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Land Accounts 1990- 2000-2006: An Update

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Part 1: Introduction and Background

1.1 Accounting for Land Cover and Ecosystems

In 2006 we presented our first comprehensive analysis of land cover change in Europe between 1990 and 2000 using an accounting framework (EEA, 2006). The work was of practical value, because it enabled people to gain a rapid overview of the way land cover had changed, and the spatial patterns in land cover that were emerging across Europe. The work was also valuable conceptually, because it described how cover accounts can be constructed, and proposed systems for of classifying land cover at and the way it changes over time. This work described the kind of land cover accounting framework that would be needed in the revised approach national accounting that was being discussed in the context of the revision of the System of Integrated Economic and Environmental Accounting (SEEA).

Since that first publication further progress has been made, and we can report here both more recent changes in the land cover of Europe and the conceptual advances that have been made in accounting for land cover and natural capital more generally.

The SEEA was launched by the United Nations and the World Bank in 1993 as a response to recommendations of the 1992 Rio conference on sustainable development. The initiative sought to address the problem that the environment was not fully taken into account in the System of National Accounts (SNA) which is the framework used to calculate GDP. A revision of the SEEA was published in 2003 (SWWA, 2003) and work continues to establish the SEEA as an international standard. The importance of such work has most recent been emphasised by the outcomes of COP10, which endorsed the development of national accounting systems for biodiversity and ecosystem services[1] (Strategic Goal A, Target 2).

The aim of the SEEA is to quantify the interaction between the economy and the environment combining physical data and monetary statistics. A key part of that quantification is land cover. The EEA has taken the international lead in showing how, practically as system of Land and ultimately Ecosystem ACcounts (LEAC) can be established. Land is an important asset in its own right. However, understanding something about the way the stocks of different land covers, the way they are used and the way they are changing can tell us much about the state of our natural capital base. Land accounts are therefore very much at the heart of what the on-going SEEA revision is seeking to achieve. The integration of information about land with other environmental data in an accounting framework will provide a range of aggregate measures that can be used alongside the standard SNA metrics to understand better the interaction between the economic system and the environment.

Since the publication of the land account in 2006, much progress has been made both in the basic methods of accounting and accessing the new sources of data about land cover that are beginning to be provided by the new generation of earth observation satellites. The availability of a third CORINE Land Cover Map for 2006 for 25 European Countries (Figure 1.1), with new data sources such as GlobCorine now makes it possible to update the land accounts published for the period 1990-2000. Given the prospect that such data will more regularly available there now the real prospect that in the future these accounts can be maintained in the longer term.

[1] http://www.cbd.int/nagoya/outcomes/

>>>>> Insert Figure 1.1 about here: CORINE 2006 Update

The EEA is now moving ahead with its *Fast Track Implementation of Simplified Ecosystem Capital Accounts for Europe.* This aims to bring essential information for decision makers on land, carbon, water and biodiversity together in an integrated framework that can be used document and monitor changes in our 'ecosystem' or 'natural' capital base. The goal is to publish a first set of such accounts in 2011. As part of this process we describe in this Report the recent work that has focussed on land and summarise the basic framework for land cover accounting that is now being used.

1.2 Land Accounts: The Conceptual Model

>>>>> Insert Figure 1.2 about here: Relationships between land cover, land use and natural capital

It is widely acknowledged that 'land cover' and 'land use' are not the same thing (Jansen and Di Gregorio, 2002; Comber, 2008). 'Land cover' refers to the physical surface characteristics of land (for example, the vegetation found there or the presence of built structures), while 'land use' describes the economic and social functions of that land. Clearly the two may be linked, but the linkages are complicated. A single type of land cover, perhaps grassland, may support many uses, such as livestock production, recreation and turf cutting, while a single use, say mixed farming, may take in a number of different cover types including grassland, cropped and fallow areas. However, while the distinction between cover and use is accepted, they are often conflated in classification schemes (Jansen and Di Gregorio, 2002), so that resulting information on change is difficult to interpret, particularly in terms of its consequences for our ecosystem capital.

One of the important contributions that an accounting framework can bring is the development and acceptance of standards. In our earlier accounting Report (EEA,2006) we described how

In the context of understanding the links between land and biodiversity, for example, it is not always clear quite what 'land use change' means. Does it mainly refer to gross changes in which there is complete replacement of one type of cover or use by another, or does it also include the more qualitative changes in the characteristics of land? These latter are what Lambin (1999) has described as 'land cover modifications', and he suggests they are probably more common that wholesale conversions. These kinds of change are subtle and often difficult to characterise, but their implications for the biodiversity characteristics of the land can, as we shall see, be as important as a complete transformation. We will refer to these modifications as changes to the *condition* of the different types of land cover (or ecosystem), by which we mean the capacity of those eland cover types to support the land uses we normally associate with them biodiversity or ecosystem services.

If we are to understand how our natural or ecosystem capital is changing then we need to understand both the quantitative changes in land cover stocks and the qualitative changes in the condition of those stocks. This idea was described by a simple graphic in the 2006 Report, which has been updated and reproduced here (Figure 1.3)

>>>>> Insert Figure 1.3 about here: Relationships between changes in the stock of and condition of land cover.

The conceptual model shown in Figure 1.3 is we suggest an important one because it shows how the accounting model can be used to look at some fundamental questions about land use and sustainability. For example, in terms of the changing stock levels of a given land cover type, we may ask whether the gains in stock compensate for any of the losses that were experienced over the accounting period. These kinds of questions about compensation are fundamental to the issues associated with strong and weak notions of sustainability, and we need to find ways of answering these questions if we are to understand whether changes in the stock of out different land covers are eroding our natural capital base. Thus in terms of the stock of wetlands, say, we would need to ask whether land restoration schemes leading to the creation of new wetlands were making up for those that have been or are being lost to other developments. The kinds of thing we might look at in the context of wetlands might be the overall capacity of wetlands to store carbon, or their contribution to coastal protection. The judgements we made as to whether these 'stock' flows are really compensating each other would clearly influence any conclusion we make about whether were on a sustainable path or not.

In perusing questions about sustainability further, we might ask whether the quality or condition the stock of land cover carried over from time 1 to time 2 has been maintained in terms of the benefits it provides to people or the support it offers to wider ecosystem functions. Maintenance of the integrity of our land cover assets or ecosystems is we suggest also fundamental to planning for sustainability. We can use wetland again to illustrate the issue. Thus we may still have the same *area* (stock) of wetlands at the end of some accounting period, but its functionality may have been damaged. The same area of wetland, for example, might no longer be able to fix the same amount of carbon or regulate water quality and quantity as it previously did. The ability to form a judgement about the way in which the quality or condition of our different land cover elements is changing is also fundamental to understanding whether we are sustaining our natural capital base.

Land accounts are therefore essential tools for the decision maker. They provide us with a framework in which information can be brought together in a systematic and consistent way so that the significance of changes over time can be assessed. Following the publication of the Millennium Ecosystem Assessment, activities designed to understand the state and trends in ecosystem services and the possible consequences that might follow. Land accounting systems such as those we have described here are a way of embedding this kind of thinking in our day to day activities. While ecosystem assessments are either one-off or might take place intermittently, land cover accounting seeks to provide a constantly updates information resource, so that decision makers can see what is actually happening from year to year. By necessity land and ecosystem accounts might have to be more focussed than ecosystem assessments to take account of the need to provide information rapidly. However, they are just as important as assessments in the tool box that decision makers need access so that they can develop and advise on policy within the context of an ecosystem approach.

1.3 Land Cover and Ecosystem Capital

The close connection between the land and the functioning of ecosystems has always been at the core of the accounting work undertaken by the EEA. Indeed, this has been emphasised in the way we have refereed to this work as 'Land and Ecosystem Accounting' or 'LEAC'. However, because of the exploratory nature of the analysis that we have been undertaking we have inevitably had to focus on some areas more than others in order to make progress. Thus in our earlier work, and especially that reported in 2006, we looked more closely at the stock of land cover and paid less attention to changes in condition or function. Over the intervening period we have begun to turn our attention to the 'ecosystem' theme more explicitly.

>>>>> Insert Figure 1.4 about here: Land and Ecosystem Capital Relationships (after JLW, 2010)

As Figure 1.4 shows, goal of developing integrated environmental and economic accounts remains. For this to be done effectively, however, we need to set land accounts alongside other aspects of ecosystem capital such as water, biomass and carbon and biodiversity more generally. We are therefore using the concept of ecosystem services as a framework in which this closer integration of land and ecosystem issues can be brought together more closely. Thus methodologies underlying our land accounting work have been refined since the publication of the accounts for 1990-2000. The classification frameworks used to describe land cover and the way it changes over time have also been developed further so that better insights can be gained about how land over change impacts on the state of our ecosystem capital. In particular we have developed approaches to analysis and describe the structure of the land cover mosaic in more detail, and extended these insights by looking at the types of boundaries between the different cover types in different types of landscapes, that is the ecotones present in an area. Finally, we have developed ways of describing how the fragmentation of our green infrastructure varies across Europe what this might mean for the potential of landscapes ecosystems to support biodiversity and the output of ecosystem services.

1.4 Characterising Landscape Structure and the Pressures upon Ecosystems

1.4.1 Describing land cover and land cover change

One of the major contributions of the EEA work described in the 2006 Report was the system for classifying land cover and the types of transformation in land cover that might be observed as one land cover type changes to another. The classification frameworks were built up around the data source for the accounts, namely CORINE land cover. Table 1.1 summaries their structure.

An essential feature of the two classifications is their hierarchical structure. The system used to classify land cover at its most detailed level had 44 classes. The full list is provided in Appendix 1. For developing the accounts these classes were aggregated by arranging them into three hierarchical levels, so that more general reporting can be achieved. Hence, the 44 detailed cover types at level 3 were grouped into five broad classes at level 1, and 15 intermediate classes at level 2. In order to build the accounts, a hybrid classification using level 1 and 2 categories was developed which consisted of eight broad classes (Table 1.1a). This approach was needed to pick out the distinction between arable areas and pastures within the agricultural class, and the different types within the forest and semi-natural habitats grouping.

For the classification of the types of change between land cover types, again a hierarchical classification was used. Using the level three classification of land cover, all the possible transitions between them were considered and grouped into similar types of transformation. At the most general level, eight broad types of change or 'flow' could be recognised (Table 1.1b). They included such processes as urban sprawl, the conversion of land to agriculture and forest creation (afforestation).

For the presentation of the 2006 update we have used the same approach. The analysis has confirmed the generic, scale independent nature of the classification framework that we developed earlier, and in Part 3 of this document we discuss the framework in more detail in the context of current approached used to classify land cover by the FAO and UNEP, and how these approaches link to the SEEA Revision. In Part 2 we use them to present the basic land cover accounts for stock and change (flow).

The accounting database constructed for the analysis of land cover change between 1990 and 2000 allowed spatially explicit or 'zonal' accounts to be presented (See Part 8, EEA, 2006). The mapping was achieved by setting up an 'accounting grid', consisting of all the 1km x 1km cells across Europe, to which the CORINE land cover for different dates could be assigned. The grid enabled both variations in the patterns of land cover across Europe to be mapped, and the locations of change to be identified.

We have also used the same accounting grid for the presentation of the 2006 update. It is now accepted as a standard mapping framework though the INSPIRE initiative (ref...)

1.4.2 CORILIS and the Importance of Spatial Context

While the 2006 report showed the importance of mapping accounts data, it also described some novel approaches to understanding and representing neighbourhood or spatial context, using the CORILIS methodology.

>>>>> Insert Figure 1.5a, b and c about here: Examples of Urban Temperature and LEP, GLI

The CORILIS methodology was developed by the Hypercarte Research Group, INSEE and IFEN (see Grasland et al. 2000). The aim was to find a general way of mapping spatial 'intensities' or 'potentials' across a region. The approach that was developed lent itself to the analysis of the LEAC database, because it could be used with any grid-based data, such as CLC. The methodology is essentially one that involves a process of smoothing that changes the values in each cell of the grid according to the characteristics of its neighbourhood. The initial value in each cell is replaced by a weighted mean derived from the values of the neighbours divided by the square of the distance between the centres of the corresponding cells. In this way maps of the intensity of the surrounding influences can be constructed.

In the 2006 report, we showed how maps of urban intensity (urban temperature) or the proximity to intensive agricultural activities could be used to better understand the pressures to which important nature conservation areas might be facing (Figure 1.5a). Using the CORILIS approach, the distance threshold used to define the smoothing process can be set at any distance; the example shown in the figure uses a radius of 10km.

Similar approaches were used to represent the density of the 'green background'. Thus the 'green background index' was based on stock estimates for pastures, mosaic agriculture, forests, dry semi-natural and natural land, wetlands and water bodies. The smoothing radius of 10 km has been used to calculate the extent (%) of these cover types within 10 km of each 100m pixel in the original land cover image. The resulting density of green surfaces has been mapped as a continuum from high to low (See Figure 1.5b). In later sections of this 2006 Update report we describe how these approaches to potential and intensity mapping have been further developed and in particular how two new potential maps have been developed for landscape *Ecological Potential* the *Green Landscape Index.*

1.4.3 Dominant Landscape Types and Zonal Accounts

The 2006 Report described how a set of Dominant Landscape Types could be defined for Europe. That could be used to help make a detailed contextual analysis of basic CORINE land cover data. It allowed the LEAC data to be disaggregated spatially to show how the dynamics of land cover varied over space and time. Other spatial disaggregations, based on elevation, biogeographical region and sea basin were used as a framework for producing additional spatially explicit or zonal accounts.

Since the earlier publication the approach used for defining the Dom,inant landscape Types has been revised and refined.

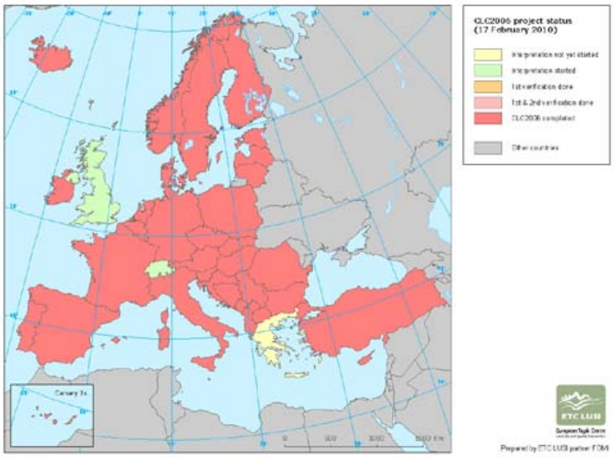
The method used to define the original set of Dominant Landscape Types was based on the recognition of the dominant and sub-dominant land covers in each cell of the accounting grid. For the purposes of the 2006 Update, a new set of dominant and subdominant land cover types have been developed to replace the previous set, because the experience of using the original suggested that a number of potential improvements were needed to overcome some practical limitations associated with the original approach. In particular it was found that classification procedure relied on calculation of the mean + standard deviation for the entire European dataset, which introduced some local classification irregularities. The new approach uses using a per-pixel classification method, comparable to proportional membership techniques used in remote sensing and image interpretation (Campbell, 2006). In this way a more transparent and robust classification of dominant land cover has been produced which does not force mixed pixels into land cover classes to which they do not belong. The new map of Dominant Landscape Types is shown in Figure 1.6 and their structure in relation to the combination of underlying land cover is described in Table 1.2. [MORE NEEDED ON METHODOLOGY LINKLING DOMINANT LAND COVER TO LANDCAPE]

>>>>> Insert Figure 1.6 and Table 1.2 and about here: new map of Dominant Landscape Types and table defining DLT according to combination of land cover types.

1.5 Report Structure

In the remaining sections of this Report we provide, in Part 2, a more detailed view of what have been accomplished in updating the land and ecosystem accounts published for the period 1990-2000. accounts . Part 3 discusses the methodological issues and refinements made since the initial publication in more detail. Finally, in Part 4 we consider the progress currently made in the context of the SEEA revision and the development of ecosystem accounts and the valuation of ecosystem services more generally.

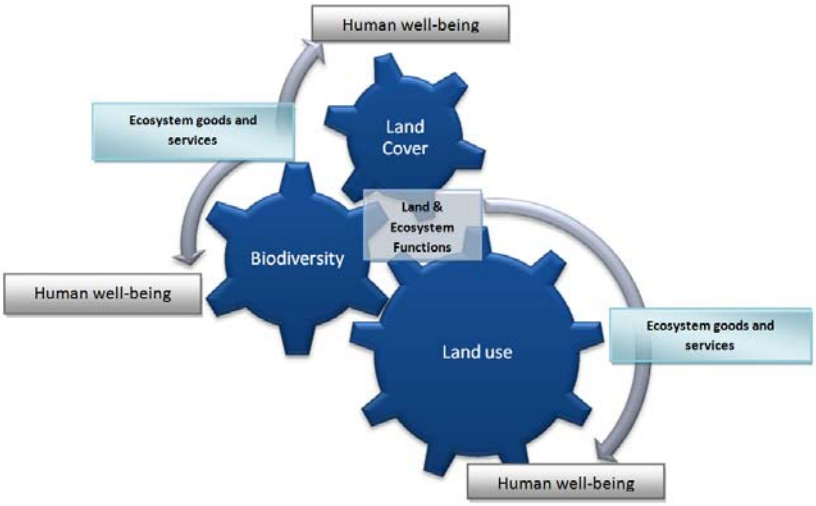
Figure 1.1 CORINE 2006 update (newer version?)



European Countries for which CORINE 2006 data are available

Austria
Belgium
Bulgaria
Croatia
Czech Republic
Denmark
Estonia

Figure 1.2: Land Cover, Land Use and Ecosystem capital (Redraw to replace biodiversity with natural capital?)



Where:

Land cover is the physical characteristics of the land surface determined by both its biotic and abotic features.
Land use is determined by the purposes of active and passive management of land by people and the material non-material benefits they derive from it.
Biodiversity is the variety of ecological elements present in a place (genes, species, communities and habitats, etc.).
Land and ecosystem functions are the potentials or capacities that land and ecosystems have to generate useful outputs for people.
Ecosystem services are the specific and final contributions that ecosystems make to human well being.

Figure 1.3: Flow accounts for land cover and the relationship between the concepts of stocks and flows and fundamental questions about sustainable development

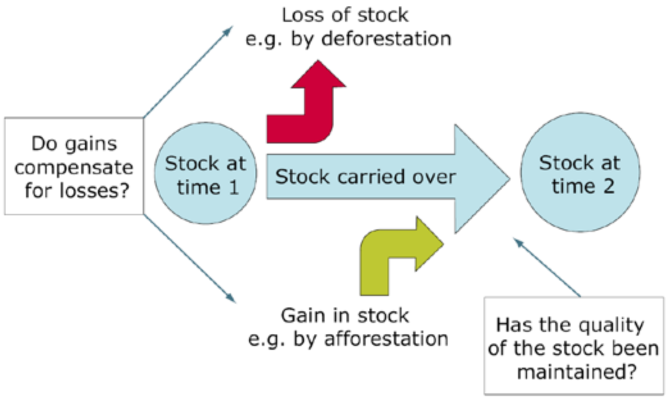


Figure 1.4: Land and Ecosystem Capital Relationships (after JLW, 2010)

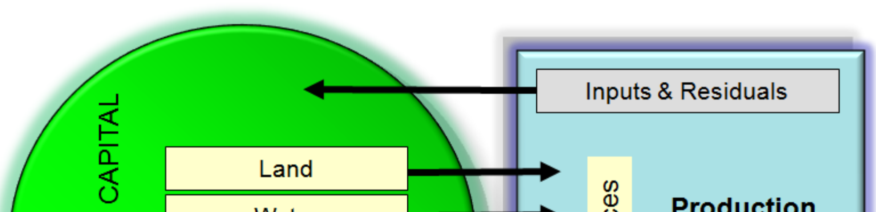


Table 1.1: Classifying land cover and land cover change for land accounting

(a) Broad land cover classes used to classify Corine land cover data for land accounts

Broad cover type	Code
Artificial surfaces	CLC 1
Arable land and permanent crops	CLC 2.1+2.2+2.4.1
Pastures and mosaic farmland	CLC 2.3+2.4.2+24.3+2.4.4
Forests and transitional woodland shrub	CLC 3.1+3.2.4
Natural grassland, heathland, sclerophylous vegetation	CLC 3.2.1+3.2.2+3.2.3
Open space with little or no vegetation	CLC 3.3
Wetlands	CLC 4
Water bodies	CLC 5

(b) The classification of the major types of land cover flow using Corine data

Major type of cover change	Code
Urban land management	LCF1
Urban residential sprawl	LCF2
Extension of economic sites and infrastructures	LCF3
Agriculture internal conversions	LCF4
Conversion from forested and natural land to agriculture	LCF5
Withdrawal of farming	LCF6
Forests creation and management	LCF7
Water body creation and management	LCF8
Changes of land cover due to natural and multiple causes	LCF9

Note: Detailed classifications are presented in Appendices 1 and 2.

