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Abstracts for the 23rd meeting of the London Group

SEEA

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METHODOLOGICAL WORK SEEA Central Framework

1. GLOBAL DSDS

SEEA CF research agenda: Global DSDs

Arturo de la Fuente, Eurostat

Abstract: SDMX is the most established standard for statistical data and metadata transmissions. Data structure definitions (DSDs) are part of the SDMX standard and are necessary for any SDMX data transmission. The DSD describes how the information in a specific dataset is structured. The DSD provides the IT system with the knowledge of the data structure.

Each statistical domain (e.g. environmental accounts) must have one or several DSDs. While other domains had already defined their DSDs (e.g. national accounts), this is new for environmental accounts. The development of environmental accounts global DSDs for data exchange is part of the SEEA CF research agenda.

This paper will report progress on the international work to develop global DSDs for environmental accounts. In particular, the governance of the process was taken over by the SDMX macroeconomic statistics ownership group (SDMX-MES OG) in December 2016. This is a group of international organisations managing the SDMX structures for national accounts, balance of payments, foreign direct investment and prices. Its members are Eurostat, IMF, OECD, World Bank, the European Central Bank and the Bank for International Settlements. A sub-group of SDMX-MES OG was set up to develop specific DSDs for SEEA. These will probably not be integrated in the DSDs for national accounts, but will share as many possible concepts and code lists with the existing national accounts DSDs. This paper will report draft versions of DSDs and will seek input from the London Group to feed this international work.

2. Economy Wide Material flow accounts

SEEA CF research agenda: Material flow accounts in raw material equivalents

Stephan Moll, Eurostat

Abstract: Material flow accounts in raw material equivalents (MFA-RME) complement economy-wide material flow accounts. MFA-RME account for products in terms of the amount of domestic extraction necessary to produce them, irrespective of where the material was extracted. Producing those estimates is closely related to IO techniques, which is one of the elements in the SEEA CF research agenda. The main MFA-RME indicator, raw material consumption (RMC), is also referred to as a material footprint, as it captures the amount of extraction of materials needed to meet the country's consumption and investment demand. There is substantial policy interest in MFA-RME in Europe, both from EU and national policy makers.

This paper will report on several Eurostat activities. First, Eurostat has developed a model to estimate MFA-RME for the aggregated EU28 economy; results have been published since several years. Secondly, Eurostat together with experts from

European countries have developed a technical note that aims at clarifying the treatment of secondary materials in the trade parts of MFA-RME. Thirdly, Eurostat has developed an RME tool for producing country estimates as a way of assisting countries who wish to start estimating MFA-RME. Fourthly, Eurostat is promoting and co-ordinating an EU-wide data collection of MFA-RME by the end of the year. This data collection will piggy-back in the existing EU MFA data collection, which is in place for several years.

This paper will report progress and seek a discussion by the London Group on these matters.

Material flows from final use to production – how to treat in RME?

Lucia Maier and Sven Kaumanns, DESTATIS

The aim of material flow accounts in raw material equivalents is presenting the flow of different types of raw materials in a national accounts' comparable input-output style. Often the second and sometimes the first quadrant of an I/O-table, representing the connection from production to final use and intermediate demand respectively, are shown. The second quadrant is used to calculate the most common indicators in raw material equivalents: Raw material input (RMI) as sum of raw material required to cover final demand and raw material consumption (RMC) as sum of raw material required to cover domestic final demand.

However, this is not the complete story of flows in raw material equivalents and a good example how mixing terminology of different domains can lead to misunderstandings: In contrast to the national accounts' monetary view final use is not necessarily final from a material flows' perspective. Products and their rucksacks of raw materials that reached final use might re-appear as input for production purposes at a later stage. Consequently, this material returning from final demand needs a separate treatment in contrast to that secondary raw material which has never left the I/O-table's first quadrant and thus is just a kind of intermediate input.

Thus, an I/O-table in raw material equivalents should contain in some way these direct or indirect material flows from final use, i.e. the second quadrant, back into the first quadrant and through this back again into the second quadrant. These flows, of course, have to be respected when calculating the main indicators RMI and RMC. The purpose of this paper is discussing ways of dealing with these kinds of flows and the allocation of material returning from final use back into production.

3. Integrated framework for environmental activity accounts

SEEA CF research agenda: integrated framework for environmental activity accounts

Arturo de la Fuente, Eurostat

Abstract: The environmental activity accounts (environmental protection expenditure accounts, resource management expenditure accounts, environmental goods and services sector accounts, environmental taxes, environmental subsidies

and other transfers) have been developed at different points in time, some of them going more than 20 years back whereas others are still in their infancy. In European, the legal basis to produce and collect those accounts has followed a modular approach. Circumstances made the different accounts to drift apart. As a consequence, some concepts, definitions, valuations and classification groupings are not identical across modules. For instance, definitions and valuation of adapted goods are not the same, groupings of classifications are not the same, valuation of exports differ, etc.

This situation is unsatisfactory. Correspondingly, an integrated framework for the monetary environmental accounts is in the SEEA CF research agenda.

Much work has been done in Europe about it since 2013. Work has advanced in several threads. A first area of work is a clarification of concepts and definitions e.g. main purpose criterion; specific, cleaner and resource efficient products; characteristic and non-characteristic activities, etc. This terminology is used in the new Eurostat EGSS and EPEA handbooks published in late 2016 and early 2017. A second area of work is about streamlining the activity accounts with the double purpose of achieving efficiencies in the compilation systems, and of providing a more coherent global picture.

This paper will review the terminology in the new Eurostat EGSS and EPEA handbooks and will discuss scenarios for streamlining the activity accounts.

4. Climate change – fossil subsidies

Development of statistics on fossil fuel subsidies

Viveka Palm, Statistics Sweden

The agenda 2030 includes an indicator on fossil fuel subsidies in goal 12 on Sustainable Production and Consumption. The statistics for this indicator are not yet being in place.

Sweden is part of a group that is discussing how to achieve this indicator with members from international organizations such as UNEP, IEA, OECD and IMF that are active in making assessments of fossil fuel subsidies. There are data and methods available to make such statistics but we are still lacking an agreement on who will produce them, with what definitions, and there is also a risk that the indicator will not be compiled in a close cooperation with the statistical system.

As it has been discussed for a long time there is a need to complement the environmental taxes and environmental subsidies that are already a part of the SEEA with an internationally harmonized set of data on fossil fuel subsidies.

Thus, the topic is part of the SEEA research agenda in order to describe and define how to include these transactions as part of the system and in an internationally harmonized way.

Data on fossil fuel subsidies are reported directly from the finance departments to the OECD, but the reference points are national and this makes international comparison very difficult.

There is also the distinction of direct subsidies, of indirect subsidies in the form of tax exemptions and of the subsidies that are calculated from the damage of the emissions that needs to be considered.

5. Environmental goods and services sector

Subject – abstract for LG research agenda – adapted goods

Drafted by C Lecavalier and J Fritzsche, EETSD, Statistics Canada

April 21st 2017

Statistics Canada is working on the development of a Clean Technology Satellite Account (CTSA)[1]. This account will provide a broader economic picture of the Canadian clean technology sector than what we have available at the moment.

Satellite accounts are based on the Canadian System of National Accounts (CSNA) and leverage some of the data produced within this system, most notably the supply and use tables (SUT). The Satellite account will also incorporate other data sources such as existing commodity databases on exports and imports, wealth and capital stock data.

The work is based on an inventory of goods and services considered Clean Technology compiled by different Canadian government departments. Clean technology refers to: "any goods or services ***that reduce environmental impacts through environmental protection activities, through the sustainable use of natural resources, or through the use of goods that have been specifically modified or adapted to be significantly less energy or resource intensive than the industry standard.***"[2]

An important challenge we are currently facing is the identification and classification of adapted goods. The current definition is to include those products that are significantly improved compared to the "normal" product. This is a challenge particularly in how to classify what is a "significant improvement" and as importantly how to identify these goods within the statistical system. For example, a turbine may be considered to be significantly improved based on one criteria but not

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[1] The first two years of the account will focus on developing the methodology, research the possible role of different data sources, and defining a pilot account. This work will then be tested using existing data.

[2] The definition is still in draft form. The plan is to base the CTSA definition of clean technology on the official Government of Canada definition of clean technology once it has been finalized. This is from the Sept 14 definition produced by -Innovation, Science and Economic Development Canada (ISED). Note that some terminology might be changed for consistency with the –Supply-Use Tables (e.g. the account functions on the basis of "goods and services"). Statistics Canada recommends the deletion of the word "processes" from the definition due to conceptual and measurement issues.

another. Additionally, current goods classifications do not distinguish between a more or less efficient or environmentally-friendly turbine.

Statistics Canada is conducting a feasibility study over the spring and summer to evaluate how to measure adapted goods in our CTSA. Although we are not promising to be able to contribute a research paper for the next LG meeting this fall, we wanted the LG bureau to know that our work could contribute to this topic and keep the discussion open this spring-summer for a possible contribution.

