Spatial units

(Levels 0 and 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**

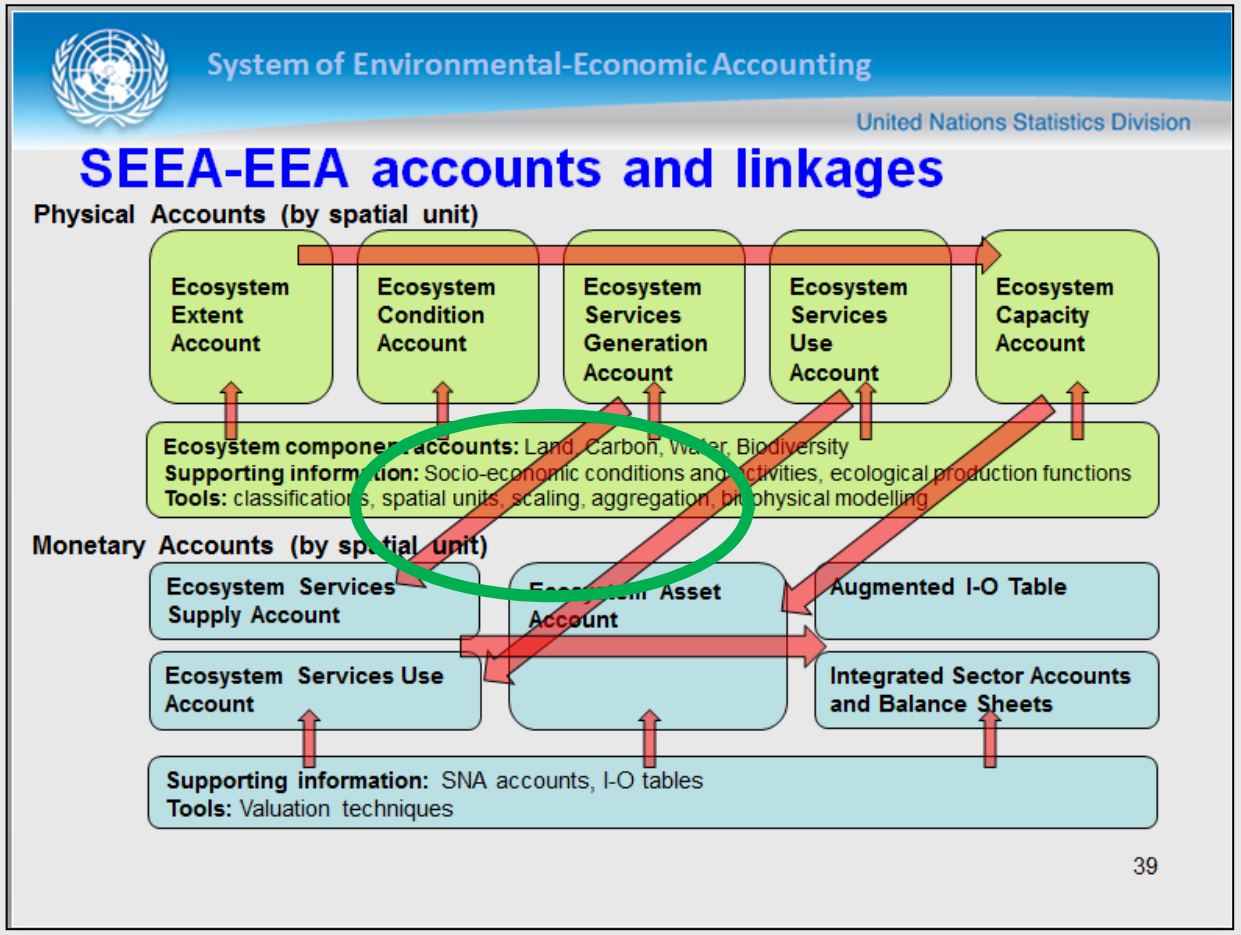
2. **Level 1: Presentation & group exercise**
   - Spatial units (10m + 15m)
   - Scaling (10m + 15m)
   - Aggregation (10m + 15m)

