** United Nations *et al.* (2014, Figure 2.1, p.13)

A unique aspect of the SEEA is its definition of the boundary of the economy. It is defined in such a way that the physical flows can be directly related to the monetary flows that are recorded in the measurement of GDP. GDP is defined by a production boundary, that is the set of goods and services that results from production by economic units. The SEEA defines this production boundary in physical terms. The outcome is that direct relationships can be made between standard economic

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accounting measures such as output and value added, and physical measures such as water and energy use, and GHG emissions.

This unique aspect may be particularly important where the physical data sets (e.g. GHG emission inventories) are commonly collected without consideration of the precise measurement scope of the economy.

Importantly, the physical flow accounts of the SEEA apply standard product, industry and institutional sector classifications such that economic data and environmental information can be readily compared. This allows straightforward and correct definition of productivity and intensity indicators where physical flows are compared to economic variables such as value added and output. Further, with physical data structure and scope following the SEEA, extensions to input–output tables are more straightforward, thus supporting the derivation of footprint and similar calculations. The generic structure of SEEA physical flow accounts is shown in Table I.

**Table 1.** Basic form of a physical supply and use table

| Accounting entries | Industries | Households | Accumulation | Rest of the world | Environment | Total |
|---|---|---|---|---|---|---|
| *Supply table* | | | | | | |
| Natural inputs | | | | | Flows from the environment | Total supply of natural inputs |
| Products | Output | | | Imports | | Total supply of products |
| Residuals | Residuals generated by industry | Residuals generated by final household consumption | Residuals from scrapping and demolition of produced assets | | | Total supply of residuals |
| *Use table* | | | | | | |
| Natural inputs | Extraction of natural inputs | | | | | Total use of natural inputs |
| Products | Intermediate consumption | Household final consumption | Gross capital formation | Exports | | Total use of products |
| Residuals | Collection and treatment of waste and other residuals | | Accumulation of waste in controlled landfill sites | | Residual flows direct to environment | Total use of residuals |

**Table I.** Basic form of a physical supply and use table

**Note:** Dark gray cells are null by definition
**Source:** United Nations *et al.* (2013, Table 2.2, p. 17)

### 4.3 Accounting for environmental assets [4]

Accounting for environmental assets is at the heart of the SEEA. From a measurement perspective however, environmental assets can prove difficult to define and, commonly, varying terms and definitions are used without a clear understanding of the links to standard measures of economic assets as defined in the SNA. Double counting or measurement gaps are therefore real risks. The SEEA Central Framework aims to bring clarity to this area of accounting.

In the first instance, environmental assets are defined broadly to encompass the whole of the biophysical environment. Thus, "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" (United Nations *et al.*, 2013, 2.17, p. 13).

It is then recognized that for measurement purposes, this definition may be tackled from two different but complementary perspectives. In the first perspective, various components of the biophysical environment are measured as individual environmental assets. These components include mineral and energy resources, soil resources, timber resources, fish and aquatic resources, other biological resources and water resources. Asset accounts that record the opening and closing stocks of these resources and the additions and reductions in stock are described in the SEEA Central Framework. Examples of the types of accounting entries are shown in Table II.

Importantly, the measurement scope of individual environmental assets is not limited to purely natural resources and hence includes, for example, fish in aquaculture facilities and timber resources

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in plantation forests. Coverage of both natural and cultivated environmental assets ensures that changes in the composition of environmental assets can be recorded.

**Table II.** General structure of the physical asset accounts

| Accounting entries | Mineral and energy resources | Land (incl. forest land) | Soil resources | Timber resources | | Aquatic resources | | Water resources |
|---|---|---|---|---|---|---|---|---|
| | | | | Cultivated | Natural | Cultivated | Natural | |
| Opening stock of resources | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| *Additions to stock of resources* | | | | | | | | |
| Growth in stock | NA | Yes* | Soil formation<br>Soil deposition | Growth | Natural growth | Growth | Natural growth | Precipitation<br>Return flows |
| Discoveries of new stock | Yes | NA | NA | NA | NA | NA | Yes* | Yes* |
| Upwards reappraisals | Yes | Yes | Yes* | Yes* | Yes* | Yes* | Yes | Yes* |
| Reclassifications | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| Total additions to stock | | | | | | | | |
| *Reductions in stock of resources* | | | | | | | | |
| Extractions | Extractions | NA | Soil extraction | Removals | Removals | Harvest | Gross catch | Abstraction |
| Normal reductions in stock | NA | NA | Erosion | Natural losses | Natural losses | Normal losses | Normal losses | Evaporation<br>Evapotranspiration |
| Catastrophic losses | Yes* | Yes* | Yes* | Yes | Yes | Yes | Yes | Yes* |
| Downwards reappraisals | Yes | Yes | Yes* | Yes* | Yes* | Yes* | Yes | Yes* |
| Reclassifications | Yes | Yes | Yes | Yes | Yes | Yes | Yes | NA |
| Total reductions in stock | | | | | | | | |
| Closing stock of resources | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

