Services Generation Account
(Levels 0, 1 and 2)

Project: Advancing the SEEA
Experimental Ecosystem Accounting
Overview: Services Generation

1. Learning objectives
2. Review of Level 0 (5m)
   • What is it?
   • Why do we need it?
   • What does it look like?
   • Expertise & data required
   • Links to related training materials
3. Level 1 (Compilers)
   • Concepts (15m)
   • Group exercise & Discussion (30m)
4. Level 2 (Data providers)
   • Data options, examples & issues (15m)
   • Group exercise & Discussion (15m)
5. Closing Discussion (10m)
SEEA-EEA Training Levels 1 and 2

• Learning objectives
  • Level 1: To understand:
    • Why accounting for Ecosystem Services is important
    • The basics of the “ecosystem services cascade” and the difference between its components
    • How Services Generation is treated in the SEEA, including basic concepts and the structure of the accounts that include services
    • How to start to build a Services Generation account
  • Level 2
    • Understand the data options and sources
    • Be aware of how other countries have approached Ecosystem Services Generation
Account 6: Services Generation
Level 0: Account 6: Services Generation

• **What?**
  • Physical and monetary flows of “final” ecosystem services from ecosystems to beneficiaries
  • Directly used by (or affect) people

• **Why?**
  • Inform policies of contribution of ecosystems to human well-being
  • Assess trade-offs between development and conservation
  • Links to standard economic production measures in SNA
  • Links to other SEEA-EEA accounts (*Condition, Supply and Use*) and tools (*Valuation*)
  • Indicators:
    • Flows of individual services (physical and monetary) ➔ change
    • Indices of aggregated services by ecosystem type ➔ change
Level 0: Account 6: Services Generation

- What does a Services Generation Account look like?
  - Spatially-detailed physical measures of "final" services according to common classification:
    - Provisioning
    - Regulating
    - Cultural
  - Physical measures (crops, flood control, clean drinking water, carbon sequestration, recreation, …)
  - Monetary measures where appropriate and available

→ Ecosystem Services Supply Account
Level 1: Account 6: Services Generation

- The Ecosystem Services Cascade

Source: Nottingham School of Geography
Ecosystem services (versus benefit)
Types of Ecosystem Services

Provisioning Services
- goods that can be harvested from, or extracted from ecosystems
- Example: providing fish for fisheries, or providing wood for timber harvest

Regulating Services
- the regulation of climate, hydrological, ecological and soil processes
- Example: pollination, carbon sequestration, flood control

Cultural Services
- the non-material benefits provided by ecosystems
- Example: recreation, tourism, providing a setting for cultural or religious practices
Level 0: Account 6: Services Generation

- What does a Services Generation Account look like?

Maps

- Land cover
- Cultural
- Regulating
- Provisioning

Tables

<table>
<thead>
<tr>
<th>Ecosystem type</th>
<th>Type of service</th>
<th>Urban and associated</th>
<th>Forest tree cover</th>
<th>Agricultural land</th>
<th>Open wetlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td></td>
<td></td>
<td>e.g., tonnes of</td>
<td>e.g., tonnes of</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>timber</td>
<td>wheat</td>
<td></td>
</tr>
<tr>
<td>Regulating</td>
<td></td>
<td>e.g., tonnes of</td>
<td>e.g., tonnes of</td>
<td>e.g., tonnes of</td>
<td>e.g., tonnes of</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CO₂ stored / released</td>
<td>CO₂ stored /</td>
<td>CO₂ stored /</td>
<td>CO₂ absorbed</td>
</tr>
<tr>
<td>Cultural</td>
<td></td>
<td>e.g., hectares of</td>
<td>e.g., number of</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>parkland</td>
<td>visitors / hikers</td>
<td></td>
<td>e.g., hectares</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>of duck habitat</td>
</tr>
</tbody>
</table>