METHODOLOGICAL WORK SEEA Experimental ecosystem accounting

6. Scaling up of spatial units

Linking ecosystem assets – extent – condition – capacity – degradation to current and potential ecosystem services: applications from carbon and biodiversity accounts

Heather Keith, Michael Vardon, David Lindenmayer and Emma Burns, Australian National University

Application of ecosystem accounts for informing natural resource management policy requires extending information about ecosystem asset extent and condition, to also incorporate change over time in relation to a reference state and ecosystem capacity. The capacity of an asset to increase (restoration) or decrease (degradation) determines the potential for change in the supply of ecosystem services. Understanding the drivers of these potential changes is critical for assessing the consequences of alternative land use activities. The concepts of condition and capacity are best applied to specific ecosystem assets and their supply of services. Implementing the ecosystem accounting framework by scaling up site level data in a regional study in the Central Highlands of Victoria, Australia, has demonstrated technical and conceptual issues, and we provide examples of solutions from the carbon and biodiversity accounts.

These examples contribute to the topics for the SEEA Experimental Ecosystem Accounts prioritized by the UNCEEA, including (1) Spatial units and their delineation; (2) Indicators of ecosystem condition; (4) Articulation of the links between ecosystem assets (and their conditions) and the supply of ecosystem services. In addition, our examples contribute to the research agenda in the SEEA EEA Technical Recommendations Consultation Draft March 2017 concerning definitions and implementation of concepts of ecosystem condition and capacity and how these are applied to thematic accounts (sections 4.6, 7.6, 9.2.3, 9.5.1, 9.5.7).

Carbon accounts were developed for the asset extent and condition in relation to a reference state defined by disturbance history. This allowed the capacity for carbon stock change to be estimated, and hence the potential for increases or decreases in the supply of ecosystem services in relation to this capacity. The carbon accounts enabled estimation of current and potential ecosystem services. This result allowed identification of the institutional changes required to gain a market benefit from the services.

The biodiversity accounts demonstrated spatial dependencies by relating animal abundance, diversity, threat status and ecosystem characteristics to the land account. Ecological monitoring data was used to apply the IUCN Red List of Species and Ecosystems in the accounting framework. Trends in biodiversity in relation to ecosystem condition, change over time, and threshold states were used to inform policy about requirements for habitat in protected areas. Testing the application of these site data in the accounts showed how to generate value from existing data, as well as informing future design of monitoring programs.

We found that assessment of competing uses of ecosystems was best achieved by analyzing the counterfactual case. In the Central Highlands case, this meant that if timber harvesting had not occurred, the resulting ecosystem condition was improved for carbon, water and biodiversity. This analysis was based on a reference state for capacity of minimal human disturbance to the ecosystem, rather than that suggested in the SEEA EEA Technical Recommendations that capacity be related to the sustainable use level of ecosystems, which can be difficult to define.

We demonstrate how results from ecosystem accounts that include change in condition, capacity relative to a reference state, and comparison of alternative land use activities, are used to inform progress towards targets in the Convention on Biological Diversity Aichi Targets and the United Nations Sustainable Development Goals. Specifically, the information in the accounts contributes to defining sustainable management of ecosystems, and quantifying levels of degradation and restoration of ecosystems.

Recommendations for ecosystem accounting guidelines:

i) Developing the land account, which integrates land cover, land use and disturbance history, is the critical first stage. Examples are provided of the challenges and solutions for spatial and temporal integration of data sources with different scales, unit delineations, classifications, aggregations and spatial representations. We recommend that the accounting guidelines include criteria to prioritise each type of data to define their order of application.

ii) Assessing change over time in ecosystem services requires information about ecological processes to derive ecosystem production functions, for example processes of growth, decomposition and emissions due to disturbance.

iii) Condition is appropriate for specific ecosystem assets, and will often be most effective when indicators are designed to meet specific policy questions or ecosystem characteristics. For example, indicators of condition related to specific SDGs or Aichi Targets.

iv) Defining capacity is critical for linking changes in assets to potential changes in supply of services. However, capacity requires a reference state, which may need specific definitions for different assets, circumstances and policy questions.

v) Demonstrating policy relevance of ecosystem accounts can be achieved well by measuring change in ecosystem condition under alternative land use scenarios.

7. Condition indicators

Ecosystem services in the Akershus and Oslo county – A county level application of the SEEA-EEA framework using already available data form Statistics Norway

Statistics Norway with partners

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Ecological thresholds and accounting

Wageningen University

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Review of ecosystem condition indicators

Michael Vardon[3], Rocky Harris[4]

The SEEA EEA identifies five broad characteristics of ecosystem condition (vegetation, biodiversity, soil, water and carbon). In the latest Technical Recommendations (TRs), another category (habitats) is proposed, and the text goes on to suggest that pressure indicators (such as waste) might also be included within the framework. Separately, the TRs recognise that other characteristics such as management practices and protected area status need to be accounted for, possibly by adapting the classification of ecosystem types to accommodate these distinctions. At the same time, work in South Africa has identified a range of different possible indicators for terrestrial and river ecosystems, implying that some of the categories of condition for marine and other open water ecosystems might again be different.

Discussion papers and presentations at the Oslo meeting of the London Group in September 2016 identified two purposes of ecosystem condition accounts: i) to measure the state of the ecosystem in terms of its capacity to continue to provide services to people and ii) to measure the state of the ecosystem in terms of its ability to function without reference to human use. The latest draft Technical Recommendations suggest that the former purpose is "beyond the field of research on the SEEA", and as a result the focus tends to be mainly on the use of indicators with a clear 'reference condition'. However, all countries will have urban open spaces for which a reference condition of naturalness would not be meaningful, so the issues of how to group indicators together and what their purpose is would appear to be ones which need to be more systematically addressed within the SEEA-EEA.

As a first step, this paper will review the condition indicators used in practice in a range of countries and attempt to identify common ground and areas where some standard approaches might be adopted.

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[3] Australian National University

[4] Department for Environment, Food and Rural Affairs, United Kingdom

8. Ecosystem services definition and classification

Modelling ecosystem services for ecosystem accounting at national scale; experiences in the Netherlands

Wageningen University and CBS Statistics the Netherlands

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Developing ecosystem service classification(s) for ecosystem accounting

Jan-Erik Petersen, EEA, and Alessandra La Notte, EU Joint Research Centre

(with input from Charles Rhodes, ORISE fellow, Dixon Landers and Amanda Nahlik (USEPA) and Roy Haines-Young, Fabis Consulting)

This paper summarises the follow-up to work on ecosystem service classifications that was previewed in a paper to the 2016 London group meeting in Oslo. This work is being developed in cooperation between the European Environment Agency/Univ. of Nottingham, the EU Joint Research Centre, and the US Environmental Protection Agency, under the guidance and support of UNSD. Three elements are worth highlighting in particular:

1) A first important step for further clarifying the requirements on ecosystem service classification for ecosystem accounting was a two-day workshop at the University of Wageningen on 17-18 November 2016. This workshop had the following objectives:

   i. Elaborate and agree upon a set of principles, criteria, definitions, and characteristics for ecosystem services classification(s) to be used, among other things for the compilation of SEEA Experimental Ecosystem Accounts;

   ii. Discuss the classification of ecosystem services for ecosystem accounting, (based on agreed criteria and principles) and relations with other classifications used in official statistics;

   iii. Agree on the next steps and required research for developing a standardized, multi-purpose international classification (or system of explicitly connected classifications), including for the SEEA Experimental Ecosystem Accounting.

The background documents, presentations [and the summary document - *note: from June 2017*] of the workshop are available under the following link: https://projects.eionet.europa.eu/ecosystem-capital-accounting/library/ecosystem-service-classification-ws-nov-2016 .

2) In the EU KIP INCA project, the EU JRC is developing detailed supply and use tables for ecosystem service accounts built on CICES as an ES classification. JRC is also testing the combination of CICES with elements of the National Ecosystem

Services Classification System (NESCS, out of USEPA) to account specifically for SNA and non-SNA benefits. Key elements of the approach being tested at JRC will be presented.

3) Further methodological discussions between the cooperation partners mentioned above have also tackled some issues such as:
   - the concept and guidelines for identifying what constitutes a final ecosystem service;
   - the question of how to classify ‘abiotic services’ (or abiotic ecosystem ‘outputs’) and how to integrate them with existing ecosystem service classification systems.

The proposed paper will provide a short summary of key conclusions arising from that exchange.

9. Valuation, general principles

Valuation of ecosystem services

Colin Smith[5], Rocky Harris[1], Emily Connors[6]

The UK has been developing and publishing natural capital and ecosystem accounts for a number of years.

During this time a range of ecosystem service flows have been valued, using a variety of methodologies. The approach to date has been to some extent pragmatic: the emphasis has been on using valuation approaches which are well-established and readily available, whilst having due regard to the National Accounting framework within which the accounts are situated.

The SEEA-EEA, subsequent draft Technical Recommendations, and other papers (such as the Obst/Atkinson paper for the World Bank) have attempted to review these different approaches and identify the extent to which they may or may not be used to place values on services within the SEEA framework. For unpriced services (such as regulating services), the SEEA-EEA (5.20) suggests the aim is to “value the quantity of ecosystem services at market prices that would have occurred if the services had been freely traded and exchanged”. Drawing upon the UK’s recently published Principles of Natural Capital Accounting, using specific examples of regulating and cultural services, this paper will explore the potential difference between valuation concepts, including (high) welfare values and (low) “near market” transaction prices. It will propose that for certain services the only practicable way forward lies in between these two “extremes”, in which an exchange value is based on a ‘hypothetical’ but conceivable market.

