Condition Account
(Levels 0, 1 and 2)

Project: Advancing the SEEA
Experimental Ecosystem Accounting
Overview: The Condition Account

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:
    • Understand the basic concepts of The Condition Account
    • Learn the steps of compiling a Condition Account
  • Level 2
    • Understand the data options and sources
    • Understand the important conceptual issues
    • Be aware of how other countries have approached measuring Condition
Account 2: Condition

SEEA-EEA accounts and linkages

Physical Accounts (by spatial unit):
- Ecosystem Extent Account
- Ecosystem Condition Account
- Ecosystem Services Generation Account
- Ecosystem Services Use Account
- Ecosystem Capacity Account

Ecosystem component accounts: Land, Carbon, Water, Biodiversity

Supporting information: Socio-economic conditions and activities, ecological production functions
Tools: classifications, spatial units, scaling, aggregation, biophysical modelling

Monetary Accounts (by spatial unit):
- Ecosystem Services Supply Account
- Ecosystem Asset Account
- Augmented I-O Table
- Integrated Sector Accounts and Balance Sheets

Supporting information: SNA accounts, I-O tables
Tools: Valuation techniques
Level 0: Account 2: Condition

• What?
  • *Ecosystem condition reflects the overall quality of an ecosystem asset, in terms of its characteristics.* (SEEA EEA paragraph 2.34)

• Why?
  • Policies to limit degradation of natural heritage, rehabilitation of degraded ecosystems
  • Links to *capacity* to produce services (*Services Generation*)
  • Indicators:
    • Indices of condition ➔ change over time ➔ where changes
    • Good/bad condition (exceeding “safe” levels) ➔ where
Level 0: Account 2: Condition

- What does a Condition Account look like?

Maps
- Carbon
- Water
- Soil
- Biodiversity
- Vegetation

Tables

<table>
<thead>
<tr>
<th>Ecosystem type</th>
<th>Ecosystem extent (ha)</th>
<th>Vegetation biomass (tonnes)</th>
<th>Biodiversity Index</th>
<th>Soil Organic matter</th>
<th>Water Quality Index</th>
<th>Carbon Balance</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban and associated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed herbaceous</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Forest tree cover</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland water bodies</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Open wetlands</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Scaling & aggregation
Level 0: Account 2: Condition

What does a Condition Account look like?

- Spatially-detailed condition measures (quality or biophysical) for each characteristic:
  - Vegetation
  - Biodiversity (species abundance, diversity indices)
  - Soil
  - Water
  - Carbon
  - Air
  - Overall measures (e.g., heterogeneity)

- **Selected** to reflect an area’s capacity to generate services
- Summarized in terms of an **index**
- Accounts for changes over time (accounting period)
- Attributes changes to **drivers** (natural and human)
Level 0: Account 2: Condition

What do you need to compile a Condition Account?

- Ecosystem Extent Account
- Common spatial database (spatial units)
- Data:
  - Condition measures from satellite imagery and field studies over two periods of time
  - Environmental monitoring data (water, air, soil, species)
- Expertise:
  - Ecologists (vegetation, soil, water)
  - Statisticians (methodologists to create indices, scaling, aggregation),
  - Environmental policy analysts (focus on relevant indices)
  - Geographers (GIS, remote sensing, integration)
Level 1: Account 2: Condition

• Concepts
  • Quality and other biophysical measures
  • Reference state
  • Creating indices
Level 1: Account 2: Condition

- Quality and other biophysical measures
  - Data are limited:
    - Select most and important and reliable condition measures
    - That link most directly to the services you are analysing
  - Examples:
    - Water quality measures \(\rightarrow\) water quality index
    - Air quality measures \(\rightarrow\) air quality index
    - Species ranges \(\rightarrow\) biodiversity index
    - Vegetation, soil types \(\rightarrow\) carbon balance
  - “Other biophysical measures” needed to interpret quality data
    - Stream flow rates \(\rightarrow\) capacity to purify water & control floods
    - Slope \(\rightarrow\) capacity for control erosion
Level 1: Account 2: Condition

