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Natural Capital Accounting

Renewable natural resources are being impacted by a range of pressures, such as biodiversity loss and climate change. A minimum level of natural resources is required to maintain the capacity of ecosystems to sustain human well-being at acceptable levels.[1] If governments do not monitor effectively the use or degradation of natural resource systems in national account frameworks ('environmental accounting'), the risks of incurring costs to future economic productivity are not taken into account, nor are impacts on human wellbeing.

Overview

- Natural capital is environmental assets, such as soils, from which beneficial services flow supplying resources to the economy, for example, agricultural crops, and disposing of its wastes, such as treated sewage effluent.
- Better understanding of the mechanisms that link ecological systems to human well-being are required to assess both the value of benefits from natural resource systems and the expenditure required to maintain the capacity to supply benefits.
- If the gap between the level of physical investment in natural capital required to maintain services and the level actually achieved could be determined, environmental accounting could then be used to calculate how far economies are from being within environmental limits.
- This would require additional integrated measurement tools to be developed and validated to inform national environmental accounts, such as relevant sets of indicators.

Natural Capital

The term 'capital' is used to describe a stock or resource from which revenue or yield can be extracted. Human wellbeing arises from the use of a combination of types of capital: social capital, human capital and built capital; but these are all based on natural capital. Four basic categories of natural capital are generally recognised: air, water (fresh, groundwater and marine), land (including soil, space and landscape) and habitats (including the ecosystems, flora and fauna which they both comprise and support).[2]

Natural capital cannot be always restored if degradation of ecosystems leads to irreversible changes, or to species that have important roles in ecological processes becoming extinct. When natural capital assets are depleted in quantity or degraded in quality, the flows of beneficial services to people are affected. Examples are decreased catches from overexploited fish stocks or decreased crop yields from degraded soils. Key processes include the production of biomass and oxygen, and the regulation of hydrological and atmospheric cycles. Policy decisions lead to actions that can impact on natural capital via changes in ecosystem structure and function, which in turn alter ecosystem services (Box 1). For example, the recreational, amenity and other benefits used by the population around a 1km stretch of a river would be reduced if policies significantly diminished the quantity of water and/or if water quality deteriorated. Commentators have suggested that maintenance of stocks of natural capital must become an explicit, accountable, and implemented element of policy.[3]

The Flow of Benefits from Natural Capital

Some benefits arising from natural resources, such as agricultural commodities, are traded on markets. However, there are difficulties in obtaining widely agreed economic values for the benefits that natural capital provides if:

- they do not have a directly traded market value,

- the traded value 'externalises' many hidden costs, such as impacts on water resources and biodiversity.

Box 1 Ecosystem Structures, Functions and Services

Ecosystems are composed of physical, biological and chemical components such as soils, water, organisms and nutrients (Figure 1). Interactions among and within these give rise to ecosystem functions, an intrinsic characteristic of the ecosystem, such as nutrient cycling. These are fundamental to an ecosystem, maintaining its integrity. These interactions between structures and processes, which may be physical (such as infiltration of water), chemical (such as oxidation) or biological (such as photosynthesis), nearly all involve biodiversity – the variety of genes, species, and ecosystems that constitute natural resource systems - although this relationship is not always straightforward. Ecosystem functions determine the capacity of a natural resource system to sustain ecosystem services, such as food provisioning, soil stabilisation, flood protection, regulation of the chemical composition of the atmosphere and pollination, on which human wellbeing directly depends. The Millennium Ecosystem Assessment (MA) separated these services into four categories: provisioning services such as food and water; regulatory services such as flood and disease control; cultural services such as spiritual and recreational benefits; and supporting services such as soil formation, photosynthesis and nutrient cycling that maintain the conditions for life on Earth (POSTnote 281). The ecological functions that contribute to an ecosystem service may also be a service in their own right, for example water quality is an intermediate service for other ecosystem services such as the provisioning service of fish for angling.

