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Ecosystem accounting to inform decisions about forest management in the Central Highlands, Australia.

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The need for information to inform policy

This paper reports on the development and application of natural capital accounting (NCA) in the Central Highlands of Victoria, in south-eastern Australia. The accounts were developed over a 2-year period specifically to feed information into government decisions about forest use in an area close to Melbourne, the capital city of Victoria.

Current natural resource management in the Central Highlands of Victoria is contending with conflicts in land use activities, including timber production, biodiversity conservation, agricultural production, water supply, carbon sequestration and recreation. These activities are dependent on ecosystem assets and services, and their use can be either complementary or conflicting. The region is also home to a wide range of species, including the endemic and critically endangered Leadbeater's Possum and Helmeted Honeyeater, the two faunal emblems of Victoria, as well as the world's tallest flowering plant, a eucalypt called Mountain Ash. The area provides practically all the water for Melbourne, a city of 4.4 million people, making it the second biggest in Australia. Water is also supplied for irrigating crops in the surrounding farmland. The forests are some of the most carbon dense in the world and maintaining this stable and resilient store of carbon in a natural ecosystem is important for climate change mitigation. With its proximity to Melbourne, the region supports a large and growing tourism industry. There is a small timber industry that uses both wood supplied from native forests and plantations that produce paper pulp and sawlogs.

The region forms part of the Central Highlands Regional Forest Agreement that is due for re-negotiation by end of 2019. These agreements are made between state and national governments and legislate a 20-year plan for forest management that guarantees wood supply from defined areas. Proponents within the native timber industry have called for a guaranteed and expanded allocation of native forests for timber harvesting. By contrast, stakeholders within the environmental and tourism sectors have promoted an expansion of the national park network proposed as the Great Forest Reserve System to promote biodiversity conservation and eco-tourism. Negotiations of previous agreements have been protracted with controversial processes involving debates among public, industry, government and non-government organisations.

Managing the various activities within the region is complex and requires evaluation of the trade-offs between different land uses. Synthesising environmental and economic information in the form of ecosystem accounts provided a basis for quantitative comparisons in physical and/or monetary terms that enabled trade-offs to be defined explicitly and spatially.

Process of developing ecosystem accounts

The study was undertaken within an academic institution using multi-disciplinary expertise. Synthesising information in the form of accounts was based on long-term ecological research in the region and understanding of the ecosystem. The goal was to provide an information system that would improve decision making by quantifying the relative values of different ecosystem services, the contributions of industries to the economy, and the

potential trade-offs in changing land use activities. Goods and services that lie outside current economic systems were identified as unrecognised contributions of ecosystems to economic activity and human well-being. The researchers provide and communicate information in the accounts but are not part of the policy process.

The framework of ecosystem accounts enabled a large amount of ecological and spatial data to be organised so that decision makers could see the potential for trade-offs. Previous reports about the region were polarised about the relative importance of specific environmental or economic factors. Ecosystem accounting provided a framework to incorporate a range of ecosystem assets and services, so that the analysis became broader than the two opposing viewpoints and the costs and benefits of land uses could be compared explicitly.

The process of developing the accounts involved collation and analysis of data from long-term research sites; adaptation and calculations using existing ecological models to describe ecosystem assets and services both temporally and spatially; and investigation of publicly available environmental, productivity and financial data in reports and spatial data. Key factors in synthesizing these data from varied sources was good ecological knowledge of the ecosystem, co-ordination of inputs from a range of disciplines, and the principle of using the best available data in terms of the most recent and highest resolution with subsequent aggregation where necessary.

A draft set of accounts was presented for discussion (1). These were available on the web and presented at a workshop in Melbourne of key stakeholders and data providers in August 2016. The draft report was reviewed by national and international experts in accounting. Feedback from all these comments was incorporated in revisions of the accounts and their analysis. The updated and final accounts incorporated additional information on plantation forestry, new and corrected spatial data. The final set of accounts were published as a full report (2) and appendices (3) on the web, as well as a summary report (4) and factsheet (5)in June 2017. A scientific paper based on the accounts was published in September 2017 (6). Other forms of communication were also undertaken and are outlined below.

Outcomes from the accounts

Structuring information in the form of ecosystem accounts revealed the interactions between human activities and ecosystem assets, and their impacts on ecosystem extent and condition. We evaluated natural resource management issues within the region at three levels of the environmental-economic interaction:

1) values of ecosystem services, both currently valued but hidden in other information, and previously unrecognised;
2) values of economic output of industries that use ecosystem services as their contribution to industry value added (IVA) (with the sum of all IVA equal to GDP for the entire economy); and
3) potential gains and losses in IVA and ecosystem services involved with impacts on assets and trade-offs between land uses.

The key outcome was the capacity to quantify ecosystem services and their contribution to industries, and hence explicitly reveal the trade-offs made or required when use of services by different industries conflicted or resulted in a reduction in ecosystem extent or condition.

