Spatial Units

(Level 1)

Project: Advancing the SEEA
Experimental Ecosystem Accounting

United Nations
UNEP
Convention on Biological Diversity
NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

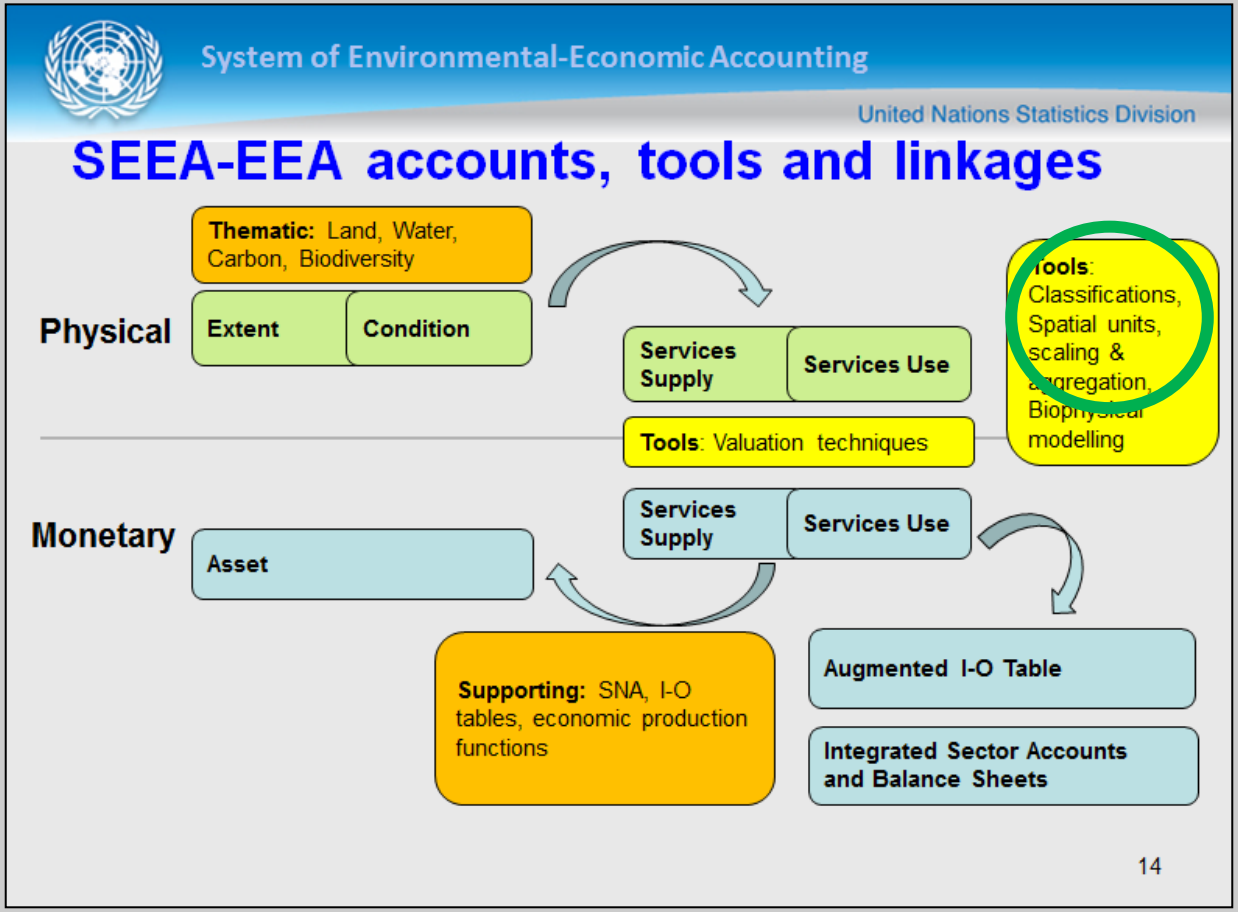
Overview: Spatial Units

1. **Learning objectives**
2. **Review of "Level 0" (5m)**
3. **Level 1 (Compilers):**
   - **Presentation & group exercise**
     - Spatial units (10m + 15m)
     - Scaling (10m + 15m)
     - Aggregation (10m + 15m)
4. **Closing Discussion (10m)**