**Table II.** General structure of the physical asset accounts

**Notes:** "NA" means not applicable; *indicates that this entry is usually not significant for the resource or is typically not separately identified in the source data
**Source:** United Nations *et al.* (2013, Table 5.2, p. 142)

The second perspective on the measurement of environmental assets is to consider how the individual environmental assets function as a system within a given spatial area, otherwise referred to as ecosystem accounting. Thus, rather than a focus simply on the timber resources in a forest, ecosystem accounting considers the functioning of the forest as the interplay between the trees, the soil, the water resources and the other characteristics (e.g. biodiversity) and processes that define an ecosystem. Ecosystem accounting is described further below.

Beyond the measurement of the physical stocks and flows of environmental assets, the SEEA Central Framework provides guidance on the valuation of individual environmental assets. To permit integration with the standard economic accounts, the valuation principles used in the SEEA Central Framework are aligned with SNA. This means that environmental assets are valued only with reference to the income streams recognized in standard economic accounting (e.g. profits from the extraction of resources, royalty flows to governments, etc.). Other potential inclusions in the value of environmental assets (amenity benefits, filtration services, etc.) are considered in ecosystem accounting.

The use of SNA-based valuation principles permits the estimation of the value of depletion of environmental assets in a manner consistent with the derivation of consumption of fixed capital (depreciation) and using a measurement scope aligned with the income measures of GDP. Consequently, the SEEA Central Framework is able to define a coherent depletion-adjusted measure of GDP (United Nations *et al.*, 2013, section 6.2.4, p. 241). It is noted that a distinction is drawn

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between the depletion of an individual environmental asset (e.g. the depletion of oil and gas resources) and the degradation of environmental assets where the broader decline in quality and condition of an ecosystem is in evidence. Conceptually, the measurement of degradation is far more challenging than accounting for depletion.

Accounting for environmental assets may be of direct use in natural resource management and in assessment of sustainable incomes and production of primary industries. Further, as the valuation approach applied is consistent between different natural resources and with produced assets such as buildings and equipment, it is possible to aggregate the values of different assets to obtain measures of net worth at the sector and national level.

**4.4 Accounting for land and ecosystems** [5]

Accounting for land is seen as distinct from the measurement of individual environmental assets such as timber, water and soil. In the SEEA, land is seen as reflecting the space within which economic activity takes place and environmental assets are situated. In the SEEA Central Framework, accounting for land comprises accounting for changes in the composition of land use and land cover within a country, noting that changes in the overall area of a country are likely to be relatively infrequent accounting considerations.

Accounting for ecosystems, as introduced above, is effectively an extension of land accounting. It aims to account for the change in quality or condition of a country's spatial areas, where the spatial areas may be classified in different ways:

- by type of ecosystem (e.g. forests, wetlands, agricultural land);
- by administrative units; or
- by some other criteria (e.g. river catchment areas).

Declines in ecosystem condition due to economic or human activity may be considered to constitute degradation.

In addition, ecosystem accounting complements the measurement of ecosystem assets by accounting for the ecosystem services generated by those assets. In general terms, this is an application of the standard accounting relationship between income and capital. In line with the general direction of work on measuring ecosystem services, as in projects such as the Millennium Ecosystem Assessment (MA, 2005), The Economics of Ecosystems and Biodiversity (TEEB, 2010) and the European Union's Mapping and Assessment of Ecosystems and their Services (Maes *et al.*, 2013), SEEA Experimental Ecosystem Accounting recognizes that the scope of ecosystem services is broader than the contributions that ecosystems make to the generation of goods and services measured in GDP. Thus, there are services, such as carbon sequestration and storage, flood protection, water purification and cultural services (among many others), that should be recognized in a complete accounting system. The corollary of extending the scope of ecosystem services beyond contributions to GDP is that the production and income boundaries are enlarged compared to GDP and the potential value of environmental assets is increased relative to the standard valuations of environmental assets defined following the SNA and the SEEA Central Framework.