Figure 1.5: Maps of urban temperatures and GBI

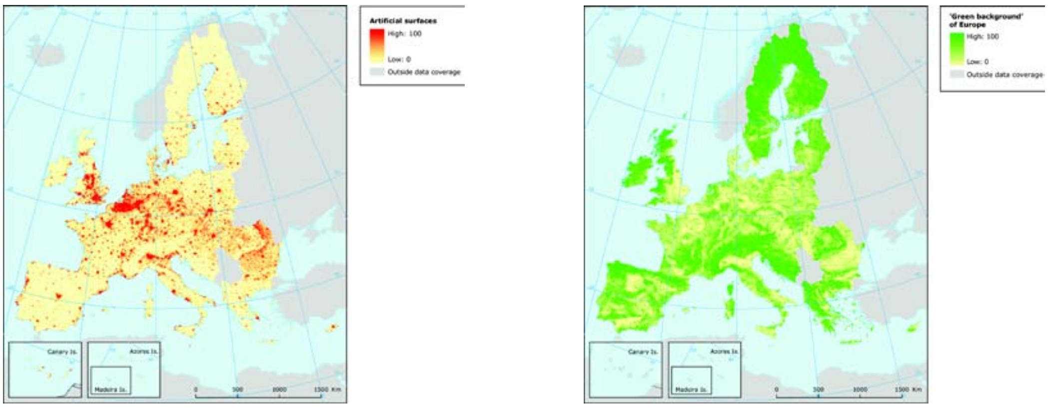


Figure 1.6: new map of Dominant landscape Types

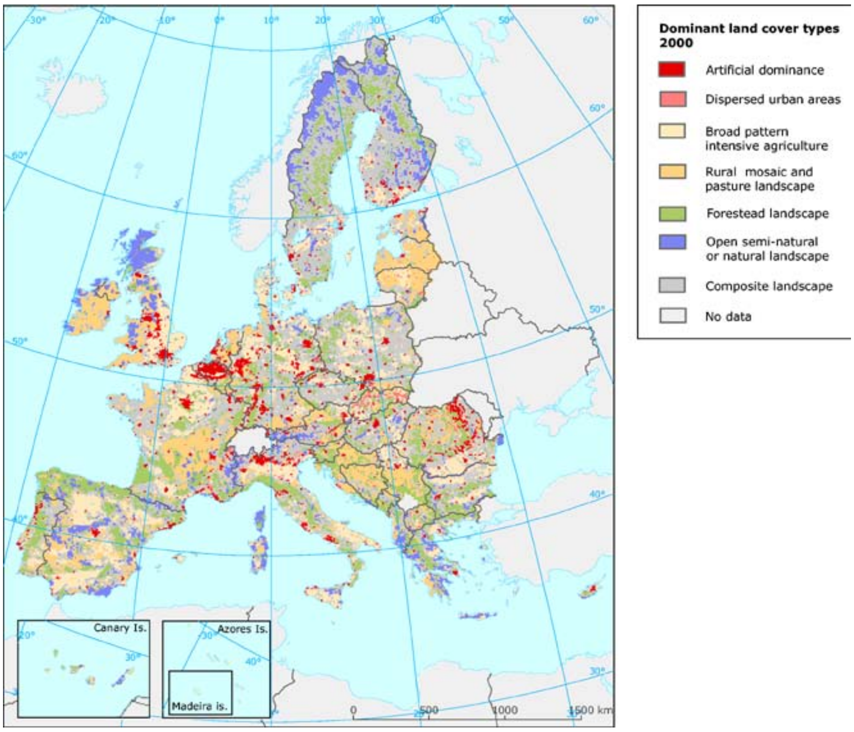


Table 1.2: Definition of DLT based on dominant land cover

Part 2: Land Cover Change 1990, 2000, 2006

2.1 Introduction

The availability of CORINE Land Cover data for 2006 (CLC2006) provide the opportunity of describing how the geographical patterns of land cover across Europe, the way they are changing over time and what types of processes are bringing about the various transformations. We report here on initially at the European scale for the 25 countries that are presently covered by CLC2006, and use these data to describe the main features of the accounting approach. As with the 1990 and 2000 data described in our earlier report, all of the information is held in a single accounting database from which different types of tabular, graphical and map views can be generated. The raw data can be accessed by visiting the EEA website[2], which also provide access to an on-line, interactive data viewer[3] that can be used to construct more customised outputs.

2.2 Stock and change accounts for Europe, 2000-2006

Table 2.1 shows a set of basic set of stock and change accounts for the 25 countries included in the CLC update. The structure of the table illustrates the key features of the underlying accounting model used by the EEA.

>>>>Insert Table 2.1 about here: Socks and change account for Europe, 2000-2006

The columns in Table 2.1 show how the stock of each of the main land cover types that we find across Europe has changed between 2000 and 2006. It is an 'account' in the sense that it shows the opening stock of each land of the main land cover types, and how this stock changes over the 'accounting period' between 2000 and 2006.

The land cover classes shown in Table 2.1 are the most general used in the EEA land accounting approach. This is referred to as level 1. More detailed breakdowns can be made using the sub-types at levels 2 and 3, within these broad categories. The land area of the 25 EEA member countries included in this account is fixed, and so the total land area (shown in the right hand column of Table 2.1) is the same at the start and end of the period. However, the distribution of the land across the different types has changed. The changes are shown by the rows for 'consumption' and 'formation of land cover types. By consumption we mean the loss of a given type to one of the others shown in the table. By formation we mean the gain in area as a result of land transferred into a given type from some other. The Table also shows these changes as a % of the original area of each main type and the stock of land that did not change over the period.

These data show that the extent of built-up or 'artificial' areas has increased as a result of urban development, while the area of other types such as semi-natural vegetation has decreased. Between 2000 and 2006 we can see that the urban area of the 25 EEA member countries showed a net increase of about 625,000ha or 3.4 %. This is roughly the same kind of trend shown in the period 1990-2000, although it should be noted that the set of countries included in the two sets of accounts was slightly different. The account also shows the area of Forested have increased by a small

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[2] http://www.eea.europa.eu/data-and-maps/data#c5=all&c11=&c17=&c0=5
[3] http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=501

amount. The main agricultural cover types (arable and pasture) also showed small net losses over the period.

The advantage of representing land cover change in the form of and the accounting table, as shown in Table 2.1, is that it helps define some broad sustainability indicators. The indicator for turnover is of interest in the context of questions about sustainable development, because it helps us to understand what proportion of the original stock is carried over from the start of the accounting period to the end. As a result, we can see how much of the initial resource has been maintained. From the perspective of conservation of biodiversity, for example, the total amount of turnover may be as important as the net change. In periods of fast change, driven for example by economic development or by climate change, the analysis of turnover would reveal information about the degradation of habitats that might previously have been stable and as a result would have been able to support a wide range of species. In Table 2.1 it is apparent that % turnover of land assigned to Forest is much larger than for the other land cover types, apart from artificial surfaces. High turnover may also reflect lack of stability suggest that a land-related asset may be vulnerable. This pattern of change clearly merits closer investigation.

2.3 Flow accounts for Europe, 2000-2006

2.3.1 Flow accounts

There information on land cover change shown in Table 2.1 is basic in the sense that it only described the overall changes and not the detailed processes that have resulted in the flows between the different stocks of land cover. To gain this richer picture we can construct a second type of account, known as a flow account, like the one shown in Table 2.2.

>>>>Insert Table 2.2 about here: Socks and change account for Europe, 2000-2006

The flow account presents the losses of initial land cover for each land cover type and the creation of new areas in more detail than was possible in Table 2.1. Consumption is shown at the top of the table, and when this figure is added to the area that has not changed over the accounting period we produce an estimate of the initial 2000 stock for each types of land cover. The bottom part of the table shows the formation flows. If formation and the stock that shows no change are added together, then this gives the amount of the final stock in 2006.

The important extra detail added in Table 2.2, is that the changes are listed according to the *processes* by which the various types of change have occurred. These define the various land cover flows. From this flow account shown we begin to see what types of changes were taking place and how important they were. In the context of the formation of new artificial areas (i.e. built-up, urban areas) by the process of residential urban sprawl, the account shows that between 2000 and 2006, urban residential sprawl added 190,006ha to artificial surfaces. This is the figure that appears at the intersection of the row for the flow, Urban and residential sprawl, in the bottom half of the table and the column for artificial surfaces. To find the types of land cover did this process of residential sprawl replaced, we can look at the block of data for consumption of land, along the row for urban residential sprawl. This tells us the source of the land that was converted to artificial surfaces. For the EEA member counties for which data are available to make the 2006 update, the formation of new artificial areas largely occurred through development on agricultural land. Of the new artificial areas, approximately 80,000 ha (42%) came from arable land and permanent crops, while 88,000ha

(46%) came from pastures and mosaics. Much larger areas of these type types of agricultural land were also lost to artificial areas by 'sprawl of economic sites and infrastructures'.

Similarly, we can see that approximately 249,000ha of new agricultural land was added to the 2000 stock by the process of conversion (flow LCF5), mainly from land that was previously forested (91,990ha) or covered with semi-natural habitats (61,356ha). At the same time, about 191,335ha was lost from agriculture, by 'withdrawal from farming' with land transferred to mainly Forest and Scrub.

The flow account shown in Table 2.2 gives only the most genera picture of the way land cover is changing. The hierarchical nature of the system for land cove classification and the system for describing the types of change allows successively greater levels of details to be shown. An example of a more complete flow account, using the second level in the classification hierarchy for the flows is shown in Table 2.2.

>>>>Insert Table 2.3 about here: Socks and change account for Europe, 2000-2006 at level 2

Flow accounts such as those shown in Tables 2.2 and 2.3 are particularly useful in that they can be used as the basis of a number of indicators of land cover change. Examples of such indicators are shown graphically in Figure 2.1, and 2.2. Thus Figure 2.1 shows the origins of land converted to artificial surfaces during the accounting period; the major source is cropped land. Figure 2.2 shows the conversions between agricultural land and forest and semi-natural types; here the largest shift is for the withdrawal of farming and the creation of new forests.

>>>>Insert Figure 2.1 and 2.2 about here

2.3.2 Patterns of Urban Change

The Europe wide data for urbanisation, that is the extent and rate of conversion to artificial land from all other cover types can be looked at in more detail across the 25 counties for which the 2006 update is available (Figure 2.3). These data give a comparison between the two accounting periods. In each case the annual rate is shown as a % of the stock of urban at the start. These data suggest that the same broad pattern has been maintained over the two accounting periods. Spain, Ireland and Portugal showed the highest percentage increases in the period 1990-2000, a situation that appears to have persisted through to 2006. However, of these three only Spain appears to show a marked increase in the most recent period, whereas Ireland and Portugal show a decline.

>>>>Insert Figure 2.3 about here

A tabular account for the subtypes of artificial land across the 25 European counties for which CLC2006 is available, is shown in Table 2.4. These data highlight that the bulk of the land lost to artificial cover types was from arable and pasture, but that proportionally larger areas of forest and semi-natural land were lost to mineral extraction and construction sites.

>>>>Insert Table 2.4 about here [Needs Checking can we make this the same as Table 3.1 in EEA 2006? – an alternative is suggested]

2.3.3 Patterns of Agricultural Change

Agriculture continues to account for the largest proportion of the land of Europe; for the 24 countries covered by CLC2006, it covers approximately 42% of the surface, compared to 36% for forest and semi-natural and 4% for urban. An analysis of the changes that take place within the areas dominated by agriculture is important if we are to monitor the outcomes of changes in European policy towards farming, which now emphasises the need for a broad approach to rural development and the maintenance and restoration of environmental quality, over production.

The agricultural account for the 25 countries covered by CLC2006 is shown in Table 2.5. As noted in the basic accounts, the area of agricultural land has declined overall by only a small amount. However, there has been considerable turnover of land, both within the agricultural types and between agriculture and the other major types of land cover.

>>>insert Table 2.5 about here [agricultural account equivalent to Table 4.1 in EEA 2006]

As the account shows, losses through urban sprawl have mainly affected the non-irrigated arable land and mosaic farmlands; pastures have been affected to a lesser extent. Both non-irrigated arable and farmland mosaics have gained land from forests in roughly similar amounts [discuss table more fully]. There has also been an internal exchange of land within the general agricultural class, with transfers from pasture land to arable. The geographical pattern of this flow is shown in Figure 2.4, which maps the transfer at the NUTS-2 level.

>>>>insert Figure 2.4 and 2.5 about here [Figure 2.5 is the equivalent of the map in Figure 4.2 of EESA 2006]

Some of the patterns of recent change are illustrated graphically in Figures 2.5 a&b, which shows the major types of conversions that have occurred on an annual basis between agriculture and forest/semi-natural land cover. Over the two accounting periods the rates of conversion have remained roughly the same, except that there has been a fall in the amount of land withdrawn from farming that has not resulted in significant forest creation [interpretation?].

2.3.4 Patterns of Change in Forests and Semi-natural Habitats

The accounts for forests and semi-natural habitats are shown in Tables 2.6 and 2.7. As we have seen overall the area of forest has increased between 2000 and 2006, while the area of Natural grassland, heathland, sclerophylous vegetation has declined. [Discuss tables...]

>>>insert Tables 2.6 and 2.7 about here [forst and semi-natural accounts equivalent to Tables 5.1 and 5.2 in EEA 2006]

Figure 2.6 shows how the change in forest area is distributed geographically. Ireland and Portugal stand out as showing the highest rates of increase, with significant transfers of land coming from....[an we identify this?]

>>>>insert Figure 2.6: change in forest area by country based on 2006 stock – needs changing to 2000?

2.4 Analysing Geographical Patterns

2.4.1 Zonal Accounts

Although the construction of basic accounts and indicators such as those described above is helpful, a major additional contribution of the accounting approach developed by the EEA is that the database used to construct these Tables can also be used to develop spatial or zonal accounts. As noted above, the data are held in and spatial accounting grid that can also be used to segment the data to give a picture of different geographical areas.

>>>>Insert Figure 2.7, 2.8 and 2.9 about here [CAN WE ADD 1990-2000 FLOWS TO THESE GRAPHS?]

A common geographical breakdown is by NUTS region. Figure 2.7 shows the distribution of changes by country (NUTS level 0), but using the hierarchical approach more detailed within country splits of the data are also possible. Figure 2.8 shows the same data displayed according to biogeographical region, and Figure 2.9 by major elevation zone; in both cases the rate per year is presented to aid the comparisons between the two time periods (1990-2000 and 2000-2006). The key patterns that stand out from these graphs is that the Mediterranean biogeographic region shows a much more diverse set of changes than the others, with the significant areas being converted to artificial land via urban residential sprawl and the sprawl of economic sites and infrastructure. This was a trend also detected in the earlier accounting period. There is also a marked difference between the rates of urbanisation in low coast compared to other elevation zones.

2.4.2 Mapping Spatial Patterns

The gridded character of the accounting data also allows maps to be constructed, showing both the distribution of the different cover types across Europe and the places where particular types of change are occurring.

Although the distribution of each type of land cover can be mapped directly, the CORILIS methodology allows the density and influence of different types of land cover to be described. The concept of 'urban temperature' was discussed in Part 1. The idea of 'urban temperature' has been borrowed from demographers who use the concept in relation to population statistics to examine the influence of patterns of population. A map urban temperature based on the 2006 data has been presented in Figure 1.5. A longer time perspective on the changes in this metric is shown in Figure 2.10, which provides a comparison between the two accounting periods (1990-2000, and 2000-2006). Figure 2.11 shows the patterns of diffuse pressure resulting from agricultural activities. Taken together the maps show....

>>>>Insert Figure 2.10 and 2.11 about here [CAN WE show the areas where pressure has increased/decreased between the two accounting periods? – may be as an inset for a particular region/area?]

The mapping of the different types of flow recorded in the accounts is also particularly important, because such information can be used to identify more precisely where our natural capital base is being put under pressure. Figure 2.12 shows the areas where urban sprawl between 2000 and 2006 has been detected. For comparison the areas showing similar types of changes between 1990 and 2000 is also indicated. It is apparent from these maps that.....discuss maps.

>>>>Insert Figure 2.12 about here showing urban sprawl [CAN WE ADD the 1990-2000 FLOWS TO THESE Maps using some system of combined colour key??]

Figure 2.13 shows those areas where there has been a withdrawal of farming between 2000 and 2006, and again a comparison with the earlier accounting period is provided. It is apparent from these maps that.....discuss maps.

>>>>Insert Figure 2.13 about here – withdrawal of farming [CAN WE ADD the 1990-2000 FLOWS TO THESE Maps?]

To illustrate the types of analysis that are possible using the various types of accounts data, and in particular its analysis using the CORILIS approach, Figures 2.14 and 2.15 show the intensity of different kinds of pressures on the Natural 2000 site network.

The Habitats Directive seeks to ensure that Europe's most important nature conservation areas, which are represented by the Natura 2000 sites, are both managed in a systematic and appropriate way, and that their integrity or functionality is protected. Partly this can be achieved by improving as habitat connectivity and the buffering the sites impacts from surrounding land use activities. In order to gain a detailed picture of where geographically, some of the most significant pressures might be, maps of the intensity of the influence of Urban and Agricultural pressures have been prepared.

>>>>Insert 2.14 and 2.15 about here

In each case, the intensity of the influence from urban and agricultural land cover types in the has been estimated for each Natura 2000 site, using maps of urban and agricultural temperature maps similar to those discussed above (Figures 2.10 & 2.11). Each Natura 2000 site has then been mapped using a colour intensity scale that picks out the different potential pressures across the network; red tones indicate higher potential pressures from the neighbouring areas. The maps for urban and agricultural intensity differ from Figures 2.10 and 2.11 in that they include countries for which the CLC2006 data are not available. In these cases (Greece and UK) the 2000 CORILIS data have been used. Moreover, in those countries where no Natura 2000 sites exist (i.e. Turkey, Croatia, Albania, Norway, CDDA sites are used instead

The map for urban influence (Figure 2.14) shows that the Natura 2000 sites subject to the greatest potential pressures are those found in a broad band running from the west to east across central Europe from the UK through to Germany. In the main these sites are small, and differ markedly in their scale and pattern from the larger sites found in northern Europe and Spain. The map for the diffuse pressure from intensive agricultural activity (Figure 2.15) shows a broadly similar pattern with the greatest pressures arising in the central belt running from the UK through to Germany, but some differences are evident. Thus, for example, the sites in Spain show moderate to high pressures from agriculture. The sites in north east Germany and western Poland also stand out as having a higher level of pressure from agriculture than from urban. Finally, the intensity of pressures from agriculture are higher in Hungary for agriculture than they were for urban influence. Overall more large sites seem to be subject to diffuse pressure from agriculture than they were for urban.

>>>>Insert Figures 2.16 and 2.17 about here

These data are summarised further in the graphs shown in Figures 2.16 and 2.17, which shows the % area of the Natura2000 sites subject to increasing or decreasing pressure from urban and agricultural influence over the period 1990-2000. In each only those countries for which CLC2006 data are available are shown. Most countries show increases in the intensity of urban influence, most notably the Netherlands, only France seems to show a significant decrease [WHY????]. Many more countries show a significant reduction in the intensity of agricultural influence, most notably the Czech Republic and Portugal.

2.5 Conclusion

In our earlier report on changes in land cover acrocc Europe for 1990-2000, we suggested that one way to visualise the dynamics of land cover in at the most general level was in terms of a 'three-cornered' relationship between artificial surfaces, agriculture and forests and semi-natural habitats. To summarise the data presented here, we redraw this earlier diagram and set it aside a similar one for the period 2000-2006 (Figure 2.18 a&b). It should be noted that the figures differed from the previously published version because it has been redrawn for the 25 countries covered by the CLC2006 data. Thus Figures 2.18 a & b are directly comparable.

Between 1990 and 2000 development largely occurred at the expense of agricultural land (Figure 2.18a). In turn, the total stock of agricultural land appeared to decline as a result of the net transfer to artificial surfaces and forest and semi-natural cover types. Although there has been a net flow into artificial, on balance the overall stock of forest and semi-natural habitats was maintained during the 1990s. Broadly similar patterns are shown in Figure 2.18b. [Discuss new diagram....]

