System of Environmental Economic Accounting

Spatial Units, Scaling and Aggregation

(Level 1)

October 2017

United Nations

Overview: Spatial Units

1. Learning objectives
2. Review of "Level 0" (5m)
3. Level 1 (Compilers):

   Presentation & group exercise

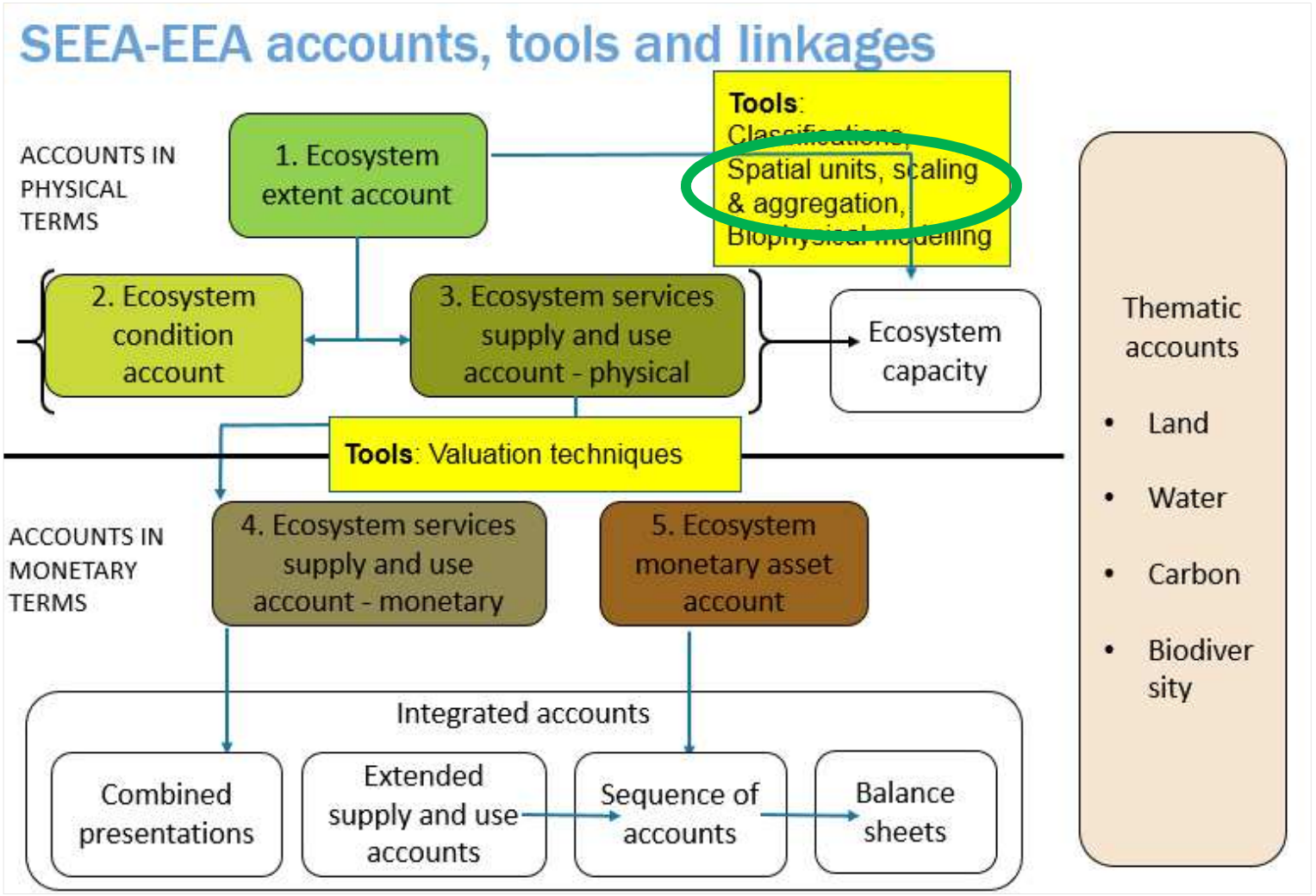
   - Spatial units (10m + 15m)
   - Scaling (10m + 15m)
   - Aggregation (10m + 15m)