A large number of aspects of accounting for ecosystems and ecosystem services have been described in SEEA Experimental Ecosystem Accounting by synthesizing a wide range of work in this area. Nonetheless, there remain many measurement challenges. These measurement challenges largely reflect the fact that the relationship between the income (ecosystem services) and the capital (ecosystem assets) is far more multi-faceted than for standard economic assets such as buildings and

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machines. That is, ecosystem assets will tend to have multiple owners and beneficiaries and can generate a variety of mixes (or baskets) of ecosystem services.

These characteristics of ecosystems have two particular accounting implications. First, it is not straightforward to assign the cost of any degradation to economic units, as one economic unit's use of an asset may have impacts on multiple economic units. Second, for asset valuation purposes (and hence to obtain estimates of the valuation of degradation), it is necessary to assume a future pattern of use of the ecosystem by multiple users of multiple ecosystem services. Both implications are not confronted in standard accounting for produced assets that have single owners/users and single streams of income.

The main rationale for land and ecosystem accounting is the assessment of trade-offs in situations where areas of land may be used for different purposes. If decisions are made solely on the basis of income from economic production, the trade-off against other benefits that may be obtained but which are more of a public good character will not be recognized. Supporting the assessment of trade-offs in forestry between timber production and the benefits of carbon sequestration and water purification is an example of the type of decision that may be supported from this type of accounting. Land and ecosystem accounting should also support more structured reporting on overall environmental condition.

### 4.5 Accounting for environmental transactions [6]

The predominant focus in natural capital accounting is on integrating environmental information into standard economic accounts. However, also of interest is the potential to glean information from standard economic accounts about activities undertaken by economic units that may be considered "environmental".

To this end, the SEEA Central Framework defines the environmental activities of environmental protection and resource management as constituting a scope that can be used to classify various standard economic flows such as output, value added, investment and employment. The SEEA Central Framework defines environmental protection expenditure accounts to record expenditures by governments, households and businesses that have the purpose of maintaining or improving the environment. The SEEA Central Framework also defines the Environmental Goods and Services Sector and an associated set of indicators that may be used to provide ongoing estimates of output and employment in environmental activities as a share of overall economic activity.

To further aid assessment of the policy response to environmental issues, this area of accounting provides definitions for environmental taxes and environmental subsidies and similar transfers. Particularly at an international level, consistent definition of these types of variables permits an assessment of alternative policy responses.

### 4.6 The sequence of environmental accounts [7]

One of the strengths of accounting frameworks is their ability to draw together a wide range of information in a complementary and internally consistent way. This strength is demonstrated in the description of the connections between the different types of accounts, known in national accounting as the sequence of accounts. The typical sequence of accounts, as shown in Table III, links production, income, consumption, saving, capital formation, financial transactions and balance sheets.

The SEEA Central Framework augments the standard sequence of national accounts presented in the SNA by recording depletion of environmental assets as a cost against income in the same way as the

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depreciation of produced assets is seen as a cost against income. In doing so, the SEEA Central Framework provides a standard measure of depletion-adjusted GDP and related measures of national income and saving. This depletion-adjusted measure may be regarded as an improved measure of economic activity, as it incorporates adjustment for a broader range of costs than usually recognized.

**Table III.** Basic SEEA sequence of accounts

| | |
|---|---|
| *Production account (elaborated in supply and use tables)* | |
| Main entries | Output, intermediate consumption, consumption of fixed capital, depletion |
| Balancing items/Aggregates | Gross value added, gross domestic product, depletion adjusted net value added, depletion adjusted net domestic product |
| *Distribution and use of income accounts* | |
| Main entries | Compensation of employees, taxes, subsidies, interest, rent, final consumption expenditure, consumption of fixed capital, depletion |
| Balancing items/Aggregates | Depletion adjusted net operating surplus, depletion adjusted net national income, depletion adjusted net saving |
| *Capital account* | |
| Main entries | Acquisitions and disposals of produced and non-produced assets |
| Balancing item/Aggregate | Net lending/borrowing |
| *Financial account* | |
| Main entries | Transactions in financial assets and liabilities |
| Balancing item/Aggregate | Net lending/borrowing |

**Table III.** Basic SEEA sequence of accounts

**Source:** United Nations *et al.* (2013, Table 2.5, p. 22)

## 5. Limitations of the SEEA approach and required research

There is no doubt that the SEEA has come to cover a wide range of aspects of natural capital accounting. The descriptions provided in the SEEA 2012 provide important observations concerning accounting in physical and monetary terms; accounting for individual environmental assets and their depletion; accounting for more recent issues such as carbon, biodiversity and ecosystem services; and accounting for environmental activities and aspects of green economic growth. Notwithstanding this broad coverage, there are a number of aspects of the SEEA 2012 that must be regarded as limitations and as areas requiring further research and testing.

