Land accounting

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1. Introduction

The UN handbook on environmental accounting (SEEA 2003) recognises the possibilities of both stock and flow land accounts in both monetary and physical terms.

Much of the development activity reported in the handbook centres on the compilation and use of physical accounts. A number of countries have also looked into the potential of monetary accounts, either in order to obtain some assessment of environmental damage, or as part of the wider production of asset accounts. However, valuation of land is judged to be difficult because of the comparative rarity of market transactions and the difficulty in distinguishing between the value of the land and the value of existing or potential structures on the land.

Since such accounts will be based, at least in part, upon data on the physical characteristics of the land, the emphasis in this discussion paper is on issues associated with the development of physical land accounting.

1.1 Basic physical land accounts

The SEEA 2003 divides land accounts into a set of four core tables which establish the interface between land use and land cover from an environmental perspective, and a further set of supplementary accounts which are targeted at the provision of issue-oriented data suitable for formulating and monitoring policy. In this context land cover is taken to consist of the biophysical features, while land use refers to the type and intensity of human interactions with the land.

The **first of the core tables** establishes the relationship between land use stock and land cover stock. The SEEA recognises, however, that establishing a single land use for a piece of land might be problematic and that in practice

data might only be available for a single classification which mixes land use and land cover.

The **second core table** is more closely related to the standard national accounts, as it sets out land use by industries and households, based on actual use not ownership. This is also a stock account, which can be linked with the economic activities of each sector to provide information about resource productivity. Again, it can be difficult to determine a primary or dominant use, especially from aerial or satellite surveys, and so fieldwork and other sources of data might be needed in order to make the link with industrial sectors.

The **third table** describes the gross flows between different stocks of land cover over time. (The same analysis can be done for land use changes.) This table provides a basis for analysis of the causes of change. The more detailed the classification the larger the proportion of change that can be described by the basic accounts.

If these gross flows are available it is possible to categorise the types of land cover changes by their principal causes in the **fourth of the basic tables** set out in the SEEA 2003.

1.2 Supplementary physical land accounts

These core or basic tables are the building blocks for a wide range of less standardised accounts which are more tailored for the analysis of particular policy issues. The SEEA suggests that it may be possible and desirable to standardise some of these supplementary accounts once we have gained further experience of developing them.

A characteristic of the supplementary accounts is that they integrate a large number of other data sources. However, a common difficulty is that data for example on the quality of the environment is often fragmented, so it is harder to establish standards.

The SEEA identifies two broad types of supplementary accounts, those which build on the link of land use to the national accounts on the one hand and those that focus on the relationship of land cover to biodiversity on the other.

Land use-based supplementary accounts

The issues covered by the first type of supplementary account concern problems of naturalness and intensity of land use, incorporating information on phenomena such as soil sealing and fragmentation, and formulating closer links with data on economic activities. These accounts can be integrated with data on the intensity of use, for example use of farm chemicals, or data on emissions and waste, water abstraction etc. The detail of geo-referencing used in the sources of information tends to determine the detail of the accounting.

An extension of the land use by industry account focuses on the artificiality of land and the link to pressures/intensity of use. The account may be classified by impacts from industry, agriculture, tourism, transport and settlements.

Land cover-based supplementary accounts

The second set of supplementary accounts is more concerned with the state of the natural environment and its biotope or biodiversity characteristics. It is correspondingly more difficult to establish a link to economic pressures. Biotope accounts are better targeted to nature conservation policy than simple land cover descriptions, but to obtain them it is necessary to cross-classify biotopes with land-cover. The biotope type refers to a statistical classification of vegetation based on species composition.

Biotype accounting often integrates quality indicators. This is because integration of various quality aspects into an aggregate quality classification would only be feasible using normative judgements. Instead, the account incorporates extra columns showing the relevant indicators such as changes in the species richness of different biotopes.

It may also be possible to link these accounts with other data to provide a more systematic, theory-based description of the state of the environment. For example, the biodiversity of habitats can be recorded by indicators of the naturalness of landscape, the biotope diversity, length of linear features, number of endangered species etc. Other potential links are with data on, for example, agricultural land management practices, with habitat data based on different classification systems such as those used for environmental change or other detailed, purpose-designed monitoring, and with data on tourism or other economic pressures. For all these different types of accounts a regional or other sub-national (e.g. watersheds, landscape types, coastal, zonal) disaggregation is possible.

2. Classifications

The clarity and relevance of the classification systems used in the source data for land accounts are critical for their development. The basic accounts require a breakdown by land use and by land cover, but the underlying data derived from surface mapping or satellite imagery may not provide the required level of detail. Where the remote-sensing data is supplemented by detailed field surveys then it should be possible to map the more detailed classification to the broader one used for satellite imagery, but a complete read across may not always be possible.