Table 2.1: A stock and change account for European land cover, 25 countries, 2000-2006 (figures show changes in ha)

	1 Artificial surfaces	2A Arable land & permanent crops	2B Pastures & mosaic farmland	3A Forests and transitional woodland shrub	3B Natural grassland, heathland, sclerophylous vegetation	3C Open space with little or no vegetation	4 Wetlands	5 Water bodies	Grand Total
Total 2000	**18,652,795**	**135,019,342**	**94,201,499**	**192,950,749**	**41,088,292**	**34,207,227**	**11,996,777**	**14,300,405**	**542,417,086**
Total consumption	185,346	832,567	485,523	4,724,269	269,284	240,817	64,539	32,984	6,835,329
Total Formation	811,115	540,982	249,283	4,835,673	101,159	176,325	21,108	99,684	6,835,329
Net formation	625,769	-291,585	-236,240	111,404	-168,125	-64,492	-43,431	66,700	0
Net formation as % of initial year	3.4%	-0.2%	-0.3%	0.1%	-0.4%	-0.2%	-0.4%	0.5%	0.0%
Total turnover	1,436,884	249,397	13,043	4,947,077	-66,966	111,833	-22,323	166,384	6,835,329
Turnover as % of initial year	7.7%	0.2%	0.0%	2.6%	-0.2%	0.3%	-0.2%	1.2%	1.3%
No land cover changes	18,467,449	134,186,775	93,715,976	188,226,480	40,819,008	33,966,410	11,932,238	14,267,421	535,581,757
No land cover changes as % of initial year	99.0%	99.4%	99.5%	97.6%	99.3%	99.3%	99.5%	99.8%	98.7%
Total 2006	**19,278,564**	**134,727,757**	**93,965,259**	**193,062,153**	**40,920,167**	**34,142,735**	**11,953,346**	**14,367,105**	**542,417,086**

Table 2.2: A flow account describing processes of land cover change in 25 countries in Europe 2000-2006

	1 Artificial surfaces	21 Arable land	22 Permanent crops	23 Pastures	24 Heterogeneous agricultural areas	31 Forests	32 Scrub and/or herbaceous vegetation associations	33 Open spaces with little or no vegetation	4 Wetlands	5 Water bodies	Total
LCF1 Urban land management	116,259	976	3	824	296	97	313				
LCF2 Urban residential sprawl		69,589	9,394	22,656	66,833	8,694	11,832	856	132	30	
LCF3 Sprawl of economic sites and infrastructures	8,462	210,223	20,750	48,879	73,758	58,369	70,279	8,034	2,152	1,445	
LCF4 Agriculture internal conversions		361,644	37,317	111,216	33,402						
LCF5 Conversion from forested & natural land to agriculture	24,424				17,022	38,865	114,481	16,184	23,456	3,597	
LCF6 Withdrawal of farming		90,152	5,709	49,272	46,202						
LCF7 Forests creation and management	19,985					3,249,238	1,269,267	115,679	30,996	98	
LCF8 Water bodies creation and management	9,557	15,519	1,721	5,563	14,836	7,621	11,236	7,649		5,741	
LCF9 Changes of Land Cover due to natural and multiple causes	6,662	2,419	140	109	1,683	62,359	90,996	92,502	7,803	22,124	
Total consumption	185,349	750,522	75,034	238,519	254,032	3,425,243	1,568,404	240,904	64,539	33,035	6,835,581
No land cover changes	17,656,687	133,924,419	31,972,699	61,591,554	160,471,472	27,488,817	35,774,477	33,796,153	11,910,859	14,167,419	528,754,556
Total area 2000	**18,653,171**	**135,018,778**	**32,243,245**	**61,959,014**	**160,847,490**	**32,103,959**	**41,089,908**	**34,213,469**	**11,996,546**	**14,300,138**	**542,425,718**
LCF1 Urban land management	118,768										
LCF2 Urban residential sprawl	190,016										
LCF3 Sprawl of economic sites and infrastructures	502,351										
LCF4 Agriculture internal conversions		228,161	179,032	93,727	42,659						
LCF5 Conversion from forested & natural land to agriculture		115,676	16,480	35,214	70,659						
LCF6 Withdrawal of farming					8,668	11,449	166,691	883	3,644		
LCF7 Forests creation and management						1,178,450	3,504,680	2,133			
LCF8 Water bodies creation and management								5,741		73,702	12,123
LCF9 Changes of Land Cover due to natural and multiple causes							75,656	167,655	17,504	25,982	4,216
Total Formation	811,135	343,837	195,512	128,941	121,986	1,189,899	3,747,027	176,412	21,148	99,684	6,835,581
No land cover changes	17,656,687	133,924,419	31,972,699	61,591,554	160,471,472	27,488,817	35,774,477	33,796,153	11,910,859	14,167,419	528,754,556
Tota area 2006	**18,467,822**	**134,727,182**	**32,133,667**	**61,832,357**	**158,612,146**	**34,450,707**	**40,921,783**	**34,148,977**	**11,953,155**	**14,366,787**	**541,614,583**

Table 2.3: Flow accounts at level 2

	1 Artificial surfaces	2A Arable land & permanent crops	2B Pastures & mosaic farmland	3A Forests and transitional woodland shrub	3B Natural grassland, heathland, sclerophylous vegetation	3C Open space with little or no vegetation	4 Wetlands	5 Water bodies	Grand Total
LCF1 Urban land management	**116,256**	**979**	**1,120**	**248**	**162**				**118,765**
LCF11 Urban development/ infilling	7,798								7,798
LCF12 Recycling of developed urban land	106,945								106,945
LCF13 Development of green urban areas	1,513	979	1,120	248	162				4,022
LCF2 Urban residential sprawl		**80,419**	**88,043**	**12,862**	**7,664**	**856**	**132**	**30**	**190,006**
LCF21 Urban dense residential sprawl		1,845	1,424	78	312	9			3,668
LCF22 Urban diffuse residential sprawl		78,574	86,619	12,784	7,352	847	132	30	186,338
LCF3 Sprawl of economic sites and infrastructures	**8,462**	**233,472**	**120,142**	**84,289**	**44,359**	**8,034**	**2,152**	**1,434**	**502,344**
LCF31 Sprawl of industrial & commercial sites		64,943	30,240	8,032	5,170	464	147	55	109,051
LCF32 Sprawl of transport networks		16,959	7,385	10,170	2,836	66	110	162	37,688
LCF33 Sprawl of harbours		64	139	105	491	53	45	208	1,105
LCF34 Sprawl of airports		4,140	969	758	195	294	209	10	6,575
LCF35 Sprawl of mines and quarrying areas		35,600	18,070	28,120	8,789	2,380	502	290	93,751
LCF36 Sprawl of dumpsites		1,906	1,661	2,046	508	64	108	143	6,436
LCF37 Construction		93,795	51,464	23,321	20,041	4,086	698	527	193,932
LCF38 Sprawl of sport and leisure facilities	8,462	16,065	10,214	11,737	6,329	627	333	39	53,806
LCF4 Agriculture internal conversions		**401,112**	**142,456**						**543,568**
LCF41 Extension of set aside fallow land and pasture		113,785	2,077						115,862
LCF42 Internal conversions between annual crops		93,406							93,406
LCF43 Internal conversions between permanent crops		2,384							2,384
LCF44 Conversion from permanent crops to arable land		33,099							33,099
LCF45 Conversion from arable land to permanent crops		158,176							158,176
LCF46 Conversion from pasture to arable and permanent crops			140,130						140,130
LCF47 Extension of agro-forestry		262	249						511
LCF5 Conversion from forested & natural land to agriculture	**24,424**		**17,022**	**91,990**	**61,356**	**16,184**	**23,456**	**3,597**	**238,029**
LCF51 Conversion from forest to agriculture				91,990					91,990
LCF52 Conversion from semi-natural land to agriculture			17,022		61,356	16,184			94,562
LCF53 Conversion from wetlands to agriculture							23,456	3,597	27,053
LCF54 Conversion from developed areas to agriculture	24,424								24,424
LCF6 Withdrawal of farming		**96,702**	**94,633**						**191,335**
LCF61 Withdrawal of farming with woodland creation		88,525	81,829						170,354
LCF62 Withdrawal of farming without significant woodland creation		8,177	12,804						20,981
LCF7 Forests creation and management	**19,985**			**4,416,511**	**101,900**	**115,679**	**30,996**	**98**	**4,685,169**
LCF71 Conversion from transitional woodland to forest				1,167,328					1,167,328
LCF72 Forest creation, afforestation	19,985				101,900	115,679	30,996	98	268,658
LCF73 Forests internal conversions				2,468					2,468
LCF74 Recent felling and transition				3,246,715					3,246,715
LCF8 Water bodies creation and management	**9,557**	**17,324**	**20,315**	**11,741**	**7,116**	**7,649**		**5,741**	**79,443**
LCF81 Water bodies creation	9,557	17,324	20,315	11,741	7,116	7,649			73,702
LCF82 Water bodies management								5,741	5,741
LCF9 Changes of Land Cover due to natural and multiple causes	**6,662**	**2,559**	**1,792**	**106,628**	**46,727**	**92,415**	**7,803**	**22,084**	**286,670**
LCF91 Semi-natural creation and rotation	6,126	400	558	20,711	20,123	64,342	4,035	5,189	121,484
LCF92 Forests and shrubs fires	7	500	1,222	83,510	26,542	423	26		112,230
LCF93 Coastal erosion	123	81	12	27	62	2,730	408	268	3,711
LCF94 Decrease in permanent snow and glaciers cover						24,784			24,784
LCF99 Other changes and unknown	406	1,578		2,380		136	3,334	16,627	24,461
No Change	18,467,449	134,186,775	93,715,976	188,226,480	40,819,008	33,966,410	11,932,238	14,267,421	535,581,757
Total 2000	**18,652,795**	**135,019,342**	**94,201,499**	**192,950,749**	**41,088,292**	**34,207,227**	**11,996,777**	**14,300,405**	**542,417,086**
LCF1 Urban land management	**118,765**								**118,765**
LCF11 Urban development/ infilling	7,798								7,798
LCF12 Recycling of developed urban land	106,945								106,945
LCF13 Development of green urban areas	4,022								4,022
LCF2 Urban residential sprawl	**190,006**								**190,006**
LCF21 Urban dense residential sprawl	3,668								3,668
LCF22 Urban diffuse residential sprawl	186,338								186,338
LCF3 Sprawl of economic sites and infrastructures	**502,344**								**502,344**
LCF31 Sprawl of industrial & commercial sites	109,051								109,051
LCF32 Sprawl of transport networks	37,688								37,688
LCF33 Sprawl of harbours	1,105								1,105
LCF34 Sprawl of airports	6,575								6,575
LCF35 Sprawl of mines and quarrying areas	93,751								93,751
LCF36 Sprawl of dumpsites	6,436								6,436
LCF37 Construction	193,932								193,932
LCF38 Sprawl of sport and leisure facilities	53,806								53,806
LCF4 Agriculture internal conversions		**408,564**	**135,004**						**543,568**
LCF41 Extension of set aside fallow land and pasture			115,862						115,862
LCF42 Internal conversions between annual crops		93,406							93,406
LCF43 Internal conversions between permanent crops		2,384							2,384
LCF44 Conversion from permanent crops to arable land		28,416	4,683						33,099
LCF45 Conversion from arable land to permanent crops		158,176							158,176
LCF46 Conversion from pasture to arable and permanent crops		126,182	13,948						140,130
LCF47 Extension of agro-forestry			511						511
LCF5 Conversion from forested & natural land to agriculture		**132,418**	**105,611**						**238,029**
LCF51 Conversion from forest to agriculture		42,061	49,929						91,990
LCF52 Conversion from semi-natural land to agriculture		57,853	36,709						94,562
LCF53 Conversion from wetlands to agriculture		24,214	2,839						27,053
LCF54 Conversion from developed areas to agriculture		8,290	16,134						24,424
LCF6 Withdrawal of farming			**8,668**	**170,354**	**7,786**	**883**	**3,644**		**191,335**
LCF61 Withdrawal of farming with woodland creation				170,354					170,354
LCF62 Withdrawal of farming without significant woodland creation			8,668		7,786	883	3,644		20,981
LCF7 Forests creation and management				**4,664,937**	**18,099**	**2,133**			**4,685,169**
LCF71 Conversion from transitional woodland to forest				1,167,328					1,167,328
LCF72 Forest creation, afforestation				268,658					268,658
LCF73 Forests internal conversions				2,468					2,468
LCF74 Recent felling and transition				3,226,483	18,099	2,133			3,246,715
LCF8 Water bodies creation and management						**5,741**		**73,702**	**79,443**
LCF81 Water bodies creation								73,702	73,702
LCF82 Water bodies management						5,741			5,741
LCF9 Changes of Land Cover due to natural and multiple causes				**382**	**75,274**	**167,568**	**17,464**	**25,982**	**286,670**
LCF91 Semi-natural creation and rotation					75,017	15,452	9,017	21,998	121,484
LCF92 Forests and shrubs fires						112,230			112,230
LCF93 Coastal erosion							2,373	1,338	3,711
LCF94 Decrease in permanent snow and glaciers cover						23,362		1,422	24,784
LCF99 Other changes and unknown				382	257	16,524	6,074	1,224	24,461
No Change	18,467,449	134,186,775	93,715,976	188,226,480	40,819,008	33,966,410	11,932,238	14,267,421	535,581,757
Total 2006	**19,278,564**	**134,727,757**	**93,965,259**	**193,062,153**	**40,920,167**	**34,142,735**	**11,953,346**	**14,367,105**	**542,417,086**

Table 2.4 Flow accounts for urban land, 2000-2006 (this table or the one below?)

	Stock 2000	LCF1 Urban land management	LCF2 Urban residential sprawl	LCF3 Sprawl of economic sites and infrastructures	LCF5 Conversion from forested & natural land to agriculture	LCF7 Forests creation and management	LCF8 Water bodies creation and management	LCF9 Changes of Land Cover due to natural and multiple causes	Total flows	NC No Change	Stock 2006
1 Artificial surfaces	**18,652,795**	**116,256**		**8,462**	**24,424**	**19,985**	**9,557**	**6,662**	**185,346**	**18,467,449**	
1 Artificial surfaces	**18,652,795**	**116,256**		**8,462**	**24,424**	**19,985**	**9,557**	**6,662**	**185,346**	**18,467,449**	
111 Continuous urban fabric	622,012	51		17					68	621,944	
112 Discontinuous urban fabric	13,569,231	1,460		63	51	14		76	1,664	13,567,567	
121 Industrial or commercial units	2,048,135	1,139		27	479	444		270	2,359	2,045,776	
122 Road and rail networks and associated land	194,910	206		1	4				211	194,699	
123 Port areas	90,085	11							11	90,074	
124 Airports	278,680	436		568	129	65		285	1,483	277,197	
131 Mineral extraction sites	617,621	1,686		440	13,684	16,486	7,329	4,443	44,068	573,553	
132 Dump sites	104,444	791		220	3,923	2,267	94	681	7,976	96,468	
133 Construction sites	168,103	104,108		6,895	6,056	693	2,115	907	120,774	47,329	
141 Green urban areas	242,257	4,141		231		16	8		4,396	237,861	
142 Sport and leisure facilities	717,317	2,227			98		11		2,336	714,981	
2A Arable land & permanent crops	**135,019,342**	979	80,419	233,472			17,324	2,559		134,186,775	
2B Pastures & mosaic farmland	**94,201,499**	1,120	88,043	120,142	17,022		20,315	1,792		93,715,976	
3A Forests and transitional woodland shrub	**192,950,749**	248	12,862	84,289	91,990	4,416,511	11,741	106,628		188,226,480	
3B Natural grassland, heathland, sclerophylous vegetation	**41,088,292**	162	7,664	44,359	61,356	101,900	7,116	46,727		40,819,008	
3C Open space with little or no vegetation	**34,207,227**		856	8,034	16,184	115,679	7,649	92,415		33,966,410	
4 Wetlands	**11,996,777**		132	2,152	23,456	30,996		7,803		11,932,238	
5 Water bodies	**14,300,405**		30	1,434	3,597	98	5,741	22,084		14,267,421	
Stock and consumption of land cover 2000	**542,417,086**	**118,765**	**190,006**	**502,344**	**238,029**	**4,685,169**	**79,443**	**286,670**		**535,581,757**	
1 Artificial surfaces		**118,765**	**190,006**	**502,344**					**811,115**	**18,467,449**	**19,278,564**
1 Artificial surfaces		**118,765**	**190,006**	**502,344**					**811,115**	**18,467,449**	**19,278,564**
111 Continuous urban fabric		3,616	3,668						7,284	621,944	629,228
112 Discontinuous urban fabric		51,293	186,338						237,631	13,567,567	13,805,198
121 Industrial or commercial units		33,966		109,051					143,017	2,045,776	2,188,793
122 Road and rail networks and associated land		16,576		37,688					54,264	194,699	248,963
123 Port areas		1,011		1,105					2,116	90,074	92,190
124 Airports		2,221		6,575					8,796	277,197	285,993
131 Mineral extraction sites		415		93,751					94,166	573,553	667,719
132 Dump sites		925		6,436					7,361	96,468	103,829
133 Construction sites		4,720		193,932					198,652	47,329	245,981
141 Green urban areas		4,022							4,022	237,861	241,883
142 Sport and leisure facilities				53,806					53,806	714,981	768,787
2A Arable land & permanent crops					132,418					134,186,775	**134,727,757**
2B Pastures & mosaic farmland					105,611					93,715,976	**93,965,259**
3A Forests and transitional woodland shrub						4,664,937		382		188,226,480	**193,062,153**
3B Natural grassland, heathland, sclerophylous vegetation						18,099		75,274		40,819,008	**40,920,167**
3C Open space with little or no vegetation						2,133	5,741	167,568		33,966,410	**34,142,735**
4 Wetlands								17,464		11,932,238	**11,953,346**
5 Water bodies							73,702	25,982		14,267,421	**14,367,105**
Stock and formation of land 2006		**118,765**	**190,006**	**502,344**	**238,029**	**4,685,169**	**79,443**	**286,670**		**535,581,757**	**542,417,086**

Alternative table 2.4?

Row Labels	1 Artificial surfaces	2A Arable land & permanent crops	2B Pastures & mosaic farmland	3A Forests and transitional woodland shrub	3B Natural grassland, heathland, sclerophylous vegetation	3C Open space with little or no vegetation	4 Wetlands	5 Water bodies	Total Stock 2006
1 Artificial surfaces	**18,592,167**	**314,870**	**209,305**	**97,399**	**52,185**	**8,890**	**2,284**	**1,464**	**19,278,564**
111 Continuous urban fabric	625,560	1,845	1,424	78	312	9			629,228
112 Discontinuous urban fabric	13,618,860	78,574	86,619	12,784	7,352	847	132	30	13,805,198
121 Industrial or commercial units	2,079,742	64,943	30,240	8,032	5,170	464	147	55	2,188,793
122 Road and rail networks and associa	211,275	16,959	7,385	10,170	2,836	66	110	162	248,963
123 Port areas	91,085	64	139	105	491	53	45	208	92,190
124 Airports	279,418	4,140	969	758	195	294	209	10	285,993
131 Mineral extraction sites	573,968	35,600	18,070	28,120	8,789	2,380	502	290	667,719
132 Dump sites	97,393	1,906	1,661	2,046	508	64	108	143	103,829
133 Construction sites	52,049	93,795	51,464	23,321	20,041	4,086	698	527	245,981
141 Green urban areas	239,374	979	1,120	248	162				241,883
142 Sport and leisure facilities	723,443	16,065	10,214	11,737	6,329	627	333	39	768,787
2A Arable land & permanent crops	**8,290**	**134,469,157**	**139,292**	**42,061**	**36,502**	**8,241**	**22,370**	**1,844**	**134,727,757**
2B Pastures & mosaic farmland	**16,134**	**123,683**	**93,739,877**	**49,929**	**24,854**	**7,943**	**1,086**	**1,753**	**93,965,259**
3A Forests and transitional woodland shr	**19,985**	**88,525**	**81,829**	**192,622,759**	**101,900**	**115,679**	**30,996**	**480**	**193,062,153**
3B Natural grassland, heathland, scleroph	**3,109**	**3,124**	**4,662**	**31,979**	**40,833,293**	**43,681**	**62**	**257**	**40,920,167**
3C Open space with little or no vegetatio	**2,861**	**600**	**2,005**	**88,207**	**31,375**	**33,995,396**	**1,318**	**20,973**	**34,142,735**
4 Wetlands	**134**	**1,546**	**3,644**	**6,059**	**898**	**2,077**	**11,936,285**	**2,703**	**11,953,346**
5 Water bodies	**10,115**	**17,837**	**20,885**	**12,356**	**7,285**	**25,320**	**2,376**	**14,270,931**	**14,367,105**
Total stock 2000	**18,652,795**	**135,019,342**	**94,201,499**	**192,950,749**	**41,088,292**	**34,207,227**	**11,996,777**	**14,300,405**	**542,417,086**