### 5.1 Coverage

In the space of limitations, the SEEA does not incorporate accounting for all forms of capital. This is not a limitation with respect to natural capital accounting *per se* but, in the context of measuring the sustainability of broader notions of well-being, it is likely that explicitly incorporating human and social capital is required. Consequently, SEEA-based measures such as depletion or degradation-adjusted GDP should not be considered equivalent to indexes of well-being and progress such as the GPI and the HDI. The great advantage of these indexes is that they do provide a broad and more comprehensive scope.

At the same time, as the SEEA integrates environmental information with standard economic data, it may be appropriate to develop broader measures of progress that themselves incorporate a SEEA-based indicator, such as depletion or degradation-adjusted GDP, rather than using GDP or household consumption as an economic variable together with another group of indicators to capture environmental matters.

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While the SEEA does not incorporate human and social capital, from an accounting perspective, some important advances in this area have been made through the avenue of wealth accounting, as noted in Section 2. It should be possible to see improved connections between the wealth accounting work and the work being undertaken for the SEEA, as it pertains to the measurement of natural capital. In particular, the organization of information on the stock and changes in stock of environmental assets in non-monetary terms using the SEEA should be of direct use in the compilation of wealth accounting estimates.

Broadening accounting frameworks to encompass so-called multiple capitals is also being pursued at a corporate level through the work of the Integrated International Reporting Council (IIRC) (IIRC, 2013). Of note, in comparison to the work of the SEEA, the IIRC's integrated reporting framework does not define explicit measurement or reporting boundaries for each of its six forms of capital. This highlights the likely challenges in fully accounting for all forms of capital, as there are likely to be important trade-offs between capital types (e.g. between produced and human capital) and inter-dependencies (e.g. between natural capital and human health/capital).

These issues become clear when defining the scope of valuation for different forms of capital, which, for accounting purposes, requires a clear link between a flow of benefits and an underlying asset. It is likely that some benefits will reflect a combination of inputs from different forms of capital, and hence, the definition and attribution of value to specific capital types is likely to be challenging.

### 5.2 Spatial scale

The SEEA has been designed for application at a national level. The nature of the approach is thus to enable consistent recording of different environmental stocks and flows across multiple locations and ecosystem types. For example, the asset accounts for different environmental assets take the same form and the supply and use tables for energy, water and other environmental flows all use the same SNA production boundary to delineate the environment and the economy. While this approach works well in the context of the SEEA Central Framework, it is far more challenging to apply at the level of ecosystems which are much harder to define in spatial terms. Importantly, one issue that has not been resolved in the SEEA Experimental Ecosystem Accounting model is how best to record the multiple and often unknown ecological dependencies between different ecosystems. While at one level the effect of not fully articulating these dependencies may net out at national level, this is not strictly the case and also makes the application of the model to corporate and global levels challenging. This is an important area of future research.

### 5.3 Valuation

Valuation is commonly a contentious issue in natural capital accounting with some viewing valuation of environmental assets and their services as the commodification of nature and hence not conducive to improved decision making (McAffe, 1999; Kosoy and Corbera, 2010), while others consider that unless there is valuation, there cannot be integration or mainstreaming of natural capital considerations (Costanza *et al.*, 1997; TEEB, 2010; World Bank, 2011). The SEEA has therefore trod a careful line. It is undoubtedly the case that full integration with the standard economic accounts requires valuation of environmental stocks and flows. At the same time, there is a significant amount of information in physical terms on environmental stocks and flows that may be better organized in a manner consistent with economic data (e.g. using standard industry classifications). Information in physical terms, compiled regularly overtime within an accounting framework, would support the process of mainstreaming this information into decision making. This might include, for example, integration of physical information on natural capital into risk management frameworks.

