Final Draft Report on Work Undertaken

As part of Specific Subcontract 5 (3402/B2009/EEA.53921)

of the Framework Service Contract for

Support to the Implementation of Ecosystem Accounting

EEA/BSS/07/007

November, 2010

Working Paper on

Land and ecosystem Accounts and the SEEA, and the Development of International Standards

Prepared by:

Roy Haines-Young and Marion Potschin,
Centre for Environmental Management,
University of Nottingham, UK

Contact:

Roy Haines-Young
Centre for Environmental Management
School of Geography, University of Nottingham
Nottingham, NG7 2RD, UK

Email:Roy.Haines-Young@Nottingham.ac.uk

1. Accounting for Land Cover and Ecosystems

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.

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 key issues in developing international standards.

2 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 about here: Land and Ecosystem Capital Relationships (after JLW, 2010)

As Figure 1 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

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

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.

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.

3 LEAC and the SEEA Revision

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.

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 2).

>>>>>Figure 2 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[2].

>>>>>Figure 3 about here

One way of characterising the relationship between the SEEA and the SNA in terms of this ecosystems perspective is shown in Figure 3. 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 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 3 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 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). 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.

3.1 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.

[2] All need references!

3.1.1 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[3]:

- 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.
- 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 1); a full description of the classes is given in Appendix B.

>>>>Insert Table 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 2 about here***

The broad correspondence between the proposed SEEA classes and the nomenclature used to classify CLC data is shown in Table 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 1 is possible to define eight land cover flow classes. These are also shown in Table 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

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

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.

3.1.2 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)[4].

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 5. As indicated, it has close connections with the classification of land cover.

>>>>Insert Figure 5 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 3 and Table 4 about there

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

Table 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 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.

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 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[5]. 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 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.

4.1 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 6.

>>>>Insert Figure 6 about here

>>>>Insert Figure 7 about here

[5] 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.

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 7). 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 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.

For the fast track implementation, land, water and carbon/biomass and biodiversity indices will be computed as a priority (Figure 7) 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.

4.1.2 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 5 about here

The algorithm used to make the calculation of the net Ecosystem Carmon balance is summarised in Table 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 figures??

4.1.3 Water

No information

4.1.4 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 8).

>>>>Insert Figure 8 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 9 about here

An overview of the methodology being developed to calculate the biodiversity index is shown in Figure 9. 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.

4.1.5 Assessing Ecosystem Potential

Do we have any notes on this?

4.2 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.

Table 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 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 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

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 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 1 Land and Ecosystem Capital Relationships (after JLW, 2010)

