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How the System of Environmental-Economic Accounting can improve environmental information systems and data quality for decision making

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ABSTRACT

The System of Environmental-Economic Accounting (SEEA) is a framework integrating information from different sources with the aim of enabling better decision making by governments, business and others. Accounting allows a wide variety of data to be synthesised so that regular information and indicators are produced and can feed into decision-making processes. The accounting recognises that while there may be discrepancies between different data sources as well as data gaps, government and business must continually make decisions. Over time both the accounts and underlying data improves across the six dimensions of data quality – relevance, accuracy, timeliness, accessibility, interpretability and coherence. In individual data sources the focus is mostly on accuracy (i.e. closeness of estimate to the real number) but accounting addresses all of the six dimensions and has particular strengths in timeliness, accessibility, interpretability and coherence providing data when it is needed in a consistent format. Using examples from high and low-income countries we describe how SEEA can improve information systems and data quality for decision making and distil lessons for the development of the European Shared Environmental Information System.

1. Introduction

The objective of this paper is to outline how better decisions aimed at balancing human and environmental needs can be enabled by having more regular, consistent and integrated environmental and economic information via accounting. In doing this the basic aspects of data quality are described, along with international accounting frameworks for organising information and how these have been applied in three case studies.

The collection, arrangement and availability of data is key to evidenced-based public policy (e.g. Banks, 2008; Head, 2010). Describing and understanding the quality of data being used in decision making is important in science (e.g. Manning et al., 2004; Regan et al., 2005), government (e.g. Vardon, 2013) and business (e.g. Samitsch, 2015). Accepting there is always uncertainty in decision making due to the quality of the data and imperfect understanding of the system(s) that the data describes is an important first step for data providers. Governments, business and others make decisions using the information available and also make assumptions about both future human behaviour (e.g. response to new taxes or subsidies) and the environmental factors (e.g. the weather). Uncertainty in data and imperfect understanding of systems can be reduced through a combination of theoretical and practical measures., which in turn enables better decisions to be made.

National economic policy is underpinned by macroeconomic theory (e.g., Keynes, 1936; Kuznets, 1949; Clarke et al., 1949) and a range of statistics to support this are collected and arranged using the System of National Accounts (SNA) (UN, 1953). The SNA covers all economic activity – production, consumption and accumulation – and all industries (e.g. agriculture, mining, manufacturing, electricity and water supply, health, education, etc.). A key indicator from the SNA is Gross Domestic Product (GDP). The basic theoretical underpinning of the SNA has not changed since 1953 but the detail has continued to evolve with technological, economic and social change (see EC et al., 2009). The SNA is a tried and tested information source, providing both a framework for understanding as well as a place for the data describing the system. For more than 50 years governments and business have used the information from the SNA in economic analysis and policy (e.g. Stuvel, 1955; Ruggles and Ruggles, 1999). However, it has been long recognised that SNA does not adequately account for the environment

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(e.g. Nordhaus and Tobin, 1972) and that economic activity is the key driver of environmental degradation (Rockström et al., 2009).

The System of Environmental-Economic Accounting (SEEA) aims to address this deficiency of the SNA by accounting for the environment and linking it to environmental information through common concepts, definitions and classifications. Environmental information in the SEEA does not rely on one overarching theory of the environment but uses the key theoretical constructs of each discipline (e.g. hydrology, geology, forestry, ecology, etc.). The SEEA has several components: the SEEA Central Framework (UN et al., 2014a); the SEEA Experimental Ecosystem Accounting (UN et al., 2014b); the SEEA Applications and Extensions (EC et al., 2014); and SEEA Water (UN, 2012). Compared to the SNA, the SEEA is not yet widely used in decision making, which is at least partly due to the fact that it has only recently be adopted as an international standard, whereas the SNA has been in place for more than 60 years. However, examples of use are emerging (Smith, 2014; Vardon et al., 2017; Ruijs and Vardon, 2018) and examples related to Guatemala, Netherlands and water management are presented in Sections 2–4 of this paper.

The SEEA helps to improve data quality (Vardon, 2013), and hence reduce uncertainty in decision making by: (1) providing a framework for systematically linking economic and environmental data; (2) identifying and correcting anomalies apparent in different data sources; (3) identifying data gaps; (4) consistently presenting information in accounts from which indicators can be derived; and (5) describing data quality (e.g. providing the mean and standard deviation for estimates derived from surveys). In addition, overtime data quality improves through regular production of accounts, encouraging improvements to existing data and the filling of data gaps.