Table 2.5: Flow accounts for Agriculture, 2000-2006

	Stock 2000	LCF1 Urban land management	LCF2 Urban residential sprawl	LCF3 Sprawl of economic sites and infrastructures	LCF4 Agriculture internal conversions	LCF5 Conversion from forested & natural land to agriculture	LCF6 Withdrawal of farming	LCF7 Forests creation and management	LCF8 Water bodies creation and management	LCF9 Changes of Land Cover due to natural and multiple causes	Total Flows	NC No Change	Stock 2006
1 Artificial surfaces	18,652,795	116,256		8,462		24,424		19,985	9,557	6,662	185,346	18,467,449	
2A Arable land & permanent crops	135,019,342	979	80,419	233,472	401,112		96,702		17,324	2,559	832,567	134,186,775	
2A Arable land & permanent crops	131,291,734	979	78,316	228,744	396,664		94,152		16,481	2,543	817,879	130,473,855	
211 Non-irrigated arable land	114,541,754	930	67,016	193,912	321,626		87,904		13,696	2,275	687,359	113,854,395	
212 Permanently irrigated land	8,140,220	46	2,486	15,365	34,633		2,214		1,740	144	56,628	8,083,592	
213 Rice fields	800,456		83	950	5,385		34		83		6,535	793,921	
221 Vineyards	3,999,091		3,805	6,035	11,578		1,517		610	19	23,564	3,975,527	
222 Fruit trees and berry plantations	2,851,323	3	3,486	9,987	21,280		1,642		268	105	36,771	2,814,552	
241 Annual crops associated with permanent crops	958,890		1,440	2,495	2,162		841		84		7,022	951,868	
2A Arable land &permanent crops	3,727,608		2,103	4,728	4,448		2,550		843	16	14,688	3,712,920	
223 Olive groves	3,727,608		2,103	4,728	4,448		2,550		843	16	14,688	3,712,920	
2B Pastures & mosaic farmland	94,201,499	1,120	88,043	120,142	142,456	17,022	94,633		20,315	1,792	485,523	93,715,976	
2B Mosaic farmland	61,958,969	296	65,387	71,263	31,240	17,022	45,361		14,752	1,683	247,004	61,711,965	
242 Complex cultivation patterns	30,211,262	160	51,194	50,645	28,555		6,396		5,552	263	142,765	30,068,497	
243 Agriculture mosaics with significant natural vegetatio	28,470,930	136	14,028	18,819	241	17,022	22,877		4,668	858	78,649	28,392,281	
244 Agro-forestry areas	3,276,777		165	1,799	2,444		16,088		4,532	562	25,590	3,251,187	
2B1 Pastures	32,242,530	824	22,656	48,879	111,216		49,272		5,563	109	238,519	32,004,011	
231 Pastures	32,242,530	824	22,656	48,879	111,216		49,272		5,563	109	238,519	32,004,011	
3A Forests and transitional woodland shrub	192,950,749	248	12,862	84,289		91,990		4,416,511	11,741	106,628	4,724,269	188,226,480	
3B Natural grassland, heathland, sclerophylous vegetation	41,088,292	162	7,664	44,359		61,356		101,900	7,116	46,727	269,284	40,819,008	
3C Open space with little or no vegetation	34,207,227		856	8,034		16,184		115,679	7,649	92,415	240,817	33,966,410	
4 Wetlands	11,996,777		132	2,152		23,456		30,996		7,803	64,539	11,932,238	
5 Water bodies	14,300,405		30	1,434		3,597		98	5,741	22,084	32,984	14,267,421	
Total		118,765	190,006	502,344	543,568	238,029	191,335	4,685,169	79,443	286,670	6,835,329	535,581,757	542,417,086
1 Artificial surfaces		118,765	190,006	502,344							811,115	18,467,449	19,278,564
2A Arable land & permanent crops					408,564	132,418					540,982	134,186,775	134,727,757
2A Arable land & permanent crops					340,166	127,541					467,707	130,473,855	130,941,562
211 Non-irrigated arable land					132,685	96,576					229,261	113,854,395	114,083,656
212 Permanently irrigated land					83,398	18,225					101,623	8,083,592	8,185,215
213 Rice fields					12,078	875					12,953	793,921	806,874
221 Vineyards					51,717	5,080					56,797	3,975,527	4,032,324
222 Fruit trees and berry plantations					58,917	6,523					65,440	2,814,552	2,879,992
241 Annual crops associated with permanent crops					1,371	262					1,633	951,868	953,501
2A Arable land &permanent crops					68,398	4,877					73,275	3,712,920	3,786,195
223 Olive groves					68,398	4,877					73,275	3,712,920	3,786,195
2B Pastures & mosaic farmland					135,004	105,611	8,668				249,283	93,715,976	93,965,259
2B Mosaic farmland					41,288	70,397	8,668				120,353	61,711,965	61,832,318
242 Complex cultivation patterns					40,777	10,049					50,826	30,068,497	30,119,323
243 Agriculture mosaics with significant natural vegetation						20,889	8,668				29,557	28,392,281	28,421,838
244 Agro-forestry areas					511	39,459					39,970	3,251,187	3,291,157
2B1 Pastures					93,716	35,214					128,930	32,004,011	32,132,941
231 Pastures					93,716	35,214					128,930	32,004,011	32,132,941
3A Forests and transitional woodland shrub							170,354	4,664,937		382	4,835,673	188,226,480	193,062,153
3B Natural grassland, heathland, sclerophylous vegetation							7,786	18,099		75,274	101,159	40,819,008	40,920,167
3C Open space with little or no vegetation							883	2,133	5,741	167,568	176,325	33,966,410	34,142,735
4 Wetlands							3,644			17,464	21,108	11,932,238	11,953,346
5 Water bodies									73,702	25,982	99,684	14,267,421	14,367,105
Total		118,765	190,006	502,344	543,568	238,029	191,335	4,685,169	79,443	286,670	6,835,329	535,581,757	542,417,086

Table 2.6 Flow accounts for Forest and semi-natural (2000-2006)

Figure 2.1 Origins of Artificial Land, 2000-2006

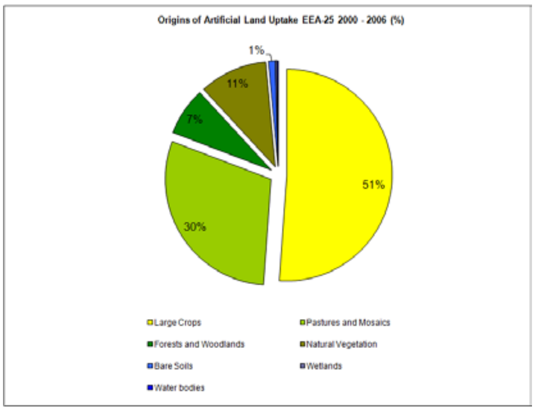


Figure 2.2

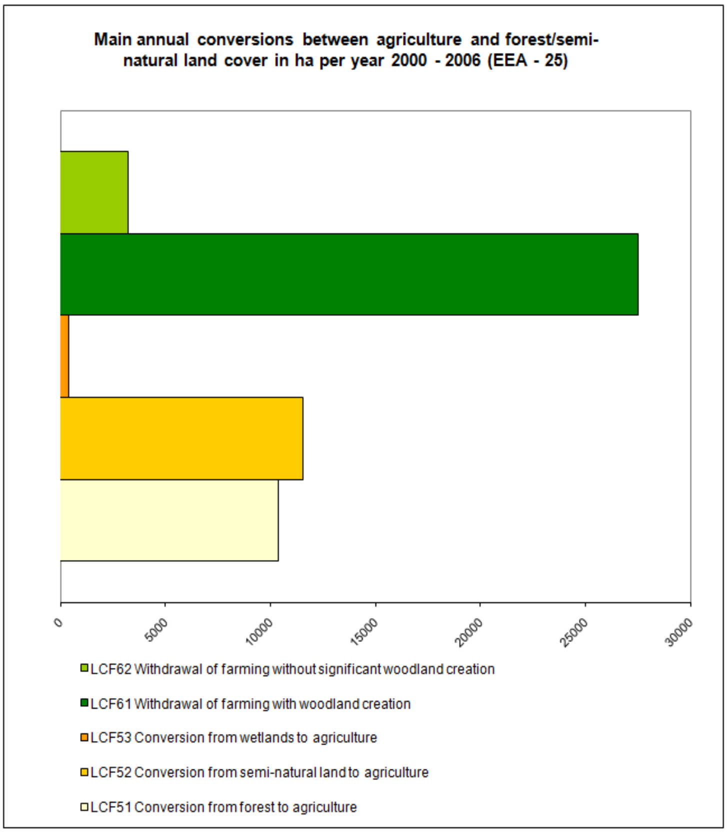


Figure 2.3:

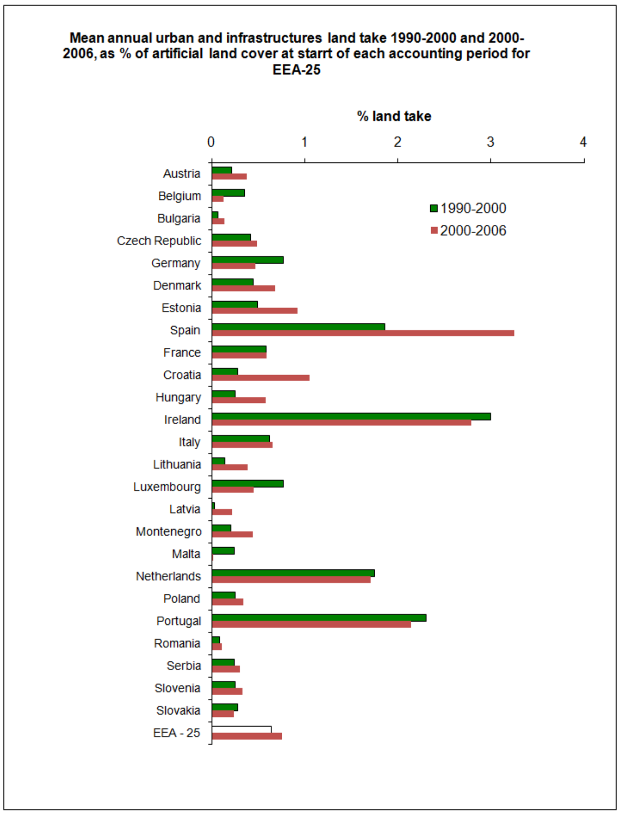
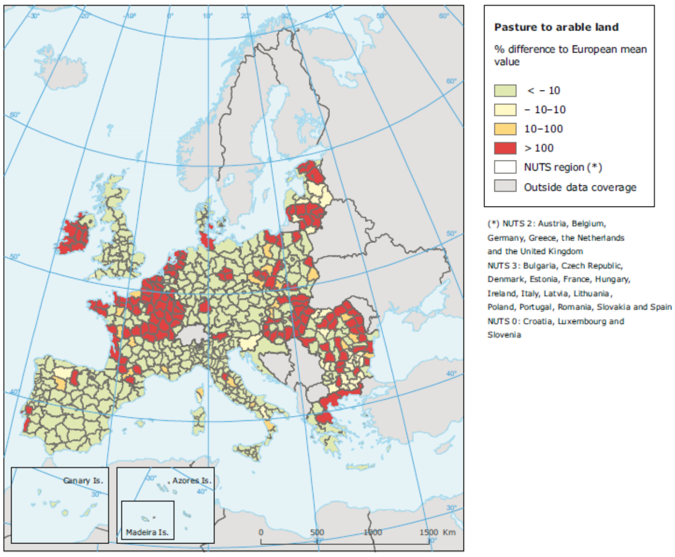


Figure 2.4

Map equivalent to for 2000-2006?



Source: Data: EEA; NUTS boundaries: Eurogeographics.

Figure 2.5

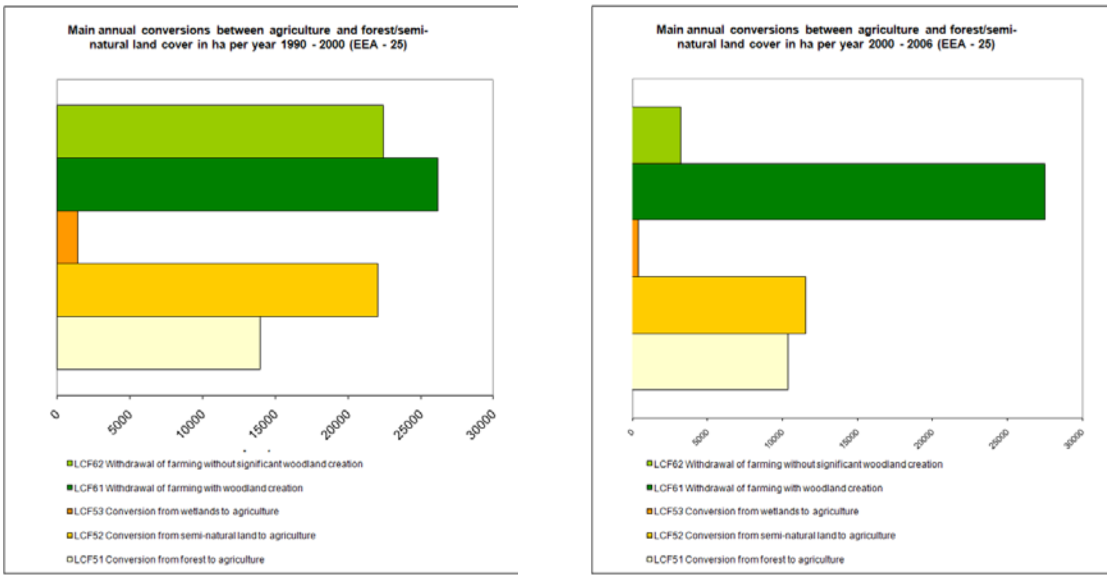


Figure 2.6 Percent change in forest area as a result of forest creation (LCF7) as a proportion of 2006 forest area [perhaps 2000 area is better?]

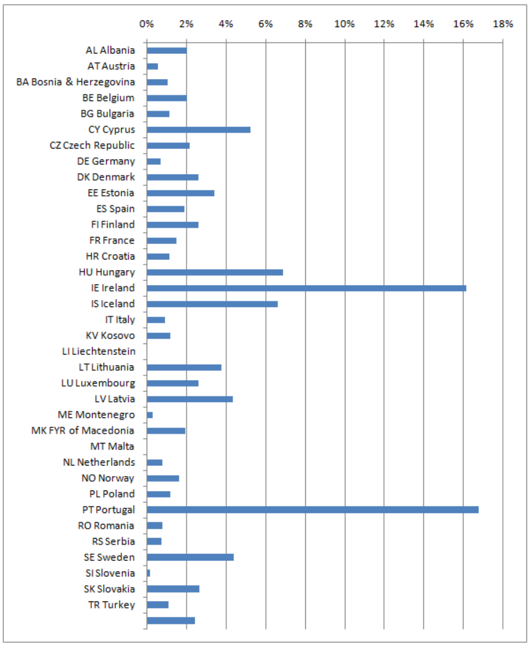


Figure 2.7 Land cover flows by country (NUTS0) ***[CAN WE ADD 1990-2000 FLOWS TO THESE GRAPHS?]***

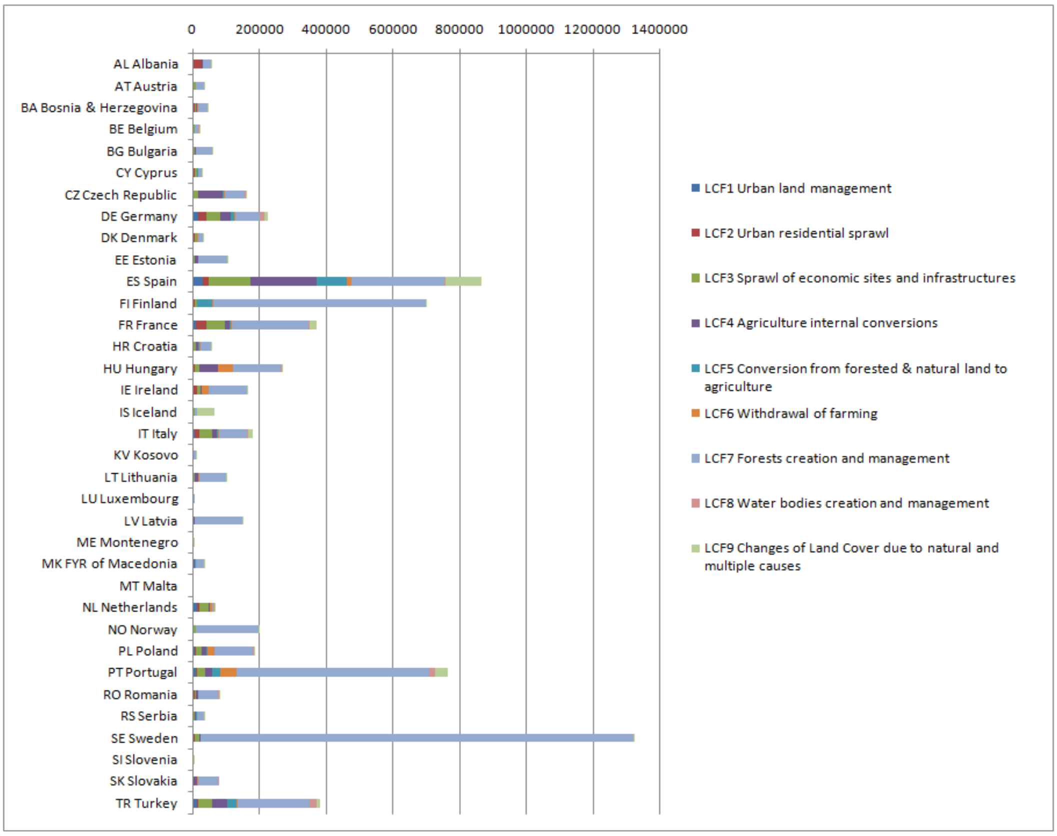


Figure 2.9: Land cover flows by major elevation zone [CAN WE ADD 1990-2000 FLOWS TO THESE GRAPHS?]; Figures in ha/yr to assist comparison

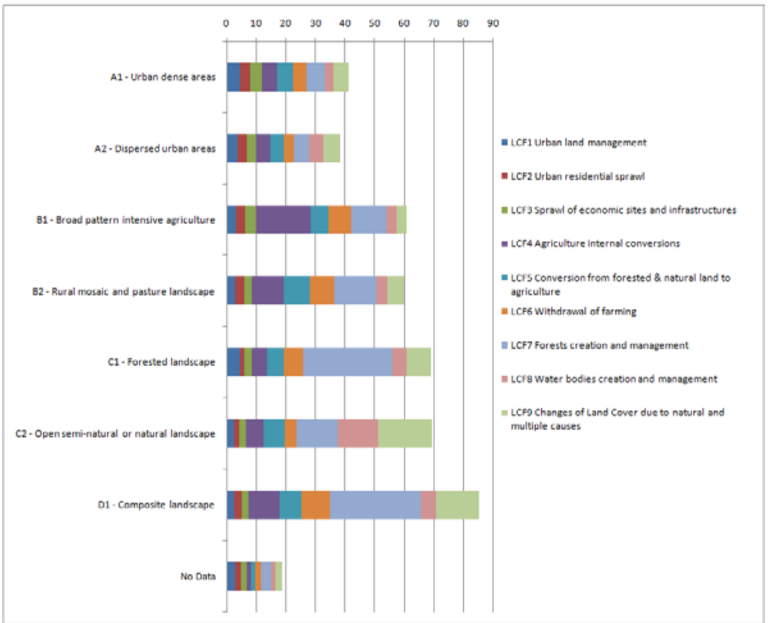


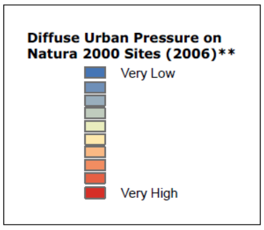
Figure 2.10 Changing urban temperatures

Figure 2.11 Changes in pressures from intensive agricultural activities

Figure 2.12: areas where urban sprawl between 2000 and 2006 has been detected.