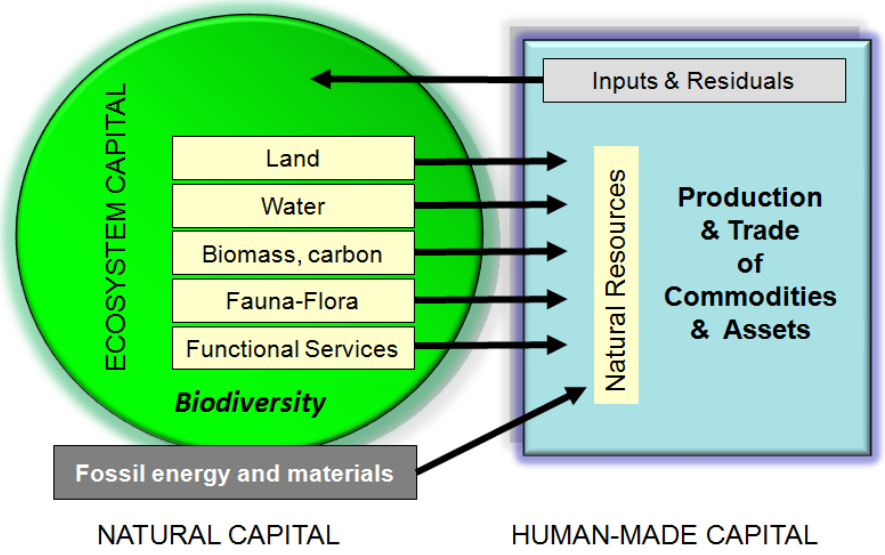

Figure 2

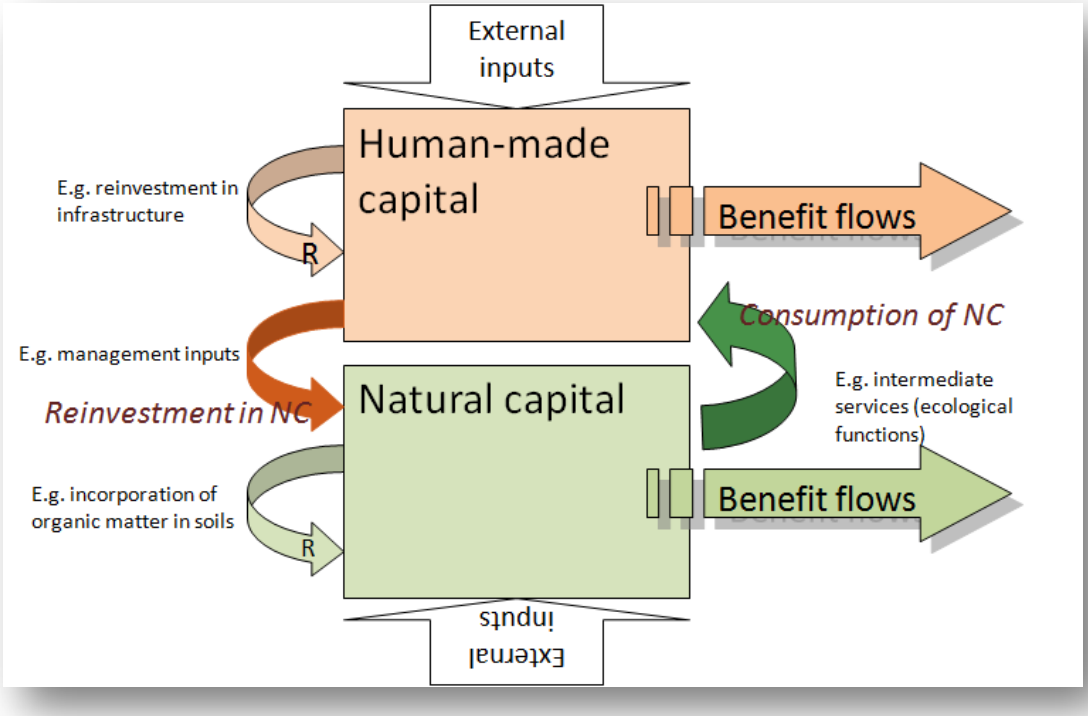

Figure 3 Redraw this to include land cover?

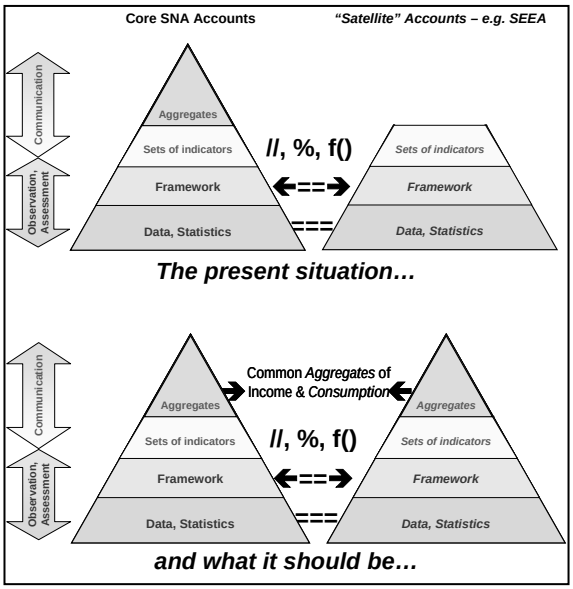

Figure 4 Proposed structure and design of national, satellite and ecosystem accounts