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When valuation is undertaken, there is no doubt that it is a difficult task, as transactions in environmental assets and services are not generally observable. Notwithstanding the practical difficulties, the SEEA takes a particular view on valuation requiring that for integration purposes (with the standard economic accounts), it is necessary to use exchange values – i.e. the prices at which the assets or services would be exchanged if a market existed (SEEA Experimental Ecosystem Accounting, 5.9). This conception of value is different from that used for economic analysis where the focus is commonly on the change in economic welfare associated with different uses of the environment. Welfare-based values are related to exchange values used for accounting but also include consumer surplus, i.e. the additional benefit that consumers/purchasers obtain by paying less than they would have been willing to pay for the asset, good or service.

While this distinction between welfare and exchange values is recognized by practitioners (Bateman *et al.*, 2011), most focus in the development of environmental values has been from a welfare perspective and only a sub-set of methods explicitly target the estimation of exchange values for environmental goods and services.

Even though exchange values may be the appropriate values for accounting purposes, the exclusion of consumer surplus means that there are some aspects of the environment that are less likely to be captured in accounting frameworks. For example, values including consumer surplus are likely to be relevant in better understanding our extensive cultural connections to the environment and various intrinsic environmental values. Whether and how such aspects might be incorporated into accounting frameworks is an important question.

### 5.4 Research agendas of the SEEA

Both the SEEA Central Framework and SEEA Experimental Ecosystem Accounting contain research agendas. They highlight important issues requiring further investigation and deliberation. Some issues concern measurement and integration, such as the need for widely adopted international classifications of land use, land cover and ecosystem types to support time-series and cross-country comparisons. Other issues relate to particular topic areas where the application of accounting principles is not well-established or has some particular challenges. Examples of this include accounting for soil resources, the valuation of water resources and accounting for biodiversity.

A final set of issues relates to establishing a more complete integration of environmental stocks and flows with the standard economic accounts. A particular challenge here is the definition and treatment of ecosystem degradation. This area requires additional discussion to consider both the valuation of non-market environmental flows and how the well-established area of externalities from economics can be applied most effectively within a national accounting setting.

In addition to these theoretical and conceptual matters, a wide array of practical challenges exist (such as the measurement of ecosystem services and the condition of ecosystem assets), and it is essential that efforts to test the current descriptions of SEEA and related natural capital accounting standards are supported. One of the lessons over the past 20 years from those countries that have been testing various iterations of the SEEA has been that there are substantial benefits simply from attempting the accounting approach. Learning by doing is very true in the accounting space.

## 6. Future directions for natural capital accounting

From an official statistics perspective, the adoption of the SEEA Central Framework as an international statistical standard has provided renewed energy to the integration of environmental information into standard economic measurement and accounting. This integration is seen as central to the process of mainstreaming the discussion of natural capital, particularly in economic

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and planning policy discussion. There are many direct and related initiatives to which the SEEA is related, and this section provides a sense of just some of the natural capital accounting work that is underway.

The SEEA Central Framework's status as a statistical standard obliges the United Nations and other international agencies to encourage and facilitate the development of statistical programs that introduce and maintain natural capital accounting at the national level. At this stage, there is no mandatory reporting, but countries are encouraged to adopt a flexible and modular approach to the implementation of the standards, taking into account relevant policy contexts, data availability and statistical capacity (United Nations *et al.*, 2013, p. 9).

In this setting, the UNSD has commenced a program of raising awareness and support for the implementation of SEEA, including drafting an overarching implementation guide (United Nations, 2013) and developing training material. UNSD also has recently commenced a joint program of work with the United Nations Environment Program (UNEP) and the Secretariat of the Convention on Biological Diversity (CBD) to advance ecosystem accounting in seven countries – Bhutan, Indonesia, Vietnam, South Africa, Chile, Mexico and Mauritius.

A natural capital accounting program that is being advanced by the World Bank is its Wealth Accounting and Valuation of Ecosystem Services (WAVES) initiative. The WAVES program is directed at ministries of finance and planning encouraging them to adopt natural capital accounting as a central part of their policy development. There are currently eight implementing countries (World Bank, 2014). The WAVES program adopts the SEEA as its technical guidance for accounting.

Still at the international level, close connections are being drawn between the natural capital accounting outlined in the SEEA and the development of indicators for the sustainable development goals (SDGs) being established as part of the United Nations Post-2015 Development Agenda. The connection here is that natural capital accounting can provide the organizing framework for information on economic-environmental linkages and thus can serve as a base for improved measurement and assessment in relation to a number of different SDGs. This is a particularly relevant development in the ambition to go beyond GDP in assessing well-being and progress, and in meeting one of the objectives of the CBD's Aichi targets to integrate biodiversity into national accounting by 2020.