3. **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



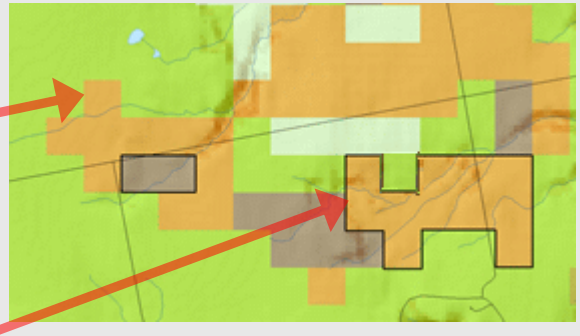
Level 0: Tools 2: Spatial units

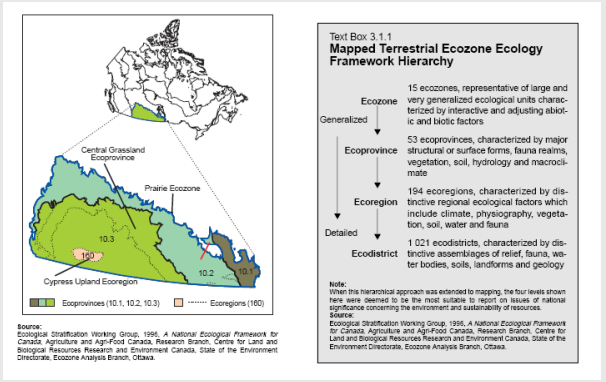
- **What?**
  - A common definition of Spatial Units for all accounts
  - Based on surface characteristics (terrestrial, freshwater, coastal and marine)
- **Why?**
  - Accounting needs **statistical units** about which information is compiled, derived, reported and compared
    - e.g., business statistics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

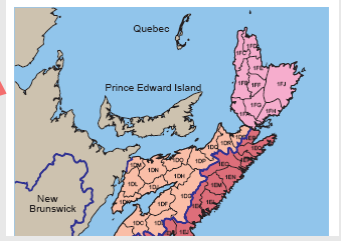
Level 0: Tools 2: Spatial units

Recommended three levels: hierarchical and mutually exclusive:

1. Basic Spatial Unit **(BSU)**
   - Pixel or grid cell
2. Land Cover Ecosystem Functional Unit **(LCEU)**
   - Homogenous according to criteria (cover, slope, drainage area, elevation…)
   - Consolidate for tables by LCEU type
3. Ecosystem Accounting Unit **(EAU)**
   - 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