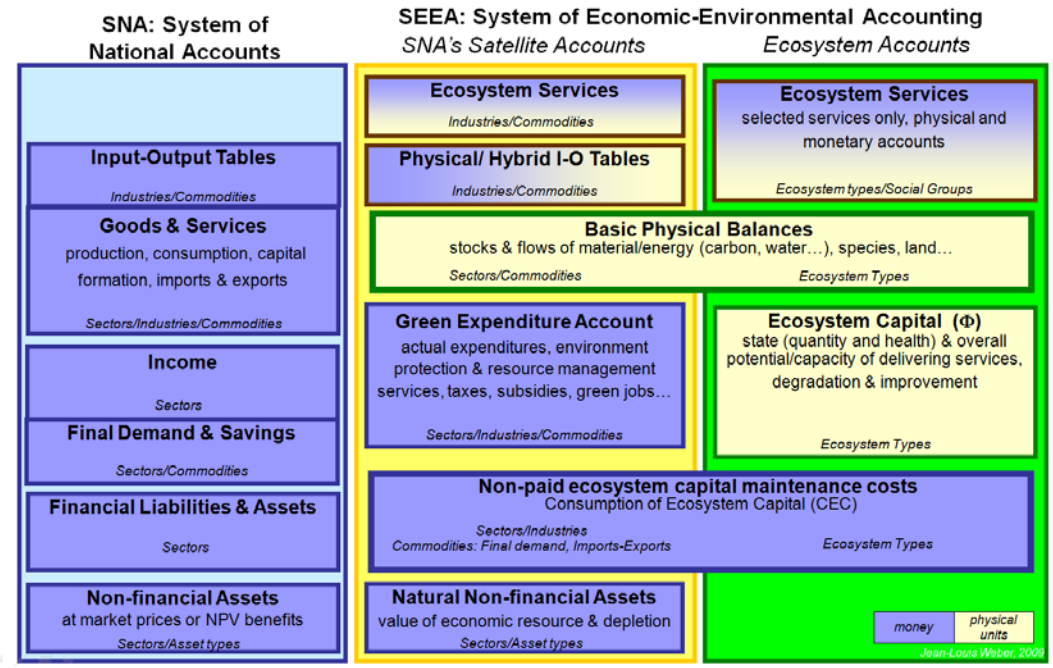

Figure 5: Conceptual framework for development of a common classification of ecosystem services

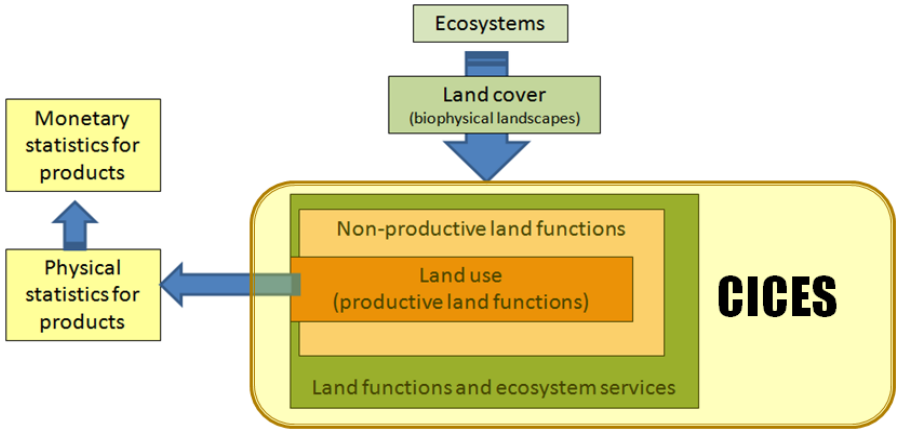

Figure 6: Conceptual Framework for the Fast Track Ecosystem Capital Iniative.