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[5] Department for Environment, Food and Rural Affairs, United Kingdom
[6] Office for National Statistics, United Kingdom

Ecosystem service valuation and ecosystem asset account in Japan

Takashi Hayashi, Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries, Japan

Masayuki Sato, Graduate School of Human Development and Environment, Kobe University, Japan

This paper aims to introduce Japan's current initiative of valuing ecosystem services and incorporate it to SEEA-EEA. Specifically, we evaluate ecological stocks (i.e. forest and wetland) and ecosystem services from them based on our economic valuations, and develop an accounting system to record these values. We also aim to apply the results to macro indicators such as a sustainability index.

Firstly, we estimate the shadow prices of forest and wetland by environmental-economic valuation techniques. Contingent valuation method (CVM) is conducted to estimate welfare values for both forest and wetland. In addition, we estimate the exchange values of ecological stocks. For exchange values, land price plus timber price and replacement cost is used for forest and wetland respectively. The estimated values are incorporated in the ecosystem asset accounts in both physical and monetary term. Then, we evaluate the value of ecosystem services produced by forest and wetland by each prefecture in Japan.

Our study can contribute to valuation of ecosystem assets and services of the LG's topics for SEEA-EEA because it provides information on how to assess economic value of ecosystem assets and ecosystem services. The differential of the values between welfare and exchange basis assessments is compared. These two types of values can be used for different policy purposes, and we apply the results to macro indicators such as Inclusive Wealth Index. The results of application are also mentioned briefly.

Experimental ecosystem accounting in urban areas – challenges for valuation techniques and relevance for municipal policy and planning with examples from the Oslo's metropolitan area

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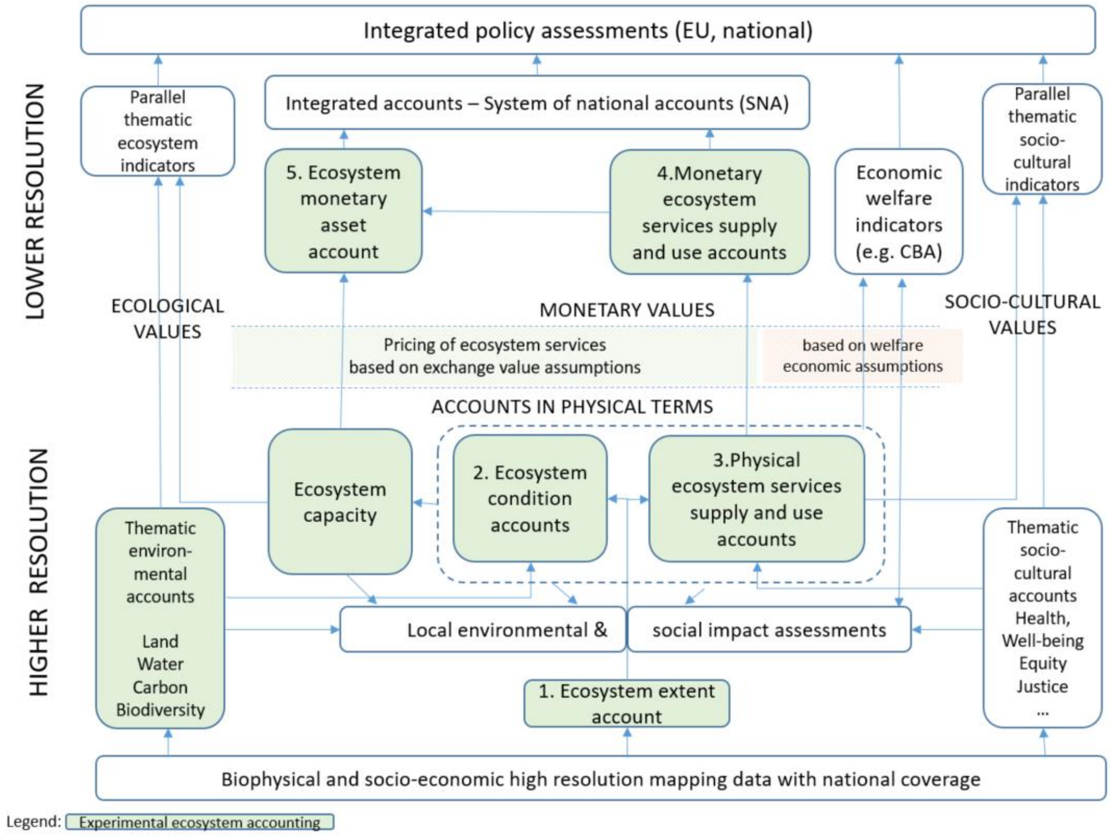
Keywords: policy applications SEEA EEA, valuation techniques beyond the SNA; parallel accounts;

[7] Experimental Ecosystem Accounting for Greater Oslo (URBAN EEA) http://urban.nina.no/

The SEEA Experimental Ecosystem Accounting: Technical Recommendations (UN 2017) discuss a number of potential uses and applications of ecosystem accounting information. Using the Oslo Metropolitan Region we present a number of examples of the use of high spatial resolution physical data collected for the purposes of EEA, which could also be used for local policy assessment and planning (Figure 1, next page). In the context of these policy/planning examples we then discuss what types of monetary valuation methods could provide decision-support. We discuss the SNA accounting compatibility of each of the valuation methods available locally, using the guidance criteria provided by the SEEA EEA Technical Recommendations. Using Oslo urban green infrastructure as an example of ecosystem assets, we contrast accounting compatibility and policy relevance of hedonic property pricing, restoration costs, replacement cost, travel cost valuation and stated preference techniques.

We provide examples of how detailed physical data collected for thematic accounts can indeed play a large role in informing municipal policy, and that the extended production boundary of SEEA and the proposals for compiling physical accounts can provide consistency to data collection efforts by local authorities. However, we argue that guidance on monetary valuation, with the aim of integration with the SNA, is very restrictive with regard to economic information that municipalities or regional governments find relevant for planning. The guidance – followed to SNA compatibility standards – would make ecosystem accounts of limited relevance for local governance of ecosystems. We argue that parallel thematic accounts can provide a basis for a suite of ecological, accounting, welfare and socio-cultural indicators that are sought after by local governments in planning (Figure 1, next page). A continued commitment to integration of ecosystem accounting information with standard national accounts, can and should be complemented by efforts to create a suite of indicators to inform integrated policy assessment at sub-national level.

Figure 1 – Extended conceptual structure of experimental ecosystem accounts



Source: own elaboration based on UN (2017) SEEA Experimental Ecosystem Accounting: Technical Recommendations. Consultation Draft. V4.1:6 March 2017

10. Valuation, specific services

The meaning and role of monetary valuation for ecosystem service accounting – notes from three applications for Europe

Alessandra La Notte, Joint Research Center

Within the KIP-INCA project, the JRC is responsible for the assessment and valuation of ecosystem service Supply and Use tables in physical and monetary terms. Our starting point are biophysical models that simulate biological systems using mathematical formalizations of physical properties. Such models are useful because they connect human influence to biological and physical factors and *vice versa*. Once we have the model outcomes in physical terms we have to convert them in monetary terms.

The applications on water purification, pollination and recreation show us several features that need to be considered:

- there is a difference between ‘economic valuation’ and ‘translation in monetary terms’. What we do for accounting purposes is the latter, because biophysical models drive the changes occurring in any accounting period. We use valuation techniques to express in monetary terms what biophysical models quantify. The first criterion for choosing the valuation technique is thus its appropriateness with respect to the biophysical model. Other criteria will fall into the debate (from an accounting perspective) concerning welfare values and transaction prices;

- the monetary side does in most cases complete the biophysical side. Biophysical models rarely provide an outcome 'ready to be used' in accounting tables, consistent with accounting rules. Our applications show that monetary valuation (or translation in monetary terms) does support in many ways the operational accounting of ecosystem services.

The three case studies built for Europe on water purification, pollination and recreation will clarify those issues and provide tangible outcomes to facilitate discussion on this important subject.

Measurement, valuation and recording of the water provisioning services in the SEEA

Michael Vardon, Heather Keith, John Stein, Janet Stein, David Lindenmayer

Fenner School of Environment and Society, Australian National University

This paper examines the theoretical and practical aspects of accounting for the ecosystem service of water provisioning using the System of Environment-Economic Accounting Experimental Ecosystem Accounting (SEEA-EEA). It is based on a case study in the Central Highlands of Victoria, Australia. In this area the water provisioning services are used by the water supply industry (Melbourne Water) to provide water to households and industry.

Using published information on the water supply industry, models of surface water run-off and the replacement cost method, the volume and value of the water provisioning service were estimated for the period 1990 to 2015. In 2015 the volume was 306 GL and the value was AUD$75 million. Two different ways of defining the water provisioning service were explored: run-off into the reservoirs, or the amount of water supplied by Melbourne Water. The run-off was used because this reflects more accurately the timing of the service provision and the management of the water by the industry, where water in the reservoirs is effectively treated as an inventory. The replacement cost method was used to estimate the value of the water provisioning service because: (1) a valuation using the resource rent approach preferred by SEEA is problematic owing to government price control and in addition calculations in another study found negative rents; (2) insufficient information exists to apply a production function; and (3) physical infrastructure was built to replace lost, or expected to be lost, services. Two replacement options were valued: desalination and transfer from another river basin. Transfer had the lower cost and so was used in the estimates. The water provisioning services were placed in the context of other water stocks and flows as well as in the overall use of the area as part of a broader accounting exercise to provide information to help resolve conflict over land use.