Lookup tables
Biophysical modelling
## Level 0: Account 6: Services Generation

### Example (services in physical units)

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Units</th>
<th>Land cover type</th>
<th>Provincial total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hunting</td>
<td>kg meat</td>
<td>Urban</td>
<td>Provincial total</td>
</tr>
<tr>
<td>Drinking water extraction</td>
<td>$10^3$ m$^3$ water</td>
<td>4,071</td>
<td>626</td>
</tr>
<tr>
<td>Crop production</td>
<td>$10^6$ kg produce</td>
<td>-</td>
<td>1,868</td>
</tr>
<tr>
<td>Fodder production</td>
<td>$10^6$ kg dry matter</td>
<td>533</td>
<td>784</td>
</tr>
<tr>
<td>Air quality regulation</td>
<td>$10^3$ kg PM$_{10}$</td>
<td>272</td>
<td>8,019</td>
</tr>
<tr>
<td>Carbon sequestration</td>
<td>$10^6$ kg carbon</td>
<td>875</td>
<td>273</td>
</tr>
<tr>
<td>Recreational cycling</td>
<td>$10^3$ trips</td>
<td>2,690</td>
<td>2,611</td>
</tr>
</tbody>
</table>

*Source: Remme et al., 2014 (Limburg, the Netherlands)*
Level 0: Account 6: Services Generation

• What is needed to create a Services Generation Account?
  • Ecosystem Asset (Extent, ha) Account, Ecosystem Condition Account
  • Common spatial infrastructure (spatial units)
  • Common classification of services
• Data:
  • Field studies
  • Transfer from other locations (benefits transfer, valuation)
  • Economic production (agriculture, forestry, fisheries, water)
  • Modelling – biophysical, condition, etc
• Expertise: ecologists, geographers (GIS), economists, policy analysts, statisticians
Level 1: Account 6: Services Generation

- Why Services Generation Accounts?
- Ecosystems provide services that are essential to the economy and human activities:
  - Food supply
  - Clean water/air
  - Flood protection
  - Carbon sequestration
  - Recreation, cultural and religious importance

- Ecosystems are being converted and degraded
  - Which ones are most important to conserve?
  - How can they best be managed to maintain services?
  - Link with national planning and accounting to ensure ecosystems are included in decisions
Ecosystem services and maps

- Forest
  - Wood production
  - Hydrological function
  - Carbon sequestration

- Intensive cropland
  - Carbon sequestration

- Extensive pasture
  - Livestock production
  - Carbon sequestration

- Recreation and tourism
Level 1: Account 6: Services Generation

- The SEEA-EEA focuses on “final services”
  - The point **before** human involvement transforms the services to benefits
    - e.g., biomass → harvesting; fish → capture…
  - Ecosystem processes and functions are **not** services
    - e.g., reproduction, predation, food web, nutrient cycle…
  - **Biodiversity** itself is not a “final” service
    - It is an aspect of Ecosystem Condition and is recorded in the Biodiversity Account.
Level 1: Account 6: Services Generation

- **How?**
  - Direct measure (e.g., socio-economic survey on recreational use, field survey of available fish...)
  - Level 0 – Biophysical modelling
    - **Lookup tables:** Take values from another location
    - **Statistical approaches:** Estimate based on known explanatory variables
    - **Geostatistical interpolation:** Estimate from nearby known locations
    - **Process-based modelling:** Use models of processes (e.g., land cover change, demand for services...)

- The group exercise will use only **Lookup Tables**...
Level 1: Account 6: Services Generation

- Compilation Group Exercise (30m)
  - Situation:
    - **Know** total services for some LCEUs
    - **Need to** calculate:
      - Missing services for based on known data and lookup table

- Objective (Groups of 3-5):
  1. Calculate missing services
  2. Calculate totals
  3. Report and discuss results
Level 1: Account 6: Services Generation

Group Exercise: Step 1 – Calculate unknown services

e.g., Crop for LCEU04 = \( \frac{18,700}{500} \) = 37.4 \(/\)LCEU01
37.4 \* 281.3 = ??

e.g., Carbon for LCEU04 = (500 \* 20)