SEEA-EEA Training Level 1: Spatial Units

- **Learning objectives**
  - Level 1:
    - Understand the basic concepts of the SEEA-EEA:
      - Spatial units
      - Scaling and
      - Aggregation used in ecosystem accounting
    - Learn the steps of
      - Using spatial units
      - Conducting scaling and
      - Conducting aggregation

Tools 2: Spatial units



Review of Level 0:
Spatial Units, Scaling and Aggregation

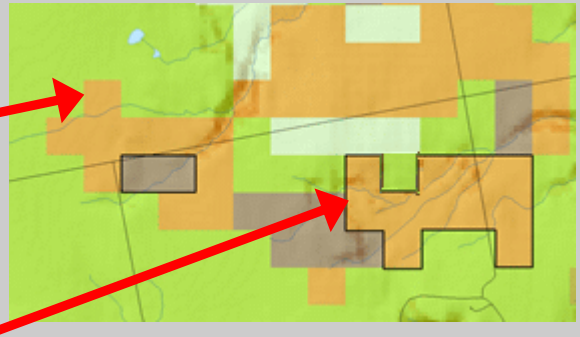
Level 0: Tools 2: Spatial units

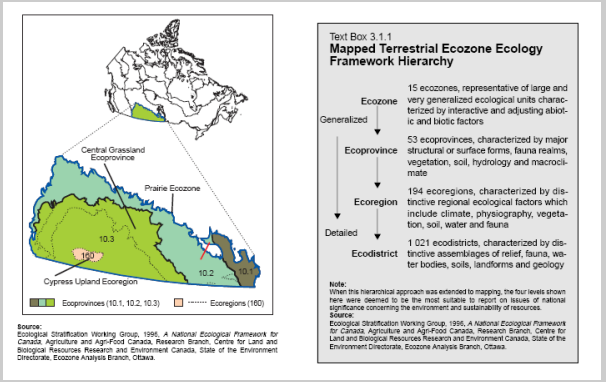
- **What?**
  - A common definition of Spatial Units for all accounts
  - Based on surface characteristics (terrestrial, freshwater, coastal and marine)
- **Why?**
  - Accounting needs **statistical units** about which information is compiled, derived, reported and compared
    - e.g., business statistics are built on locations, establishments, companies and enterprises
  - Information is collected on many **spatial levels**
    - Needs to be consolidated within a GIS or spatial model
  - First step in **tabulating & aggregating** more detailed data
    - Not everybody is a GIS expert
  - Links accounts together:
    - (**Extent, Condition, Services Supply…**)

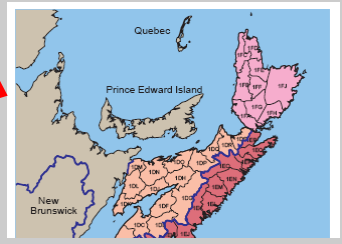
Level 0: Tools 2: Spatial units

Recommended three levels: hierarchical and mutually exclusive:

1. Basic Spatial Unit **(BSU)**
   - Pixel or grid cell
2. Ecosystem Unit **(EU)**
   - Homogenous according to criteria (cover, slope, drainage area, elevation…)
   - Consolidate for tables by EU type
3. Ecosystem Reporting Area **(ERA)**
   - For reporting (sub-drainage area, administrative area…)







→ **Establishes Ecosystem Extent Account**

Source: Statistics Canada, 2013

Level 0: Tools 2: Scaling

- **What?**
  - Converting information from one scale to another (spatial, temporal, thematic)
- **Why?**
  - Information exists in various types:
    - Point (water quality monitoring, “study sites”, etc.)
    - Area (land cover, protected area, species range, etc.)
    - Network (roads, streams, corridors, etc.)
  - Need to understand how and when to attribute information from one scale to another

Level 0: Tools 2: Scaling

- **Main approaches**
  - **Downscaling**
    - Attributing information from larger areas to smaller areas contained within them
    - **Caution**: Data need to be evenly distributed
  - **Upscaling**
    - Attributing information from smaller areas to larger areas
    - **Caution**: Data need to be representative
  - **Transfer**
    - Transferring information measured in one location to another
    - Often used in terms of **Benefits Transfer**
    - **Caution**: Locations need to be very similar

Level 0: Tools 2: Aggregation

- **What?**
  - Combining many measures into simpler ones
  - Dissimilar measures may be aggregated using:
    - Indices (e.g., water quality index)
    - Conversion to common units (e.g., CO_2 equivalents)
- **Why?**
  - Accounting requires **aggregates** (of dollars, business types, sub-populations, regional summaries, national indicators…)
  - Summary indicators for dashboards, linking to economic accounts