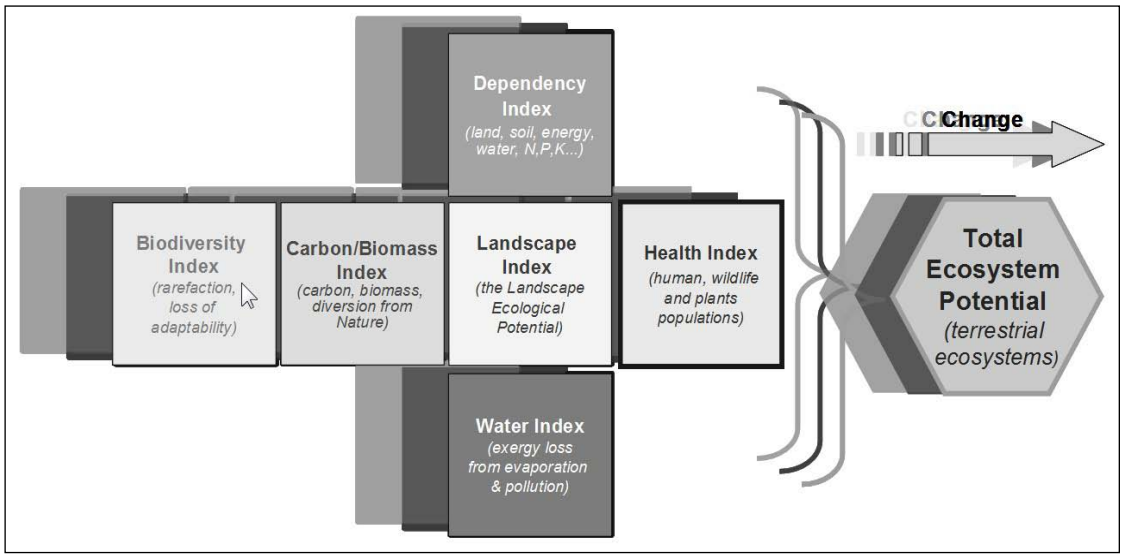

Figure.7

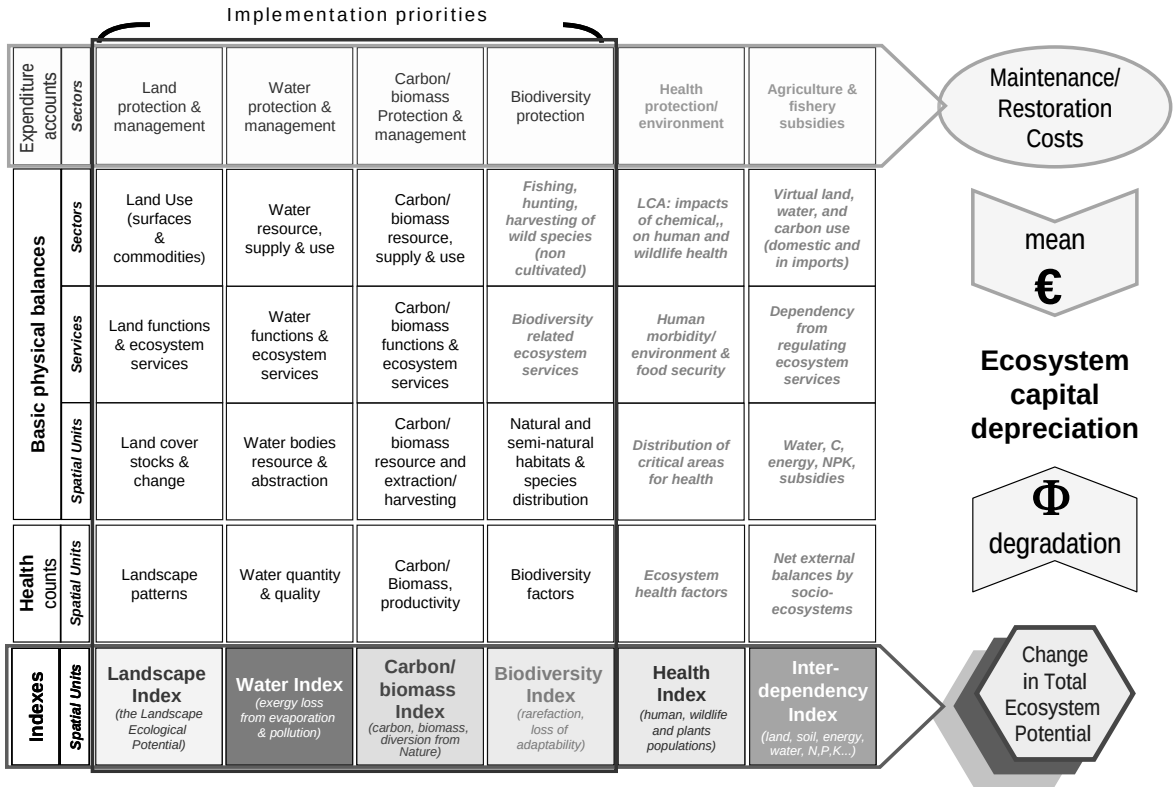

Figure 8 Article 17 biodiversity data