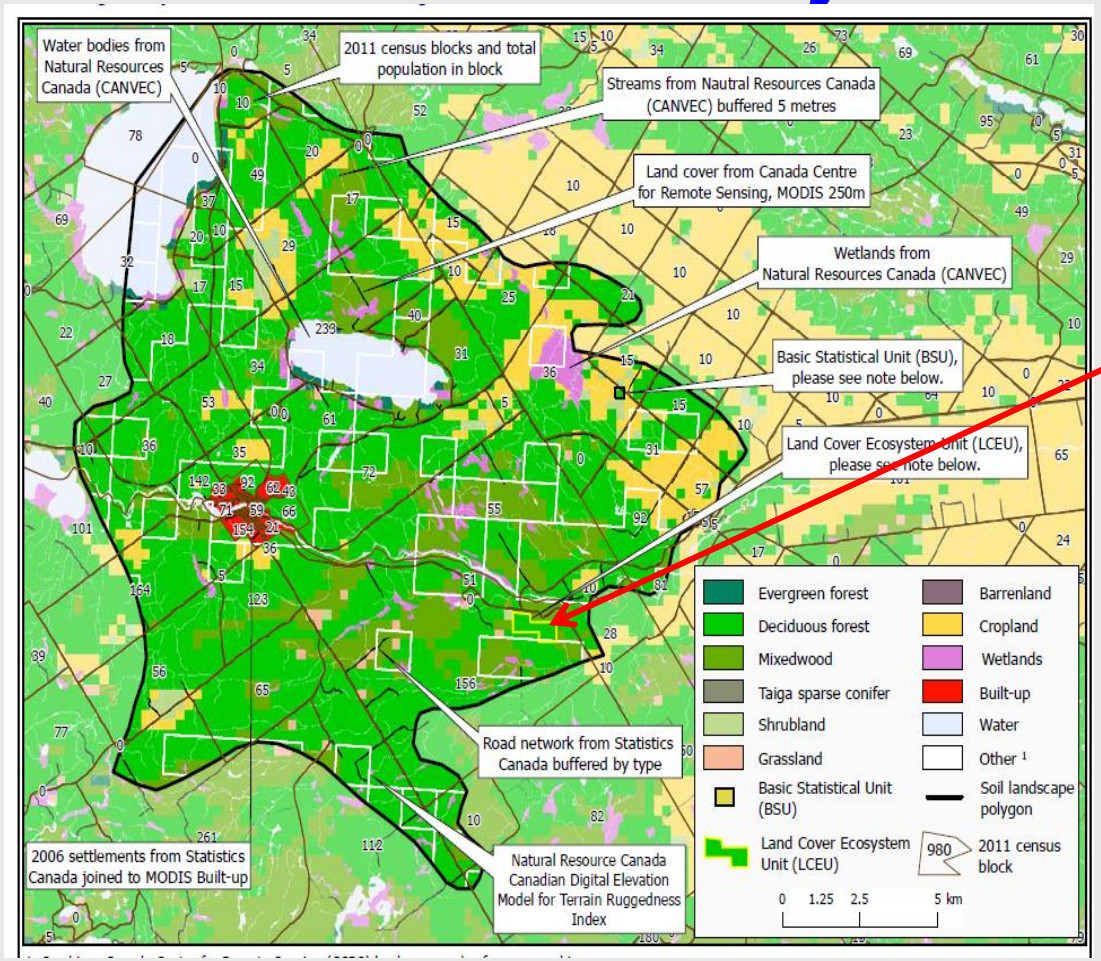
Level 1: Tools 2: Spatial units

- Basic Spatial Unit (BSU)
  - Based on land cover data from remote sensing
  - The BSU is the smallest working unit
    - This could be 5m or 100m, depending on resolution
    - Higher resolution is usually better
  - Comparable national data are required for at least two periods
  - The choice of “pixel” size will affect the certainty of the results (e.g., larger pixels may be averages of many ecosystem types)

Level 1: Tools 2: Spatial units

- Landscape Ecosystem Functional Unit (LCEU)
  - 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



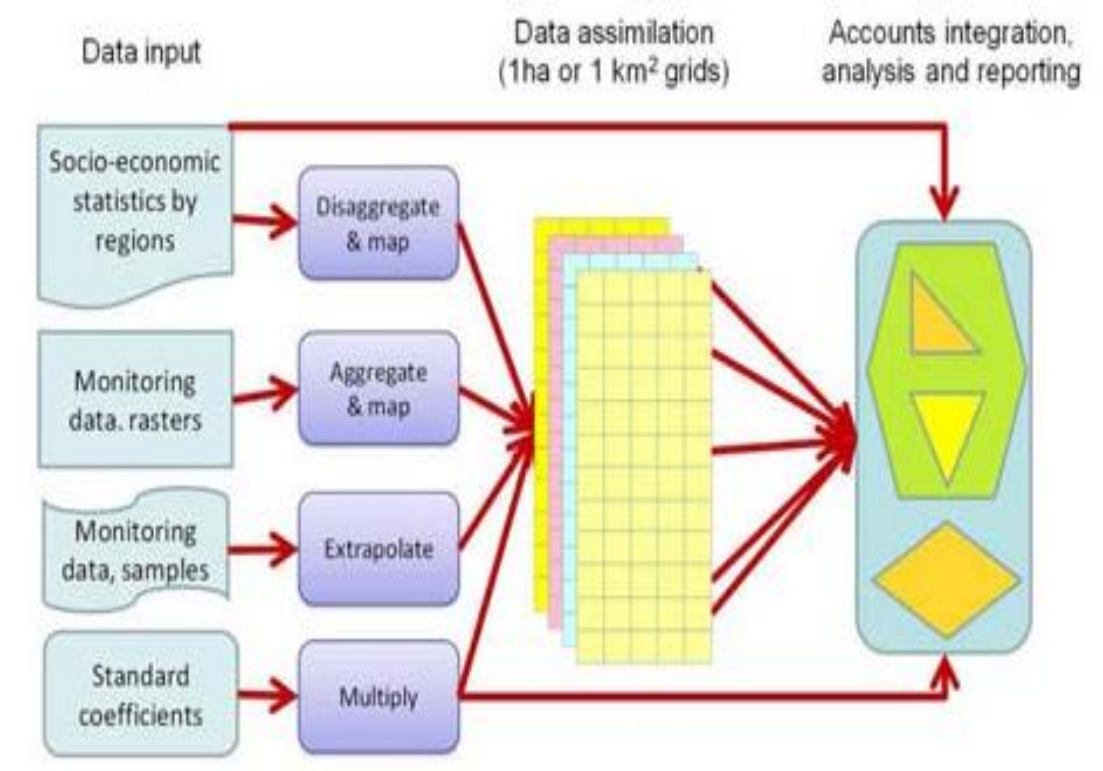
MEGS (Measuring Ecosystem Goods and Services) used detailed hydrological, topographic, population and road data.