Level 0: Tools 2: Aggregation

- **Aggregating dissimilar biophysical measures:**
  - Requires indexing (comparison with reference)
  - Example: ecosystem condition measures, service measures
  - **Caution**: Requires understanding of relative importance of component measures (weighting)
- **Final aggregates**
  - e.g., total value of ecosystem services, total asset value
  - Require many assumptions (relative importance, methods…)
  - Services can be competing, complementary or independent
  - **Caution**: Monetary valuation is often applied inappropriately

  → **Valuation** results can be misleading

Level 1: Tools 2: Spatial units

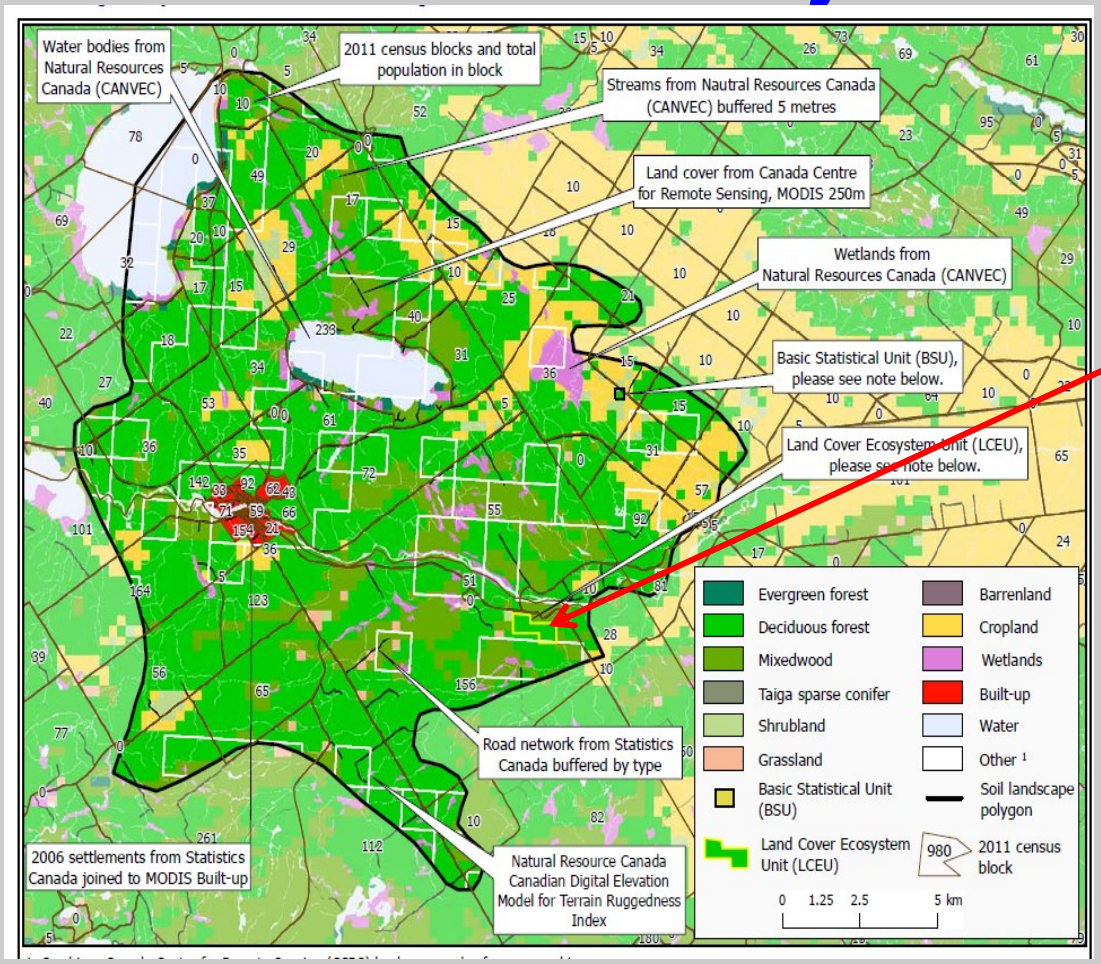
Level 1: Tools 2: Spatial units

- Basic Spatial Unit (BSU)
  - May be a “pixel” of land cover from satellite data
  - May be a “raster” downscaled from ecological data
  - The BSU is the smallest working unit
    - This could be 5m to 500m, depending on resolution
    - Higher resolution is usually better
  - Comparable national data are required for at least two periods
  - The choice of BSU size will affect the certainty of the results (e.g., larger BSUs may be averages of many ecosystem types)