For the Central Highlands, ecosystem accounts can inform decision-making by:

1) identifying drivers of change in ecosystem extent and condition, including the changing balance of economic activities in the region, biodiversity loss, carbon emissions and reduction in carbon stocks, influence of climate change and variability on water supply, expansion of built-up land and infrastructure and fragmentation of habitats;
2) tracking progress towards policy targets, such as improving regional economic outlook or decreasing risks to threatened species and ecosystems;
3) assessing the sustainable use of natural resources, especially timber and water;
4) assessing the cost-effectiveness of expenditure on conservation of species or habitats;
5) enabling analysis of trade-offs between different land uses and scenario modelling.
6) Identifying goods and services that can be replaced easily while others cannot. Most of the timber from the native forest is used by a pulp and paper mill. Ready alternative products exist in the form of de-inked newsprint, recycled paper and plantation timber, so while ceasing native forest logging may increase costs of product supply, the production of paper can continue

The conclusions from the ecosystem accounts for the Central Highlands were that a transition away from harvesting of native forests would improve the condition of ecosystem assets and provision of ecosystem services for other activities, such as water supply, carbon storage, culture and recreation, and biodiversity conservation. The accounts demonstrated that solutions to conflicting land uses could be seen as a process of maximising benefits for the greatest number of beneficiaries.

Presenting information in the form of the accounts showed the relative economic contributions of key industries within the region, and the contributions of ecosystem services that were not recognised explicitly in economic data. Monetary values were not assigned to assets but the value of market goods was estimated and the contribution of ecosystem services was undertaken. The information in the accounts identified trade-offs between land uses. The trade-offs were considered in the following terms:

1) The economic gains from increased water supply and carbon storage exceeded the losses from ceasing native timber production. Entering the carbon market could replace the money from native timber harvesting if the right regulatory framework was established.
2) A judgement about whether conservation of biodiversity in the threatened ecosystem of the Mountain Ash forest and reducing the threat of extinction of the critically endangered Leadbeater's Possum is worth the loss of the AUD$12 million per annum from ceasing native forest timber harvesting.

Communication

Outputs and analysis from the accounts have been communicated widely to government policy makers, political leaders, community groups, business community, organisations implementing accounting, and the academic community. Providing information in a policy relevant form and timely manner were important to contribute effectively to the public and political negotiations about forest management in the region.

1. Report
    a) Publication of the full report and appendices on the web.
    b) Summary report and factsheet printed for distribution to stakeholders.

2. Publication in the scientific literature
    a) synthesis paper in Nature Ecology and Evolution
    b) papers on thematic accounts for carbon, water and biodiversity are in preparation and will be submitted to Environmental Science and Policy, Ecosystem Services and Biological Conservation
    c) methodological paper about carbon measurements will be submitted to Austral Ecology
    d) Papers about accounting processes were contributed to the London Group Meeting on Environmental Accounting including water accounts, ecosystem condition, methodologies and policy processes.

3. Publication in the popular literature and newsletters
    a) Science for Saving Species
    b) The Conversation, with an extensive on line discussion with more than 50 comments
    c) EnviroNews
    d) World Bank global partnership Wealth Accounting and the Valuation of Ecosystem Services (WAVES) website and newsletter

4. Media
    a) Interviews on national radio plus local radio in Canberra and Melbourne
    b) ANU media release
    c) Short videos about ecosystem accounting and the Central Highland region available on YouTube

5. Government engagement
    a) Results from the accounts were used by the Victorian government forest industry taskforce.
    b) Researchers met with the Victorian Minister for Environment. The Victorian government is negotiating potential changes to the Regional Forest Agreement, with considerations about changing government regulations, subsides, planning rules and industry support.
    c) Invited presentation at workshop on environmental-economic accounting by the Commonwealth Department of Environment and Energy. Melbourne.

d) Invited contribution to a Department of Environment and Energy document on the national strategy for environmental-economic accounting to be presented to the Meeting of Environment Ministers in December 2017.
e) Briefing to the Department of Environment and Energy sections on forest policy, threatened species conservation and environmental accounting.
f) Communication and response to the Assistant Minister for Agriculture and Water Resources about the Regional Forest Agreement.

6. Education

The research from the Central Highlands is being used for teaching at ANU:

a) ANU-ABS course Introduction to Environmental Accounting
b) Guest lecture to 3rd year course Complex Environmental Problems in Action

The synthesized information presented in the accounts and the links between environmental and economic values has produced greater traction in political considerations than previous conservation advocacy. The ultimate impact is not yet known, as political decisions have not yet been made, but the accounts are being influential in shaping discussions.