LCEUs 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 LCEUs 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 land cover as the starting point
  - Allocate all data to BSU level **or** maintain overlapping intermediate units (land cover, drainage area…)
  - Recording relationships between distant ecosystems:
    - Birds winter in one area and breed in another
  - Treatment of networks (e.g., rivers):
    - 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 “ecosystems”
    - Surface and bottom are different “ecosystems”

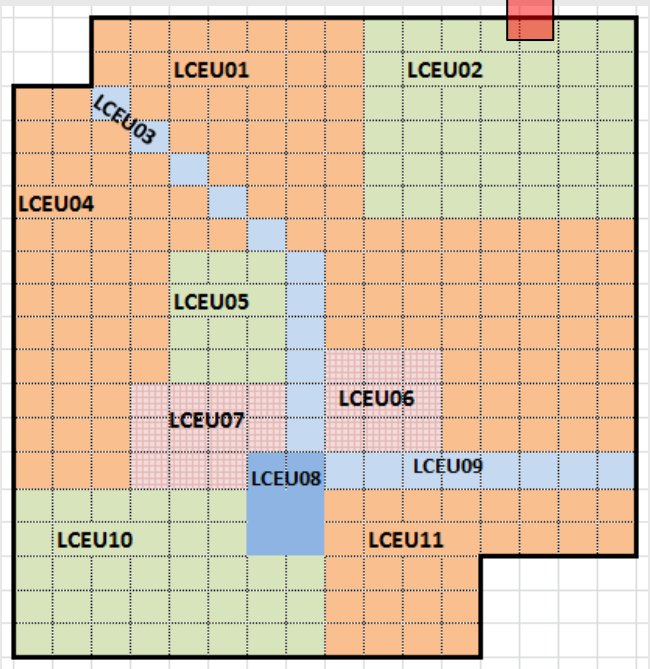
Level 1: Tools 2: Spatial units

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

Level 1: Tools 2: Spatial units

Group exercise: Step 1 – Count area for each LCEU

Map of BSUs



LCEU table

LCEU	BSU count	Area (km^2)
LCEU01 = Rainfed herbaceous cropland		
LCEU02 = Forest tree cover		
LCEU03 = Inland water bodies		
LCEU04 = Rainfed herbaceous cropland		
LCEU05 = Forest tree cover		
LCEU06 = Urban and associated developed		
LCEU07 = Urban and associated developed		
LCEU08 = Open wetlands		
LCEU09 = Inland water bodies		
LCEU10 = Forest tree cover		
LCEU11 = Rainfed herbaceous cropland		
Total		

Level 1: Tools 2: Spatial units

Group exercise: Step 2 – Calculate area for each LCEU

LCEU table

LCEU	BSU count	Area (km^2)
LCEU01 = Rainfed herbaceous cropland		
LCEU02 = Forest tree cover		
LCEU03 = Inland water bodies		
LCEU04 = Rainfed herbaceous cropland		
LCEU05 = Forest tree cover		
LCEU06 = Urban and associated developed		
LCEU07 = Urban and associated developed		
LCEU08 = Open wetlands		
LCEU09 = Inland water bodies		
LCEU10 = Forest tree cover		
LCEU11 = Rainfed herbaceous cropland		
Total		