Level 1: Tools 2: Spatial units

- Ecosystem Unit (EU)
  - Is an aggregate of similar, adjacent BSUs
    - Ideally, **homogenous** with respect to ecosystem condition and services
    - A proxy for "Ecosystem type"
  - For example, if **only** land cover is used, then they are contiguous areas of land cover type
  - Better to use more criteria
    - Canada uses land cover, soil, elevation, slope as well as drainage area, hydrology networks, barriers (roads, hydro lines)
  - Countries may have own definitions of ecosystem types (e.g., ecozones, bioregions). These could also be used as building blocks…

Canada's MEGS Project



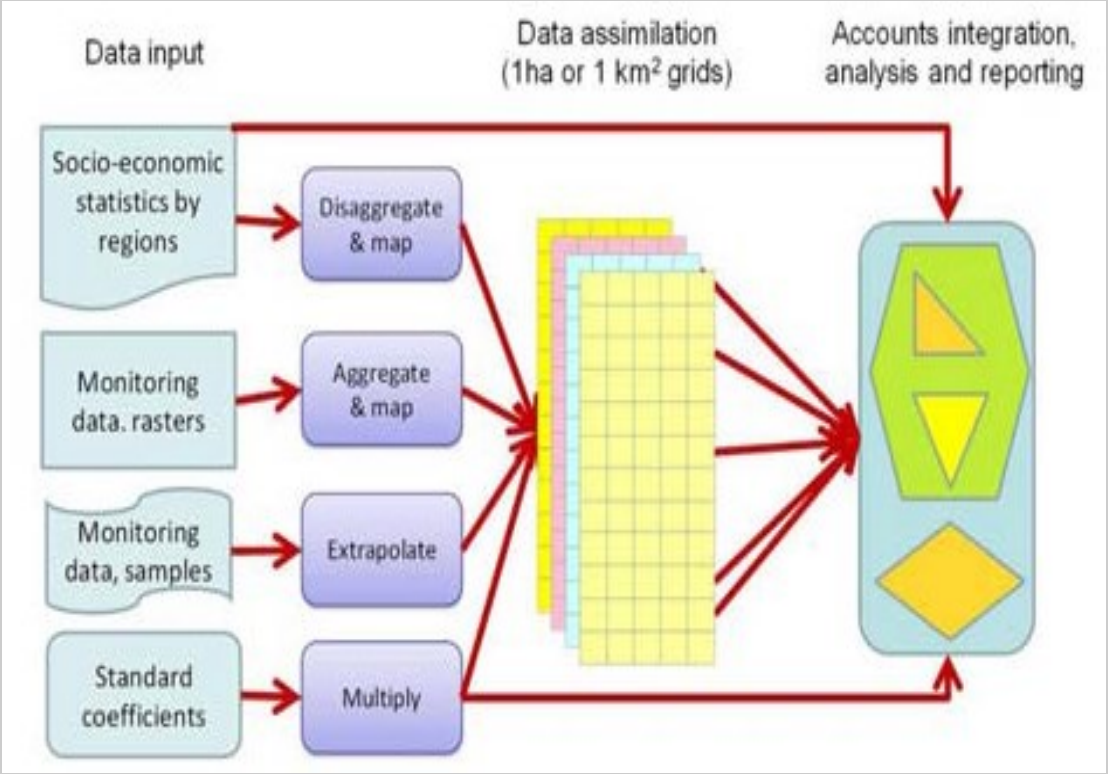
MEGS (Measuring Ecosystem Goods and Services) used detailed hydrological, topographic, population and road data.

EUs are areas of homogenous land cover, elevation, slope, "ruggedness", soil type, that did not cross roads, electrical transmission lines, railways, streams or watersheds.

This defined 921,000 EUs for Canada.

Statistics Canada, 2013

SCBD's Quick Start Package (Weber, 2014)



The suggested SCBD (Secretariat for the Convention on Biological Diversity) QSP data framework allocates data to 1km^2 grids for further analysis.

