Keynote: Statistics

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<table>
<thead>
<tr>
<th>CI For</th>
<th>Sample Statistic</th>
<th>Margin of Error</th>
<th>Use When</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population mean (μ)</td>
<td>$\bar{x}$</td>
<td>$\pm z^* \frac{\sigma}{\sqrt{n}}$</td>
<td>$\chi$ is normal, or $n \geq 30$; $\sigma$ known</td>
</tr>
<tr>
<td>Population mean (μ)</td>
<td>$\bar{x}$</td>
<td>$\pm t^*_{n-1} \frac{s}{\sqrt{n}}$</td>
<td>$n &lt; 30$, and/or $\sigma$ unknown</td>
</tr>
<tr>
<td>Population proportion (p)</td>
<td>$\hat{p}$</td>
<td>$\pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$</td>
<td>$n\hat{p}, n(1-\hat{p}) \geq 10$</td>
</tr>
<tr>
<td>Difference of two population means (μ₁ − μ₂)</td>
<td>$\bar{x}_1 - \bar{x}_2$</td>
<td>$\pm z^* \sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}$</td>
<td>Both normal distributions or $n_1, n_2 \geq 30$; $\sigma_1, \sigma_2$ known</td>
</tr>
<tr>
<td>Difference of two population means μ₁ − μ₂</td>
<td>$\bar{x}_1 - \bar{x}_2$</td>
<td>$\pm t^*_{n_1+n_2-2} \sqrt{\frac{(n_1-1)s_1^2 + (n_2-1)s_2^2}{n_1+n_2-2}}$</td>
<td>$n_1, n_2 &lt; 30$; and/or $\sigma_1 = \sigma_2$ unknown</td>
</tr>
<tr>
<td>Difference of two proportions (p₁ − p₂)</td>
<td>$\hat{p}_1 - \hat{p}_2$</td>
<td>$\pm z^* \sqrt{\frac{\hat{p}_1(1-\hat{p}_1)}{n_1} + \frac{\hat{p}_2(1-\hat{p}_2)}{n_2}}$</td>
<td>$n\hat{p}, n(1-\hat{p}) \geq 10$ for each group</td>
</tr>
</tbody>
</table>

Six Capitals

The Revolution Capitalism Has To Have – or Can Accountants Save The Planet?

Jane Gleeson-White

The acclaimed author of Double Entry
A System of National Accounts and Supporting Tables

1953: 46 pages

2008: 722 pages
GDP = C + I + G + (X - M)

C = Spending by consumers
I = Spending by businesses
G = Spending by government
X = Exports
M = Imports
System of environmental-economic accounting (SEEA)

**Stocks (P & Q)**
- Minerals & energy
- Land, Soil
- Timber
- Aquatic
- Other biological
- Water
- Ecosystems + conditions

**Flows (P & Q)**
- Materials
- Energy
- Water
- Ecosystem services

**Residuals (Q)**
- Solid waste
- Air emissions
- Water emissions
- Ecosystem impacts

**Environment**

**Economy**
- Production
- Consumption
- Accumulation
- Imports
- Exports

**Benefits/Costs**
- SNA: Contribution of natural inputs to economy (rent)
- Depletion, degradation adjusted net savings
- Non-SNA: Contribution of natural inputs to well being
- Externalities (health, poverty)

**Mitigate & Manage (P)**
- Protection & Goods & Services
- Taxes & subsidies

**National wealth**
- National Balance Sheet
- Resource life
- “Critical” Natural Capital

P = Price (monetary value)
Q = Quantity (physical)
SEEA-Ecosystems (spatially detailed)

**Physical**
- **Thematic**: Land, Water, Carbon, Biodiversity
- **Extent**
- **Condition**

**Monetary**
- **Asset**

**Services Supply**
- **Services Use**

**Tools**: Classifications, Spatial units, scaling & aggregation, Biophysical modelling

**Supporting**: SNA, I-O tables, economic production functions

**Augmented I-O Table**

**Integrated Sector Accounts and Balance Sheets**
SEEA Ecosystems
Early work

Source: Remme et al., 2014 (Limburg, the Netherlands)