<table>
<thead>
<tr>
<th>LCEU</th>
<th>Extent (ha)</th>
<th>(C) Crop</th>
<th>(F) Recreation</th>
<th>(W) Water</th>
<th>(S) Carbon Sequestration</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCEU01 = Rainfed herbaceous cropland</td>
<td>500.0</td>
<td>18,700.0</td>
<td>500.0</td>
<td>600.0</td>
<td>20</td>
</tr>
<tr>
<td>LCEU02 = Forest tree cover</td>
<td>262.5</td>
<td>0.0</td>
<td>1,500.0</td>
<td>500.0</td>
<td>30</td>
</tr>
<tr>
<td>LCEU03 = Inland water bodies</td>
<td>68.8</td>
<td>0.0</td>
<td>1,600.0</td>
<td>15,000.0</td>
<td>5</td>
</tr>
<tr>
<td>LCEU04 = Rainfed herbaceous cropland</td>
<td>281.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCEU05 = Forest tree cover</td>
<td>75.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCEU06 = Urban and associated developed</td>
<td>56.3</td>
<td>0.0</td>
<td>500.0</td>
<td>500.0</td>
<td>0</td>
</tr>
<tr>
<td>LCEU07 = Urban and associated developed</td>
<td>68.8</td>
<td>0.0</td>
<td>700.0</td>
<td>400.0</td>
<td>0</td>
</tr>
<tr>
<td>LCEU08 = Open wetlands</td>
<td>37.5</td>
<td>700.0</td>
<td>5,000.0</td>
<td>10,000.0</td>
<td>40</td>
</tr>
<tr>
<td>LCEU09 = Inland water bodies</td>
<td>50.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCEU10 = Forest tree cover</td>
<td>225.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LCEU11 = Rainfed herbaceous cropland</td>
<td>175.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,800.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Level 1: Account 6: Services Generation

- Is everyone clear on the objectives?
- 30 minutes group work
- Please ask questions!

Results:
- Each group report:
  - Totals for each service
  - Which LCEU generates the most of each service?
  - Were there any surprises?
System of Environmental-Economic Accounting

Level 1: Account 6: Services Generation

- The answers:
  - LCEU01 generates the most services for Crop and Carbon Sequestration.
  - LCEU03 generates the most services for Water.
  - LCEU08 generates the most services for Recreation.

<table>
<thead>
<tr>
<th>Services Generation Database</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCEU</td>
</tr>
<tr>
<td>LCEU01 = Rainfed herbaceous cropland</td>
</tr>
<tr>
<td>LCEU02 = Forest tree cover</td>
</tr>
<tr>
<td>LCEU03 = Inland water bodies</td>
</tr>
<tr>
<td>LCEU04 = Rainfed herbaceous cropland</td>
</tr>
<tr>
<td>LCEU05 = Forest tree cover</td>
</tr>
<tr>
<td>LCEU06 = Urban and associated developed</td>
</tr>
<tr>
<td>LCEU07 = Urban and associated developed</td>
</tr>
<tr>
<td>LCEU08 = Open wetlands</td>
</tr>
<tr>
<td>LCEU09 = Inland water bodies</td>
</tr>
<tr>
<td>LCEU10 = Forest tree cover</td>
</tr>
<tr>
<td>LCEU11 = Rainfed herbaceous cropland</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>
Level 2: Account 6: Services Generation

- Learning objectives (Level 2)
  - Understand the data options and sources
  - Be aware of how other countries have approached Services Generation Accounting
Level 2: Account 6: Services Generation

- A full Services Generation Account is more complex than the exercise:
  - More services (48 “final” services in SEEA EEA - CICES)
  - More types of data (tonnes, risks, visitors, air quality, cultural significance…)
  - Less measured data → need models to estimate
  - High variability among ecosystem types and region

- **Do not** need to include all services:
  - High priority services → measure or estimate
  - Get started with available data
  - Respond to policy needs
Ecosystem services in an account

- Ecosystem service account developed for Limburg Province, the Netherlands
- 2200 km², 1.1 million inhabitants
- Analysis of 7 ecosystem services

Source: Remme et al., 2014
### Example (services in physical units)