2.1 Classification of land use

The SEEA 2003 provides an initial classification of land assets, based in part on the System of National Accounts, but does not go on to propose a standard classification of land use (or indeed of land cover).

While a standard classification of land use, allowing direct links with economic activities, is widely recognised as overdue (see for example Eurostat 1999), little progress has been made. The UNECE classification is a possible option but is apparently currently being revised (and a further disaggregation of agriculture would be desirable). The problem of how to deal with multiple uses of individual land parcels will also need to be considered.

2.2 Classification of land cover

The classification of land cover overlaps to some extent with land use, for example for forestry and agriculture. A number of existing classifications have been devised to facilitate the rapid assessment of large areas using remote sensing. Thus data based on the CORINE Land Cover (CLC) classification is available for large parts of Europe.

A particular issue to recognise is that rotational crop practices may lead to a false impression of real-world land use changes. It is also possible that the classification of land cover by altitude may require different thresholds depending upon the geographical area covered, for example upland and lowland grassland may be defined differently according to the country or zone being analysed.

While it may be desirable to develop a standard international classification, such broad constructs (showing for example the extent of deserts or tundra in Britain) may have little relevance to local policy needs, and inevitably more detailed classifications will be required. One possibility is to build on the FAO's Land Cover Classification System, which may become an ISO standard by 2005.

2.3 Classification of habitats, vegetation, landscape types and ecological regions

The classifications of wildlife habitats and landscape type are closely related to those for land cover. Habitat classes may have more specific definitions relating to key biological functions or species, and in the UK a classification of 'broad habitats' has been developed to bridge the two approaches.

Habitats may be further characterised by vegetation type, which can be based upon a phyto-sociological classification focused on vegetation communities of restricted distribution or on categories of vegetation classes which can be grouped according to the major ecological gradients of fertility, shade and moisture.

Classifications of landscape types and ecological regions can be derived from land cover data by analysing the intensity of a given land cover type within an area.

2.4 Classification of causes of change

These are derived classifications which are largely dependent upon the quality of the underlying data. They can be created for either land use and/or land cover changes, as well as for habitat and landscape change. The structure of the classification tends to be similar in each case, providing such categories as agricultural intensification, developed land recycling, water body creation etc. However, no standards yet exist. The relationship with the broader SEEA classification of change into three groups (those due to economic causes, those due to natural causes, and those due to a mixture of causes) should not pose any difficulties.

3. Data issues

3.1 Data availability

There is a clear tension between the need for up-to-date information to inform policy, and the timescale on which many national surveys of land use or land cover are conducted. Significant changes at a national level are usually only observable over a fairly long time scale, and so national data may only be compiled every four or more years. However, major changes can occur quite rapidly on the boundaries of large homogeneous blocks. This suggests that we should sample or survey these transition areas more intensively and more frequently. The costs of these more ad hoc surveys and, where fieldwork is involved, the difficulty of generalising from small samples may well be prohibitive. Often a compromise will be required between the need for summary national indicators and the detailed disaggregations required for policy or management-related analysis. Efficient survey designs are clearly essential and the ability to link information systems (for example with agricultural statistics) is vitally important in order to maximise data use.

Generally geo-referenced land use and land cover data is a pre-requisite. If there is no geo-referenced data available then only accounts of stocks and net changes are possible.

3.2 Data consistency

It is well recognised that the value of data increases more than proportionately with a longer time series. This suggests a need for consistency over time for both fieldwork and land cover mapping, but this may conflict with the need to improve the classifications and the amount of detail collected.

There has to date been little assessment of quality. For field surveys, use of statistical techniques such as bootstrapping may provide some measures. For remote-sensing data, fieldwork providing a measure of ground-truthing and adjustment for known weaknesses may be required. Particular difficulties may occur in attempting to derive estimates of change by comparing pairs of land cover maps, each with their own inherent uncertainties. Further research

is needed into the statistical techniques needed for making such comparisons, in the presence of complex, spatially-structured error and uncertainty.

Linkage with other data sets has been frequently limited by the lack of common methodologies and data formats between different surveys and sources – consistency with statistics on agricultural land use and soils, surveys of common plants, administrative data on designated or agri-environment scheme areas, or on surface and groundwater quality, etc, would all enhance the usefulness of the accounts. In summary, improved consistency between different parts of the accounts requires close collaboration and agreed procedures for data exchange with all relevant data providers.

3.3 Confidentiality and copyright issues

Field surveys require the permission of land owners, and may involve agreements that the observations will not be disclosed at site level. Furthermore, there is a risk that repeated surveys of particular sites will affect land owners' behaviour, leading to biased results. Release of data for research at a local level may therefore not be compatible with the need to compile national summaries.

