Lessons from ecosystem accounts for forests in the Central Highlands, Australia

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Tall, wet temperate evergreen eucalypt forest
Central Highlands, Victoria, Australia
1. Policy issues:  
- contested forest management  
- conflicting uses of ecosystem services

Industries dependent on ecosystem services from the Central Highlands region

- Water supply
- Tourism
- Native timber
- Carbon sequestration
- Agricultural production
- Plantation timber

Ecosystem accounts demonstrated the trade-offs in physical and monetary terms, and this is influencing the decision-making process.
Challenges in the policy context for forests

1. Different land tenures: public, private, corporate

2. Multiple land uses: conservation, production, water supply, recreation, biodiversity

3. Market and non-market values eg timber vs biodiversity

4. Use of ecosystem services cross asset boundaries

5. Complex ecosystem: long-lived trees, influence of age structure on growth dynamics, stochastic disturbance events
2. Defining relevant spatial areas

Boundary of the ecosystem accounting unit:
- Catchments
- Forest ecosystem types
- Forest management areas
- Natural resource management areas
- Biogeographic regions
- Local government areas
- Statistical areas

Pragmatic boundary related to policy question

Basic statistical unit:
- Land cover as raster data
- Land use as polygon data

Conversion loses resolution
- Continuum of forest states eg primary and secondary forest, plantation

Difficult to classify and define boundaries

Resolutions of data sources:
- Biophysical data small-scale and spatially referenced
- Economic data highly aggregated to industries and sectors

Assumptions associated with changing scales
3. Types of ecosystem services

Provisioning:
- water
- fibre
- food
- energy source
- genetic diversity
- habitat

Regulating:
- water filtration
- air filtration
- pollination
- seed dispersal
- carbon storage
- carbon sequestration
- flood mitigation
- erosion control

Cultural:
- recreation
- education and research
- spiritual
4. Measuring ecosystem condition

Purpose:
1. To measure the state of the ecosystem in terms of its capacity to continue to provide services to people related to human use
2. To measure the state of the ecosystem in terms of its ability to function without reference to human use related to naturalness

Measurements:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation</td>
<td>Leaf area index, biomass, mean annual increment, structure</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>Species richness, relative abundance</td>
</tr>
<tr>
<td>Soil</td>
<td>Soil organic matter, nutrient availability, water holding capacity</td>
</tr>
<tr>
<td>Water</td>
<td>River flow, water quality</td>
</tr>
<tr>
<td>Carbon</td>
<td>Carbon stock, net carbon balance, primary productivity</td>
</tr>
<tr>
<td>Habitat</td>
<td>Fragmentation, key features</td>
</tr>
</tbody>
</table>

Challenges:
Differentiation of types of characteristics and indicators:
1. General composite indicators
2. Indicators specific for ecosystem types
3. Indicators specific to supply of ecosystem services
4. Limited indicators of overall ecosystem function
Examples of measuring ecosystem condition

Potential characteristics:
- Forest age
- Structural complexity
- Tree density
- Composition
- Canopy cover / leaf area
- Ground cover
- Fragmentation

Potential indicators:
- Age class eg old growth
- Endangered species
- Index of species richness
- Biomass / volume
- Presence of weeds, pests, diseases
- Size, distribution, edges of patches

Challenges:
- Different characteristics relate to services
- No all-encompassing indicators
- Indicators are specific to policy issues
- Dilemma of the general vs specific
5. Defining reference levels for condition

Reference levels defined in relation to:
1. Benefits to people
2. Reference to a natural state
3. Relative reference to a point in time

Distribution of ‘natural’ forest

Forest Cover
- Intact Forest Landscapes
- Current Forest
- Original Forest


[Kormos et al. 2017]
Distribution of primary forest patches in Europe

Demonstrates the possibility of a reference level of a ‘natural’ forest.