<table>
<thead>
<tr>
<th>Ecosystem service</th>
<th>Units</th>
<th>Urban</th>
<th>Pasture</th>
<th>Cropland</th>
<th>Forest</th>
<th>Heath</th>
<th>Peat</th>
<th>Water</th>
<th>Other nature</th>
<th>Provincial total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hunting</td>
<td>kg meat</td>
<td>-</td>
<td>9,100</td>
<td>14,732</td>
<td>8,100</td>
<td>678</td>
<td>70</td>
<td></td>
<td>1,513</td>
<td>34,193</td>
</tr>
<tr>
<td>Drinking water extraction</td>
<td>$10^3$ m³ water</td>
<td>4,071</td>
<td>7,026</td>
<td>11,227</td>
<td>3,117</td>
<td>214</td>
<td>-</td>
<td>478</td>
<td>862</td>
<td>26,995</td>
</tr>
<tr>
<td>Crop production</td>
<td>$10^6$ kg produce</td>
<td>-</td>
<td>-</td>
<td>1,868</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1,868</td>
</tr>
<tr>
<td>Fodder production</td>
<td>$10^6$ kg dry matter</td>
<td>533</td>
<td>251</td>
<td>784</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>784</td>
</tr>
<tr>
<td>Regulation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air quality regulation</td>
<td>$10^3$ kg PM$_{10}$</td>
<td>272</td>
<td>404</td>
<td>717</td>
<td>700</td>
<td>45</td>
<td>7</td>
<td>40</td>
<td>69</td>
<td>2,254</td>
</tr>
<tr>
<td>Carbon sequestration</td>
<td>$10^6$ kg carbon</td>
<td>875</td>
<td>8,019</td>
<td>273</td>
<td>50,664</td>
<td>393</td>
<td>149</td>
<td>-</td>
<td>1,056</td>
<td>61,429</td>
</tr>
<tr>
<td>Cultural</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recreational cycling</td>
<td>$10^3$ trips</td>
<td>2,690</td>
<td>1,863</td>
<td>2,611</td>
<td>1,565</td>
<td>30</td>
<td>3</td>
<td>139</td>
<td>220</td>
<td>9,121</td>
</tr>
</tbody>
</table>

**Note:** Units are very different

**Source:** Remme et al., 2014 (Limburg, the Netherlands)
Level 2: Account 6: Services Generation

- Data options and sources
  - Field studies
    - Literature on similar sites or specific research
  - Transfer from other locations (benefits transfer, valuation)
    - Ecosystem valuation research databases (e.g., www.evri.ca)
  - Economic production (agriculture, forestry, fisheries, water)
    - Socio-economic statistics already available with spatial detail
  - Biophysical modelling
    - Know conditions, can estimate some services using production functions (e.g., hydrography → flood control)
Canada Example:

Water purification potential
and change by drainage area for boreal wetlands
Index based on:
- % forest cover
- % agricultural land
- % riparian forest
- % wetlands
- % anthropogenic disturbance
- % burn area
- Edge & linear density (fragmentation)
- Human footprint
- Slope
- Nitrogen & Sulphur exceedance (from atmospheric deposition)

Source: Statistics Canada, 2013
Level 2: Account 6: Services Generation

Canada example

Net biomass extraction for human use

Includes:
- Agricultural crops
- Livestock and poultry
- Milk
- Maple products and honey
- Forestry
- Fisheries (inland and marine)

Source: Statistics Canada, 2013
Level 2: Account 6: Services Generation

Canada example

Weight of commercial fish landings by marine statistical area

Includes:
- Ground fish
- Pelagic fish
- Shellfish

Statistical area defined by Ministry of Fisheries and Oceans

Source: Statistics Canada, 2013
Level 2: Account 6: Services Generation

- Services flow data commonly available

<table>
<thead>
<tr>
<th>Service</th>
<th>Flow measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provisioning services</td>
<td></td>
</tr>
<tr>
<td>Timber services</td>
<td>timber increment</td>
</tr>
<tr>
<td>Crops</td>
<td>crop production</td>
</tr>
<tr>
<td>Livestock</td>
<td>livestock production</td>
</tr>
<tr>
<td>Water provision</td>
<td>annual freshwater supply</td>
</tr>
<tr>
<td>Regulating services</td>
<td></td>
</tr>
<tr>
<td>Water quantity regulation</td>
<td>total amount of water stored</td>
</tr>
<tr>
<td></td>
<td>total amounts of pollutants removed annually</td>
</tr>
<tr>
<td>Climate regulation</td>
<td>annual carbon fixation</td>
</tr>
<tr>
<td>Storm protection</td>
<td>total number of storms mitigated</td>
</tr>
<tr>
<td>Air quality regulation</td>
<td>total amount of pollutants removed via dry deposition on leaves</td>
</tr>
<tr>
<td>Erosion control</td>
<td>total amount of soil retained</td>
</tr>
<tr>
<td>Pollination</td>
<td>increased yield of crops due to pollination</td>
</tr>
<tr>
<td>Soil quality regulation</td>
<td>increased yield of crops attributable to soil quality</td>
</tr>
<tr>
<td>Cultural services</td>
<td></td>
</tr>
<tr>
<td>Recreation</td>
<td>number of visitors</td>
</tr>
</tbody>
</table>