In the corporate sector, there is an increasing appetite for integrating environmental information in corporate measurement, assessment and reporting. Broad initiatives include the work of the Global Reporting Initiative (GRI), and the International Integrated Reporting Council (IIRC). There is specific work on natural capital accounting protocols by the Natural Capital Coalition and as part of the United Nations Environment Program – Finance Initiative (UNEP-FI). Overall, while there are some differences between accounting at the national and corporate level, the majority of the accounting principles are the same and much of the thinking underpinning the establishment of accounting standards in the SEEA may well provide a basis for the drafting and discussion of similar standards at the corporate level. In turn, the work that has been completed on accounting for natural capital at the corporate level, for example the environmental profit and loss statement of Puma (2011), may provide insights into the challenges that remain for the SEEA.

An associated consideration is that, once implemented, the SEEA is likely to provide industry-level benchmark information on environmental stocks and flows. Such benchmarking (and international comparability) may provide a relevant tool for comparison of corporate accounts and reports. From the opposite perspective, standardized corporate reporting could provide very useful input to national-level accounting for these environmental dimensions. Another avenue of collaboration may be in the development of decision-making support tools – such as risk management frameworks – into which natural capital considerations need to be incorporated.

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Alongside these positive potential connections, it must be recognized that corporate initiatives such as the IIRC and GRI are themselves subject to various concerns. Flower (2015) raises concerns about the focus of the IIRC efforts over the past four years as having become overly focused on broader conceptions of value from the perspective of corporations rather than seeking to embed broader notions of societal value and costs of corporate activity within corporate accounting practice. Adams (2014) rejects these concerns, highlighting the importance of corporations building a broader understanding of their operations and dependencies on multiple capitals. Importantly, however, both authors recognize the relevance of accounting moving beyond its traditional financial capital base.

It is in this broadening of traditional accounting that connections being made between SEEA and various corporate accounting initiatives can be developed further and an alignment of concepts, terminology and standards might be facilitated to the extent appropriate.

From an academic perspective, there are some important connections that remain to be better established. From a purely data supply side, a fully populated set of SEEA data would provide, over time, a higher quality set of base information for all types of analysis at national and international level, such as input–output analysis, computable general equilibrium analysis and life cycle and supply chain analysis. It would also facilitate cross-country comparisons of environmental sustainability issues and has the potential to link to a range of social data (e.g. access to water and energy, nutrition), thus facilitating enhanced assessment of sustainable development.

From a research perspective, there are also a range of potential areas of engagement. Particularly in the area of ecosystem accounting, there is much required research and testing in relation to the assessment of ecosystem condition, integration across spatial scales, the measurement and valuation of ecosystem services, the definition of ecosystem degradation and its allocation to economic units and other areas. The SEEA's accounting framework might thus provide a way in which the different aspects of ecosystem research can be placed in context rather than being seen as distinct, and possibly competing, approaches.

Finally, regarding improving measures of progress, Costanza and colleagues in their article "Time to leave GDP behind" observe that:

The successor to GDP should be a new set of metrics that integrates current knowledge of how ecology, economics, psychology and sociology collectively contribute to establishing and measuring sustainable well-being (Costanza *et al.*, 2014).

While there have been many attempts to develop alternative metrics by combining indicators from various domains, these alternatives have not led to the underlying integration of data from these different domains. Consequently, these indicators find themselves standing somewhat alone and in competition with GDP and its supporting body of integrated economic information.

The work on SEEA and other related developments in natural capital accounting in recent years suggests that, in going beyond GDP, accounting approaches may provide another way forward. This potential lies in the capacity of accounting approaches to integrate different types of information in a rigorous and detailed way. With the integration of data in place, the derivation of alternative measures that complement GDP can follow and thereby lead to the mainstreaming of broader measures of progress using well-established and well-accepted methods. Overall, accounting may well be essential in establishing the new metrics that have been required for so long.

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**Notes**

1. Further details on the history of the development of the SEEA are provided in SEEA Central Framework Chapter 1.
2. For further details, see United Nations *et al.* (2013, Chapter 2).
3. For further details, see United Nations *et al.* (2013, Chapter 3).
4. For further details, see United Nations *et al.* (2013, Chapter 5).
5. For further details, see United Nations and European Union (2014, Chapter 5) and United Nations *et al.* (2013).
6. For further details, see United Nations *et al.* (2013, Chapter 4).
7. For further details, see United Nations *et al.* (2013, Chapter 6).

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