Other countries have experienced problems of copyright over access to data held by local organisations.

4. Methodology issues

In general the process of developing land accounts is to integrate the available "top-down" data on features (landscape, land cover) with "bottom-up" data on activities or environmental quality.

Particular methodological issues concern

- the rules for allocating land use to 'producers' where multiple use is involved, for example: forest to forestry, recreation and nature conservation; or the use of unmetalled roads in rural areas to agriculture or forestry

- how to identify discontinuous landscapes such as 'diffuse urban sprawl' without recourse to higher resolution imagery

- whether to make the definition of the width of a coastal zone dependent upon the height of the relief

- for monetary asset accounts, how to determine the value of land under buildings, or the amenity or bequest benefits of natural capital.

5. Uses and applications of physical land accounts

The uses of the accounts generally depend upon the type of supplementary account that has been developed. The applications referenced below are drawn from a limited number of sources and cannot be taken as a complete statement of potential applications.

On the land use side, the accounts can be used to

- assess the proportion of new housing that is on previously developed land, and monitor the rate of transfer of agricultural land to housing or other development
- estimate the development of vacant land in urban areas
- assess the resource productivity of land
- project the rate of urban growth in the future and assess the density of new developments
- establish greenhouse gas inventories, if combined with some information on land cover and intensity of use
- inform the valuation of natural capital or the damage from unsustainable use.

On the land cover side, the development of habitat accounts, combined with information on the condition of the habitat, can

- indicate the underlying driving forces and their relative importance
- provide a view of the turnover of habitats and the extent of compensation by the creation of new habitat
- offer an integrated view across major land use sectors and a framework for analysing interactions between competing land use objectives
- inform the choice of biodiversity indicators and how they relate to each other.

This suggests that land accounts can be used in support of the following policies:

- as a source of information for the **Biodiversity Action Plans** on the extent and condition of Broad Habitats, especially if linked with information on changes in biodiversity, ecological status and species composition
- on the effect of **sustainable agriculture policies** at national and regional level
- for **water management**, focusing attention on the catchment area as a key management and reporting unit. The integration of several layers of information (land cover, river network, erosion maps, crop statistics, fertiliser use, soil types) allows river water quality to be modelled
- for the development and implementation of strategies for **soil protection**

- for understanding pressures from **urban development**, when linked with land use change data
- for monitoring the impact of **environmental pollutio**n such as climate change and eutrophication; the accounts need to be linked with other pollution-related data for modelling the impacts of pollution
- for modelling of **countryside change** scenarios
- for the provision of **sustainable development indicators**. The value of targeted accounts is that they allow the calculation of a wider range of indicators that can describe the potential or value or quality of particular resources, or of the intensity of pressure upon them.

These conclusions are qualified by some limitations, in that

- a national assessment of significance may not reflect changes of local importance, and there might be limited coverage of rare habitats, uses or land cover types
- some of the analyses require complex statistical analysis and a detailed understanding of the ecological processes involved and of the complex interactions of factors causing change
- drivers of change may have to be inferred from biological outcomes
- the usefulness of indicators may be limited by small numbers of observations for trends.

7. Conclusions and next steps

There is strong evidence of the potential of land accounting to contribute usefully to a wide range of policy issues. Its usefulness will increase as more years' data becomes available, software tools improve and some of the data consistency problems are overcome. Key points for further consideration are:

- The clarification of existing classifications and the use of standard classifications at least within countries is an absolute priority for some countries. Standards would also be desirable within larger political entities such as the European Union. It is unclear whether global standards are essential as yet. These standards should apply to land use and land cover classifications, but could usefully be extended to broad habitat, landscape type, and causes of change.

- A more systematic approach to supplementary accounts, bringing some of the more common accounts into the basic framework, will be needed in due course but is probably too early to attempt at present. This work should include the development of a number of sustainable development indicators based upon the accounts.

- The use of the accounts for policy applications is likely to increase in the future and the potential for wider application of techniques and the development of standards will need to be monitored. Potential areas for further work include: targeted accounts for new functions such as

nature protection and water management; the compilation of local and/or regional accounts for selected areas having a common network of similar interests; and the use of the accounts for scenario development e.g. for assessing the impact of the reform of the European Union's Common Agricultural Policy or the impact of climate change.

- Accessibility to data sources for use in land accounting is a significant issue for some countries. For some applications, access to the basic data is limited because of confidentiality and copyright constraints.

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Note: the views expressed in this paper are those of the author and do not necessarily represent those of the Department for Environment, Food and Rural Affairs.

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