• Reference state
  • Aggregates could be “arbitrary”
    • For example, average of water quality measures
  • Or, indexed to a “reference state”
    • For example, compare with “quality standard” for use (drinking, recreation, livestock, wildlife, irrigation…)
    • Can compare with past or “ideal” reference condition:
      • Pristine or Pre-development state,
      • Sustainable state (theoretical)
      • Earliest available information
  • Choice of reference state can affect interpretation
    • e.g., Are we experiencing short-term fluctuations or a long-term trend?
Level 1: Account 2: Condition

• Creating indices
  • “Up” may be better or worse
    • e.g., if pollutants increase this is usually worse
    • e.g., if biodiversity increases, this is usually better
  • “Up” or “Down” from ideal may be worse
    • e.g., pH of drinking water should be neutral
    • e.g., species may have an “optimal” abundance

• Is there a need for weighting?
  • One measure may be more important than another

• Is there a need for scaling?
  • One measure may represent a larger area
Level 1: Account 2: Condition

- Compilation Group Exercise (30m)
  - Situation:
    - LCEUs defined in Spatial Units
    - Added environmental quality data (indices scaled 1-10)
    - “Reference state” is Opening Conditions
  - Objective (Groups of 3-5):
    1. Record quality data in appropriate cells in Condition Table
    2. Using formulas provided, calculate an unweighted index for each forested LCEU
       – For the Opening Conditions
    3. Calculate a summary for each indicator for Forest Tree Cover
    4. Calculate and allocate changes to improvements or reductions in condition
    5. Report your results
Level 1: Account 2: Condition

Group Exercise: Step 1 – Transfer data for Forest LCEUs

Opening Conditions

Condition table

<table>
<thead>
<tr>
<th>LCEU Type</th>
<th>Extent (BSU)</th>
<th>Vegetation</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban and associated</td>
<td>20</td>
<td>2.00</td>
<td>1.45</td>
<td>3.45</td>
<td>2.30</td>
</tr>
<tr>
<td>Rainfed herbaceous cropland</td>
<td>153</td>
<td>3.52</td>
<td>2.52</td>
<td>4.34</td>
<td>3.46</td>
</tr>
<tr>
<td>Forest tree cover</td>
<td>90</td>
<td>4.16</td>
<td>4.74</td>
<td>5.16</td>
<td>4.68</td>
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<tr>
<td>Inland water bodies</td>
<td>19</td>
<td>4.16</td>
<td>4.74</td>
<td>5.16</td>
<td>4.68</td>
</tr>
<tr>
<td>Open wetlands</td>
<td>6</td>
<td>5.00</td>
<td>7.00</td>
<td>5.00</td>
<td>5.67</td>
</tr>
<tr>
<td>Total</td>
<td>288</td>
<td>4.01</td>
<td>3.96</td>
<td>4.57</td>
<td>4.18</td>
</tr>
</tbody>
</table>
**Level 1: Account 2: Condition**

Group Exercise: Step 2 – Calculate indices for each LCEU

### Condition table

<table>
<thead>
<tr>
<th>LCEU Type</th>
<th>Extent (BSU)</th>
<th>Vegetation</th>
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<th>Index</th>
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<tr>
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<tr>
<td>Open wetlands</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Calculate index:**

\[ I = \frac{(V+B+W)}{3} \]

**Prorate by area**
- Multiply data value in each area by number of BSU
- Sum the results
- Divide by total area
Level 1: Account 2: Condition