Figure 2.13 Withdrawl of farming 90-00 and 00-06

Figure 2.14:



The index of Diffuse Pressure combines intensity from within N2000 sites and the surrounding neighbourhood (EEA 11/2006)

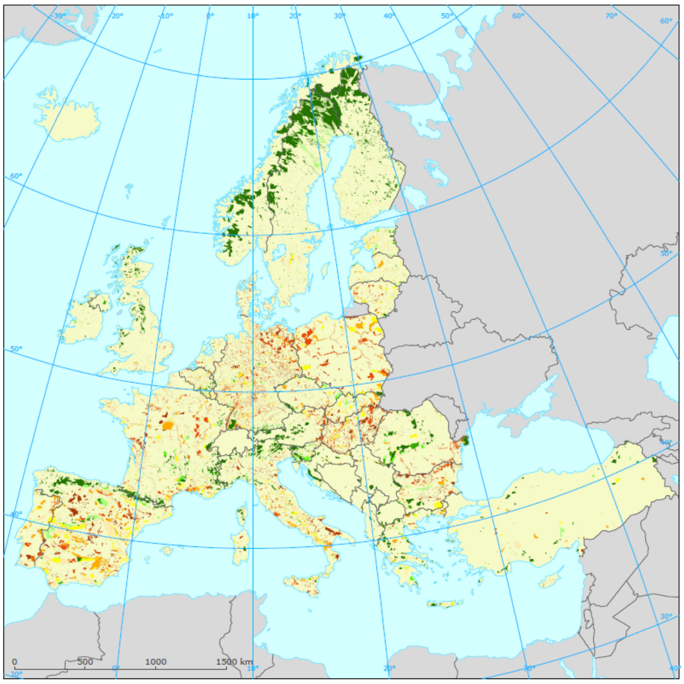
*Natura 2000 Sites used in all cases where they are recorded. For purposes of map completion CDDA sites are used in countries with no Natura2000 status:

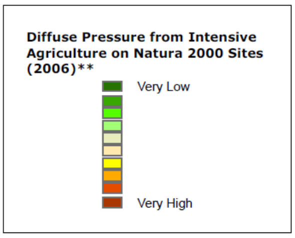
Turkey, Croatia, Albania, Norway

**For Purposes of map completion Corilis 2000 data is used for countries with no current Corilis 2006 data:

UK, Greece

Figure 2.15:





The index of Diffuse Pressure combines intensity from within N2000 sites and the surrounding neighbourhood (EEA 11/2006)

*Natura 2000 Sites used in all cases where they are recorded. For purposes of map completion CDDA sites are used in countries with no Natura2000 status:

Turkey, Croatia, Albania, Norway

**For Purposes of map completion Corilis 2000 data is used for countries with no current Corilis 2006 data:

UK, Greece

Figure 2.16

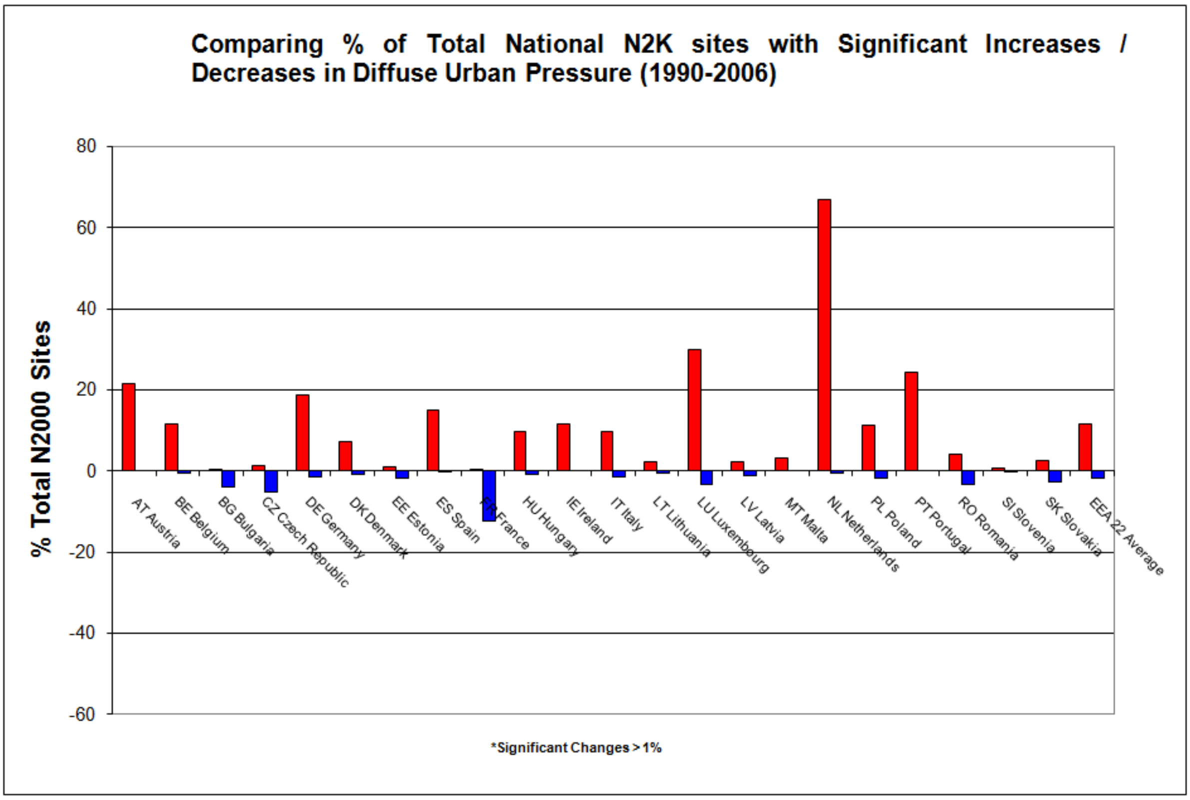
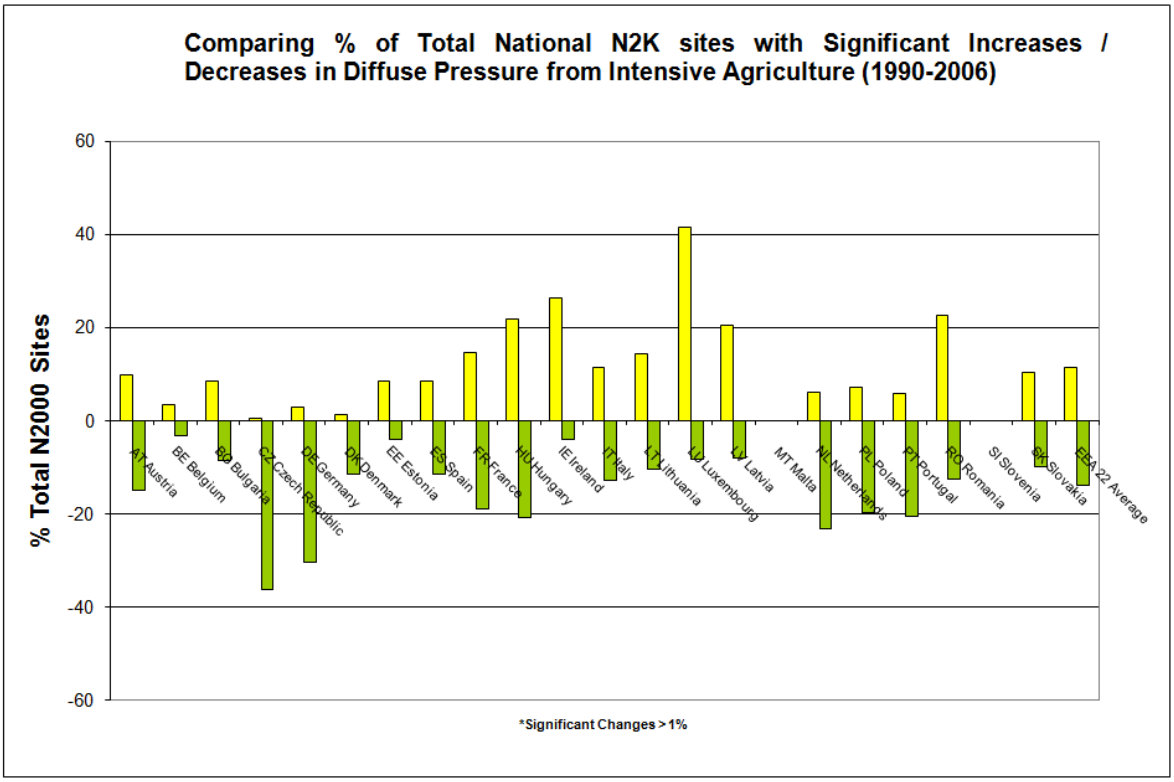


Figure 2.17



Part 3 Land Cover Accounts for Europe: Methodological Developments

3.1 Introduction

In our report of the land cover changes across Europe 1990-2000 we described the methodologies underpinning their construction. The same methods have been used for this update although there have been some refinements. For transparency we describe more fully here how the current set of accounts was produced and any changes we made to the way data were processed.

3.2 Building the Accounts Database

Although the land cover data used to produce CLC1990, CLC2000 and latterly CLC2006 are fully geo-referenced and co-registered so that change could be mapped accurately, further processing is required to create the Land and Ecosystem Account database (LEAC) that is the basis of the work reported here. As we noted in our earlier report (EEA, 2006, Part 8) this involved the creation of a system of spatial grids, starting from the 100m x 100m CLC raster files which have then been assimilated statistically into successively larger grids at 1km x 1 km, 5km x 5km and 10km x 10km resolution; the 5- and 10km grids were created using the CORILIS methodology described in Part 1. The important point to note, however, is that the statistical assimilation of data at these different scales differs from cartographic generalisation in the sense that it preserves the original values rather than assimilating small land cover objects into the larger ones. Although the accounting grid may have a resolution of 1 km x 1 km, the 100 m resolution of the underlying CLC data and thus the properties of the underlying CORINE vector data are retained by the approach. Thus all the analyses presented are consistent even through the scale of the basic accounting unit may change.

The accounting grid used for the LEAC work is the same one as used in the 1990-2000 analysis. This was based the recommendations of a workshop on European reference grids which was part of the INSPIRE initiative. Since then the grid has become an agreed European Standard[4]. The grid is made up of about 4.5 million 1 km x 1 km cells, each of which can hold a data record in the LEAC database. The approach used to build this information resource is shown in Figure 3.1.

>>>>Insert Figure 3.1 about here

The basic CORINE mapping for all three time periods (1990, 2000 and 2006) consists of a vector data set which shows the boundaries of the various interpreted land cover parcels for the various survey dates. The methods underpinning CORINE are fully described elsewhere[5]. From these data raster maps were created at 100m and these data used to record the stock of each land cover type within each 1km x 1km cell. This was done by superimposing the 1 km x 1 km cells onto the underlying raster, and calculating the extent of each cover type and the change observed between the three CORINE images. The full process is illustrated in Figure 3.1. The important feature to note is that the calculation of stock and change reflects the _actual_ data contained in each cell, and no generalisation is involved in the calculation of the resulting statistics even though the resulting maps and takes are based on the 1km accounting grid. The records are formed by identifying the relationships between

[4] Reference to INSPIRE standard grid?
[5] CORINE methodology

cover elements at CORINE level 3 between the three image dates via a transition matrix that can be used to code up the exchanges between the land cover types for each cell.

Figure 3.1 provides a worked example, showing how the database stores the stock of each cover type and calculates the changes over a given time period. The particular strength of this approach is that the records can be grouped for analytical or reporting purposes in a consistent way. The aggregation of data is achieved by assigning each cell in the accounting grid to different analysis and reporting units, according to where they are located in the various administrative levels in the NUTS hierarchy, or other physical divisions. This is the technique used to produce the zonal account discussed in Part 2 of this document.

>>>>Insert Tables 3.1 and 3.2 about here

Table 3.1 shows the additional data associated with each cell in the accounting grid that can be used to aggregate the basic stock and change data, and Table 3.2 give the definition of the elevation zones applied to the zoning. Together these define the set of Land and Analytical reporting Units (LARU) used in LEAC. The new attributes added since the earlier accounting report, are cities... are there any more? [new ECRINS-catchments??] Future additions will include... The LEAC data are now available as data cubes that can be opened in EXCEL; the LAUR can be used to define the structure of pivot tables for the display of information and the construction of accounts tables (see Appendix A for details of data access).

3.3 Mapping Potentials and Indicators

The CORILIS methodology was described in the introduction to this Report and has been used as part of the analytical framework for the accounts in Part 2. In this section we focus more on the underlying the methods of this 'potentials mapping' approach. For although the application of the basic CORILIS methodology has remained the same, since the earlier publication of the accounts for 1990-2000, the some of the key mapping outputs used in association with the LEAC data have been refined and modified. New indicators related to ecological potential and ecotones have also been produced. The major developments have surrounded the mapping of the 'green background', first described in EEA (2006).

3.3.1 The Green Background Index and Landscape Ecological Potential

The Green Background Index [or is it Landscape?] is proposed as an indicator map which shows the spatial variations in 'ecological potential'. It is based on the spatial distribution of pasture, agriculture mosaics, forests and other semi-natural or natural land, open spaces, wetlands and water bodies. The CORILIS smoothing algorithm has been applied to each point on each of the maps, so that the area of each cover type within a fixed radius can be calculated. The mapped layers are then added together to produce the smooth surface representing the density of 'green' cover. Although the smoothing radius can be fixed at any value, for the purposes of the LEAC analysis XXkm was used

The Green Index,, bow called formally the Green Background Index is a continuous variable with values ranging from 0 to 100. For mapping, the output can be modified in a number of ways, using for example, different thresholds can be used to indicate the areas of highest ecological potential. In the earlier publication we showed how the green background index could be mapped using different thresholds. Given the availability of CLC2006 data it is now possible to calculate the *change* in the index. Some of these techniques have been used already in the context of changing urban and agricultural potentials discussed in Part 2. Similar techniques can be applied to the Green background Index (Figure 3.3)

>>>>Insert Figure 3.2 about here.

Although the Green Background Index can be used as a stand-alone indicator, current work involves its integration with several other metrics to develop a more comprehensive measure of Landscape *Ecological Potential (LEP)*. The latter is based on a combination of measures (see Figure 3.4)

>>>>insert Figure 3.4 about here

The LEP is formed by combining information about land cover, the density of the green background, the density of NATURA 2000 sites, with measures of fragmentation. The latter has been assessed using a method based on the calculation of 'Effective Mesh Size' (MEFF) derived from TeleAtlas Roads and CLC data (Figure 3.5). MEFF attempts to measure the barriers to biodiversity represented by built structures; the MEFF value can be interpreted as the expected size of the area that is accessible when starting a movement at a randomly chosen point inside the reporting unit (in our case 1km grid) without encountering a physical barrier. So the higher MEFF value the less fragmented area around.

>>>>insert Figure 3.5 about here

The final value of the LEP Index for a given reporting unit is the quadratic mean of the various data layers shown in Figure 3.4. Figure 3.6 and 3.7 show the calculation of the LEP using the CLC2006 data and the new MEFF product, and the changes observed since 2000

>>>>insert Figure 3.6 and 3.7 about here

3.3.2 Dominant Landscape Index

Zonal accounts using the Dominant Landscape Types (DLT) for Europe have been presented in part 2 of this Report. As noted in the introduction a new map has recently been produced as a result of some draw-backs associate with the original version. The old classification of types relied on calculation of the mean + standard deviation for the entire European dataset, which were then used to define the most important or distinctive 'dominant' land covers in each 1km cell, and the various sub-dominant types. This introduced some local irregularities in to the classification and so a new approach using a per-pixel classification method has been developed. The approach is comparable to the proportional membership techniques used more widely in remote sensing and image interpretation (Campbell, 2006). Using these methods a more transparent and robust classification of dominant land cover has been produced, which does not force 1km cells into landscape classes to which they do not rightly belong.

>>>>Insert Figure 3.8 about here [method of defining DLT...]

The method used to define the DLTs is documented in Figure 3.8. It involves a rule based procedure that first assigns dominance on the basis of the land cover class that exceeds 51% of the 1km x 1km cell.....[not sure Ifollow the methodology in the papers....- can we clarify?]. Figures 3.9 and 3.10 illustrate the resulting DLT maps using the 51% and 34% rules. [So which do we use?]

>>>>Insert Figures 3.9 and 3.10 [DLT maps for 51% and 34%]

3.3.2 Ecotones

An ecotone is a transition area between two different ecosystems, along which species often mix and interact. This can produce an edge effect along the boundary line, with a greater than usual diversity of species of species operating the large number of ecological niches. They often contain species common to the communities on both sides of the transition and any include a number of species able to colonize and specialise on such transitional areas. It is widely acknowledged that diversity and density of species is often higher at such transitions compared to the neighbouring habitats. As a result they are high interest for biodiversity.

Ecotones can vary in width and also differ in their distinctiveness. Thus they can appear on the ground as a gradual blending of the two communities across a broad area, or as a sharp boundary line. This makes their detection particularly difficult. The resolution that is available using the sources of CLC data means that small linear features cannot be easily detected or mapped; often they contribute to one of the mixed classes. However, it is possible to get some insight into the types of boundary zone that might exist and the density of ecotones by looking at the junctions between the land cover elements that make up the land cover image. Work is currently underway to examine whether these data provide an additional layer of information use to improve correlations between land and biodiversity data. The approach is illustrated in Figure 3.11.

>>>>Insert Figure 3.11 about here

At the most detailed level of mapping land cover, there are 44 classes. This potentially defines 924 ecotonal types ((44 x 44)/2)-44). For analysis these have been grouped hierarchically following the same approach used for the classification of different levels in the hierarchal land cover classification system. The aggregation approach and the definition of types is described in Figure 3.11. These types can then be mapped.

The final inset map in Figure 3.11 shows a compilation of various forest Ecotones hotspots across Europe using the CLC2006 data. They have been overlaid onto a the GBI background to indicate where the two influences might be strongest. This kind of analysis is useful in highlighting areas of high natural-landscape diversity. Areas of multiple Ecotones hotspots (including the circled regions in Southern France) would potentially indicate high levels of species biodiversity. He links between these measures of landscape structure and biodiversity are currently being tested.

3.4 Tools and tutorials

The LEAC data presented in this report can be accessed in a number of ways. The most direct is via the on-line, interactive viewer[6] which provides tools for the production of accounts, maps, tables and graphical output. An example of the output that can be produced using this viewer is shown in Figure 3.?

>>>>insert Figure 3.? about here

A guidebook is also available [is this for public consumption?][7]

What more should go in here?

---

[6] http://www.eea.europa.eu/themes/landuse/interactive# and http://dataservice.eea.europa.eu/PivotApp/pivot.aspx?pivotid=501

[7] http://www.eea.europa.eu/data-and-maps/data/land-cover-accounts-leac-based-on-corine-land-cover-changes-database-1990-2000/leac-methodological-guidebook/leac-methodological-guidebook/

Hyperatlas?

Quickscan?

Table 3.1: The land analytical and reporting units coded into the LEAC database

Administrative units
NUTS 0 (countries)
NUTS 1
NUTS 2
NUTS 3
Cities
Geographic regions
Regional sea basins (according to international conventions on sea)
Coastal zones (High and low coast, inland)
Mountain areas (Massifs)
Urban morphological zones
Biogeographic regions (according to Natura 2000)
Land cover units (Corine land cover)
Land cover intensity in neighbourhoods (CORILIS modifiable layers)
Dominant land cover and landscape type areas
Elevation (lowland, upland, mountain)

Others???

Table 3.2: Definition of altitude classes used in LEAC

Lowland: all land below 200 m; lowland can be subdivided between coastal zone (10 km strip from the coastline) and low inland.
Upland: all land above 200 m and lower than 500 m, as well as up to 1 000 m when the average slopes in the 1 km² grid cells is < 2 % (i.e. a plateaux surface).
Mountain: all land above higher than 1 000 m as well as land between 500 m and 1 000 m, when the average slope in a 3 km x 3 km grid cells is > 2 %.

Figure 3.2: Change in GBI – Map like this one but for GBI?