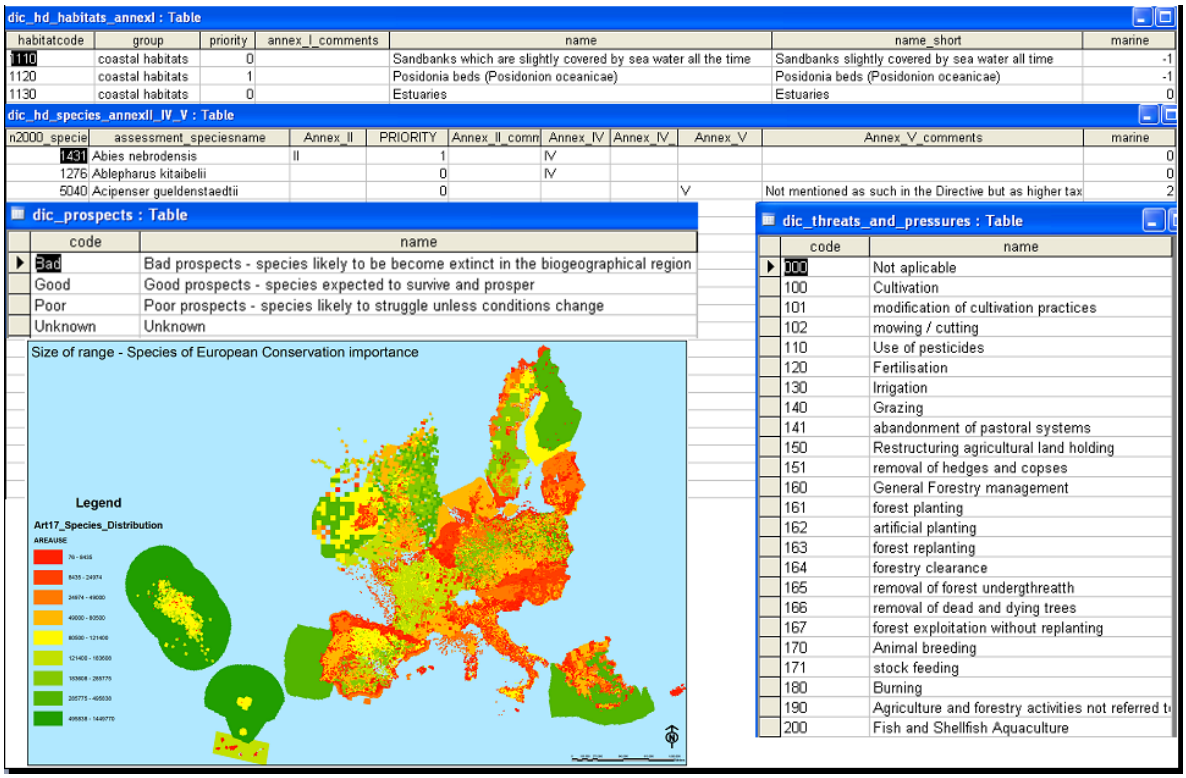

Figure 9: Proposed methodology for calculation of biodiversity index.