Urban Accounts

Emily Connors[8], Rocky Harris[9], Colin Smith[2]

The world is becoming increasingly more "urbanised". According to the UN, over 50% of the world's population live in urban areas. In the UK 4 out of 5 inhabitants live in towns and cities. Open spaces such as parks and gardens are increasingly recognised as providing a range of health and other benefits, but pressure to use these spaces for other purposes is intense. Natural capital accounts for urban areas in the UK are being developed by a number of municipal authorities and are a high priority work stream for the national level accounts.

Since the end of 2016 ONS and Defra have been developing initial Urban Accounts. By the time of the 2017 London Group conference, a definition of urban will have been established and initial accounts for some key urban ecosystem services will have been developed, including air pollution absorption, noise mitigation and local climate regulation. The project will also seek to establish the value of nature implicit in house prices, using the hedonic pricing method. This will impute benefits of urban green and blue spaces through the regression of house price and geospatial data.

This paper will present initial findings from this study and discuss the issues involved in valuing relatively small areas of natural open spaces in extremely populated areas .

Valuing water purification and crop pollination services for ecosystem accounting: a multi-country study

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To further develop the methodology in the SEEA-EEA, countries are encouraged to experiment on areas that pose challenges to the development of the guidelines. One such area is how to derive the monetary value of benefits from ecosystem services. In this paper, we summarize a four year collaborative and multi-country research program (Ecosystem Service Accounting for Development (ESAfD)[10]) that aims at enhancing ecosystem accounting methods by developing and testing empirical methods of economic valuation of ecosystem services. Our assessments focus on regulating services and take place in seven different countries; China, Costa Rica, Ethiopia, Kenya, South Africa, Sweden and Tanzania. In each country, our objective is to develop empirical estimates of the value of ecosystem services using methods consistent with both economic theory and SEEA. Moreover, the assessments aim at reaching representativeness at the geographical level of the accounting unit (national or subnational). Our studies in different countries are directly comparable, enabling between-country comparisons and learning.

Our study methodologies empirically determine the economic contributions of ecosystems to different ecosystem services, including water purification and crop pollination. We achieve this by compiling spatial and temporal panel data on economic outcomes of interest (water treatment costs, agricultural production outputs and revenues), land cover (forest, wetland, grassland, etc.) as a proxy for ecosystems, and other relevant environmental and socioeconomic drivers of the value of ecosystem services. Then, we use panel estimation methods to identify the marginal contributions of ecosystems to the cost of water treatment and revenue from agricultural production. By measuring land cover (ecosystems) at different distances from the unit of analysis (a water intake or agricultural field) and then measuring the contribution of ecosystems within different distances on the value of ecosystem services we empirically examine how the proximity of ecosystems to the water treatment plant or agricultural fields affects the value of ecosystem service generated by a specific area of land. The advantage of panel data estimation methods is that they allow to control for potential unobservable confounders that do not vary across time. The methodology enables the identification of marginal effects of changes in different types of land cover such as the cost of losing certain amounts of forest at different distances from an agricultural field. Our use of spatial and geographically representative data allows the derivation of spatially determined and nationally representative unit values of benefits from the ecosystem services examined.

The results show that changes in forest cover statistically significantly affect both surface water treatment costs and agricultural revenues. We also find that the effect of marginal forest gradually diminishes as the distance to the water treatment plant or agricultural field increases.

The methodologies developed are founded on the economic production (and cost) function methods, aligned with the accounting principles. Using information on

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[10] http://www.efdinitiative.org/our-work/research-programs/esaford

actual economic activities provides a direct link to the economic SNA. The application of the same general methodology in different countries requires adaptation to country differences (e.g. data availability) and helps evaluate the replicability of the method under various circumstances. The analysis can support the construction of statistically based transfer functions that can help to transfer values across different countries and their sub-regions.

11. Valuation of assets

Future price and physical flow projections

Rocky Harris[11], Emily Connors[12], Colin Smith[1]

The UK has been developing and publishing natural capital and ecosystem accounts for a number of years.

During this time monetary accounts for a number of natural capital assets have been compiled, based on the expected future flows of services such as recreation, air pollution removal, carbon sequestration, and a variety of provisioning services such as timber and fish, using the Net Present Value (NPV) approach.

The SEEA-EEA suggests (para 5.121.(i)) that the assumption of business as usual is most likely to be appropriate but says little about methodologies for making such projections of service flows. The SEEA-CF (para 5.133 et seq.) indicates that the expected pattern of service flows should be based on current estimates as far as resource rents are concerned, and gives a little more guidance (e.g. para 5.210) on possible assumption about future extraction rates.

Drawing upon the UK's recently published Principles of Natural Capital Accounting, this paper will explore various issues that arise when attempting to project service flows in respect of non-provisioning services such as carbon sequestration, air pollution filtration and recreation. The choice of asset life and discount rate will also be explored particularly when thinking about comparability with other wealth estimates, such as social and human capital.

12. Capacity accounts

Proposal for additional accounts to assess sustainability and to track the causality nexus

Alessandra La-Notte, JRC

The possibility to work with biophysical models allows the compilation of the basic Supply and Use tables presented in the SEEA-EEA and of complementary information where a further extended production boundary can be tested.

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[12] Office for National Statistics, United Kingdom

There are in fact some ecological concepts that require further developments of the current frame: by keeping the strict rules that regulate the accounting mechanism of SNA we attempt to extend the production boundary to allow a more active role to be played by ecosystem types as full accounting units. Specifically, ecosystem types as accounting units should be able to produce, accumulate and consume (being aware that we deal with ecological processes).

The very first implication of considering ecosystem types as accounting units in the Supply and Use tables, is that what should be assessed on the supply side is what ecological types are able to offer independently of how much of it will be used. When an ecosystem service (provided by relevant ecosystem units) is identified because there is a human need for it, two different kinds of flows should be reported in accounting:

- on the one hand, there is the maximum potential flow that relevant ecosystem types are able to generate for each individual service;
- on the other hand, there is the amount of flow that is currently used/consumed by economic sectors and households, which we can call actual flow.

About the first typology of flows, for some ecosystem services the over-use may lead to degradation; a sustainable flow should be defined to guarantee the ecosystem service capacity in the long term. There is thus the need to make a distinction between ***potential and sustainable flows***. The factor that distinguishes the two typologies of flow is whether actual use can affect sustainability during the accounting period. This is quite an important remark to be made when considering how to deal with particular groups of ecosystem services in accounting. We attempt a first overview.

The second implication of considering ecosystem types as accounting units and of explicitly separating them from benefits, requires to address the issue of how to combine 'products' (SNA) and environmental assets (SEEA-AFF, SEEA Water) with what in the SEEA-EEA is called SNA benefits and ***non-SNA benefits***. While the former records examples, definitions and classifications (ref. SEEA-CF), the latter has never been investigated. We address the issue of dealing with non-SNA benefits for selected ecosystem services.

The importance of specifically reporting benefits in the use table is to clearly separate the service flow generated by ecosystem units from the final benefit perceived. There might be cases (third implication) where the enabling actor of the service differs from those who perceive the final benefit (beneficiaries). This is true especially for sink-related services. In the case of polluters, enabling actors are those who activate the service: without them the service would not be there. One purpose we need from the accounting tool is to establish the ***causality nexus*** between the behavior of human actors (economic sectors and households) and sustainability.

Since each ecosystem service has its own peculiarities, this experimental framework needs to be tested and validated through as many applications as possible. So far we can show the outcomes reached for water purification, pollination and recreation.

13. Thematic accounts

The SEEA EEA carbon account for the Netherlands

Marjolein Lof, **Sjoerd Schenau**, Rixt de Jong, Roy Remme, Cor Graveland, Lars Hein.
Statistics Netherlands/ WUR

The carbon account provides a comprehensive overview of all relevant carbon stocks and flows. The carbon account for the Netherlands was developed within the scope of the ‘System of Environmental Economic Accounts – Experimental Ecosystem Accounting’ (SEEA-EEA) project for the Netherlands (Natuurlijk Kapitaalrekeningen Nederland: NKR_NL), which is currently carried out jointly by Statistics Netherlands and Wageningen University. Funding and support was provided by the Ministries of Economic Affairs and Infrastructure and the Environment. Within the NKR_NL project, a number of accounts are currently under development. The Carbon account is described in detail in this report.

The carbon account was developed to allow for a consistent and quantitative comparison of carbon stocks and flows in the reservoirs ‘biocarbon’ (organic carbon in soils and biomass), ´geocarbon’ (carbon in the lithosphere), atmospheric carbon and carbon in the economy. Hence, the account provides a comprehensive overview of stocks of carbon in its many different forms and the ways in which carbon flows through these different reservoirs. The carbon account was based on the combination of datasets from numerous sources, combined with new modelling efforts to capture aspects of the carbon account that were not yet known. For biocarbon, the inputs to the account were modelled in a spatially explicit manner. For the development of these maps, existing models and data describing biocarbon (kindly provided by, among others, PBL and Wageningen Environmental Research) were combined with new data and with the EU_NL map. This resulted in an up-to-date overview of major stocks and flows of biocarbon for the ecosystem units recognized in this map (these ecosystem units are also the basic spatial unit throughout the NKR_NL project). For geocarbon, data were derived from existing accounts for fossil fuel assets and flows. These data were complemented with trade data to assess imports and exports of geocarbon, and with additional data on other types of geocarbon. Data on atmospheric carbon were derived from the air emissions reports and accounts, whereas the information on carbon in the economy was primarily derived from the Energy accounts, the economy wide Material Flow accounts, the physical supply and use tables (Material Monitor) and the Waste accounts. Carbon in the oceans was not included in this carbon account due to a lack of data. For Biocarbon and carbon in the atmosphere, a comparison to other reporting frameworks (e.g. LULUCF) was provided.

