ENVIRONMENTAL STOCKS AND FLOWS

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Contents

Summary

This article demonstrates how environmental accounting can contribute to understanding the relationship between environmental flows and stocks. First, the paper discusses how flow information on natural resource inputs and pollution outputs can be connected to economic activities, describing their relationship to the national accounts. Subsequently, the interaction of these flows with stocks or environmental assets is further discussed. In this respect, a distinction is being made between the quantitative and the qualitative decline in natural resources. Quantitative aspects deal with the direct use functions of natural resources such as mineral and timber reserves while the qualitative aspects concern losses in the natural environment resulting from pollution and land alterations.

1. Introduction

This article explains how human activity may influence the state of the natural environment. Human controlled processes such as production and consumption activities require the use of raw materials, energy, and space. These are supplied by nature but excessive use may affect the natural environment and subsequently reduce the amount or quality of goods and services it can provide. The extraction of materials from the natural environment may result in declining accessible stocks and lead to increasing scarcity of these resources. At the same time, the use of raw materials may entail excavations, land alterations, or the accumulation of waste materials in the environment. This article discusses one approach for representing the relationship between environmental stocks and flows, and human activities in an accounting framework. Purely natural processes are not given much consideration, although it may

be clear that understanding ecological processes is often crucial for understanding certain flow-stock relationships. At the same time, it is acknowledged that a full explanation between human action and resultant natural impacts cannot always be given. While accounting for the various ranges of pollution flows entering the natural environment already requires a substantial amount of information, explaining the resulting quantitative or qualitative changes in environmental or other assets (health) is often hampered by the nonlinear and multidimensional characteristics of the response.

There is a long tradition of economic accounting for income and assets on the micro level (enterprises) as well as on the macro level (national economies). With respect to the latter, the United Nations (U.N.) *System of National Accounts 1993* (SNA) explains in money terms the relationship between production (the income received from production), the expenditure of income (i.e. consumption), and the changes in financial and non-financial assets due to savings and capital formation. However, with respect to environmental concerns, the scope of the SNA is mainly restricted to market transactions and the rather limited set of economic assets it takes into account.

Besides the various kinds of produced and financial assets (and liabilities), the SNA balance sheets include a number of what are known as non-produced environmental assets. These, however, are restricted to assets over which human ownership is enforced and which are capable of bringing direct economic benefits to their owners, either due to their exploitation or due to their holding gains.

When looking at the environment, the limited scope of the SNA has principally two dimensions. The first concerns the physics lacking from macroeconomics that are crucial for understanding the environmental consequences of various economic phenomena such as production, consumption, and trade. The second relates to the valuation of environmental scarcity and its potential to review the environmental dimension of welfare. Both aspects indicate the possible direction in which the national accounts should be expanded in order to incorporate environmental information.

Specific parts of the SNA are quite capable of accommodating information on physical flows in the economic system. For example, the accounting identities used for commodity transactions in supply and use tables have often been used to account for the underlying physical quantities or other physical aspect of these commodity transactions. These accounting rules provide a sound basis for recording economic-environmental interactions such as natural resource inputs and outputs of residuals. Further, for certain environmental assets the balance sheets in the SNA can be helpful to systematize information on the human influence on natural assets such as the extraction of natural resources, and the effects of pollution on natural assets, or on produced capital such as the effects of acid rain on buildings.

The *System of Environmental and Economic Accounts* (SEEA) published in 2000 was developed as a framework to extend the SNA with environmental accounts. The SEEA is a multipurpose system to categorize, organize, and present information on physical flows of material and energy in connection with economic transactions and activities as described in the SNA. Secondly, the system includes a comprehensive description of natural assets in balance sheets. The close link to the national accounts allows the use of

this database for economic tools and models to assess the driving forces (structures and activities of society) and pressures on the environment, and the responses by society as well as the pressures triggering these responses.

The SEEA also allows for monetary valuation of environmental stocks and flows. However, the application of non-market valuation in an accounting context entails considerable methodological difficulty on its own (see *The Valuation Problem and Non-Market Valuation Theories*). It is nevertheless quite clear that non-market valuation of environmental uses requires firstly a sound understanding of the underlying physical aspects.

A preliminary version of the SEEA manual was published in 1993. This was essentially directed towards the compilation of an environmentally adjusted national income indicator. Since then, much new experience has been gathered in the development and implementation of physical accounts. Comprehensive systems of physical flow accounts have been developed in countries such as Canada, Japan, Philippines, and European Community (E.C.) member states. The revised SEEA represents a wider range of accounting methods, each connected to specific problem fields. In this respect the SEEA 2002, on which representatives of the London Group of Environmental Accounting have worked, is an internationally agreed manual on best practices rather than an international standard. This article represents some of its basic principles.