Level 1: Tools 2: Spatial units

- Issues → testing
  - Effect of BSU size
  - Using ecological classifications as the starting point
  - Allocate all data to BSU level **or** maintain overlapping intermediate spatial units (e.g., drainage areas)
  - Recording relationships between distant ecosystems:
    - Birds winter in one area and breed in another
  - Treatment of networks:
    - Streams and wetlands may not be visible in land cover data
    - Upstream and downstream relationships
  - Treatment of coastal and marine areas:
    - Land cover data does not delineate aquatic “ecosystems”
    - Surface and bottom are different “ecosystems”
  - Seasonality
    - Land cover and ecosystem dynamics change over the year

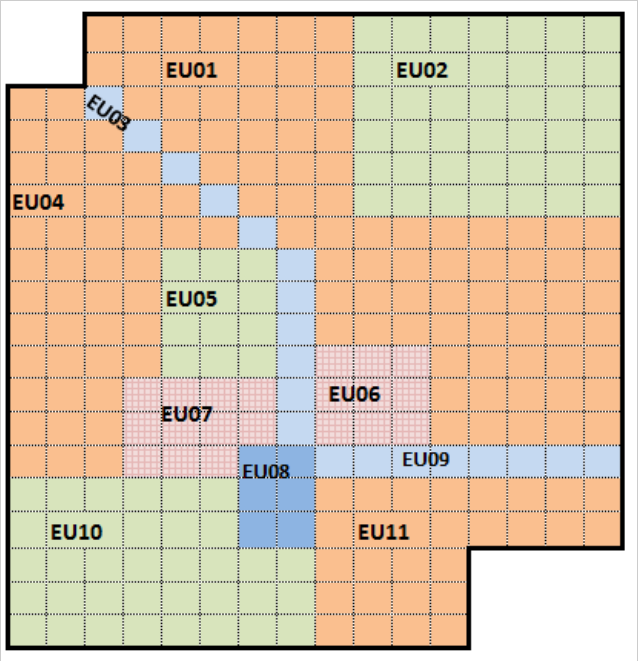
Level 1: Tools 2: Spatial units

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with land cover types
    - Need a Summary Table by EU type in km^2
  - Objective (Groups of 3-5)
    1. Define EUs and count the total area of each
       – Record results in EU Table
    2. Compile total area by EU type
       – Record results in Summary Table

Level 1: Tools 2: Spatial units

Group exercise: Step 1 – Count area for each EU

Map of BSUs



EU table

EU Table

EU	BSU count	Area (km^2)
EU01 = Herbaceous crops		
EU02 = Tree covered areas		
EU03 = Inland water bodies		
EU04 = Herbaceous crops		
EU05 = Tree covered areas		
EU06 = Artificial surfaces (urban)		
EU07 = Artificial surfaces (urban)		
EU08 = Shrubs..regularly flooded (wetland)		
EU09 = Inland water bodies		
EU10 = Tree covered areas		
EU11 = Herbaceous crops		
Total		

Note: One BSU = 250m*250m = 6.25 ha

Level 1: Tools 2: Spatial units

Group exercise: Step 2 – Calculate area for each EU

EU table

EU Table

EU	BSU count	Area (km^2)
EU01 = Herbaceous crops		
EU02 = Tree covered areas		
EU03 = Inland water bodies		
EU04 = Herbaceous crops		
EU05 = Tree covered areas		
EU06 = Artificial surfaces (urban)		
EU07 = Artificial surfaces (urban)		
EU08 = Shrubs..regularly flooded (wetland)		
EU09 = Inland water bodies		
EU10 = Tree covered areas		
EU11 = Herbaceous crops		
Total		

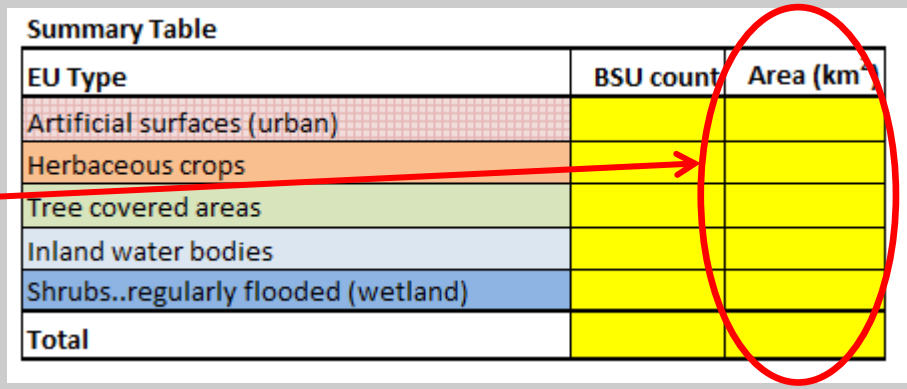
Note: 1 Km^2 = BSU count / 16

Summary table

LCEU Type	BSU count	Area (km^2)
Urban and associated		
Rainfed he		
land water bodies		
Open wetlands		
Total		