For natural capital assets lacking market values, unmodified markets will undersupply supporting activities and oversupply activities that reduce them through environmental degradation, risking the breaching of ecological thresholds at some future point.[1] Current policy approaches attempt to balance environmental protection against economic growth. This has failed to halt loss of benefits and increases in environmental risks, despite regulatory and legislative approaches to conserving natural capital stock, such as statutory area-based conservation designations. [1]

Natural Capital Accounts

The Globe International Commission on Land Use Change and Ecosystems recently produced a Natural Capital Action Plan for the 'Parliamentarians and Biodiversity' session at the tenth Conference of the Parties to the Convention on Biological Diversity (CBD). This recommended that a ministerial position should be created within finance ministries or treasury departments for managing natural capital. In addition, such ministries should develop a comprehensive set of natural capital accounts accompanied by a report that outlines which policy choices would be affected by integrating the true value of ecosystem services into policy decisions.

It also recommended an inter-departmental Ministerial Committee on Natural Capital to oversee these accounts, advised by an expert technical advisory group. Individual government departments should be tasked with developing natural capital inventories of natural capital assets for which they are responsible, with external auditors of government expenditure, (such as the National Audit Office [NAO] in the UK case), to issue public reports on the economy, efficiency and effectiveness of government policies on natural capital issues.[4]

The development of national-scale accounting and performance assessment for natural capital stocks and flows will need to be consistent with conventional national income accounting, the principles of the underlying ecology and be measured consistently over time. Any accounting framework needs to describe the stock *and* flow of natural capital, to allow accounting and analysis of the interactions between the economy and the environment. With some forms of natural capital, such as forests, the flow of benefits (timber) needs to be exploited at a rate which the overall stock (the forest) is maintained over time to avoid damaging the ecological infrastructure that supports it. The present value of a stock of natural capital incorporates a measure of the future flows of benefits that it can generate.

To inform environmental accounts it needs to be established how natural capital and economy interactions manifest themselves in physical terms and how to select the appropriate data to describe these. Accounts could detail changes in ecosystem quantity and quality either in physical units based on different indicators of ecosystem functioning, or on changes in the monetary value of benefits flowing from an ecosystem. Over time, the stock of an ecosystem will change depending on the balance between human uses that degrade or restore it, and the quality of the stock of ecosystems may change with the level of pressures that impact on ecological processes.

Accounting for Changes in Ecosystem Services

Ecosystem services are a conceptual device that is helpful in understanding the transformations that link humans to natural capital by making a distinction between the natural capital assets that give rise to a flow of benefits and a particular aspect of human well-being (Box 1). Broadly speaking, accounting frameworks require at least three things: the definition and measurement of quantities; the aggregation or adding-up of those quantities; and, weights for the individual elements in the aggregation index. With regard to ecosystem services, this entails:[5]

- defining the size of the system, including definition of which and how many natural capital stocks are relevant to any given ecosystem service;
- weighting these stocks appropriately, to allow an accounting price to be estimated for each of them; and,
- estimating the growth (or decline) in stocks and the conditions for the flows of ecosystem services from these stocks (on the basis of modelling).

Ecosystem Service Valuation Frameworks

Ecosystem Service Valuation Frameworks have been suggested as a basis for describing the stock and flow of natural capital for accounting purposes. Rather than being a complete valuation of every aspect of the environment, they are intended to clarify the complex nature of interactions between it and humans and to reflect the implications and trade-offs inherent in policy choices.[6] Several essentially similar valuation frameworks have been proposed by the US National Research Council, the Natural Capital Project, the US Environmental Protection Agency Science Advisory Board, the French Council for Strategic Analysis, The Economics of Ecosystems and Biodiversity (TEEB) and the and the UK National Ecosystem Assessment.[7]

These frameworks separate the core ecosystem processes integral to ecological infrastructure from beneficial processes directly linked to ecosystem service provision (Box 2). Ecosystem services are defined as those aspects of ecosystems used to produce human wellbeing, with the ecosystem service being the link between ecosystems and the things that benefit humans,[8] (Figure 1). Ecosystem services are transformed to provide benefits by other forms of capital, such as built capital. For example, the ecosystem service of clean water provision requires water treatment and distribution infrastructure to realise the benefit of drinking water.[9]