Accounting for Ecosystem and Biodiversity Related Themes in Uganda

Steven King, UNEP World Conservation Monitoring Centre

The National Development Plan II (NDP II) for Uganda sets out objectives for Environmental and Natural Resources (ENR) in pursuit of sectoral growth and socio-economic development, with tourism identified as a key development sector. The second National Biodiversity Strategy and Action Plan for Uganda (NBSAP II) further recognises the importance of biodiversity to Uganda's economy and livelihoods of Ugandans and provides national targets aligned with the ambitions of the NDP (II) and the CBD Aichi Biodiversity targets. Both plans explicit recognise the role that natural capital accounting can play in informing decision-making towards achieving their objectives.

This paper describes the first attempt to rapidly compile a set of policy relevant ecosystem and biodiversity related natural capital accounts using the System of Environmental-Economic Accounting – Experimental Ecosystem Accounting (SEEA-EEA) framework in Uganda. The accounts have been compiled for 1990, 2005, 2010 and 2015 using several existing datasets. These data have been integrated using a common spatial data infrastructure. This allows accounts to be compiled for multiple Ecosystem Accounting Areas, including national and sub-region scales as well as the protected areas system to inform on different policy priorities. The accounts compiled concern land cover, ecosystem extent, three non-timber forest product (NTFP) species (Gum Arabic, Shea butter tree nuts, *Prunus africana*) and two flagship mammal species (Chimpanzees and Elephants).

The accounts reveal substantial reductions in the extent of natural ecosystems in Uganda, particularly for the forest (29% original extent remaining) and moist savannah (32% remaining) by 2015. In addition, large areas of natural cover are revealed to have been intermittently used for farming and plantation use between 1990 and 2015 (up to 4 million ha). The current protected areas estate is revealed to have performed well in reducing the loss of key habitat for iconic flagship species and associated wildlife watching tourism opportunities. A large majority (87%) of the remaining 493,000 ha of fully-suitable chimpanzee habitat is protected, located in sub-regions in the west of the country. Similarly, for elephants the majority (80%) of the remaining 1,064,000 ha of fully-suitable habitat is protected, largely located in sub-regions in the north east and west of the country. The accounts identify large areas with the potential to support Gum Arabic (> 2 million ha) and Shea butter tree nut (> 1 million ha) harvesting, mainly in sub-regions in the north and west of the country. These areas have remained natural vegetation between 1990 and 2015 and are not in conflict with the protected area estate. As such they offer the best prospects for supporting sustainable harvesting activities.

These initial findings will assist planners to identify where tourism and NTFP harvesting livelihood opportunities could be realised via investments in maintaining Uganda's natural capital. They also reveal broad trends in the extent of ecosystems and their ability to support flagship and other species. This will support the assessment of progress towards the objectives and targets of the NDP (II) and NBSAP II in Uganda. The rapid development of the accounts using existing data has allowed these insights to be quickly disseminated. This will assist in retaining the support of key users of the accounts and foster ownership through elicited feedback to direct future iterations. It is also likely to prove more efficient as investments to fill gaps can then be targeted in the context for policy and user priorities.

IMPLEMENTATION and EXTENSIONS

14. Air emission accounts

Mapping IPCC greenhouse gas emissions categories to ISIC A in the SEEA AFF

Francesco N. Tubiello[1], Silvia Cerilli[1] , Giulia Conchedda[1] and Aldo Femia[2]

Countries report their anthropogenic greenhouse gas (GHG) emissions as part of well-defined international reporting commitments under the UN Framework Convention on Climate Change (UNFCCC). Specifically, they report data collected and analysed following the international -Guidelines for National Greenhouse Gas Inventories (NGHGI) of the Intergovernmental Panel on Climate Change (IPCC). The reporting commitments differentiate between developed and developing countries, referred to under the convention as Annex I (AI) and non-Annex I (NAI), respectively. AI countries, including most OECD countries, report annually since 1992 and undergo stringent international review; NAI countries may report at multi-year intervals, notably within their National Communications (NC) or via Biennial Update Reports (BURs), and undergo limited review. For all countries, their NGHGIs represent the basis for so-called Monitoring, Reporting and Verification (MRV) processes, which are at the basis of enhanced transparency in reporting National Determined Contributions (NDCs) under the Paris Agreement.

The paper explores the issue and suggests a first tentative allocation of all processes relevant to AFF activities, i.e. those that should be included in an ideal implementation of SEEA AFF table 4.5, Physical flow account for air emissions. These processes include some human-induced land use changes that – although affecting environmental assets used by AFF – are not caused by the latter activities but are connected to other ISIC’s economic output and should therefore not be recorded under AFF, but that are worth reporting in table 4.5. As a by-product of this exercise, we identify, within LULUCF processes, those that are not connected at all to AFF activities, not even through the assets they affect, and should therefore be reported as other ISIC’s entries in a non-AFF-specific AEA application.

Finally, we produce examples of tier-1 implementations, developed using FAOSTAT GHG emissions database.

The paper aims at making available a first guidance tool for the implementation of table 4.5 of the SEEA AFF, in its latest version (the one presented at the 2016 LG meeting), to which we will refer, with a minor adjustment of terminology. The LG is expressly asked to express its opinions and to provide possible contributions to the further development of this work.

Completing the links between UNFCCC reporting categories and SEEA AFF Air Emission Accounts. A tier-1 application to the Italian case

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Greenhouse Gas emissions are estimated by countries and international organisations (FAO as far as Agriculture, Forestry and Other Land Use – AFOLU are concerned) following the IPCC guidelines. These do not refer to the classification of human activities (industries, households consumption) used in national accounting but to technological *processes*, which are not always typical of specific economic activities but may be carried out in several different activities. Conversely the SEEA-CF Air Emission Accounts establish first the economic activities (industries, households' consumption) generating emissions and then assess which of the processes causing the emissions are actually carried out in the candidate activities, in order to split the emissions between those activities. This is very often the data flow process followed in most Annex I parties (developed countries, mostly OECD members) of the UN Framework Convention on Climate Change (UNFCCC) when reporting their National Greenhouse Gas Inventories (NGHGI).

Notwithstanding the wide experience gained in Annex I parties mapping UNFCCC NGHGI to SEEA Air Emissions Accounts, this exercise has to date excluded emissions falling under the IPCC Land Use, Land Use Change and Forestry (LULUCF) category. Only recently the mapping of the latte and the underlying ISIC A activities has been completed, specifically under the SEEA Agriculture Forestry and Fisheries (SEEA AFF) framework.

This paper explores a first tentative allocation of all processes relevant to ISIC A activities mapping relevant emissions data presented in the Agriculture and LULUCF reporting tables of Italy, an Annex I party, to table 4.5 of the SEEA AFF. While establishing all the links by referring the most disaggregate level of the Common Reporting Format, we also propose some tier-1 and tier-2 approximations that would allow other countries to map ISIC A related emissions to SEEA tables in a resource efficient way.

Physical Energy Flow Accounts

Physical energy flow accounts

Stephan Moll, Eurostat

Physical energy flow accounts (PEFA) record the flows of energy (in terajoules) from the environment to the economy (natural inputs), within the economy (products), and from the economy back to the environment (residuals). Since 2014 Eurostat has been collecting PEFA from European countries on a voluntary basis. In 2017 provision will become mandatory to national statistical institutes of the EU (see Annex VI of Regulation (EU) 691/2011 consolidated version). The methodologically harmonised European PEFA are based on the physical accounting framework outlined in SEEA-CF. At the core of the European PEFA stands a pair of physical supply and use tables.

This paper will present 'lessons learnt'. It will introduce the comprehensive European annual PEFA questionnaire which consists of seven tables. Eurostat provides an IT-tool ('PEFA-builder') facilitating the compilation of PEFA starting from energy statistics (IEA/Eurostat annual energy questionnaires) which will be briefly explained. The paper will further present certain methodological choices beyond the SEEA guidelines which were taken such as e.g. the recording of nuclear energy, treatment of biofuels, etc.

15. Water accounts

Aspects of consumption and losses of water

Gerry Brady, Central Statistical Office, Ireland

We are finalising a new release on domestic metered public water consumption based on meter readings from a utility. We have data for around 800,000 meters. There is a very wide variation in consumption because of leaks etc.

This presentation will challenge the idea of consumption and losses of water.

16. Terminology on EGSS, bioeconomy and cleantech

On differences and connections between EGSS, bioeconomy, circular economy and cleantech

Sami Hautakangas, Statistics Finland

The terminology among economic activities connected to environmental aspects is diverse. One that is well defined is statistics on Environmental goods and services sector (EGSS). However, there are plenty of different expressions of activities which underline the environmental friendliness of the actions carried out under the umbrella of the expression at stake. These umbrellas include for example bioeconomy, circular economy and cleantech. Whether the terminology is invented by governments or corporations, they are after all used miscellaneously. In this paper, we intend to put the various expressions in the context by comparing them with

EGSS. How do they differ from EGSS and what do they have in common? Are there clear definitions describing the various expressions?