Group Exercise: Step 2 – Prorate area for each LCEU

Condition table

<table>
<thead>
<tr>
<th>LCEU Type</th>
<th>Extent (BSU)</th>
<th>(V) Vegetation</th>
<th>(B) Biodiversity</th>
<th>(W) Water</th>
<th>BSU</th>
<th>V</th>
<th>BSU</th>
<th>V</th>
<th>BSU</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfed herbaceous cropland</td>
<td>80</td>
<td>4.00</td>
<td>3.00</td>
<td>5.00</td>
<td>4.00</td>
<td>4</td>
<td>320</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest tree cover</td>
<td>42</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Inland water bodies</td>
<td>11</td>
<td>5.00</td>
<td>6.00</td>
<td>6.00</td>
<td>5.67</td>
<td>3</td>
<td>135</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rainfed herbaceous cropland</td>
<td>45</td>
<td>3.00</td>
<td>2.00</td>
<td>4.00</td>
<td>3.00</td>
<td>3</td>
<td>84</td>
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<td></td>
<td></td>
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<tr>
<td>Forest tree cover</td>
<td>12</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Urban and associated developed</td>
<td>9</td>
<td>2.00</td>
<td>2.00</td>
<td>4.00</td>
<td>2.67</td>
<td>3</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban and associated developed</td>
<td>11</td>
<td>2.00</td>
<td>1.00</td>
<td>3.00</td>
<td>2.00</td>
<td>3</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open wetlands</td>
<td>6</td>
<td>5.00</td>
<td>7.00</td>
<td>5.00</td>
<td>5.67</td>
<td>3</td>
<td>135</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inland water bodies</td>
<td>8</td>
<td>3.00</td>
<td>3.00</td>
<td>4.00</td>
<td>3.33</td>
<td>3</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest tree cover</td>
<td>36</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed herbaceous cropland</td>
<td>28</td>
<td>3.00</td>
<td>2.00</td>
<td>3.00</td>
<td>2.67</td>
<td>3</td>
<td>84</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>288</td>
<td>4.01</td>
<td>3.96</td>
<td>4.57</td>
<td>4.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BSU V
80 * 4 = 320
45 * 3 = 135
28 * 3 = 84
153 Total 539
539/153 = 3.52

Prorate by area
Level 1: Account 2: Condition

Group Exercise: Step 3 – Finalize Condition Account

Condition Table (Opening Conditions)

Condition Table (Closing Conditions - Provided)

Condition Account

<table>
<thead>
<tr>
<th>Condition Account</th>
<th>Extent (BSU)</th>
<th>Vegetation</th>
<th>Biodiversity</th>
<th>Water</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening Conditions</td>
<td>288</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvements in condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reductions in condition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Closing Conditions</td>
<td>288</td>
<td>3.99</td>
<td>4.03</td>
<td>5.32</td>
<td>4.45</td>
</tr>
</tbody>
</table>

Calculate and allocate changes
(Closing – Opening) + → improvement
- → reduction
Level 1: Account 2: Condition

- Is everyone clear on the objectives?
- 30 minutes group work
- Please ask questions
- Results:
  - Each group report:
    - Forest Tree Cover Index result
  - Has condition been improved or reduced?
  - For which components?
Level 2: Account 2: Condition

• **Learning objectives (Level 2)**
  
  • Understand the data options and sources
  
  • Understand the important conceptual issues
  
  • Be aware of how other countries have approached measuring Condition
Level 2: Account 2: Condition

- Data Options
  - Types of condition data
  - Sources of national condition data
  - Estimating condition data
  - Selecting condition measures
Level 2: Account 2: Condition

- Types of condition data
  - Quality data may refer to different levels of “holism”
    - Reductionist = indicator species, ratios between organisms
    - Composite indicators = biomass, primary productivity
    - Holistic = diversity, resilience, thermodynamic capacity
  - There are many possible quality measures
    - Water quality is often an index based on selection of indicators (BOD, COD, pH, metals…) according to fitness for use (drinking, recreation, livestock, wildlife, irrigation…)
    - Air quality (Ozone, PM$_{2.5}$, NO$_x$, SO$_2$…) is often measured only in urban areas and indexed on effects on human health
    - Soil quality (moisture, texture, contaminants) should be available from soil inventories
    - Ecosystem integrity (fragmentation, heterogeneity) can be estimated from satellite and administrative data (e.g., roads)
Level 2: Account 2: Condition

- Types of condition data
  - For ecosystem accounting, it is not necessary to have all measures
  → link available data to **important** services

- Examples:
  - Water purification of wetlands: Type of wetland, flow rates, quality of inflow, quality of outflow (phosphorous? metals?)
  - Erosion control: Density of vegetation, slope, soil type
  - Crops: Soil type, soil carbon, slope
Level 2: Account 2: Condition

- **Sources of national condition data**
  - **Departments of Environment**: Water quality, air quality, Species diversity indices
  - **Departments of Natural Resources**: Hydrology
  - **Departments of Agriculture**: Soil type, soil quality, farming practices
  - **Departments of Forestry**: Forest status, species mix, forest inventory, carbon balances
  - **Departments of Fisheries**: Coastal and marine water quality, species diversity
  - **International sources**:
    - FAO: land cover, soil, marine species distributions
    - IUCN: protected areas, red list of threatened species
Level 2: Account 2: Condition