Note: 1 Km^2 = BSU count / 16

Summary table

LCEU Type	BSU count	Area (km^2)
Urban and associated		
Rainfed herbaceous cropland		
Forest tree cover		
Inland 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

LCEU Type	BSU count	Area (km^2)
Urban and associated		
Rainfed herbaceous cropland		
Forest tree cover		
Inland water bodies		
Open wetlands		
Total		

Level 1: Tools 2: Scaling

- Issues → testing
  - What is the best spatial level to maintain data (BSU, LCEU 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

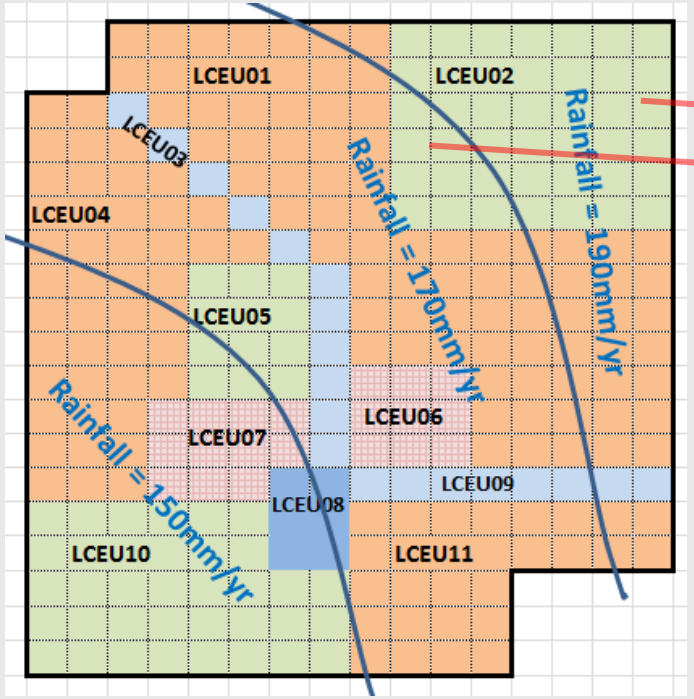
Level 1: Tools 2: Scaling

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with LCEU types
    - Have another map with **average** annual rainfall
    - Need to calculate **average** annual rainfall in LCEU02
  - Objective (Groups of 3-5)
    1. For LCEU02
       - 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 LCEU02