Level 1: Tool 2: Spatial units

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - Report totals
  - Do totals add up?
    - 288 BSU
    - 18 km^2



Summary Table

EU Type	BSU count	Area (km^2)
Artificial surfaces (urban)		
Herbaceous crops		
Tree covered areas		
Inland water bodies		
Shrubs..regularly flooded (wetland)		
Total		

Level 1: Tools 2: Scaling

Level 1: Tools 2: Scaling

- **Main approaches**
  - **Downscaling**
    - Attributing information from larger areas to smaller areas contained within them
    - **Caution**: Data need to be evenly distributed
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    - Transferring information measured in one location to another
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Level 1: Tools 2: Scaling

- Issues → testing
  - What is the best spatial level to maintain data (BSU, EU or original level, such as management region, drainage area…)?
  - What is the effect of scaling on uncertainty (error)?
  - Implications for temporal (time) and thematic (classifications) scaling?

→Recommendation:

→Maintain data at highest resolution possible

→Be aware that downscaling and upscaling may introduce additional error

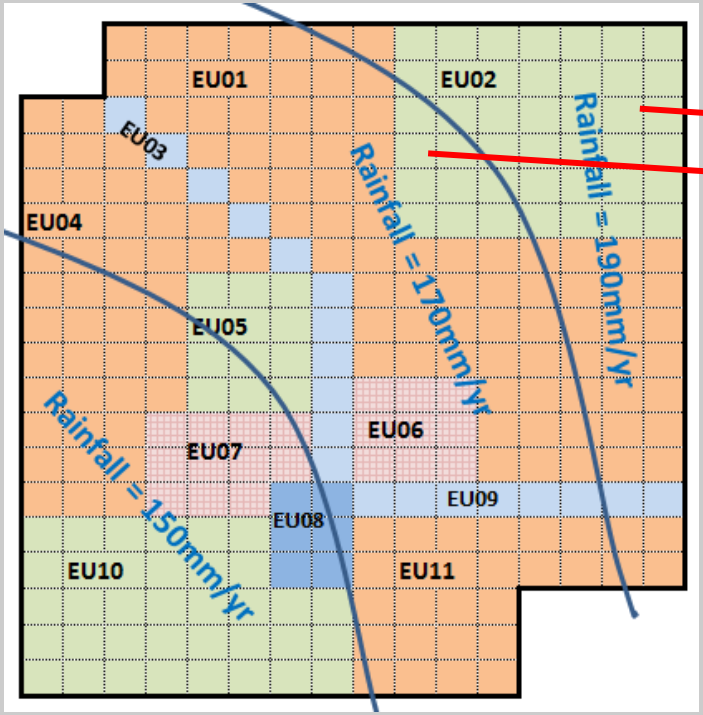
Level 1: Tools 2: Scaling

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with EU types
    - Have another map with **average** annual rainfall
    - Need to calculate **average** annual rainfall in EU02
  - Objective (Groups of 3-5)
    1. For EU02
       - Count number of BSUs in each rainfall "band"
       - Calculate "Total rainfall"
       - Calculate Total BSU count
       - Calculate the "Average rainfall"
    2. Report your results

Level 1: Tools 2: Scaling

Group exercise: Step 1 – Count rainfall area for EU02

Map of BSUs and rainfall



Rainfall table

Rainfall table

EU02	BSU Count	Total rainfall (mm)	
A: Rainfall = 190mm/yr			=BSU*190
B: Rainfall = 170mm/yr			=BSU*170
Total			= A + B

Level 1: Tools 2: Scaling

Group exercise: Step 2 – Calculate totals and average

Rainfall table

Rainfall table

EU02	BSU Count	Total rainfall (mm)	
A: Rainfall = 190mm/yr			=BSU*190
B: Rainfall = 170mm/yr			=BSU*170
Total			= A + B

Rainfall summary table

Rainfall summary table

	BSU Count	Average rainfall (mm)	
LCEU02 average Rainfall			=(A+B)/(BSU Count)

Level 1: Tool 2: Scaling

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - Report average annual rainfall for EU02
  - Are the results “reasonable” (between 170 and 190)?