Source: (Maes, Paracchini et al. 2011)
Level 2: Account 6: Services Generation

- **Data sources**
  - Agricultural statistics: crop, livestock production
  - Energy statistics: biomass for fuel
  - Fisheries statistics: catch, stock
  - Forestry statistics: timber stock, harvest
  - Park surveys: visitors, use
  - Water statistics: withdrawals, consumption
  - Natural disasters: incidence of floods, erosion, storms
  - Soil inventories: erosion potential
  - Health statistics: regulation of biotic environment

- Are these spatially-detailed national data?
- Do we know the methods and classifications?
Level 2: Account 6: Services Generation

- Data sources: Ecosystem valuation databases
  - Based on codifying scientific studies
  - Include data for many countries, ecosystem type, physical services measures
    - Environmental Valuation Reference Inventory (www.evri.ca)
    - TEEB Ecosystem Service Valuation Database (ESVD)
    - Gulf of Mexico Ecosystem Services Valuation Database (www.gecoserv.org)
  
  - Need to understand location, definitions and methods used
Level 2: Account 6: Services Generation

- Data sources: Specific studies & models
  - These may not be included in databases
  - Specific studies:
    - National or regional ecosystem assessments (Millennium Ecosystem Assessment, UK National Ecosystem Assessment)
    - Small-area studies (e.g., one park, one region)
    - TEEB studies and country studies (multiple ecosystems and services)
  - Decision-support models
    - There are landscape-scale and site-scale models that can help estimate service flows (AIRES, InVEST, LUCI...)
    - See Biophysical Modelling
Level 2: Account 6: Services Generation

- **Data sources: Special surveys and case studies**
  - High-priority data gaps may also be addressed by collecting new data
    - Ecological field studies to determine “production functions”
    - Socio-economic surveys to determine use of services (e.g., water, food, recreation)
    - Case-studies for specific locations or social groups (e.g., dependence on nature of low-income residents)
  - Possible to add questions to existing surveys, for example,
    - Households use of water, source of food, incidence of hazards (flooding, erosion, drought, disease), source of biomass for fuel
Level 2: Account 6: Services Generation

- Group exercise (15m) (Groups of 3-5)

1. In your country, what are three important *ecosystem services* that should be included in a Services Generation Account?
2. Which land cover types generate them?
3. What *national data* are available in your country on the generation of these services?
4. Report your results
Level 2: Account 6: Services Generation

- Concepts Group exercise (15m)

- Group reports
  - The ecosystem services you selected
  - The main land cover types for each
  - Are national data available in your country on the generation of these services?

- Discussion
  - What other ecosystem services would be important to measure?
  - On what topic might a special survey be used to fill priority data gaps?
Level 2: Account 6: Services Generation

- Discussion and questions
- Take home points
  - Services Generation in biophysical terms is one of the most important aspects of Ecosystem Accounting
  - Data on Services Generation are available from many sources
  - There are some simple methods available to start to integrate these data
  - Start by focussing on available data and priority services
Level 2: Account 4: Carbon

- Further Information
  - SEEA Experimental Ecosystem Accounting (2012)
  - SEEA-EEA Technical Guidance (forthcoming)
    - Detailed supporting documents
    - “Linking Flow and Asset Accounts” and
    - “Biophysical Modelling” by Lars Hein
References

- CICES, 2013. www.cices.eu
Evaluation of the training module

- Please complete the evaluation form for this module
- For this module
  - What did you learn that you could apply in your work?
  - Was the presentation clear and informative?
  - Was it too simple? Too complex?
  - Was there anything you did not understand?
  - What additions or deletions would you suggest (recognizing that the unit is intended for a general audience)?
  - Do you have any suggestions as to how the SEEA-EEA may be improved (concepts, principles) in this area?
Acknowledgements

- This project is a collaboration of The United Nations Statistics Division, United Nations Environment Programme and the Secretariat of the Convention on Biological Diversity and is supported by the Government of Norway.