Government information agencies and scientific researchers usually provide information on data sources and methods, providing a means for those using the data to make assessments of uncertainty and "fitness-for-purpose" of the information for specific decisions or processes. Uncertainty in data sources can be described many ways. For climate change, rightly or wrong an area of contention, the Intergovernmental Panel on Climate Change (IPCC) defines uncertainty as:

> "An expression of the degree to which a value (e.g., the future state of the climate system) is unknown. Uncertainty can result from lack of information or from disagreement about what is known or even knowable. It may have many types of sources, from quantifiable errors in the data to ambiguously defined concepts or terminology, or uncertain projections of human behaviour. Uncertainty can therefore be represented by quantitative measures, for example, a range of values calculated by various models, or by qualitative statements, for example, reflecting the judgement of a team of experts (see Moss and Schneider, 2000; Manning et al., 2004, cited in IPCC, 2007)."

The uncertainty of estimates is sometimes portrayed as a target, with the true value at its centre and the estimates made of the true value represented by arrows hitting the target. In this how close you get to the target is the accuracy of measure, while how closely grouped are the arrows is a measure of the precision. While this is a good representation of the theory, the key issue is that we usually do not know the true value, so accuracy is usually less well known than precision (the ability to repeat the measurement with the same or similar result).

A key aspect of accounting is that as an integrated system it forces many checks and balances in the process of compilation. For example, supply must equal use and all changes between opening and closing stocks must be accounted for, even if this is through the inclusion of balancing items. The use of multiple data sources or estimation procedures forces differences in data to be reconciled.

The internal consistency of the accounting system sets it apart from measures of uncertainty of individual components. The aim is to maximise the usefulness of the data provided by the system (i.e. an overview of the interactions of the environment – land, water, energy, pollution – with the economy), which is not necessarily achieved by maximising the accuracy of every component of the system.

There is difficulty in providing quantitative metrics of uncertainty or data quality in environmental-economic accounting and a range of factors need to be considered when managing and describing data quality (Vardon, 2013). A key point is that in the assessment of data quality, while accuracy is important, it is only one of the dimensions of data quality.

1.1. The six dimensions of data quality

Data quality frameworks are available from a range of international or national statistical agencies. For example, the Australian Bureau of Statistics (ABS, 2009), Eurostat (2005), IMF (2012), OECD (2012) and Statistics Canada (2002). These are all similar and in general describe six dimensions of data quality:

1. Relevance – how well the statistics meets the needs of users in terms of the concept(s) measured, and the population(s) represented;
2. Accuracy – refers to the degree to which the data correctly describe the phenomenon they were designed to measure;
3. Timeliness – which is the delay between the reference period (the time to which the data pertain) and the date at which the data become available; and the delay between the advertised date and the date at which the data become available (i.e., the actual release date);
4. Accessibility – the ease of access to data by users, including the ease with which the existence of information can be ascertained, as well as the suitability of the form or medium through which information can be accessed;
5. Interpretability –the availability of information to help provide insight into the data;
6. Coherence – is the internal consistency of a statistical collection, product or release, as well as its comparability with other sources of information, within a broad analytical framework and over time.

These dimensions also reflect academic notions of data quality (e.g. Clarke et al., 2011).

It is important to recognise that for decision making, data need to be more than accurate and there are often trade-offs between the various aspects of quality. Making information available when it is needed may require, for example, that timeliness be prioritised at the expense of accuracy. For example, the relevance of flood warning is greatly increased by a focus on timeliness rather than accuracy: is it is better to get a flood warning four hours before the flood, with an estimated peak of 4–8 m in height, than a warning 30 min before saying the peak will be 5.6 ± 0.3 m.

While some aspects of data quality can be assessed objectively (these are quantifiable errors mentioned in the IPCC definition of uncertainty), an assessment of the wider concept of fitness-for-purpose is largely qualitative as it also brings to account other factors including user views, the soundness of methodologic practices and corporate culture within the agency compiling data.

A key issue in the production of accounts is availability of data. Repeated production of accounts helps to build trust between different data providers and the producers of accounts. This comes about because of the repeated requests for data usually lead to the development of both administrative and technical mechanisms of data exchange as well as data providers seeing how data are used to create a new product (i.e. the accounts) and how it may be used in decision making. Repeated production of accounts also helps to build trust between account producers and account users.

Underlying the six dimensions of data quality is the notion of integrity – that information policies and practices are guided by ethical standards and professional principles which are transparent. The integrity of data producing agencies may be aided by the laws under