Map of BSUs and rainfall

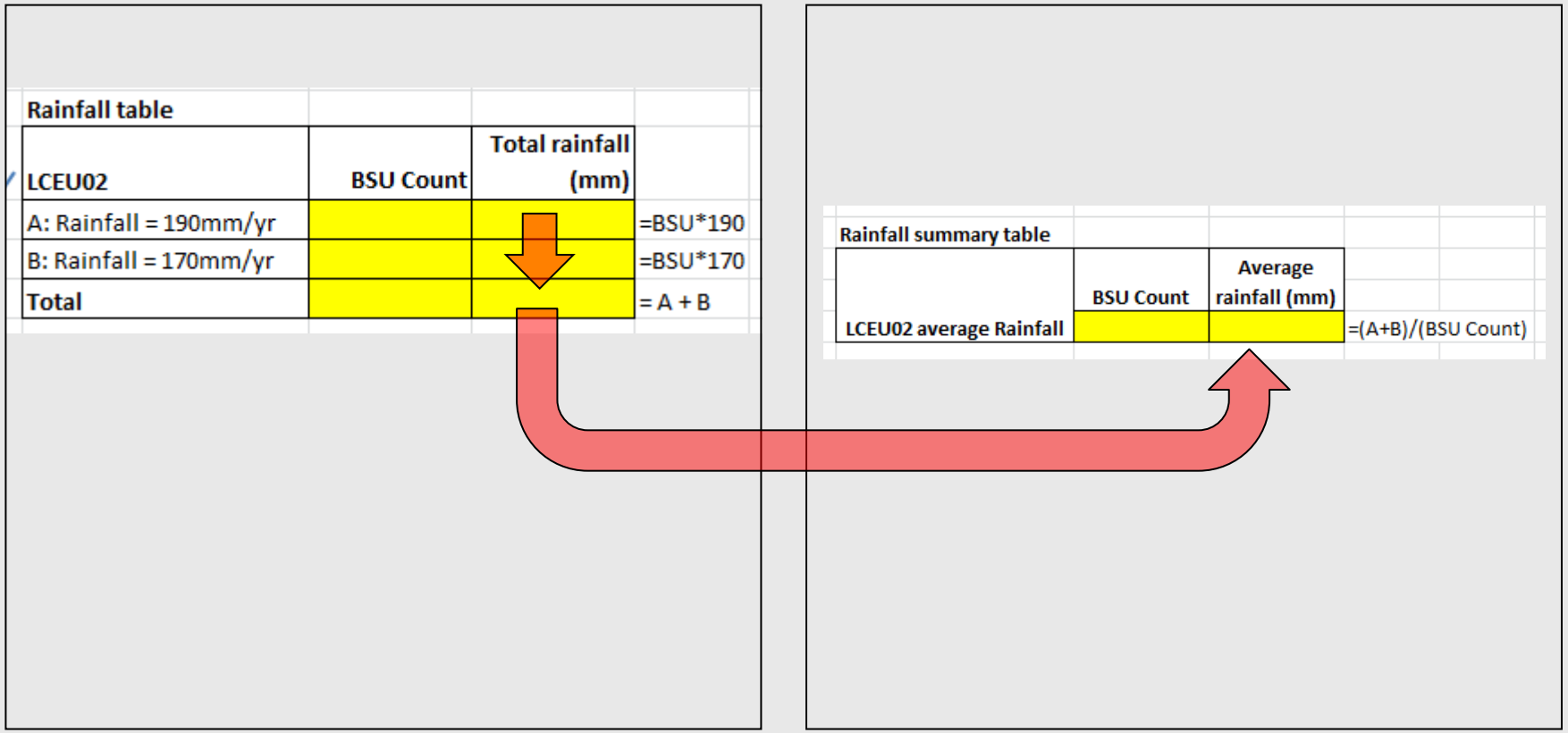


Rainfall table

LCEU02	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



Level 1: Tool 2: Spatial units

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - Report average annual rainfall for LECU02
  - Are the results “reasonable” (between 170 and 190)?

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

  - Why might this not be very precise?

Level 1: Tools 2: Aggregation

- Issues → testing
  - How to aggregate:
    - Ecosystem condition: Need one index or many?
    - Ecosystem services: physical units, different types (tonnes, risk, m^3, beneficiaries…)
  - Final aggregates:
    - e.g., total contribution of ecosystems to economy and human activities (well-being, health, welfare…)
    - Some recommend to monetize all services (real or potential dollars)
    - Cautions about monetary valuation:
      - Some services inappropriate to monetize (e.g., cultural fulfillment, flood risks)
      - Some approaches may mix market and welfare benefits (e.g., willingness to pay using contingent valuation)

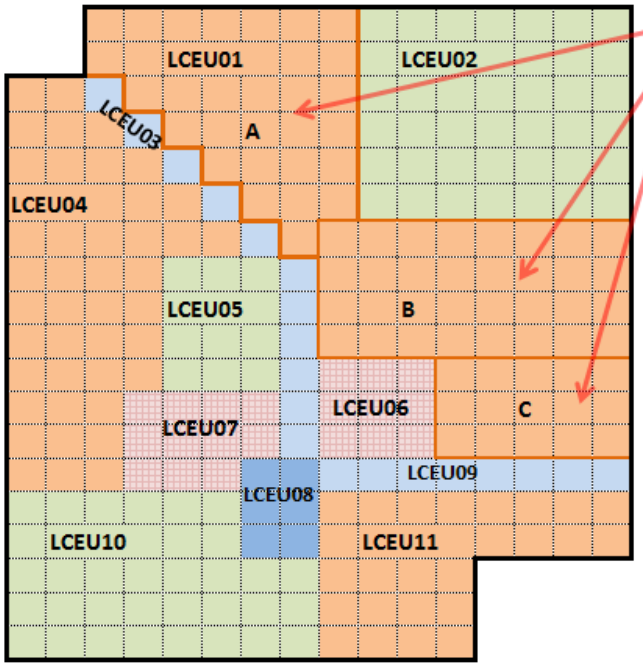
Level 1: Tools 2: Scaling

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with LCEU types
    - LCEU01 contains three farms (A, B and C) with different amounts of wheat production
    - Need to calculate **average** wheat production (tonnes/ha) for LCEU02
  - Objective (Groups of 3-5)
    1. Calculate productivity (tonnes/ha) for each farm in LCEU01
    2. Calculate total production (tonnes)
    3. Calculate average productivity (tonnes/ha) for LCEU02
    4. Report your results