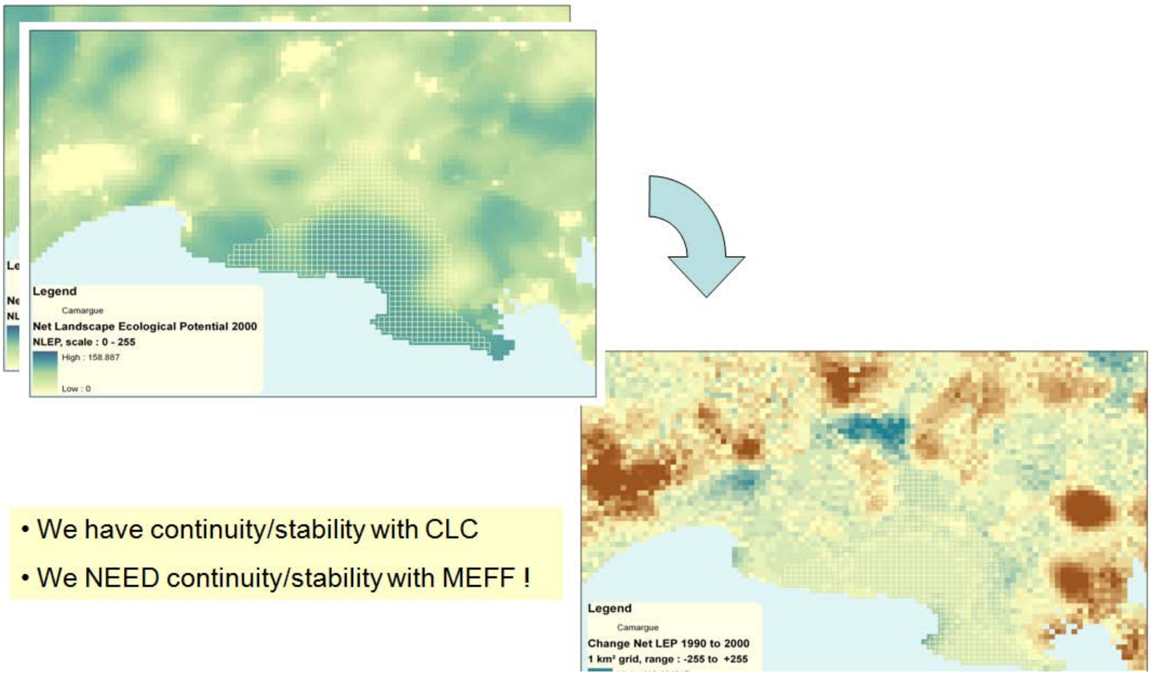


Figure 3.3

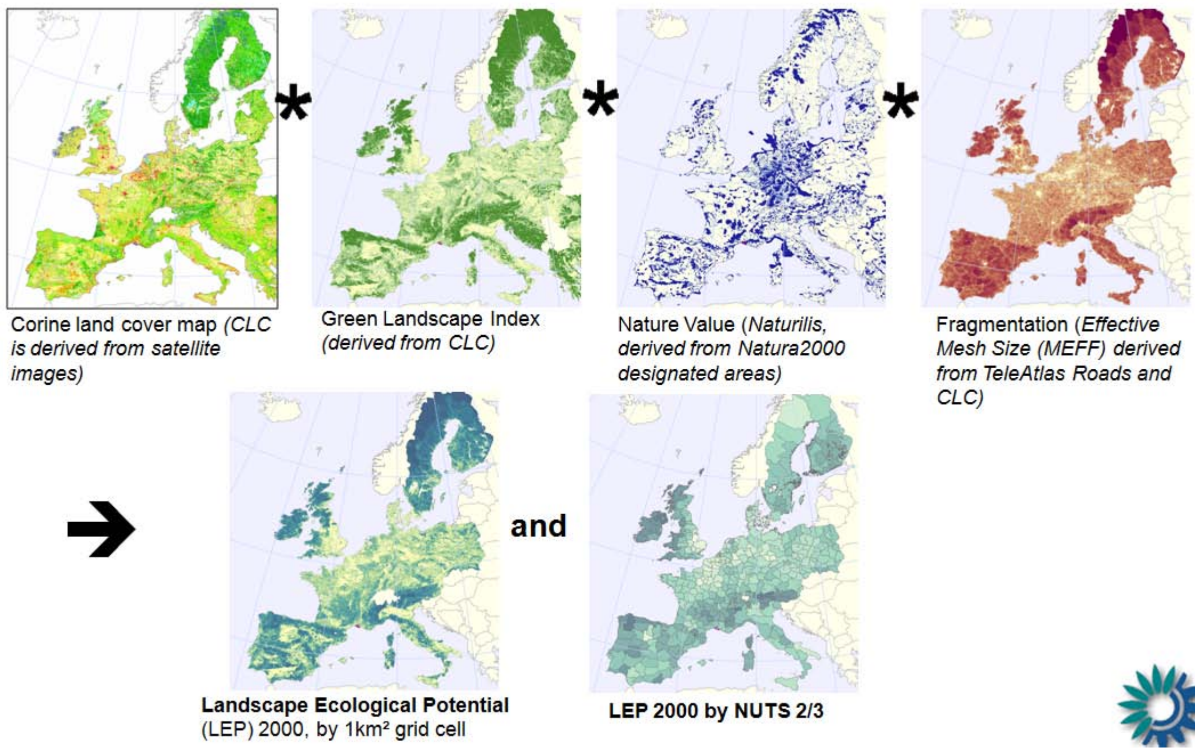


Figure 3.5

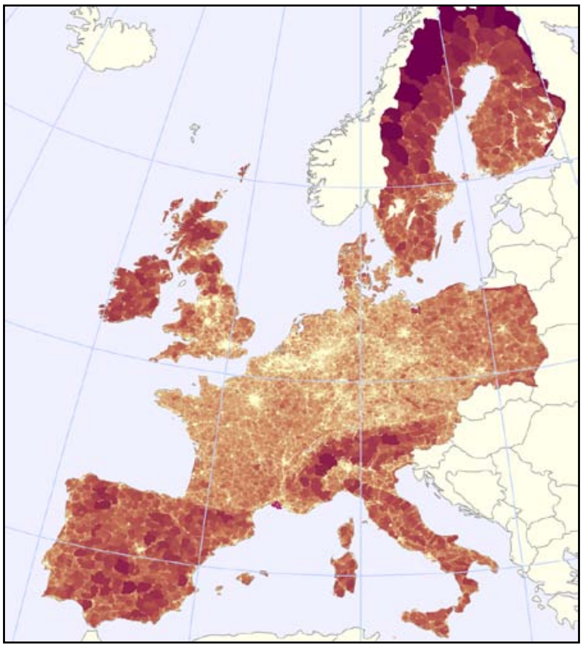


Figure 3.6 map like this for 2006

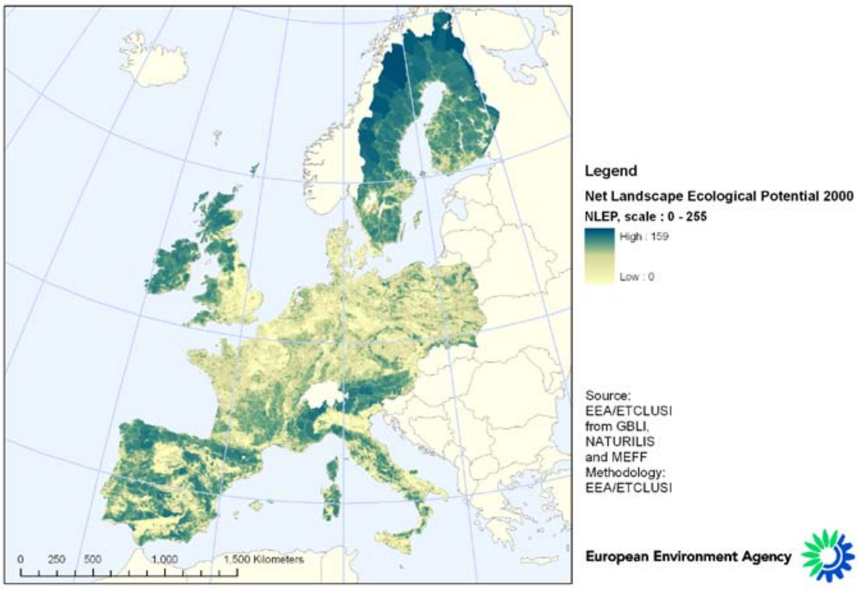


Figure 3.7 Map lke this for 2000-2006

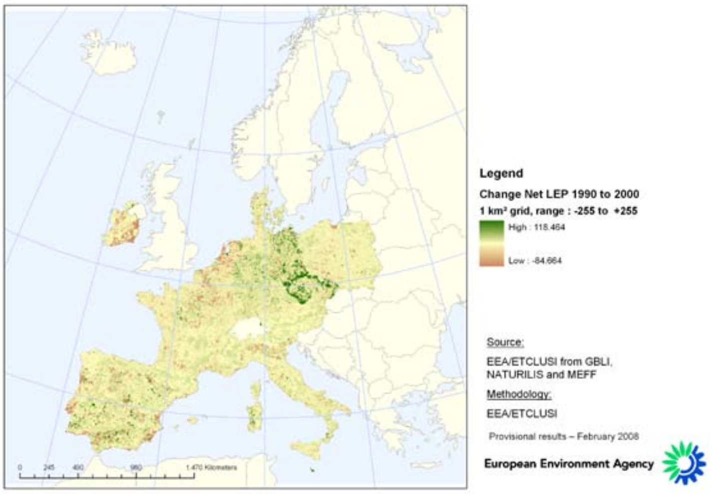


Figure 3.8 - Method of assigning DLT using Dominant land cover Needs redrawing and explaining as flow diagram?

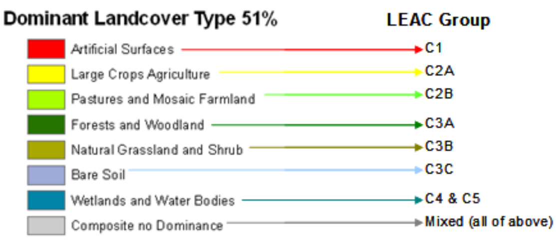


Fig 1. Corine Groupings for DLT 51

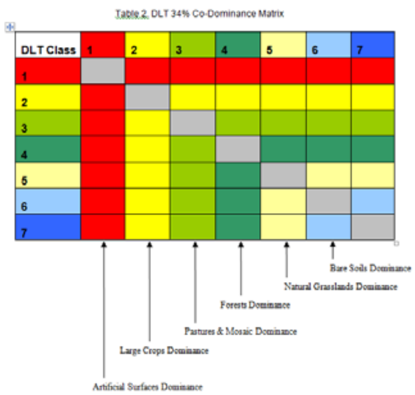


Figure 3.9 DLT – 51% rule

The DLT 51% method utilizes the principle of "majority ownership" in order to establish DLT, applying the logic that if any given pixel has 51% class membership, it is certainly dominant over all other Landcover types. DLT classes are filtered according to per-pixel percentage membership, and pixels containing less than 51% proportional membership to a respective DLT class are classified as composite land with

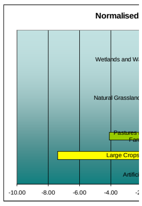
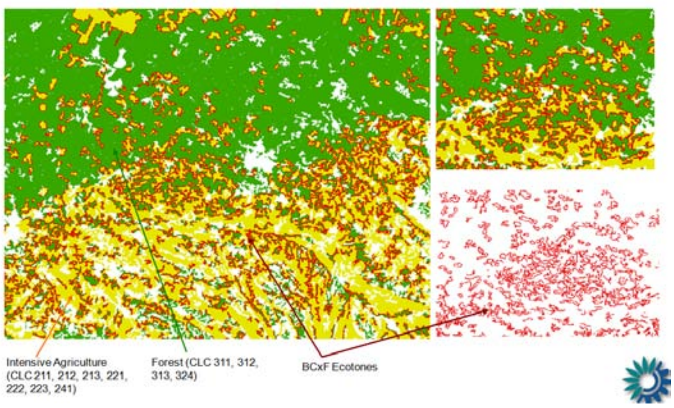


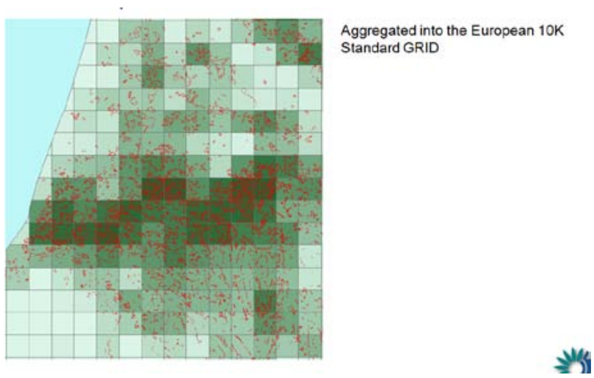
Figure 3.10 DLT using sub-dominant rule

Fig 4. Dominant Landcover Types for Europe (2000) according to the 34% co-dominance rule (see legend)

Figure 3.11: Ecotones

		1	2A		2B		3A		3B	3C	4	5	
			2A1	2A2	2B1	2B2	3A1	3A2				5A	5B
		Artificial areas	Arable land & permanent crops	Irrigated agriculture	Pastures	Mosaic farmland	Standing forests	Transitional woodland & shrub	Semi-natural vegetation	Open spaces/ bare soils	Wetlands	Inland water bodies	Sea
		A	B	C	D	E	F	G	H	I	J	K	L
A	Artificial areas	A#A	A#BC		A#DE		A#FG		A#HIJ			A#K	A#L
B	Arable land & permanent crops		BC#BC		B#DE		BC#F	BC#G	B#HI		B#J	B#K	BC#DE#L
C	Irrigated agriculture				C#DE				C#HI		C#J	C#K	
D	Pastures				DE#DE		DE#F	DE#G	DE#HI		DE#J	DE#K	
E	Mosaic farmland												
F	Standing forests						FG#FG		F#HIJ			FG#K	FG#L
G	Transitional woodland & shrub								G#HIJ				
H	Semi-natural vegetation								HI#HI		HI#J	HI#K	H#L
I	Open spaces/ bare soils												I#L
J	Wetlands										J#J	J#K	J#L
K	Inland water bodies											K#K	K#L
L	Sea												L#L





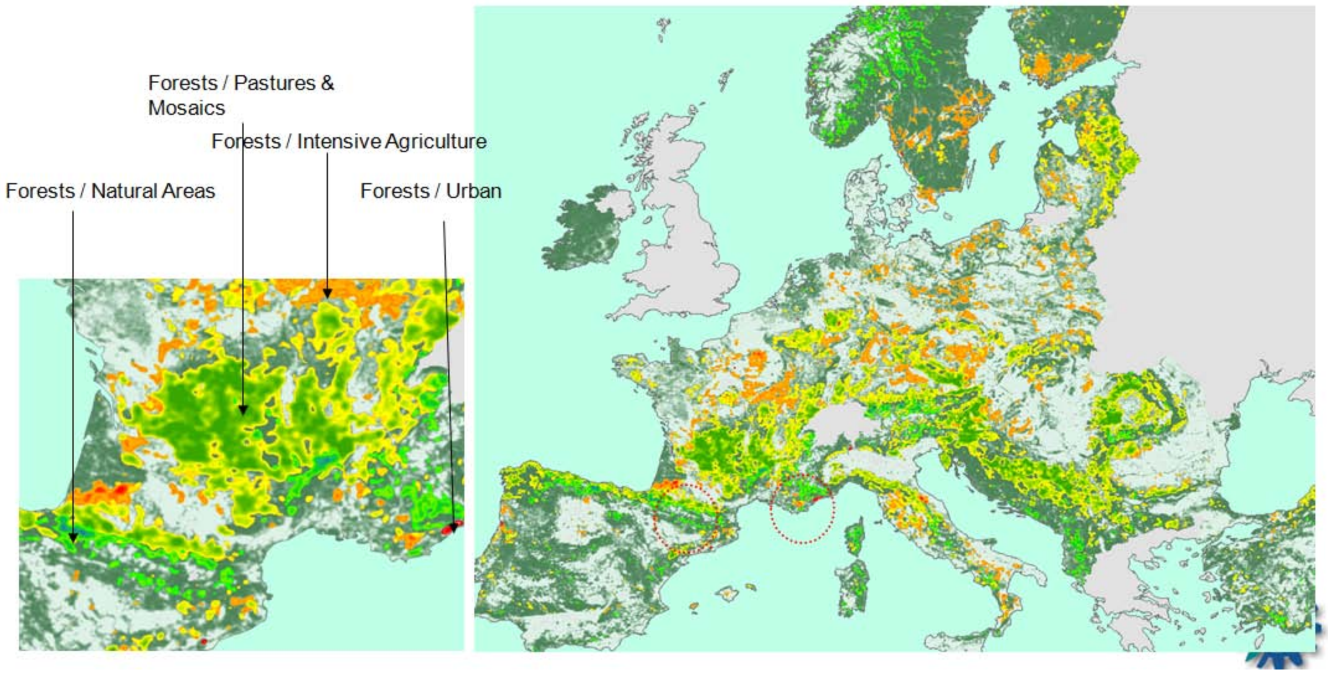
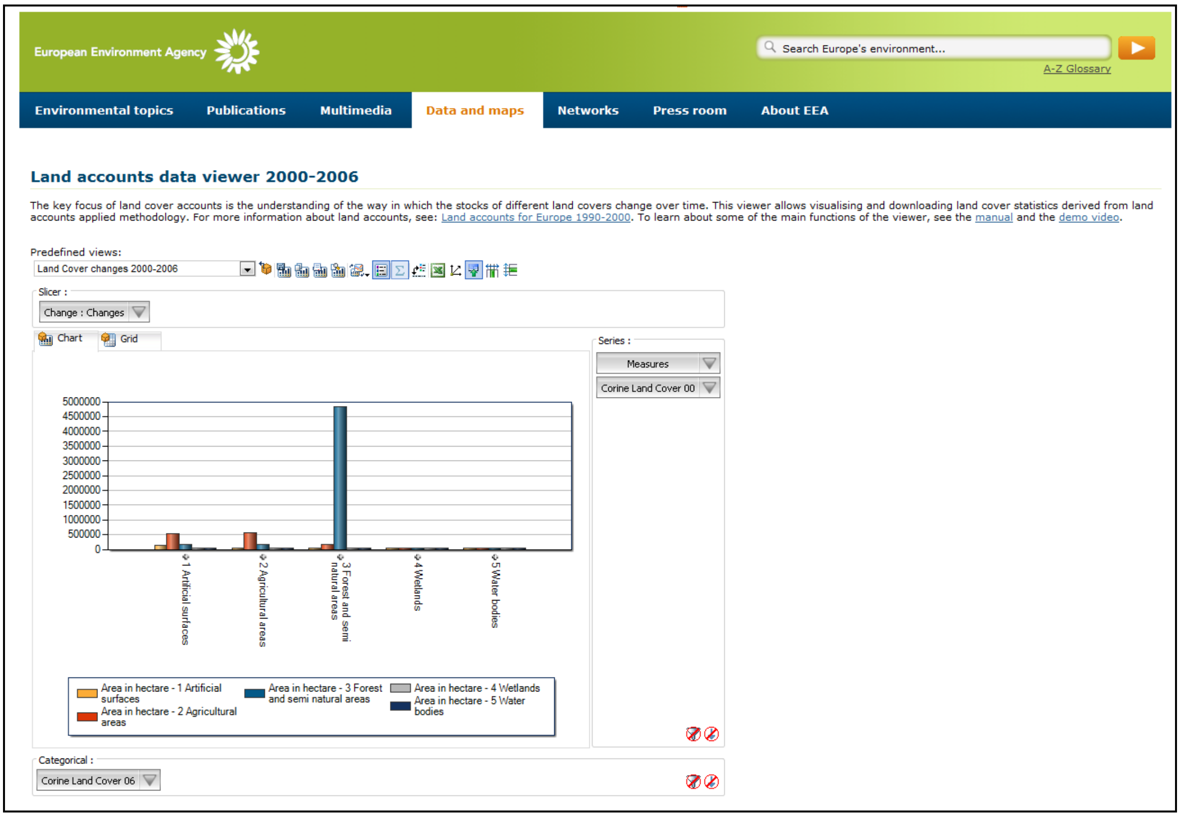


Figure 3.?


European Environment Agency
Search Europe's environment...
A-Z Glossary
Environmental topics
Publications
Multimedia
Data and maps
Networks
Press room
About EEA
Land accounts data viewer 2000-2006
The key focus of land cover accounts is the understanding of the way in which the stocks of different land covers change over time. This viewer allows visualising and downloading land cover statistics derived from land accounts applied methodology. For more information about land accounts, see: Land accounts for Europe 1990-2000. To learn about some of the main functions of the viewer, see the manual and the demo video.
Predefined views:
Land Cover changes 2000-2006
Slicer :
Change : Changes
Chart
Grid
Series :
Measures
Corine Land Cover 00
1 Artificial surfaces
2 Agricultural areas
3 Forest and semi natural areas
4 Wetlands
5 Water bodies
Area in hectare - 1 Artificial surfaces
Area in hectare - 2 Agricultural areas
Area in hectare - 3 Forest and semi natural areas
Area in hectare - 4 Wetlands
Area in hectare - 5 Water bodies
Categorical :
Corine Land Cover 06

Part 4: Prospects

4.1 Introduction

Although the accounting approach described here has been developed by the EEA to address problems in the European context, an additional major impetus has also been the contribution that the work could make to the general problem of environmental accounting in the international arena. The links between LEAC and the on-going revision of the System of Integrated Economic and Environmental Accounting (SEEA) by the UN Statistical Division was discussed in Part 1. In this final Part of this Report we consider what has been achieved in Europe from this broader perspective, and explore what and ecosystem accounts would look like as part of the revised SEEA, and what prospects there are for moving towards a framework that is supported by a suite of internationally recognised standards.

4.2 LEAC and the SEEA Revision

The UN and the World Bank launched the first System of Integrated Economic and Environmental Accounting in 1993 as a response to recommendations of the 1992 Rio conference on Sustainable Development. In order to steer the process of developing this system the UN 'London Group' was set up in 1994, based on a joint initiative of Statistics Canada and Eurostat. Experimental work then followed in both Europe and elsewhere and as a result a first revision was published in 2003 (SEEA, 2003).

In 2006 the UN Statistical Commission took the decision to raise the status of the SEEA to the level of an international standard. It therefore created an expert committee (UNCEEA) to steer the process of making a further revision. The plan is to publish the first volume in 2012, which will focus on hte issues related to establishing the methods dealing with core environmental resource accounts (e.g. water, land and air) as a statistical standard. The second volume, which will deal with non-standard issues such as ecosystem services and their valuation, will follow in 2013. Eurostat and the European Environment Agency represent Europe on both the UNCEEA and the London Group, and so the work described here can be used to test concepts and demonstrate approaches.