17. Implementing the accounts

Environmental Economic Accounts for Forests (CEAF): Proposal of a Methodological and Institutional approach for Application in Brazil

José Antonio Sena do Nascimento, Instituto Brasileiro de Geografia e Estatística

The growing concern about the environmental impacts of economic activity in contemporary society is reflected in the field of statistics. It has long been argued that the system of national accounts (SNA), that measures economic activity, fails to measure the contribution of the environment to the economy and the subsequent impacts of the economy on the environment. Activities that contribute to environmental degradation are often recorded as positive contributions to the economy, and are accounted for as economic growth, in an expansion often supported by the depletion of non-renewable natural resources. Problems of this nature have led to an effort by the United Nations and the World Bank to reform the system, enabling it to properly record such phenomena and to produce indicators that reflect the impacts of environmental degradation promoted by production and consumption activities. In 2012, the United Nations adopted the System of Environmental-Economic Accounting Central Framework (SEEA) as a satellite system to the SNA in an effort to better understand the interactions between the environment and the economy.
This article presents a methodological proposal to carry out Environmental Economic Accounts for Forests based on the United Nation’s SEEA framework. .
Databases, surveys and studies available in Brazil are presented and can serve as input for the accounts also a proposal is presented to establish an institutional platform for the development of Forest Accounts in Brazil. This will allow the compilation of a system of satellite accounts that will enable the System of National Accounts to incorporate environmental dimensions, such as the physical and monetary accounts of forest and wood products.
The expected results of this work are related to the dissemination of the environmental accounting methodology and the incentive to build an institutional platform for the elaboration of the CEAF in Brazil. This work will contribute to support the Brazilian Forest Service in the creation of an Interministerial Ordinance to establish an Executive Group and a Steering Committee for the compilation of Environmental Economic Accounts for Forests.

The Contribution of Energy and CO2 Accounting for Policy in Costa Rica
Henry Vargas Campos and Irene Alvarado Quesada, Central Bank of Costa Rica

Energy accounting identifies in detail which economic activities use energy and what are the main energy sources. This is particularly relevant for a country like Costa Rica, which aims to reduce the country's dependence on fossil fuels and create the conditions for higher economic growth at the same time as using less petroleum and reducing greenhouse gas emissions. In 2013, around 70% of gross CO_2 emissions were from fossil fuel combustion, while the remaining 30% resulted from the use of other sources (geothermal, bagasse, coffee husks, and other plant residues, and firewood). The food industries, transport activities and electricity production used the most energy and were responsible for the highest shares of CO_2 emissions. Economic activities such as manufacturing of sugar and wood products are highly intensive in energy and emissions of CO_2, and have a relatively low contribution to total economic production in the country.

The energy account provides a deeper understanding of the relationship of the energy sector with the environment and the economy than previous energy data by linking physical and economic information and specifying various interactions. While energy accounting is new in Costa Rica and has not yet been used in government policy and planning, the indicators from the accounts can assist the formulation of activities related to key national policies like the VII National Energy Plan and the National Climate Change Strategy. Primarily the accounts would be a tool for monitoring energy use patterns, greenhouse gas emissions, productivity and sustainability. Accounts also have potential to be used in analyses to identify and test various options for attaining policy targets.

Strengthening and positioning the environmental and economic accounts in Colombia
Bayron de Jesus Cubillos López, Departamento Administrativo Nacional de Estadística

In the last years, Colombia has made important progress in implementing the System of Environmental and Economic Accounts (SEEA). As a outcome, the Environmental Satellite Account (CSA) results have been published through specific Environmental Accounts: Mineral and Energetic Assets, Soil Resource, Timber Resource, Energy Flows, Forest Product Flows, Water Flows, Material Flows (Air Emissions and Solid Waste) and Environmental Activities.

Despite the important progress already accomplished, it has been necessary to improve the dissemination of the CSA results. In consequence, different socialization meetings have been organized, the website has been redesigned, and new indicators have been added according to the information needs expressed by stakeholders responsible for environmental policy design and monitoring.

Consolidation of the solid waste account and development of the air emission account
Bayron de Jesus Cubillos López, Departamento Administrativo Nacional de Estadística

Colombia has accomplished important progress in the construction of the Solid Waste Account, as a result of the joint institutional effort, led by DANE, with entities as the

Public Services Superintendence (SSPD) and the Institute of Hydrology, Meteorology and Environmental Studies (IDEAM). This joint work aims to harmonize the official administrative records on these matters, which are essential for the Account structure. Some results of this joint effort to be highlighted are:

- Concept Standardization related to solid waste and residual products, established according to national and international references.
- Draft of a correlative classification between solid waste and residual products, using as reference: i) European Waste Classification: Statistical Presentation, ii) Fee Subheading, iii) Common Product Classification and iv) Colombian National Account Product Nomenclature (2005).
- Statistical Information harmonization from statistical operations and administrative registers developed by DANE and other environmental associated entities (according to their official responsibilities).
- Technical assistance for institutional capacity building with the aim of diagnosing and identifying opportunities to improve the information in the registers and the Account results.

Also, as part of the continuous improvement process, following the ECLAC recommendations received through technical assistance sessions for the Energy Flow Account in March of 2016, the team identified the need to strengthen the registers related to the Energy Supply and Use Matrix, specifically in the energy flows linked to the transformation from primary to secondary energetic products. Moreover the energetic products with non-energetic use were included as well.

Finally, one result to highlight is the construction at DANE of a proposal for the Air Emissions from Industrial Processes Account. The objective is to estimate supply and use of emissions produced by extraction and energetic combustion processes; as well as by the physical and chemical transformation processes held for the production of materials, disaggregated in gas type (greenhouse effect, acidification, ozone precursors, air quality and heavy metals), which belong to the mining, chemical and metal Industries.

POLICY APPLICATIONS AND LINKS BETWEEN SEEA CF AND SEEA EEA

18. Interfaces between CF and EEA – Presentational issues

Presenting SEEA CF and SEEA EEA statistics together: UK experience and lessons learnt

Emily Connors[13], Gemma Thomas[14], Rocky Harris[15], Colin Smith[2],

In 2011 the UK Government committed to working with the UK Office for National Statistics (ONS) to incorporate natural capital into the UK Environmental Accounts by 2020. The aim of this project being that the benefits of nature would be better recognised. In partnership with the Department for Environment, Food and Rural Affairs (Defra), ONS has been developing and publishing natural capital and ecosystem accounts for a number of years.

By 2020 we envisage the accounts moving beyond experimental status, to be part of the UK Environmental Accounts, and integrated as far as possible. As the 2020 target draws nearer it has led to a lot more discussion and thought about how the general Environmental Accounts, which tend to follow the SEEA Central Frameworks (CF) and the UK Ecosystem Accounts, which follow the SEEA Experimental-Ecosystem Accounts (EEA), are presented together.

Currently, there is a wealth of environmental information being published in the UK Environmental Accounts, including air emissions, environmental protections expenditure, waste and renewable energy. When this is combined with the natural capital and ecosystem accounts it can be difficult to pull this information together in a user friendly way, which has affected the impact our statistics have. The end user of the statistics produced by each framework may not be the same, so further thought is needed to establish who the users are.

Consistency issues can arise, for example when comparing pollution emissions in the central framework with pollution removed by vegetation in the ecosystem accounts, or timber extraction in the CF with provisioning services in the ecosystem accounts. There are obvious links and potentially high value in combining the statistics supplied by the CF and EEA. Linking the two consistently will bring together the impact human activity has on the environment and resultant changes in services we receive.

It is something the UK continues to work on and develop, and a session at the London Group would be appreciated to explore in more detail some of the issues we have faced.

[13] Office for National Statistics
[14] Office for National Statistics
[15] Department for Environment, Food and Rural Affairs

Natural Capital Accounting in the United States: Recent Efforts in Developing Land and Water Accounts and the Path Forward
Bureau of Economic Analysis and partners

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Land accounts for ecosystem services in Sweden

Nancy Steinbach, Statistics Sweden

Ecosystems are affected daily by the economy and decisions and actions in society. The use of statistics to show some of the complex interlinks that exist provides information that may contribute to a greater understanding and improved decisions for society and a sustainable development.

At Statistics Sweden a production system has been developed with calculation routines and data management for the preparation of basic land accounts. The aim was that this production system should be fully harmonised with the environmental accounts system and be possible to put into operation. The production system that has now been created for land accounts provides several ways of reporting by linking micro data with other registers and statistics. For the statistics produced in this project alone, the following information can be reported:
- Type of land by time and owner category according to the real estate assessment records.
- Type of land by time and property type code according to the real estate assessment records.
- Type of land by time and NACE code including section, division, group, class and detailed group.