Level 1: Tools 2: Aggregation

Group exercise: Step 1 – Count BSUs for each farm

Map of farms in LCEU02



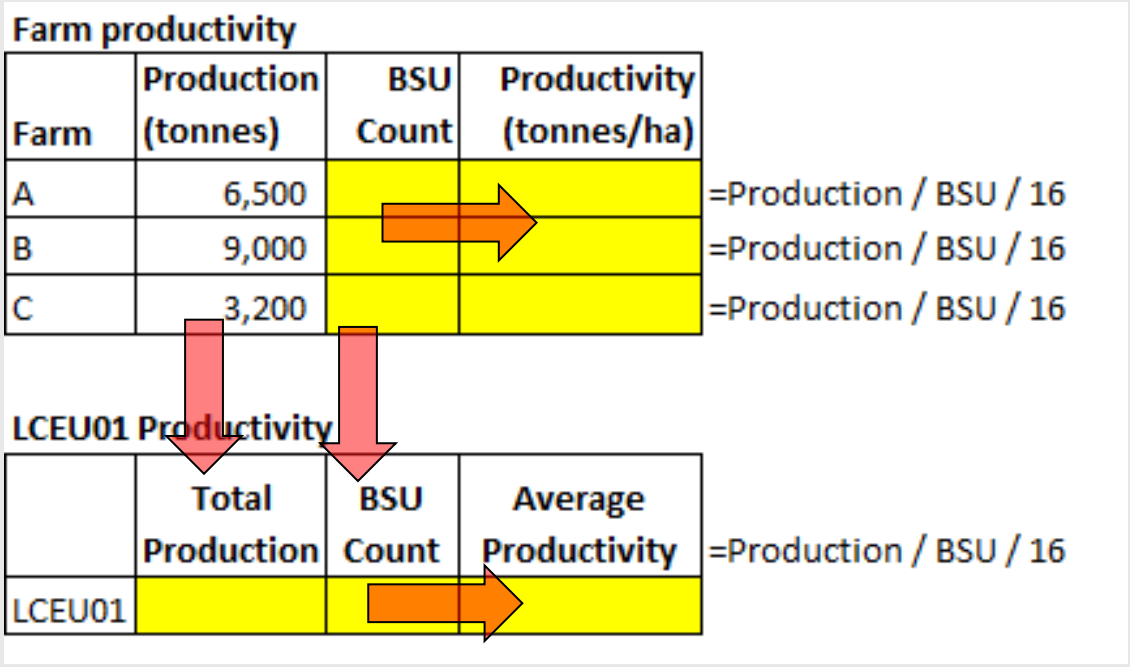
Farm Productivity Table

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

Level 1: Tools 2: Aggregation

Group exercise: Step 2 – Calculate productivity for each farm and LCEU02 total



Farm productivity

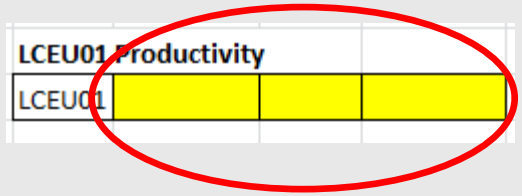
Farm	Production (tonnes)	BSU Count	Productivity (tonnes/ha)	
A	6,500			=Production / BSU / 16
B	9,000			=Production / BSU / 16
C	3,200			=Production / BSU / 16

LCEU01 Productivity

	Total Production	BSU Count	Average Productivity	
LCEU01				=Production / BSU / 16

Level 1: Tool 2: Aggregation

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - Report for LCEU02



    - Total wheat production
    - Total BSU count
    - Average wheat productivity
  - Are the results “reasonable”?
    - e.g., is LCEU 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 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
  - Not all the methods have been worked out
  - 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 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

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