This article is structured as follows. In the following section, the physical and biotic world is divided into the economic sphere and the natural environment. This demarcation is introduced to support a systematic explanation of human-nature interactions. The third section defines different types of physical flows, and groups them together into natural resource flows, product flows, and residual flows. The two sections that follow are devoted to flow-stock relationships, where a distinction is made between the quantitative and the qualitative decline in natural resources. The quantitative aspects deal with natural resources such as minerals, energy, timber, game, and fish reserves, which prefigure indirect use functions. The qualitative aspects concern losses in the natural environment resulting from pollution, land alterations, and excavations that are sometimes referred to as degradation.

2. The Economic Sphere and the Natural Environment

In analyzing the influence of human behavior on the natural environment, we have to consider which elements of the physical or biotic world are part of human creation. In order to provide a clear and systematic description of all human interactions with the environment, a separation can be made between the economic and the environmental sphere, although at first glance such a separation may seem somewhat artificial.

The economic sphere is defined as all the underlying physical flows and stocks that coincide with economic transactions and human produced assets. The environment is simply characterized as all other physical and biotic appearances that do not belong to the economic sphere. Subsequently, produced assets (buildings, infrastructures, machinery equipment, etc.) are part of the economic sphere while non-produced assets are considered elements of the natural environment. It should be recognized that non-

produced assets liable to ownership are explicitly included in the SNA. The fact that these assets are non-produced indicates that they are outside the economic sphere. Therefore, it is logical to describe the extraction of natural resources as a (physical) transfer from the environment to the economic system.

From a spatial perspective, it is clearly impossible to divide the world into an economic sphere and the natural environment, since both are usually entwined. However, it is possible to divide up all possible physical or biotic transformation processes in that way. Production and consumption are the only processes that belong to the economic sphere. Production and consumption activities may have an impact on ecological processes. However, these processes are not transferred into the economic sphere. From a national accounting perspective, all other processes are regarded neither as consumption nor as production, and take place entirely in the natural environment.

For the material flows associated with agricultural and forestry production, distinguishing between the economic and the environmental spheres is particularly difficult. According to the SNA, economic production includes cultivation of plants and animals. An exception holds for wild biota, the consumption of which is considered an extraction from nature. Unlike most other human controlled processes, agricultural and forestry production is mainly the result of biological metabolism interacting more or less directly with the natural environment. Since this biological metabolism is influenced by human intervention because of water regulation, ploughing, harvesting, and the use of fertilizers and pesticides, agricultural production and animal husbandry are included in the economic sphere.

The SNA delimits the national economy from other foreign economies (i.e. “the rest of the world”) by the following two key principles.

2.1. Economic Territory

The SNA defines the economic territory of a country as the geographic territory administered by a government within which persons, goods, and capital circulate freely. All land and structures within the economic territory is deemed to be sufficient in itself for the owner to have a center of economic interest in that country. In other words, the owner is by definition regarded as a resident entity. In environmental accounting, a broader demarcation can be applied, including a wide range of natural assets without direct use functions and not represented in the SNA. Equally, these assets are supposed to be situated on economic territory and, as such, under the management responsibilities of a resident unit (one could argue whether nature is subject to ownership).

However, this demarcation is applicable only to assets with locally bounded appearances, so that it is meaningless to assets with appearances on supranational scales such as the ozone layer and global climate regulation (the greenhouse effect). Secondly, non-territorial waters fall by definition outside the economic territory of a nation. Management responsibilities for both climate and oceanic oriented assets (Antarctica) are principally subject to international agreements.

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Biographical Sketch

Mark de Haan obtained his master's degree in economics at the Erasmus University Rotterdam, his main subjects being macroeconomics and environmental sciences. In 1992, he started his professional career at Statistics Netherlands with the development of the National Accounting Matrix including Environmental Accounts (NAMEA), an environmental information system that has been adopted by many other countries. He has published articles on environmental accounting, integrated economic and environmental analysis, and on the incorporation of environmental issues into macroeconomic models. He also contributed to the revision of a statistical handbook on integrated environmental and economic accounting (SEEA 2000). Currently, he is employed in the research department of the Division of Macroeconomic Statistics and Dissemination of Statistics Netherlands, where he is responsible for research in national accounts methodology and satellite accounting.