[Sabatini et al. 2018 Diversity and Distributions]
# Classification of forest states

<table>
<thead>
<tr>
<th>Stand origin</th>
<th>Natural forest</th>
<th>Man-made forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genesis</td>
<td>Self-sown forest</td>
<td>Planted forest</td>
</tr>
<tr>
<td>Tree species origin</td>
<td>Native forest</td>
<td>Exotic forest</td>
</tr>
<tr>
<td>Processes, structures</td>
<td>Primary forest</td>
<td>Secondary forest</td>
</tr>
<tr>
<td>Management</td>
<td>Conservation objectives</td>
<td>Multiple use objectives</td>
</tr>
<tr>
<td>Forestry activities</td>
<td>Minimum intervention</td>
<td>Production</td>
</tr>
</tbody>
</table>

- **Primary forest**
- **Secondary forest**
- **Exotic plantation**
Example: choice of reference level affects ecosystem account

A reference level for forest carbon stock of ‘harvest maturity’ of a secondary forest results in half the carbon stock of that in a primary forest, and so does not reveal the carbon sequestration potential of allowing secondary forest to continue growing.
Change in condition used in carbon accounting

Net – Net
Net emissions in each year of the commitment period minus the net emissions in 1990.

Activities: cropland, grazing, revegetation

Gross – Net
Net emissions in each year of the commitment period without comparing it with 1990.

Activities: af/ re/ de/ forestation

Reference level
Net emissions in each year of the commitment period minus the value of the reference level, eg natural disturbance regimes.

Activities: forest management
### 6. Valuation of ecosystem services

Methods used in the Central Highlands accounts

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
<th>Services</th>
</tr>
</thead>
</table>
| Unit resource rent   | Estimated as the market price less the unit costs of labour, intermediate inputs and produced capital | Services used in agricultural and plantation timber production  
Cultural and recreational services |
| Stumpage             | Value of timber sold, less harvesting and haulage costs                     | Native timber provisioning                                                |
| Replacement cost     | Based on the cost of replacing the ecosystem services from alternative sources | Water provisioning                                                       |
| Payment for services | Use of values from market-based systems set up to either minimize or offset negative environmental impacts or for the provision of particular services | Carbon sequestration                                                      |

**Challenges:**
- These methods are all exchange values
- But are they comparable when trade-offs are assessed?
- Not all ecosystem services can be valued by these methods.
Balancing trade-offs between land use activities

Ceasing native timber harvesting increases ecosystem services for:
- Carbon sequestration and water provisioning – calculated known gain
- Plantation timber provisioning and recreational services – estimate potential gain
- Biodiversity - undefined gain

Industry Contribution to the Economy 2013–2014 ($M)

- Native timber (12)
- Carbon sequestration (49)
- Water supply (310)
- Tourism (260)
- Plantations (30)
- Agriculture (312)

Current Total $973M

Current Total less Native Timber $961M
Plus Potential Gains $104M (scenario 3)
Potential Total $1,065M

Scenarios ($M gain per year)

<table>
<thead>
<tr>
<th>Known gains</th>
<th>Potential gains</th>
<th>Biodiversity gain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>13</td>
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<tr>
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<tr>
<td>6</td>
<td>12</td>
<td></td>
</tr>
</tbody>
</table>
7. Barriers to measurements in forests

1. Measuring cryptic creatures

2. General or composite indicators vs specific indicators

3. Identifying the production boundary to differentiate the ecosystem service from production, eg water flows

4. Differentiating ecosystem services conceptually and physically, eg carbon sequestration – reducing atmospheric CO$_2$ conc. carbon storage – avoiding loss due to human activities

5. Scaling up site and biophysical data to landscapes
   - resolution and consistent time series of remote sensing data
   - changes in methods and technologies over time
   - ecological relationships between site and spatial data

6. Disaggregating economic data to spatial areas and land use activities.
Ecosystem accounts define explicit and spatial trade-offs for managing natural resources.