The SEEA revision process has seen some substantial achievements in terms of implanting better methods of linking environment and economy. Three key areas can be identified, namely: those dealing with environmental protection and management related expenditures; material flow accounts; and, input-output analysis (NAMEA, National Accounting Matrix including Environmental Accounts). NAMEA is a statistical information system designed to combine national and environmental accounts in a single matrix which can sit alongside the more conventional national monetary accounts as a set of 'satellite' tables. The accounts are designed to describe selected aspects of the interrelationships between the natural environment and the economy, such as the consequences that the physical demands that the economy places on the environment. These accounts are used, for example, to examine the use of material and energy by the economy 'decoupled' from economic growth.

Accounts for environmental expenditure, material flows and input-output analysis based on the NAMEA have been published on a regular basis since the early 1990s in several European countries, although in none of them are implemented as part of a core, regular European accounting programme. However, these areas have now been acknowledged as priorities in the European Strategy for Environmental Accounting, and Eurostat is working to implement them.

Despite the achievements noted above, it is now clear that in terms of developing and fully integrated picture of the inter-linkages between environment and economy, more work needs to be done. Not only does the growth of GDP need to be decoupled from material and energy use, in the sense that outputs should require progressively reducing resource inputs, additionally the level of wider environmental impacts generated by economic activity also needs to be reduced. This is the concept of "double decoupling". To track this aspect of the link between environment and economy, then additional new types of accounting system are required, and it is in this area where the current EEA effort is most relevant.

The new perspective brought about the need to 'double decouple' results in a shift of focus in accounting systems away from the economic viewpoint, towards one that considered ecosystems in a more general sense. The economic viewpoint is one that concentrates mainly on direct economic resources and their depletion. The ecosystems viewpoint starts from the position of needing to understand and characterise the dynamics of a coupled 'socio-ecological system' (ref...), in which physical environmental impacts are equivalent to the degradation of natural capital and related aspects of human well-being. From this perspective 'degradation' is not simply damage to ecological function but also the loss of the capacity of ecosystems to renew themselves and so sustain the output of goods and services need by people. Since such outputs are not often associated with markets, but rather public goods, these accounts have to go beyond the simple valuation of the products of nature. They have to record in some way, the over-use of ecosystem capital for final consumption in the economy, the lack of investment in nature when ecosystem functions are eroded, and the fact that such actions result in a concealed ecological debt for future generations (Figure 4.1).

>>>>>Figure 4.1 about here

The limitations of the current System of National Accounts, to deal with the impacts of economic activity on nature have been widely debated. Problems include the inability of these accounts to deal with non-market or public goods, the lack of attention to well-being; the inappropriate use of financial accounting valuation methods; and the over-dependence on macro-indicators, such as GDP which given a narrow view of national wealth. As a result of the wider recognition of these failures, policy makers, international organizations, NGOs, and the business sectors are demanding looking to develop alternative approaches. Recent attempts include the 'Genuine Savings' initiative of the World bank, the discussions initiated by the European Commission in relation to 'Beyond GDP', Stern Report on the Economics of Climate Change by Stern, in the UK; the G8+5 and Germany TEEB initiative (The Economics of Ecosystems and Biodiversity); the Stiglitz/Sen/Fitoussi Report on.... in France[8].

>>>>>Figure 4.2 about here

One way of characterising the relationship between the SEEA and the SNA in terms of this ecosystems perspective is shown in Figure 4.2. The SEEA are satellite accounts in the sense that they are not part of the SNA, but they are not less important. For the ambition is that they should provide

[8] All need references!

aggregate indicators of the state and condition of our natural capital that can be used alongside traditional economic measures like GDP, to make a more complete assessment of our wealth.

The development suggested in Figure 4.2 is that the SEEA satellite should in the future achieve a similar level of priority to GDP in decision making. To do this, there three things are needed: first, the establishment of timely physical and monetary aggregates from satellite accounts that can then be considered alongside GDP to describe the changes in our natural capital; second, clarification and communication of methodological and conceptual contributions that the two accounting approaches provide, which might be lost in any attempt to integrate them technically; and third, recognising the distinctive but complementary contributions that each of them bring in the decision making arena. The accounting approach described here for land, and its planned development by the EEA to provide a more comprehensive set of *ecosystem* accounts is an attempt to put in place some of the new aggregate measures that the revised SEEA could in the future deliver.

>>>>Insert Figure 4.3 about here

As contribution to the development of the new SEEA standard, work at the EEEA has been exploring what a fully fledged ecosystem capital accounting framework would look like, and how it would be linked to environmental accounts of economic sectors (see Figure 4.3). As this figure indicates it would consist of a combination of monetary and non-monetary (physical accounts), including tables giving physical accounts or balances, ecosystem services, the measurement of ecosystem capital, and the various sector accounts..... [discuss figure a little.]

In order that this framework can be developed, however, approaches to developing accounts for the basic physical and biological [ecological?] balances are needed, along with indicators describing the changes in ecosystem capital. The aspiration to develop these components has formed the basis of the so-called *Fast Track Implementation of Simplified Ecosystem Capital Accounts for Europe* now being undertaken by the EEA. Its design and the role that land accounts lay in this approach is described below.

4.3 Standards for the Classification of Land Cover and Ecosystem Services

For a robust system of integrated environmental and economic accounting to be developed a number of standards are required. Recent work at the EEA has looked at standards for land cover classification and standards for the classification of ecosystem services.

4.3.1 Standards for the classification of land cover

As part of its work towards establishing the SEEA as an international accounting standard, it has worked on the problem of developing a robust system for the classification of land cover. Any candidate system must meet a number of criteria, including[9]:

- That it must be capable of characterising land cover change in ways that clearly link to the processes driving those transformations.
- That they must be easily connected to land use statistics in order to facilitate the eventual integration of land use data with information about socio-economic activities.
- That they should support the construction of ecosystem accounts so that the close connection between land and natural capital can be described and represented effectively.

[9] Based on: Weber, JL (2010) Land cover classification in the revised SEEA.

- That it should be sufficiently flexible to support a range of applications and easily implemented using a diverse range of data sources.
- That it is easily translatable into other land cover nomenclatures or legends, and in particular the LCCS-based classifications used in international programmes such as those of IGBP, DISCover, MODIS land cover products, FAO-Africover, Global Land Cover, ESA GlobCover..., IPCC and the EU CORINE Land Cover.
- That it can be easily refined using hierarchical methods so that different levels of detail can be provided in ways that are relevant to different types of application.

Using these criteria as a guide, an initial proposal has been made in terms of an exhaustive list of 14 non-overlapping categories headings for land plus one for 'coastal water bodies' and one for 'sea'[2] (Table 4.1); a full description of the classes is given in Appendix B.

>>>>Insert Table 4.1 about here

It is not appropriate here to discuss in detail the development of this international standard. Rather the main interest is to consider how it relates to the land cover classification system used in the European work, and show that the approach has the potential to link with these wider international systems. Land cover classification is essentially a modelling exercise in which the biophysical characteristics of land and sea are used systematically to develop a useful set of classes or legend. The outcomes of such exercises should be assessed in terms of the underlying logic and the fitness of the classification for the purposes that it has been developed.

>>>>***Insert Table 4.2 about here***

The broad correspondence between the proposed SEEA classes and the nomenclature used to classify CLC data is shown in Table 4.2. [Discuss??]. Apart from the correspondence between the classes a key test of the effectiveness of the potential linkage between the two classifications is in terms of the extent to which they can capture the processes of land cover change and allow the accurate translation of statistics between systems. Using the basic classes of the draft SEEA classification shown in Table 4.1 is possible to define eight land cover flow classes. These are also shown in Table 4.1. Using this system a test has been carried out using the CORINE land cover database for 1990-2000, for 25 European countries, designed to compare the estimates of of change obtained using a detailed computation based on the 44 CLC classes (ie. level three in the classification system) with the direct calculation of change based on SEEA-LC 16 classes. The average loss [difference?] (i.e. difference in estimates?) observed was small, namely around 1.7%. The larges difference was 6.8% is for urban internal changes (most of them being due to the non-recording of the flow from "construction" to the various built-up classes). In addition about 5% of internal agriculture conversions were lost in the translation process. The conclusion that we draw from these work is that even though the SEEA classification is at a draft stage, it is fit for the purpose of accounting land cover change, and that the land classification system used for the European work is sufficiently flexible and robust to also integration with these emerging international standards.

4.3.2 Standards for the classification of ecosystem services

In addition to the development of standards for the classification of land cover, the revision of the SEEA would also require some agreement about the nomenclature and definition of ecosystem services. With this issue in mind the EEA has developed a proposal that has now fomally been submitted to the UN Statistical Division for a 'Common International Classification of Ecosystem Services' (CICES)[10].

The aim of the CICES initiative has been to develop a flexible structure for classifying ecosystem services that links the categories that are being discussed in on-going international initiatives such as the MA follow-up, TEEB, and the functional groupings for economic sectors currently being considered in the SEEA revision. In proposing a common structure the aim has not been to put forward a new scheme that replaces existing typologies, but to provide a consistent standard that allows the translation between different systems. The context in which this work is set is illustrated in Figure 4.4. As indicated, it has close connections with the classification of land cover.

>>>>Insert Figure 4.4 about here

Given the involvement of the EEA in the SEEA revision process, the development of the CICES draft standard has taken account of the need to link service classes to the particular groupings used in the various international standard classifications for products and activities. Thus a prerequisite of the design has been that the groupings should initially be generic and amenable to further sub-categorisation to produce a nested, hierarchical structure. It attempts, where possible, to use terminology and definitions around which consensus currently exists. However, from the discussion that have emerged around the standard it is clear that while the system will benefit the SEEA revision process, the classification may be more generally useful as a way of comparing and integrating the wider body of on ecosystem services more concerned with the problem of valuation and assessing the links between services and underlying biophysical processes.

The CICES classification approach is based on the widely accepted definition of ecosystem services as ***the contributions that ecosystems make to human well being,*** and the general categories introduced in the MA. The classification also seeks to distinguish 'services' from 'benefits'. Thus a benefit is seen as a component of human well-being (e.g. health) while a service is anything that may change the level of that benefit (e.g. air quality, food supply). For the purposes of the classification the term 'ecosystem services' refers to both 'goods' and 'services', although the distinction between the provisioning theme on the one hand, and the regulating and cultural themes on the other, can be used to separate the two sets of ecosystem outputs.

>>>>Insert Tables 4.3 and Table 4.4 about there

Table 4.3 shows the suggested correspondence between the major service themes covered by CICES and the so-called 'functions of natural capital' described in SEEA2003. Although the terminology differs it is clear that there is a good read-across conceptually between the different groupings. It is proposed that in revising the SEEA approach these new groupings are used to reflect the more general framing of ecosystem services that is now being used in wider literature.

Table 4.4 shows the suggested structure for CICES built up around these three major thematic areas. A hierarchical structure is proposed to take account of the different levels of thematic and geographical scales used in different studies. This approach, it is suggested enables summaries of service output at different levels of generality to be constructed, a feature that is difficult to accomplish using present systems. The full CICES classification is given in Appendix C.

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[10] Ref to UN docs and updated cices site?

In order to test the robustness of the approach two areas have been considered. First the ease of integration with other international ecosystem service initiatives. Second, the ease of linkage between the ecosystem service categories in CICES and existing standard classifications of economic activities and products.

Table 4.5 shows the cross-reference between the CICES Themes and Classes and the categories of the 2003 SEEA model and the service breakdown suggested in TEEB. The relationship to the SEEA was noted above. In relation to TEEB, the work suggested that it is relatively easy to nest the TEEB categories into the nine classes proposed as the basis for CICES. The important feature to note, however, is that in naming the latter an effort has been made to use a generic terminology that can identify groupings that can progressively be refined according to the interests of the user. Thus potentially, the TEEB categories 'raw materials', 'genetic', 'medicinal' and 'ornamental' resources could be sub-classes of the CICES 'materials group'. The main discontinuity with the suggested TEEB classification is in the treatment of so-called 'habitat services'. The importance of ecosystems in maintaining the gene-pool and life systems is mentioned in the current SEEA, and included within the 'Service Function'. While TEEB chooses to identify them as a distinct service grouping at the highest level, the draft classification presented here suggests they are part of the regulating and maintenance theme. It is suggested that they form a sub-class that captures aspects of natural capital that are important for the regulation of the 'biotic' environment (e.g. pest and disease control, pollination, gene-pool protection etc.).

The second test of the robustness of the CICES system was made by attempting to cross reference the different categories to existing standard classifications for activities and products used in the System of National Accounts, namely: the International Standard Industrial Classification of All Economic Activities (ISIC V4), the Central Products Classification (CPC V2), and the Classification of Individual Consumption by Purpose (COICOP).

The work showed that cross-tabulation for each of them are possible and that the approach potentially offered a way of identifying the 'final outputs' of ecosystems, and thus potentially helps overcome the problem of 'double counting' in valuation studies. It was also apparent that the linkages between ecosystem services and activity and product classifications helped to define the 'concrete outcomes' sought by the EPA in its 2009 report (EPA, 2009). However, it is also clear that further work is probably needed in terms of developing the CICES as a standard, in order to overcome some obvious complexities. These arise, for example, from the fact that some product and activity classes can potentially be linked to more than one ecosystem service group at the higher levels in the classification. This problem may be resolvable by allowing additional levels to be defined in the product, activity and service hierarchies.

An additional issue that needs to be addressed in developing the application CICES is that since products and activities depend on the combination of natural and human capitals, the 'links' between ecosystems and economic sectors is complex. Use of the cross-tabulation would seem to imply the need to develop some method of weighting to indicate the relative strengths of the different kinds of capital input to each product and activity. This could be achieved by constructing some kind of 'production function'. These production functions would have to be tailored to the particular application, but would seem to be vital if the aim of better understanding the links between economy and environment is to be achieved. They may also need to take account of the scale at which a given ecosystem service operates.

Finally, the extent to which non-renewable, mineral outputs should be excluded fromt he classification needs to be considered further[11]. If ecosystems are defined as the interaction between living organisms and their physical environment then it is generally argued that *ecosystem services have to be traceable back to some living process* (i.e. **dependent** on biodiversity) (cf. Fisher and Turner, 2008). Any set of international standards would have to be clear about how abiotic outputs from ecosystems are to be handled.

4.4 From Land Cover to Ecosystem Accounts

In the final parts of our earlier Report on the land accounts for Europe 1990-2000, we emphasised the need to develop the linkages between land and ecosystem accounts further. The developments in the land account area that are described here now show that the concepts have moved from the theoretical stage through to application. The regular updating of land accounts for Europe is now possible operationally. The current focus is now to develop this work further in the context of a more comprehensive ecosystems framework. As has been argued above this will involve the development of methods for 'ecosystem capital accounting'. This approach is based initially on the construction of physical accounts targeted primarily at specific outcomes, such as the measurement of ecosystem degradation, and then the better understanding of how this relates to their capacity to continue delivering services in a sustainable way. As part of the EEA's contribution to developing this capital accounting approach, it has developed a 'fast track implementation' initiative, designed to provide a critical test of the concept.

4.2.1 The Fast Track Accounting Framework

The fast track initiative of the EEA is based on a number of requirements, including: that the work should be **outcomes oriented**, so that the relevance of the approach to solving current problems can be established quickly; and that i**t should be based on existing data**, so that results can be provided in a timely fashion in order that strategic decisions about the future can be made quickly. The overall aim is to develop a measure of net ecosystem potential that can be used to make an overall diagnosis of the state of heal of our natural capital base. The conceptual framework for the *Fast Track Initiative* is shown Figure 4.5.

>>>>Insert Figure 4.5 about here

>>>>Insert Figure 4.6 about here

The principle is that if the overall extent of the degradation of natural capital can be measured, then the costs of that consumption can be calculated in terms of what it would take to restore or maintain the either the original level of ecosystem functioning or its restoration to some more enhanced state as defined by societies various management or policy targets. The fast track approach starts from the proposition that this overall measure of the potential (status) of natural capital can be based on an aggregation of a number of measures. Six basic indicators supported by accounts have been suggested (Figure 4.6). From bottom of the figure (the outcome) to the top they are: accounts of ecosystem health, for establishing the diagnosis; basic physical accounts of stocks and flows by ecosystem type; basic physical accounts of ecosystem services; basic physical flow

[11] They could, for example, be included as a sub-class of the CICES 'materials' category, which at its highest level could split biotic and abiotic materials.

accounts of sectors (MFA, NAMEA); measures of environmental protection and resource management expenditure accounts. The six indicators proposed are:

- **Landscape index, based on measures derived from** land cover, the richness of semi-natural habitats and their fragmentation in the landscape.
- **Carbon/Biomass index:** describing ecosystem productivity and net source/storage of carbon
- **Water index:** documenting the available [ecological?] water resources in terms of quantity & quality, across river basins.
- **Biodiversity index:** describing long term species trends.
- **Dependency index:** describing the artificial inputs into different economic sectors, in terms of say fertilisers and other chemicals, irrigation, energy, work, and other subsidies.
- **Health index:** describing the health of human populations as well as wildlife and plant populations.

>>>>>Insert Figure 4.6 about here

For the fast track implementation, land, water and carbon/biomass and biodiversity indices will be computed as a priority (Figure 4.6) because it is felt that they can be implement most rapidly using existing data resources, and they can also provide an early diagnosis in a number of different situations. The accounting approaches being currently explored in each of the priority fast track areas is described below.

4.4.2 Carbon

The aim of the ecosystem carbon accounts is to calculate the ***Net Ecosystem Carbon Balance*** (also called Net Biome Production, or Net Biomass Production). This is an index discussed widely in the literature, and several procedures have been put forward for its calculation. The approach being adopted by the EEA reflects this work, but also takes account of the information available at pan-European scales. Thus we use data for earth observation satellites for the calculation of NDVI and NPP, as well as official harvesting statistics, and coefficients from global balances or derived from *in situ* monitoring. The goal is to construct accounts for the period 1999 through to 2009.

>>>>insert Table 4.5 about here

The algorithm used to make the calculation of the net Ecosystem Carmon balance is summarised in Table 4.5. An estimate of the supply of biological carbon (Ecosystem Primary productivity, EPP) is made by subtracting the level of soil respiration from an initial estimate of NPP derived from remotely sensed data, and then adding in to the balance the left-over's from forestry and agriculture, as well as manures and organic fertiliser inputs and the effects of any change in land cover. On the consumption side the total removals are found by aggregating removals due to harvest, grazing and felling with losses due to leakage, erosion emissions and fires. Once again the removals will be estimated using remotely sensed data, but the losses will be approximated using coefficients derived from the literature and other sources.

>>>do we have any mapped products to go in figures??

The balance will be provided for countries, regions and different land cover types, as well as the standard accounting grid. The data will be made available through an OLAP cube to report results by geographical breakdowns and to prepare datasets for input into HyperAtlas.

A novel aspect of this work will be the use of Harmonic ANalysis of Time Series (HANTS) to look at phonological change in the vegetation cover and detect departures from standard trajectories resulting form events such as felling, harvest or fires.

>>>do we have any mapped products to go in a figures??

4.4.3 Water

No information

4.4.4 Biodiversity

It is proposed that a biodiversity index can be calculated using the Article 17 reporting data for Europe. The European Directives for Habitats (92/43/EEC) and Birds (79/409/EEC) requires its signatories to undertake a number of commitments in relation to biodiversity. Article 11, for example, requires Member States to monitor the habitats and species listed in the annexes, and Article 17 requires a report to be sent to the European Commission every 6 years in a standardised format (Figure 4.7).

>>>>Insert Figure 4.7 about here

A major part of the Article 17 Report is an assessment of the conservation status of all the habitats and species that occur within their territory, both within and outside of the Natura 2000 network. The aim of the Article 17 reporting process is to assess the conservation status of species and habitats using a standard methodology that will allow aggregation and comparisons between Member States and biogeographical regions. The assessment of conservation status assigns species or habitats to the categories: 'favourable', 'unfavourable-inadequate' and 'unfavourable-bad' according to a defined set of criteria. The report also asks the member states to make an assessment of future prospects. These data may be used as the basis for the construction of a biodiversity index.

>>>>Insert Figure 4.8 about here

An overview of the methodology being developed to calculate the biodiversity index is shown in Figure 4.8. It is based on the construction of a Bayesian Belief Network (BBN) that allows different components of the Article 17 data to be combined with other data sources to calculate the final biodiversity index on a probabilistic basis. This technique allows the assumptions behind the index to be fully transparent. Thus the species data on present status, relating to range, population and habitat is equally weighted and combined into an index of 'present status'. This is then combined with the assessment of future prospects to form the finalised Article 17 index; present and future prospects are again equally weighted in the calculation. Since the Article 17 data is available on a 10km x 10km grid basis for the whole of Europe, this defines the spatial resolution of the underlying biodiversity data.

For the final calculation the Article 17 index is linked with an assessment of the landscape structure in each 10km grid cell, based on the data for ecotones derived from the analysis of the boundaries between land cover types defined in the CLC 2006 dataset (see section 3.3.2). The final index also includes a measure of the way the ecotones are changing over time, and takes account of the proportion of specialist and generalist species in each 10km cell.

4.4.5 Assessing Ecosystem Potential

Do we have any notes on this?