Rainfall summary table

	BSU Count	Average rainfall (mm)	
EU02 average Rainfall			=(A+B)/(BSU Count)

  - Why might this not be very precise?

Level 1: Tools 2: Aggregation

Level 0: Tools 2: Aggregation

- **What?**
  - Combining many measures into simpler ones

- **Aggregating dissimilar biophysical measures requires**
  - Indexing (comparison with reference)
  - Conversion to common units (e.g., CO_2 equivalents)
  - Weighting (scaling by relative importance)

- **Examples**
  - **Ecosystem Condition**: Need one index or many?
  - **Ecosystem Services Supply**: Physical units, different types (tonnes, risk, m^3, beneficiaries…)

Level 1: Tools 2: Aggregation

- **Final aggregates**
  - Require many assumptions (relative importance, methods…)
  - Monetary valuation is often applied inappropriately
- **Examples**
  - Total contribution of ecosystems to economy and human activities (well-being, health, welfare…)
  - Some studies monetize all services (real or potential dollars)
- **Cautions about monetary valuation:**
  - Some services are inappropriate to monetize (e.g., cultural fulfillment, flood risks)
  - Some studies may mix market and welfare benefits (e.g., willingness to pay using contingent valuation)

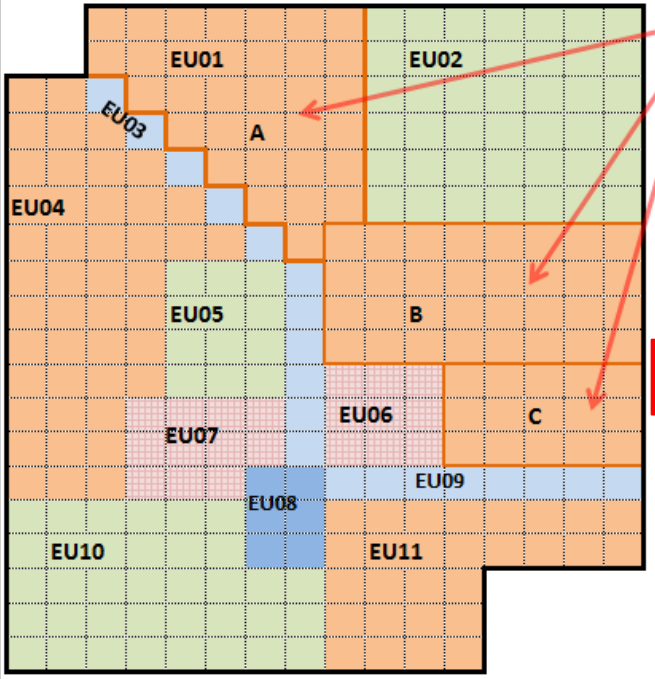
Level 1: Tools 2: Aggregation

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with EU types
    - EU01 contains three farms (A, B and C) with different amounts of wheat production
    - Need to calculate **average** wheat production (tonnes/ha) for EU01
  - Objective (Groups of 3-5)
    1. Calculate productivity (tonnes/ha) for each farm in EU01
    2. Calculate total production (tonnes)
    3. Calculate average productivity (tonnes/ha) for EU01
    4. Report your results