Box 2 Ecosystem Service Valuation Frameworks

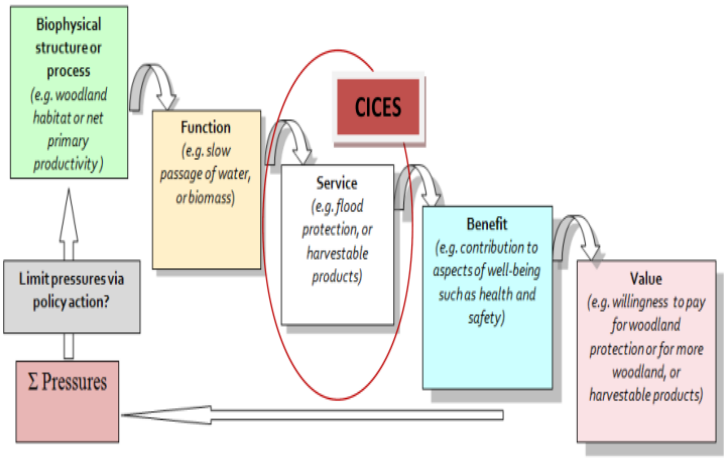
The term ecosystem service is applied by the MA both to outcomes that can be directly used and measured, such as water quality, and to processes that lack a distinct output in terms of human well-being, such as nutrient cycling (Box 1). By contrast, many ecosystem service valuation frameworks are based on the assumption that services arise at the point at which an ecosystem provides an asset that is used by humans, with outputs such as nutrient cycling classed as ecosystem functions.[10] As such, valuations are attached to the benefits arising from the flow of natural capital rather than to the stock of natural capital itself. By avoiding mixing the ecosystem functions and the services they generate, (the means and the ends), they aim to eliminate double-counting in economic valuations of natural capital stocks. Frameworks usually separate ecosystem interactions into two categories:

- core ecosystem interactions that underpin basic supporting functions, such as nutrient cycling and retention, also referred to as 'intermediate services'; and,
- interactions that underpin processes that directly benefit human well being, such as water quality, referred to as 'final services' or ecosystem services.

Ecosystem Service Classification for Accounting

The scale and relative importance of ecosystem services to society at the local and global scales has yet to be fully determined. There is also a lack of integrated measurement and accounting tools to evaluate the contribution of ecosystem services to national incomes. However, the European Environment Agency has suggested a 'Common International Classification for Ecosystem Services' (CICES) could be developed.[10]

Figure1 Context for CICES[10]



This would be consistent with accepted typologies of ecosystem goods and services, such as the Millennium Ecosystem Assessment (MA), and compatible with the design of integrated environmental and economic accounting methods being considered in the UN System of Environmental and Economic Accounts (SEEA, Box 3). The need for CICES arises because at present there is no accepted classification of ecosystem services defined for accounting frameworks. The current valuation frameworks are designed to inform individual policy decisions, rather than as a link to the classification systems used in economic and environmental accounting.

Box 3 The UN System of Environmental and Economic Accounts

The 2003 SEEA handbook provides a framework for incorporating the role of the environment and natural capital into measures of the economy through a system of satellite accounts alongside the system of national income accounts (SNA). The SEEA has a structure similar to the SNA, consisting of both stocks and flows of environmental goods and services. Physical accounts help set priorities for policy, based on the volume of resource use, pollution and so on, while monetary accounts identify the relative costs and benefits of reducing pollution or resource use. The SEEA 2003 maintains four categories of accounts:

- natural resources asset accounts, which record the volume and economic value of these stocks and changes in them, in both physical and monetary terms;
- flow accounts for environmental management and protection, which provide information at the industrial sector level about inputs such as the use of energy and materials in production (including the input of non-market environmental services) and outputs in terms of pollutants and solid waste;
- expenditure on environmental protection and natural resource management and other environmental financial transactions, including taxes, fees and property rights in relation to the environment; and,
- valuation of non-market flows and environmentally adjusted aggregate indicators.

Most environmental assets are not traded in markets, and those that are such as mineral deposits, fish or timber do not have their depletion factored into the SNA asset accounts. The SEEA calculates the cost of traded natural resources according to conventional economic rules. Most developed countries focus their environmental accounting efforts on pollution damage and control costs and material and energy flows in their economies rather than on the depletion and degradation of natural resource systems. The 2012 UN SEEA revision will be split into two volumes, the first a set of standardised methods for environmental accounting that can be integrated with the System National Accounts (SNA), including the existing four categories, with the second volume covering areas where there is not yet a standardised methodology, such as ecosystem accounting.