4.5 Maintaining Land and Ecosystem Accounts

The CORINE Land Cover project currently covers XXX European countries, and will be udated on a 5-year basis, with a gap of around 2 years between the image acquisition and the publication of the results. The availability of new sources of earth observation data, such as GlobCover based on MERIS data, now makes it possible for additional strategic monitoring to be undertaken, and a more 'real-time' picture established.

The GlobCover initiative (Arino, 2007), has resulted in the production of a global land cover map at 300m resolution using MERIS data acquired between mid 2005 and mid 2006. At the international scale these data have updated other comparable global products, such as GLC2000 which has a much coarser spatial resolution of 1 km. The GlobCorine project has built on this success and is now delivering a customised product for Europe that is consistent with the CORINE Land Cover data used in the previous accounting work (see Bontemps et al. ???).

The GlobCorine project aims to make the use of the MERIS time series for frequent land cover monitoring at the pan-European scale using automated classification procedures. The 300m resolution of GlobCorine will not identify landscape patterns as precisely as the CORINE, but it will shorten the time between data acquisition and publication, and it will expand the geographical coverage. The result is that a more frequent monitoring of some of the more important land cover change processes will be possible, that can then be confirmed by the more periodic and more detailed mapping of CORINE. As a result the land and ecosystem accounting approach developed by the EEA is moving towards a fully operational system.

The potential use of GlobCorine data for maintaining the land accounts has emphasised the importance for achieving consistency between the major international systems for land cover mapping. Work in this important area has also progressed since the publication of the 2006 Report, and in the final part of this document we consider the general issue of consistency of approaches with international initiatives in more detail.

Other datasets?

4.5 Conclusion

Table 4.1

LC01 Built up and associated areas
LC02 Rainfed annual crops
LC03 Irrigated agriculture, rice fields
LC04 Permanent crops, agriculture plantations
LC05 Mosaic agriculture
LC06 Grassland and herbaceous vegetation
LC07 Forests
LC08 Transitional woodland
LC09 Shrubland, bushland, heathland
LC10 Sparsely vegetated areas
LC11 Bare land
LC12 Permanent snow and glaciers
LC13 Open wetlands
LC14 Inland water bodies
LC15 Coastal water bodies
LC16 Sea

Potential classification of land cover change processes:

LF01 Urban sprawl
LF02 Land cover rotation within urban areas
LF03 Conversion of land to agriculture
LF04 Land cover rotation within agriculture
LF05 Conversion of land to forest
LF06 Land cover rotation within forested land
LF07 Water bodies management
LF08 Change due to natural and multiple causes

Table 4.2: Correspondence between SEEA-Land Cover and the CORINE Land Cover Nomenclature

SEEA-Land Cover Nomenclature		CORINE Land Cover Nomenclature	
LC01	Urban and other artificial areas	1	Artificial surfaces
LC02	Rainfed annual crops	*211*	*Non-irrigated arable land*
LC03	Irrigated agriculture, rice fields	*212*	*Permanently irrigated land*
		213	*Rice fields*
LC04	Permanent crops, agriculture plantations	22	Permanent Crops
LC05	Mosaic agriculture	24	Heterogeneous agricultural areas
LC06	Grassland/herbaceous vegetation	*231*	*Pastures*
		321	*Natural grassland*
LC07	Forest	31	Forests
LC08	Transitional woodland	*324*	*Transitional woodland shrub*
LC09	Shrubland, bushland, heathland	*322*	*Moors and heathland*
		323	*Sclerophyllous vegetation*
LC10	Sparsely vegetated areas	*333*	*Sparsely vegetated areas*
LC11	Bare land	*331*	*Beaches, dunes and sand plains*
		332	*Bare rock*
		334	*Burnt areas*
LC12	Permanent snow and glaciers	*335*	*Glaciers and perpetual snow*
LC13	Open wetlands	4	Wetlands
LC14	Inland water bodies	*511*	*Water courses*
		512	*Water bodies (lakes & reservoirs)*
LC15	Coastal water bodies	*521*	*Coastal lagoons*
		522	*Estuaries*
LC16	Sea	*523*	*Sea and ocean*

Table 4.3:

CICES Theme	CICES Class	Correspondence to SEEA 2003 'functions' of natural capital
Provisioning	Nutrition	Resource function
	Materials	Resource function
	Energy	Resource function
Regulation and Maintenance	Regulation of wastes	Sink function
	Flow regulation	Service function (environmental quality)
	Regulation of physical environment	Service function (environmental quality)
	Regulation of biotic environment	Service function (environmental quality)
Cultural	Symbolic	Service function (amenity)
	Intellectual and Experiential	Service function (amenity)

Table 4.4

Theme	Class	Group
Provisioning	Nutrition	Terrestrial plant and animal foodstuffs
		Freshwater plant and animal foodstuffs
		Marine plant and animal foodstuffs
		Potable water
	Materials	Biotic materials
		Abiotic materials
	Energy	Renewable biofuels
		Renewable abiotic energy sources
Regulation and Maintenance	Regulation of wastes	Bioremediation
		Dilution and sequestration
	Flow regulation	Air flow regulation
		Water flow regulation
		Mass flow regulation
	Regulation of physical environment	Atmospheric regulation
		Water quality regulation
		Pedogenesis and soil quality regulation
	Regulation of biotic environment	Lifecycle maintenance & habitat protection
		Pest and disease control
		Gene pool protection
Cultural	Symbolic	Aesthetic, Heritage
		Religious and spiritual
	Intellectual and Experiential	Recreation and community activities
		Information & knowledge

Table 4.5: Draft classification of ecosystem goods and services for CICES and its relationship to other classification systems

SEEA 2003function	CICES Theme	CICES Class	TEEB Categories			
resource	Provisioning	**Food & Beverages**	Food	Water		
resource		**Materials**	Raw Materials	Genetic resources	Medicinal resources	Ornamental resources
resource		**Energy**				
sink	Regulating and Maintenance	**Regulation of waste assimilation processes**	Air purification	Waste treatment (esp. water purification)		
service		**Regulation against hazards**	Disturbance prevention or moderation	Regulation of water flows	Erosion prevention	
service		**Regulation of biophysical conditions**	Climate regulation (incl. C-sequestration)	Maintaining soil fertility		
service		**Regulation of biotic environment**	Gene pool protection	Lifecycle maintenance	Pollination	Biological control
service	Cultural	**Symbolic**	Information for cognitive development			
service		**Intellectual and Experiential**	Aesthetic information	Inspiration for culture, art and design	Spiritual experience	Recreation & tourism

Figure 4.1

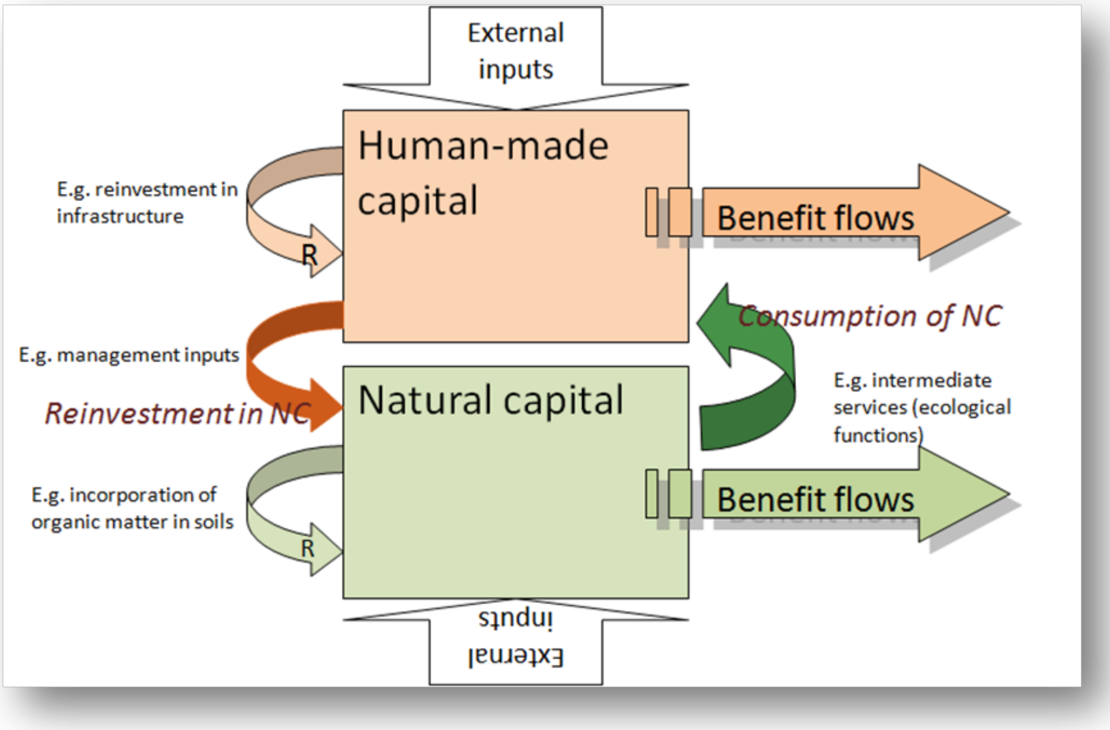
External inputs
Human-made capital
E.g. reinvestment in infrastructure
R
Benefit flows
E.g. management inputs
Consumption of NC
Reinvestment in NC
Natural capital
E.g. intermediate services (ecological functions)
E.g. incorporation of organic matter in soils
R
Benefit flows
External inputs

Figure 4.2 Redraw this to include land cover?

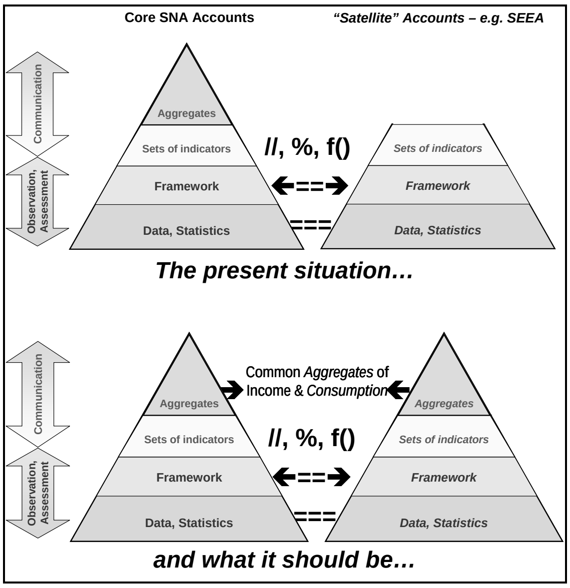

Figure 4.3 Proposed structure and design of national, satellite and ecosystem accounts

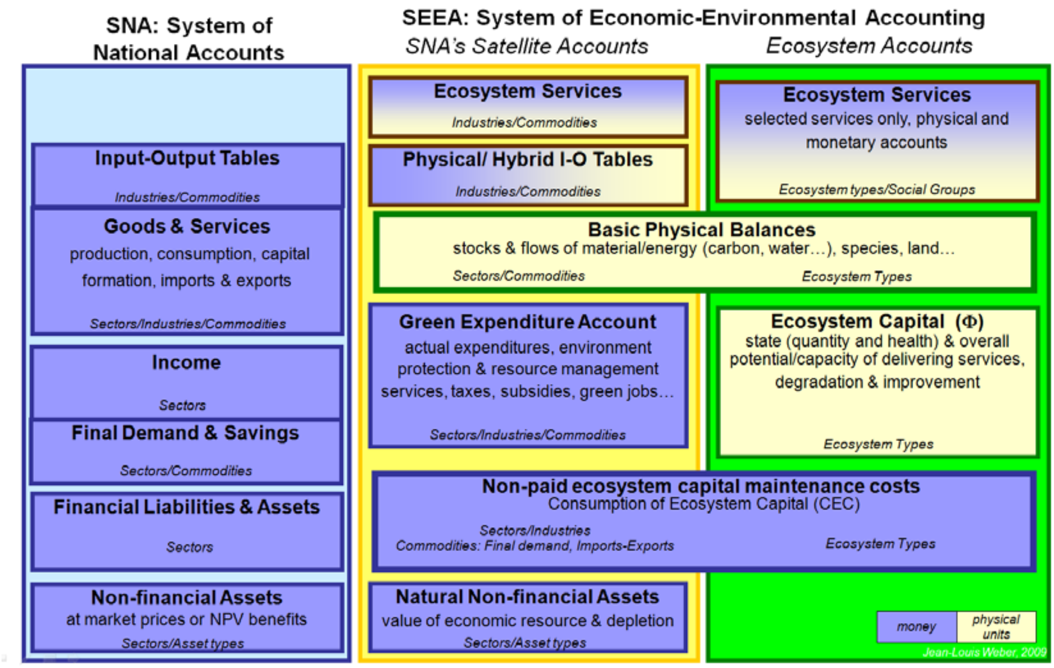

Figure 4.4: Conceptual framework for development of a common classification of ecosystem services

Figure 4.5: Conceptual Framework for the Fast Track Ecosystem Capital Iniative.

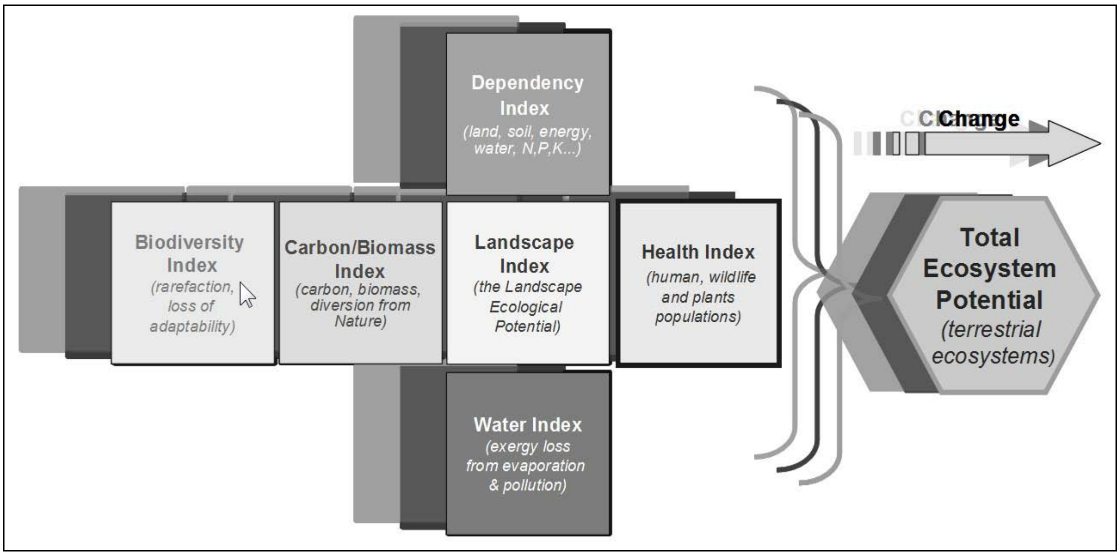

Figure 4.6

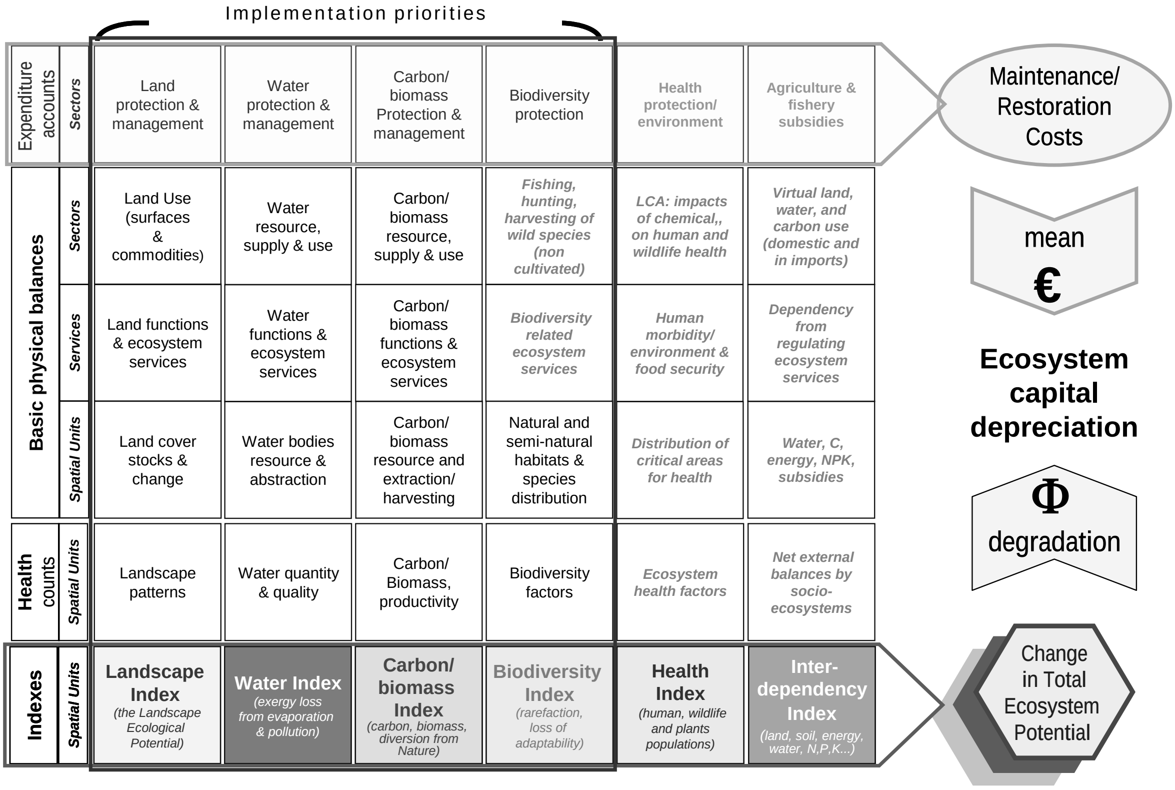

Figure 4.7 Article 17 biodiversity data

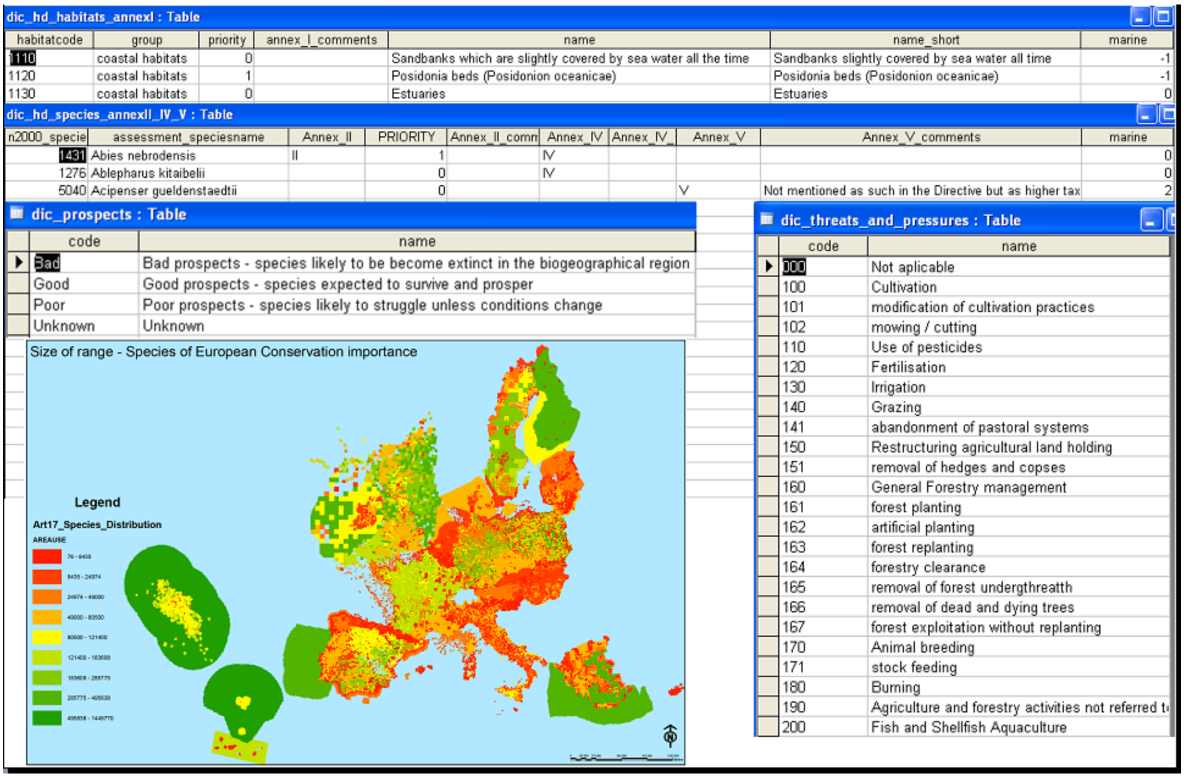

Figure 4.8: Proposed methodology for calculation of biodiversity index.