Level 1: Tools 2: Aggregation

Group exercise: Step 1 – Count BSUs for each farm

Map of 3 farms in EU01



Farm Productivity Table

Farm productivity

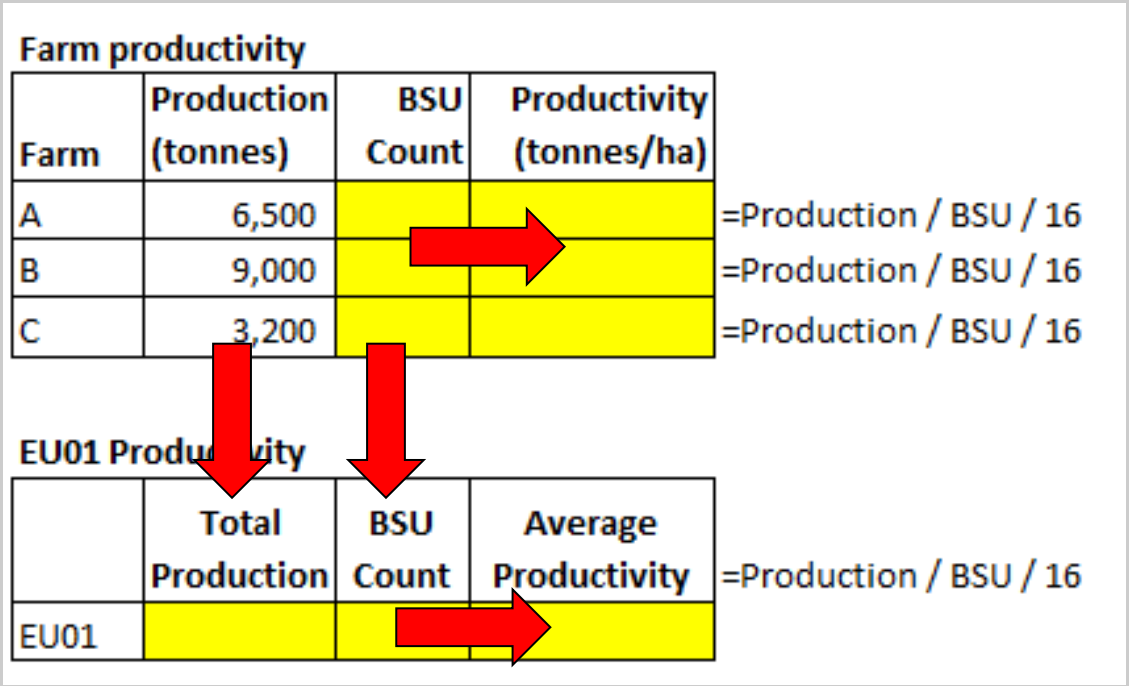
Farm	Production (tonnes)	BSU Count	Productivity (tonnes/ha)	
A	6,500			=Production / BSU / 16
B	9,000			=Production / BSU / 16
C	3,200			=Production / BSU / 16

EU01 Productivit

	Total Productio	t	Average Productivity	=Production / BSU / 16
EU01				

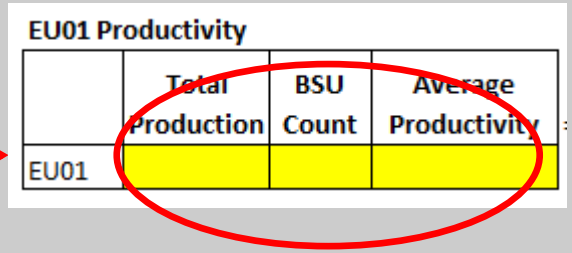
Level 1: Tools 2: Aggregation

Group exercise: Step 2 – Calculate productivity for each farm and EU01 total



Level 1: Tool 2: Aggregation

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - Report for EU01
    - Total wheat production
    - Total BSU count
    - Average wheat productivity
  - Are the results "reasonable"?
    - e.g., is EU productivity within the range of productivity for farms?



Level 1: Tools 2: Spatial units

- Discussion and questions
- Take home points:
  - Need common spatial units
    - To compile complex spatial data and
    - Coordinate the work of many contributors
  - Delineating spatial units, scaling and aggregation can be done in a GIS
    - But everyone needs a common understanding of statistical procedures
  - Countries will have different data and standards
  - Testing is an opportunity to adapt the SEEA-EEA principles to your needs

Level 1: Tools 2: Spatial units

- References

- STATISTICS CANADA, 2013. Human Activity and the Environment: Measuring Ecosystem Goods and Services 2013. 16-201-XWE. Ottawa: Government of Canada.
- WEBER, J., 2014. Ecosystem Natural Capital Accounts: A Quick Start Package. 77 (Technical Series). Montreal: Secretariat of the Convention on Biological Diversity.

- Further Information
  - SEEA Experimental Ecosystem Accounting (2012)
  - SEEA-EEA Technical Guidance (forthcoming)
    - Detailed supporting document on "Spatial Units, Scaling and Aggregation" by Michael Bordt

Evaluation of the training module

- Please complete the online evaluation form for this module http://tinyurl.com/pbopmy2
- 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.

- Contact: seea@un.org

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