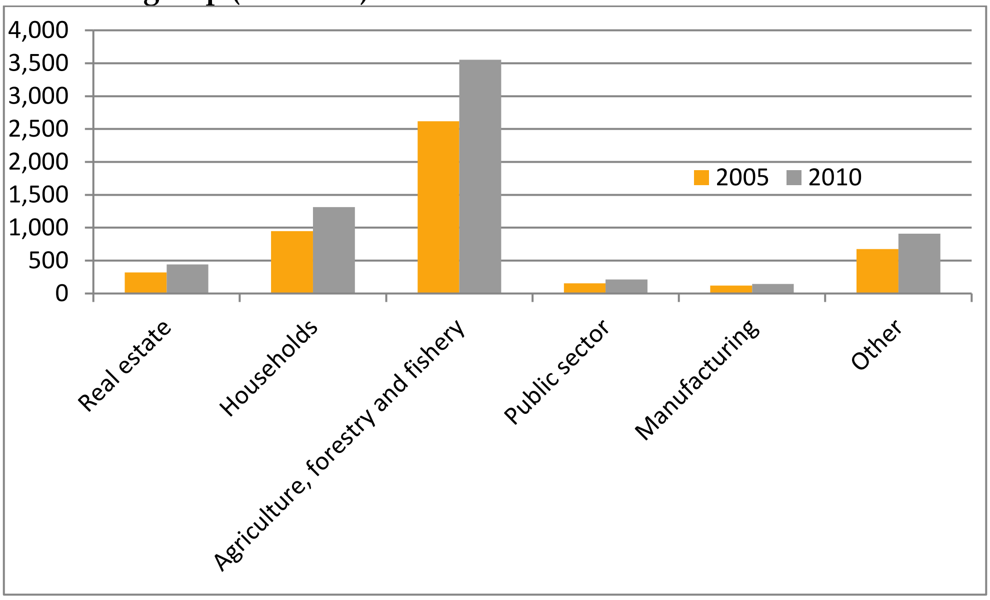
All variables can be reported at national and regional level, including water districts.

This data is seen as a basic foundation to moving further into ecosystem accounting. Without it there is no understanding of the frame on which to start adjusting behavior that is unwanted or needs to be encouraged. However, moving on from land cover extent to the provision of ecosystem services or their benefits is not straightforward. In this respect, the study aimed at testing and describe opportunities rather than providing a complete concept.

A number of minor tests has been carried out but most importantly, proposals for potential continued development were prepared. It is believed there is great potential to develop land statistics further, allowing its use to assess changes relevant to ecosystem services.
One example is the carbon sequestration. By using the extension of land ownership with data from researchers on carbon a new way of thinking regarding carbon could be presented. In our example we tested the area of Gotland (an island in-between Sweden and Finland) and the carbon contents in the hands of the Swedish economy. The results indicate that most carbon is owned by the agriculture, forestry and fishery industry and very little by the public sector. As carbon sinks are an important source

for mitigating climate change the figure provides insights to the stability of those carbon sinks.

Figure 1
Above ground carbon content (in tonnes) in forests on Gotland and forest area by industrial group (SNI 2007).



Source: Statistics Sweden, MIR 2017:1: Land accounts for ecosystem services

Further development is possible within classifications, links to workplaces for local connections, a more detailed breakdown of existing types of land, such as built-up land and sealed soil. It is also possible to build further on the connection with ecosystem services associated with land, such as by using agricultural statistics, information about carbon sinks and biodiversity.

This contribution to the London group is to enhance the discussion of linking the existing information from the SEEA CF to the experimental ecosystem accounts. This is still an area worth exploring more.

19. The use of GIS

Experimental Ecosystem Accounts. The experience of Mexico

Presented by: Raúl Figueroa Díaz, J. Federico González, Diana Enciso Gómez, Cesar Cabrera Cedillo

The purpose of this document is to share the experience gained in Mexico during the implementation process of SEEA-EEA, which is being developed as part of the pilot countries of the initiative led by UNSD, and is coordinated in the country by the National Institute of Statistics and Geography (INEGI).

The use of Geographic Information Systems is a recurring practice in the world, however, it is necessary to use information that meets certain standards that make it possible to make the different layers of each ecosystem comparable and at different points in time.

In Mexico the homologation includes the use of shapes with projection Albers Equal Area, with scale 1: 250,000. It is important to mention that these unifications have allowed to take advantage of the information generated by different sources of the environmental sector, such as the National Water Commission (CONAGUA), National Commission for the Knowledge and Use of Biodiversity (CONABIO), National Commission on Natural Protected Areas (CONANP), among others. These institutions have long developed works that respond to the particular needs and objectives related to the functions of each institution, and which have been taken up in a coordinated and consensual way for the EEA-Mexico project.

On the other hand, the municipal delimitation has been determined as EAU, using information in vector format. It is important to emphasize that, in cases where municipalities have a very small extension, several municipalities have been added based on the regionalizations established in the plans of the state governments. This decision was taken mainly considering that one of the objectives of the EEA-Mexico is that the derived information serves to construct economic, environmental and political indicators. This delimitation seeks to present information to a level that allows knowing, analyzing and making decisions at clear levels of local governance.

Finally, the advances that have been achieved to date are the result of the coordinated work between the institutions that integrate the environmental sector in Mexico and the areas of geography and statistics within INEGI. An inter-institutional technical working group was created, in which its members are aware of the contribution they can make to the project and, in addition, of the benefits they will have for their work, to have the information derived from the EEA-Mexico.

21 Challenges for policy

Natural capital accounting for policy – a global view of achievements, challenges and prospects

This paper is part of a collaboration between The World Bank WAVES Program, The International Institute for Environment and Development and The Netherlands Environmental Assessment Agency. Authors: Steve Bass (IIED), Sofia Ahlroth (WB), Arjan Ruijs (PBL) and Michael Vardon (ANU)

Natural capital accounting (NCA) has been used in all phases of the policy cycle and incorporated into the policy machinery of several governments. Uses range from the monitoring of sector based policies, like water, energy and forests, through to more complex areas of putting into place or analyzing cross-sectoral policies for green growth and climate change. Countries like the Netherlands, Sweden and the United Kingdom that have had NCA programs for many years have developed the capacity and relationships between the users and producers of accounts that enable more effective use of the accounts in policy processes. While it takes time to produce NCA with the full range of functions, countries with relatively new NCA programs have also had achievements in applying NCA to decision-making, for example in setting prices for water and energy, as well as in enriching national, sector and regional planning. There are several challenges to getting NCA used in policy, including the prevailing policy focus on the short term (limited policy readiness for change), the acceptance of the information (its perceived credibility and trustworthiness), the communication of complex information, the alignment of NCA supply with NCA demand, ensuring collaboration and understanding between diverse professions and institutions, and maintaining high-level support. Many opportunities for using NCA are also identified, including for the Sustainable Development Goals, Green Growth, Climate Change and the Independently Nationally Determined Contributions, and sector policies (e.g. water, energy, forests). The stock-take of experience to date has enabled the identification of 10 "living principles" to ensure that NCA is fit-for-policy. The principles are grouped under four headings – Comprehensive, Purposeful, Trustworthy and Mainstreamed – and can be tested and revised. The next steps are to work together to develop more thematic applications of NCA, especially to realize the opportunities identified, as well as to develop practical guidance documents.

Statistical systems role in monitoring of the ecological tax reform in Estonia, present state and way forward

Kaia Oras, Statistics Estonia

Document provides an insight into statistical system's efforts in measurement of the effectiveness of the implementation of ecological tax reform in Estonia, its present state and way forward. Implementation of ecological tax reform has started in Estonia more than a decade ago. But have environmental taxes really caused a shift towards more environmentally friendlier behaviour of consumers and producers and improved environmental-economic effectiveness in terms of resource use and environmental pollution? In addition to environmental effectiveness the Organisation for Economic Co-operation and Development brings out wider circle of important aspects to consider while monitoring the ecological tax reforms. OECD has suggested that open, transparent communication of all elements of the green fiscal reforms – including the use of revenues, distributional and competitiveness impacts, and how the governments intend to deal with them – are a key to successful implementation (OECD, 2011[16]). Estonian Ecological tax reform (2005[17]) stresses the need to monitor the maintenance of the neutrality of an overall taxes impact as well.

[16] Environmental Taxation A Guide for Policy Makers, OECD, 2011

[17] *Environmental tax reform base document. Estonian Ministry of Finance, 2005*

What could statistical system offer for the monitoring of these substantial aspects? Harmonized environmental and economic data hub in statistical system allows to carry out analyses relevant to ecological tax reform.

For the sake of effective environmental policy, it has been emphasized that it is important to have a feedback loop if the tax has been effective in reaching environmental goals eg reducing the tax base. In Estonia, e.g. country where the share of environmental taxes in GDP is already above the average EU level and the environmental pressure is rather high, environmental taxes account is a necessary instrument for tuning of the environmental taxes. The effects of taxes on a certain environmental pressures and resource use could be quite clearly observed on a detailed sectoral level in Estonia. If the effect of air pollution taxes on industrial air emissions seems to be almost missing than positive inhibiting effect of the electricity and fuel excise duties on the respective tax base (consumption of electricity and transport fuels) could be observed. Trends of the revenues of established taxes and respective changes in environmental pressures will be presented in document and presentation.

The evaluation of the sectoral competitiveness helps to answer the question if there is still space to increase the environmental taxes. The data provided by the environmental taxes account in combination with available data in national accounts allows for example to evaluate the effect on sectoral competitiveness, e.g. if the profits of the target sectors could be critically affected by higher taxes. Some sectors have relatively high environment tax burden (land transport, households) while others may favour lower taxes on resource use and pollution: in some sectors environmental taxes exceed the operating surplus in relative terms but in some others with high environmental impact the surplus could exceed the environmental charges they pay.