CICES aims to describe the links between ecological structures and processes and the benefits that flow from them, while broadly reflecting the categories of ecosystem service that are discussed in ongoing international initiatives on Ecosystem Service Valuation Frameworks, such as TEEB. CICES is intended to describe the connections between the biological and physical components of ecosystems and the various products and activities that are wholly or partly dependent on them, illustrating the 'pathway' from ecosystems to human well-being while avoiding the issue of double counting processes and benefits (Figure 1). Only three broad thematic categories are suggested as the basis of CICES; provisioning, regulating and cultural outputs. These can be further subdivided into nine generic classes, such as nutrition or regulation of wastes, and these can be cross referenced to existing standard classifications for activities and products used in the System of National Accounts.[11]

Metrics for Ecosystem Accounting

The recent TEEB report for policy has extensively discussed the options for developing indicators for natural capital and ecosystems within national accounting frameworks.[12] TEEB builds on studies undertaken by the European Environment Agency (Box 4), which has been developing and testing a system of ecosystem accounts as part of the revision of the UN System of Integrated Economic Environmental Accounting undertaken by the UN London Group.[13]

Box 4 Ecosystem Accounting Metrics

Ecosystem accounting indicators are intended to measure three key issues:

- whether the ecosystem asset is being maintained over time through natural processes both in terms of quantity (the stock of ecosystems) and in quality (the capacity of ecosystems to maintain benefit provision) at levels consistent with the current and future requirements of society
- whether the full cost of maintaining the stock and quality of ecosystems is covered by the current price of goods and services produced the economy
- how the flow of ecosystem goods and services supplied for human use is factored into the overall calculation of wealth or social well-being.

The EEA has proposed a framework of metrics required to ensure both that ecosystem integrity is being maintained and that the required output of ecosystem service benefits is being achieved. This framework was used to show ecosystem accounts could be implemented in four coastal Mediterranean wetland test studies.[14] The aim of constructing accounts was to determine whether the value of natural capital of the wetlands was changing over time, with the services associated with these ecosystems categorised in terms of the strength of their link to biodiversity.

To achieve this there will need to be appropriate metrics to determine the amount and quality of ecosystem assets, the level of ecosystem assets required and suitable metrics for determining the gap between requirements and existing ecosystem assets.[1] Any large set of summary indicators of ecosystem accounting may also need to be further combined for national accounting requirements, such as the proposed UK National Well-being Index.

Challenges to Developing Accounting Procedures

National accounts require the systematic description of both the 'costs' and 'benefits' associated with ecosystem service provision. To sustain the flow of an ecosystem service, there needs to be sufficient reinvestment in the stocks of natural capital. This represents the 'costs' of maintaining ecosystem service provision. For example, management measures to conserve biodiversity at levels sufficient to maintain the flow of an ecosystem service is a cost arising from provision of benefits from ecosystems.[15] Only a limited number of studies are currently available that look at the costs of ecosystem service maintenance.[16]

The 'reinvestment' in natural capital may take a number of different forms other than the costs of management measurements, including protection, restoration or forgoing the use of natural capital assets to ensure that natural resource systems retain their capacity to renew themselves. The lack of information about the level of natural capital required to maintain the capacity of ecosystem services at acceptable levels is a major impediment to the development of effective accounts.

Further work is also required to clarify the assumptions underlying valuation classification systems and to develop consistent definitions and a universally accepted ecosystem service typology.[17] Specific challenges to developing methodologies include:

- disentangling the value of an ecosystem service from the benefit which embodies it (for example, water quality and drinking water)
- the cumulative effects of individual economic activities that will only impact on ecosystems in a small way along with small impacts from many other economic activities
- the low incremental economic value of individual environmental impacts versus the long-term cumulative environmental cost of such impacts. For example, although a small area of habitat may have a low current economic value, the cumulative impacts of the losses of lots of small areas of habitat over an extended period will have large impact on the ecosystem services supported by that habitat in a given area
- how changes in natural capital area or stock affect different ecosystem service outputs. For example, the loss of half of a forest would halve the provisioning service of wood production, but could lead to far greater loss of other outputs, such as recreational services.

The Sustainability Gap

The levels of natural capital required to sustain benefits from ecosystem services within acceptable levels are yet to be determined.[1] If they are agreed, the deficit between the level of physical investment in natural capital required and that actually achieved by economies could be calculated. This deficit in the stock of natural capital would reflect the reinvestment an economy needs to make to maintain, protect and restore ecosystems to the level required by society, both within an economy and for any benefits imported. This deficit has been referred to the sustainability gap (SGAP).[18]

Endnotes

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