- UNEP-WCMC Composite map of global ecosystem assets

Source: Dickson, Blaney et al. (2014)
Level 2: Account 2: Condition

- Recommendation:
  - Conduct an **inventory** of available data in government, academia and NGOs

- Data inventories are inexpensive and have many benefits
  - Engage the data providers
  - Improving metadata
  - Improving use of existing data
  - Suggesting means of harmonizing existing data
  - Identifying data gaps
Level 2: Account 2: Condition

- Estimating condition data
  - Not all data need to be measured (or measured frequently)
  - Can estimate condition or services from other condition data using Biophysical Modelling
- Examples:
  - Land cover class → carbon storage
  - Sampled data on forest production → estimate for other areas
  - Forest cover, distance from roads, etc. → orangutan habitat
  - Primary production (from remote sensing), soil respiration → carbon sequestration
Ecosystem services Central Kalimantan

Carbon storage

- High: 7882.64 ton/ha
- Low: 32.34 ton/ha

Model used

**Look Up Tables** (every land cover class is attributed a specific carbon storage value)

Timber production

- High: 1.67 m³/ha/year
- Low: 0.42 m³/ha/year

**Kriging** (values are interpolated from samples)

Source: Sumarga and Hein, 2014
Ecosystem services Central Kalimantan

Orangutan habitat

Model used:

**Statistical model** (**Maxent**) (habitat suitability predicted on the basis of forest cover, distance from road, etc.)

Carbon sequestration

**Process-based Model** (primary ecosystem production minus soil respiration)

Source: Sumarga and Hein, 2014
Level 2: Account 2: Condition

- Conceptual issues
  - Measurement
    - Are data representative?
      - Do monitoring sites represent all ecosystem types?
    - What is the quality of the data?
    - Are data consistent over time?
  - Linkage to services
    - Condition and services have a complex relationship
      - A small change in condition may have a large effect on services (e.g., change in coastal water quality on coral)
      - A large change in condition may have a small effect on services (e.g., change in coastal water quality on tourism)
Level 2: Account 2: Condition

Are data representative?

Canada example:
- Monitoring sites selected to identify “problems”
- Some areas and types of streams undersampled
- Populated areas oversampled
- Solution?

Source: Statistics Canada, 2007
Level 2: Account 2: Condition

Linkage to services

- As some services increase (e.g., crops) quality (biodiversity, heterogeneity) may decrease
  - This is not good, since intensive and extensive cropping creates ecosystems that are less resilient to change.

- Some services (e.g., iconic species habitat) may be very sensitive to disturbance.

- Research on resilience is trying to understand how to better link conditions with services.
Level 2: Account 2: Condition

Linkage to services

- In this hypothetical example, an ecosystem encountering changes in condition.
- It recovered its level of services, since the change was below the first threshold.
- After the second perturbation, it could not recover, since the conditions changed to below the new threshold.
- The result was a permanent decrease in that service.

Source: Millennium Ecosystem Assessment, 2005.
Level 2: Account 2: Condition

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

1. Choose one **ecosystem type** and a **service** it provides (e.g., forests → flood protection)
2. Suggest **three** condition measures (quality and biophysical) that could inform the relationship between the **condition** and the **service**
3. Report:
   - The service and condition measures you selected
   - How are they related? (direction, importance)
   - Are **national** data available in your country for these condition measures?
Level 2: Account 2: Condition

- Concepts Group exercise (15m)

- Group reports
  - The service and condition measures you selected
  - How are they related? (direction, importance)
  - Are national data available in your country for these condition measures?

- Discussion
  - What other condition measures could you suggest?
  - What other data sources could you suggest?
Level 2: Account 2: Condition

- Discussion and questions
- Take home points
  - Data on ecosystem condition may be limited, but much can still be used in ecosystem accounting
  - There are no simple formulas to calculate ecosystem condition indicators for all purposes
  - Testing will provide a better understanding of data opportunities and constraints
  - Focus on available data and priority services
Level 2: Account 2: Condition

References

- Dickson, B., Blaney, et al., 2014. Towards a global map of natural capital: Key ecosystem assets. DEW/1824/NA. Nairobi, Kenya: UNEP.

Further Information

- SEEA Experimental Ecosystem Accounting (2012)
- SEEA-EEA Technical Guidance (forthcoming)
  - Detailed supporting document on “Ecosystem Condition and Capacity” by Michael Bordt
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.