Source: Statistics Canada, 2013

<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>Surface water</th>
<th>Other nature</th>
<th>Provincial total</th>
</tr>
</thead>
<tbody>
<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>1,513</td>
<td>14,193</td>
<td></td>
</tr>
<tr>
<td>Drinking water extraction</td>
<td>10^3 m³ water</td>
<td>4,071</td>
<td>7,026</td>
<td>3,122</td>
<td>1,117</td>
<td>214</td>
<td>478</td>
<td>862</td>
<td>26,995</td>
<td></td>
</tr>
<tr>
<td>Crop production</td>
<td>10^5 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>10^5 kg dry matter</td>
<td>533</td>
<td>251</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>784</td>
</tr>
<tr>
<td>Air quality regulation</td>
<td>10^3 kg PM10</td>
<td>272</td>
<td>404</td>
<td>717</td>
<td>700</td>
<td>45</td>
<td>7</td>
<td>60</td>
<td>69</td>
<td>2,251</td>
</tr>
<tr>
<td>Carbon sequestration</td>
<td>10^3 kg carbon</td>
<td>875</td>
<td>8,029</td>
<td>273</td>
<td>50,664</td>
<td>393</td>
<td>149</td>
<td>1,056</td>
<td>61,429</td>
<td></td>
</tr>
<tr>
<td>Cultural</td>
<td>10^3 trips</td>
<td>2,690</td>
<td>1,863</td>
<td>2,611</td>
<td>1,265</td>
<td>30</td>
<td>3</td>
<td>139</td>
<td>220</td>
<td>9,121</td>
</tr>
</tbody>
</table>
The Ocean
A Different kind of “ecosystem”

• It’s very large
• Water keeps moving
• Multi-layer
• All looks the same from a satellite
• Trans-boundary / shared / most outside of national jurisdictions
• Less studied / known / measured
• Not tested with SEEA

• ESCAP YouTube Video; UN Environment: Ocean Pollution
Ocean accounts – Map view

National Spatial Data Infrastructure (NSDI)
SEEA Ecosystem extent
- Terrestrial and Freshwater ecosystem types (Land Accounts)
- Coastal communities
- Coastal infrastructure
- Pollution sources

Ocean spatial units
- Ocean ecosystem types
- Marine protected areas
- Fishery, tourism, mining areas
- Water quality / temperature

National statistics
- Emissions, effluents, wastes
- Assets: fish stock
- Supply/use: catch, beneficiaries

Analyses
- Main sources of land-based pollution (by whom)
- Degraded and pristine “Hot spots”
- Cost/benefit of rehabilitation and protection
- Value of natural inputs (to whom)
- Policy options → values at risk
- Capture of “rent” (returns on investment)
# Ocean accounts – Table view

<table>
<thead>
<tr>
<th>Drivers</th>
<th>Ocean Assets:</th>
<th>Ocean Services Supply (physical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific units</td>
<td>Industry</td>
<td>% to ocean</td>
</tr>
<tr>
<td>SEEA Air emissions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEEA Effluents[^1]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SEEA Solid wastes[^1]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[^1]: would benefit from spatial disaggregation

<table>
<thead>
<tr>
<th>Ocean governance</th>
<th>Ocean Conditions</th>
<th>Ocean Services Use (physical)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific units</td>
<td>Industry</td>
<td>Specific units</td>
</tr>
<tr>
<td>Policies, plans and regulations</td>
<td></td>
<td>Acidification (pH)</td>
</tr>
<tr>
<td>Institutions</td>
<td></td>
<td>Eutrophication (BOD)</td>
</tr>
<tr>
<td>Management practices</td>
<td></td>
<td>Plastics (T)</td>
</tr>
<tr>
<td>- research</td>
<td></td>
<td>Temperature (°C)</td>
</tr>
<tr>
<td>- enforcement</td>
<td></td>
<td>Accessibility/quality</td>
</tr>
<tr>
<td>SEEA Goods and Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- technologies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[^2]: Including critical natural capital areas, settlements, coastal infrastructure, protected areas, fishing zones, designated tourist areas, coral reefs, mangroves, coastal beaches...

[^3]: As in the SEEA-EEA, Carbon and Biodiversity could be full accounts.

[^4]: Only some services can be valued in monetary terms.

[^5]: Would benefit from disaggregation by large/small enterprise and linkage to employment by beneficiary type.

[^6]: SNA for some services

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Note: This is a stylistic representation of the SEEA-EEA with additional components required for including sources of land-based pollution, abiotic services (such as minerals, energy and medium for transport), expenditures and governance. This is not as comprehensive as described in the text. Much of the data on flows of land-based pollution, ecosystem types, and condition would be derived from detailed maps and aggregated as shown in the tables for reporting.
Many SEEA accounts → many related SDGs

SEEA: Central Framework + Ecosystems
Take home points

- Official statistics is based on **fundamental principles** and agreed standards
- The System of National Accounts is used by **everyone** to measure national wealth and production
  - The SEEA is linked to the SNA and endorsed by **all** official statisticians
- Ocean Accounts are an extension and adaptation of the SEEA to the ocean and SDG14
  - The main components are extent, condition, services supply and use, drivers, and governance.
- **We can** save the ocean!
  - If statisticians collaborate with scientists and policy experts
Technical Guidance on Ocean Accounts 2019

System of Ocean Accounts 2025

2019: 75 pages

2025: ??? pages