In addition, bringing into the same framework environmental taxes paid in one hand and environmental pressures in another hand allows to draw out equity aspect of environmental tax burden. Even simple comparisons like: relative sectorial distributions of the payments of excise duty on transport fuels and consumption of transport fuels by economic activities, shed light on the aspect of the equity of environmental taxes.

In order to evaluate if the environmental tax reforms implementation has followed the criteria of revenue neutrality (is there a “zero impact” on total tax burden?), the changes in burden of social contributions and environmental taxes in environmental taxes account on sectoral level will be looked at.

The use of the revenues raised from environmental taxes would be set alongside with the financing of the countries environmental protection (environmental expenditure account) in absolute terms in order to bring out the government’s effort in covering total environmental costs.

Way forward in order to design a sound framework for monitoring of the efficiency of environmental taxes and for the implementation of ecological tax reform in Estonia would be briefly touched upon.

Assessing Wealth and Ecosystem Service Impacts of Green Growth Strategies
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Overview
This paper develops a framework for estimating wealth and ecosystem service (ES) impacts and trade-offs of public policy and investment alternatives. We link the Integrated Economic-Environmental Modelling (IEEM) platform developed in Banerjee et al (2016 and 2017) with an ecosystem service model (ESM) to enable the estimation of impacts on economic indicators, wealth and ecosystem service supply. To illustrate the approach, the linked modelling framework is applied to analysis of Rwanda's Green Growth Strategy.

The Modelling Framework
IEEM advances previous economic-environmental modelling frameworks by: (i) integrating rich environmental data organized under the first international standard for environmental statistics, namely, the United Nations' System of Environmental-Economic Accounting (SEEA; European Commission et al., 2012); (ii) given the different dynamics of environmental resource-based economic sectors (e.g. the car manufacturing sector does not have the same structure of production nor face the same constraints and policy issues as the fisheries sector), IEEM contains environmental resource-specific modules to provide a customized and more appropriate treatment of environmental sectors than that found in conventional models; (iii) the indicators generated by IEEM go beyond standard measures of flows (e.g. Gross Domestic Product) to include more robust indicators that capture public policy and investment impacts on wealth (wealth being comprised of manufactured, human and natural capital; examples of indicators include genuine savings and the inclusive wealth index), and; (iv) IEEM contains a microsimulation module which enables estimation of poverty impacts which is particularly powerful when assessing the development impact of policies/investments is of concern (e.g. the Sustainable Development Goals).

In this study, IEEM is calibrated with Rwanda's 2011 National Accounts and Integrated Household Living Conditions data. The environmental modules of IEEM are calibrated with Rwanda's new land and water environmental accounts organized under the SEEA. These accounts were developed in 2017 and this study represents their first application to public policy analysis. While IEEM is designed to make use of the full suite of SEEA accounts, its modular structure enables those environmental modules that are not calibrated, to be switched off. Once data on other environmental resources becomes available (forestry, mining, fisheries, energy/emissions), IEEM can be calibrated with this data thus expanding the potential applications of the framework. The IEEM for Rwanda (IEEM-RWA) is a top-down multi-regional model of Rwanda's 5 regions and 5 types of Land Use and Land Cover (LULC), namely forest, annual crops, perennial crops, wetland and urban areas.

Ecosystem services are the benefits that nature provides which contribute to human well-being (Millenium Ecosystems Assessment, 2005, Costanza et al., 1997, Daily, 1997, TEEB, 2010). ES are classified as provisioning, regulating and cultural and aesthetic services; habitat services underpin all ES. Provisioning services include food, water and fiber; regulating services include flood mitigation and carbon sequestration, and; cultural and aesthetic services are those related to tourism, recreation and related benefits.

While an international standard is yet to be developed for ES accounting as has been developed in the case of environmental accounts (SEEA), guidance material (SEEA Experimental Ecosystem Accounting) has been prepared in efforts to ensure that ES accounts are compatible with the System of National Accounts (European Commission et al., 2013). Fortunately for economy-wide modelers, this compatibility also ensures that the data structures are compatible with the data used to calibrate computable general equilibrium models- and IEEM.

The ESM model, named 'InVEST', used in this study is comprised of 22 modules that may be used to estimate and map different ES on a site-specific, regional or national basis based on data availability1. Through a Science for Nature and People Partnership (SNAPP)2, ecosystem accounts were developed to quantify two regulating ES: carbon storage and sediment regulation, and; a provisioning ES, namely water provisioning. The ES supply of these services was estimated for Rwanda for the years 1990, 2000 and 2010 (Bagstad et al., 2017). The carbon, sediment retention and water provisioning ESMs were calibrated with various sources of mostly spatial data including precipitation, land cover, elevation, and soil erosion data layers. While the ESMs were calibrated based on historical data sets, new layer and parameter estimations could be used to estimate future ES supply given changes in a particular layer or parameter.

1 http://www.naturalcapitalproject.org/invest/

2 http://snappartnership.net/groups/natural-capital-accounting/

The main linkage between IEEM-RWA and ESM is through changes in LULC. Depending on the specific national or regional public policy or investment under consideration, a reconfiguration of LULC may occur. Where reconfiguration of LULC occurs, IEEM-RWA will generate results indicating the magnitude of these changes at the regional level. Based on these changes and through consultation with experts from relevant Rwandan governmental ministries including the Ministry of Natural Resources, the Ministry of Agriculture and the Ministry of Finance and Economic Planning, the areas where these changes within regions are most likely to occur will be delineated to produce a new LULC for a pre-specified temporal interval until 2050, the final year of analysis (in light of Rwanda's Vision 2050 planning horizon). The new LULC maps are then used as inputs to the ESM to generate projected changes in ES supply.

Simulations
Rwanda has made formidable advances in economic and human development in the last decade with a doubling of agricultural output since 2007 as well as more off-farm jobs to employ the rapidly growing population (2.8% growth per year) in the country with the highest population density in Africa (987 people/km2 for a total of 12 million). In light of this population pressure (an estimated 26 million people by 2050), an orderly urbanization process (urbanization rate of 4.4% per year) is imperative with a concomitant increase in agricultural output to ensure the nation's food security. Rwanda's dependence on rain-fed agriculture (80% of national employment, 35% of GDP) is its main vulnerability to climate change, while high soil fertility presents a significant advantage to the agricultural sector (Republic of Rwanda, 2011).

In addition to food security, energy is a key concern for Rwanda and its economy. With all of its oil-based products imported, Rwanda is highly vulnerable to changes in oil prices. Up to 39% of electricity is generated using diesel, while its entire transport sector is dependent on oil. That Rwanda is landlocked results in high import and export costs, again sensitive to changes in oil prices. Currently, hydropower provides 50% of its electricity and prospects are good for alternative clean sources such as geothermal, hydro, solar and methane gas deposits. Geothermal power generation is particularly promising with the potential for generating up to 700MW of geothermal power by 2020, exceeding domestic demand, if the appropriate investments are made. Geothermal power costs four times less to generate than diesel-generated power.

Given current challenges and opportunities, this study uses the linked IEEM-RWA and ESM framework to evaluate the economic, wealth and ES impacts of two main scenarios: (i) an intensification of agricultural development through investments in irrigation infrastructure, agroforestry and agro-ecological technologies for enhanced agricultural factor productivity, and; (ii) development of Rwanda's geothermal potential.

The scenarios are implemented in IEEM-RWA to determine economic and wealth impacts of the strategies and estimate any land reconfiguration that arises. Drawing on the data generated by IEEM-RWA, focus groups with Rwandan experts will be conducted to generate new LULC maps. The new LULC maps are then used as inputs to the ESM to estimate projected ES supply of carbon storage, sediment retention and water provisioning for each scenario. Results of this analysis will shed light on trade-offs that may exist with the proposed strategies and enable the analysis of alternative strategies and implementation schedules.

Future Directions
Currently, the IEEM-RWA and ESM linkage is a one way linkage where results from the IEEM-RWA are used to generate inputs for the ESM. An objective of future work with this framework is to create the possibility of two-way feedbacks, with the estimated changes in ES supply generated by the ESM serving as inputs back to IEEM-RWA. One example of a potential feedback between the ESM and IEEM-RWA

relates to the important hydropower sector in the case of Rwanda. Where a public policy or investment modelled with the framework is found to have important implications for sediment retention, this can have a direct impact on hydroelectric power generation. Increased costs where sedimentation retention worsens as a result of a policy could be introduced into IEEM-RWA as an environmental externality/feedback. Of course, the importance of these feedbacks depends on the specific question being addressed by the modelling exercise.

Another future direction for this line of research involves consideration of endogenous change in LULC. In the case of Rwanda, with its high population density and absence of an agricultural frontier, the working assumption in this study is that changes in LULC are planned and directed by Government. For example, the Green Growth Strategy line of action to create high density, walkable cities is not something likely to materialize endogenously, but rather would be instituted by the Government. Where population density is less and frontier areas exist, LULC change dynamics are likely to be less regulated/organized and in some instances, more predictable given a certain number of explanatory variables. One example is the agricultural frontier in the Brazilian Amazon where considerable modelling of LULC change has been undertaken. The presence or absence and proximity of certain features in the landscape have been used to make reasonable predictions about how LULC may evolve under certain futures scenarios. Future research with IEEM and ES modelling will explore how IEEM may be linked to ESM through a LULC model to enable a more automated workflow and endogenous change in LULC.