Lessons for ecosystem accounting development

Implementing the SEEA ecosystem accounts in the Central Highlands has identified conceptual issues, data gaps and topics that require further consideration, and these include:

1) Biophysical data are collected mostly at the site scale, but this must be scaled up to the landscape scale to be used in accounts. This is one of the most critical processes in implementing ecosystem accounting.
2) The experimental design for establishing monitoring systems and collecting site data is paramount so that the data can be scaled up successfully.
3) Site and spatial data need to be linked through relationships derived between site data and ecosystem characteristics that can be presented spatially, from remote sensing, survey, or ground-based classifications. The most relevant ecological processes that determine these relationships for different ecosystems need to be identified.
4) Ecological processes need to be defined in terms of functions over time, for example carbon accumulation, decomposition, mortality, reproduction, dispersal, and collapse of dead trees. These functions are used in deriving accounts of change over time in ecosystem assets.
5) Drivers of ecological change need to be identified and quantified, such as disturbance events and degradation processes. These drivers are important to understand the reasons for change in the past that are documented in the accounts, and to allow prediction of future changes.
6) Economic data is generally for large spatial areas not related to biophysical characteristics. Methodological development is needed to improve spatial attribution of

economic and social data to match environmental data. More detailed economic data that is region and industry specific would be valuable.

7) Selecting the boundary for a study area is complex because the many sources of data integrated in the accounts use different boundaries, such as natural resource management area, catchments, local government, statistical areas, ecosystem types and land use regions. No single boundary will accommodate all the different sources of data. Furthermore, social, geographical and policy considerations all play a role in the selection of appropriate boundaries. Thus, consideration should be given to the appropriate boundaries and how these may impact findings, particularly in terms of how the choice of study area can best address the policy questions that need to be answered.
8) The boundary between market and non-market contributions from ecosystem services is difficult to define in many cases, but decisions are needed to ensure boundaries are defined explicitly and classifications are compatible and mutually exclusive. An example is the ecosystem service of water provisioning as the inflow to reservoirs and the water supply as the outflow from reservoirs.

Assessment of study in light of the "10 living principles"

The study was initiated before the 10 living principles for making NCA fit-for-policy that emerged from the 1st Policy Forum were conceived. In reviewing the principles now, only a few months since the publication of the final accounts, a number of observations may be made (Table 1).

Table 1. Assessment of the Central Highlands NCA against the '10 Living Principles for making NCA fit-for-policy'.

Principles	**Observations from Central Highlands**
Comprehensive	
Inclusive – acknowledging the diverse stakeholders concerned with decisions affecting natural capital, responding to their information demands, respecting different notions of value, and using appropriate means of engagement	A draft report and workshop were the primary means used to engage stakeholders. Much of the engagement was technically focused. The polarized positions about forest management were revealed in the workshop as well as in online discussion forums.
Collaborative – linking the producers of NCA, the users of NCA for policy analysis, and the policy makers using the NCA results; and building their mutual understanding, trust and ability to work together	The production of the accounts involved a multi-disciplinary team primarily of data producers, although some with experience in the policy area. On-going work is aimed at strengthening the links with policy.
Holistic – adopting a comprehensive, multi/interdisciplinary approach to the economic and environmental dimensions of natural capital and to their complex links with policy and practice	

Purposeful	
Decision-centred – providing relevant and timely information for indicator development and policy analysis to improve and implement decisions with implications for natural capital Demand-led – providing information actually demanded or needed by decision-makers at specific levels	Relevant information was provided in time for consideration of the accounting information in the decision-making process targeted. Information was provided on the key industries (agriculture, forestry, water supply and tourism) within the region as well as key aspects of biodiversity.
Trustworthy	
Transparent and open – enabling and encouraging public access and use of NCA, with clear communication of the results and their interpretation including limitations of the data sources, methods and/or coverage Credible – compiling, assessing and streamlining data from all available sources; deploying objective and consistent science and methodologies	The draft and final accounts were published with extensive details of methodology and data sources. There was expert review of the accounts as well as a workshop to discuss the data sources and methodology. Comments received were incorporated into the final accounts. The journal article was published after a standard international peer-review process.
Mainstreamed	
Enduring – with adequate, predictable resourcing over time; continuous application and availability; and building increasingly rich time series of data Continuously improving – learning-focused, networked across practitioners and users, trialing new approaches, and evolving systems to better manage uncertainty, embracing innovation and taking advantage of emerging opportunities Embedded – NCA production and use becoming part of the 'machinery' of government and business, building capacity, improving institutional integration for SD and incorporating NCA use in procedures and decision-support mechanisms.	The accounts were produced within an academic institution and not by government. The data sources and methods used could be used to repeat the accounts for the area and some could be applied to other areas. The process of developing the accounts has been shared with both national and state government agencies and are feeding into the development of environmental accounting in Australia and internationally.

Future work

We are planning to apply the SEEA framework in an agri-environment landscape to assess the relative values of land management activities on farm productivity compared with water supply, carbon storage, soil conservation, and biodiversity conservation. This will provide information to policy makers in a complex landscape.

Based on practical accounting in regional studies and developing conceptual frameworks for accounting, we will be continuing contributions to the following issues:

1) biodiversity accounting, measurement, interpretation and recommendations for monitoring
2) aligning results from carbon accounts with the policy needs for emissions reduction targets and payments for abatement activities
3) developing the processes of linking accounting to government and business decision making.