4. Closing Discussion(10m)

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

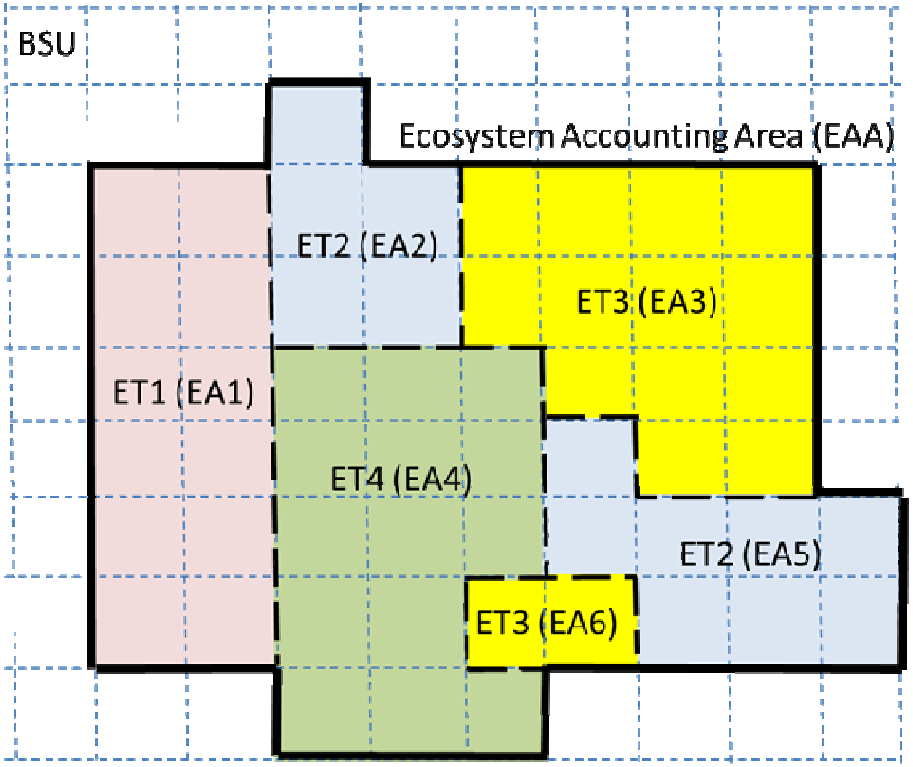


Review: Level 0
Spatial Units, Scaling and Aggregation

Level 0: Tools 2: Spatial units

- **What?**
  - A common definition of Spatial Units for all accounts
- **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



4 types of units

-Basic spatial units (BSU)

-Ecosystem asset (EA)

-Ecosystem type (ET)

-Ecosystem Accounting Area (EAA)

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

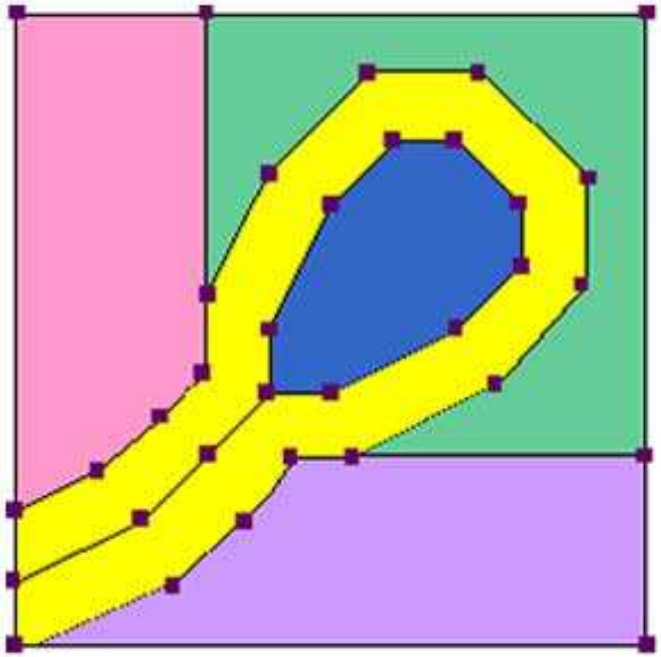
Level 1
Tools 2: Spatial Units

Level 1: Tools 2: Spatial units

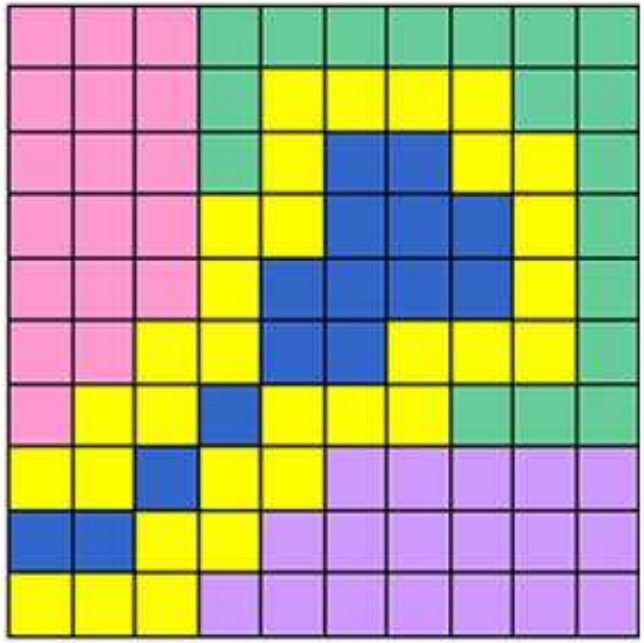
- Basic Spatial Unit (BSU), 2 types:
  - 1. A grid cell in raster based approach
    - "pixel" of land cover from satellite data
    - a "raster" downscaled from ecological data
  - 2. Individual polygon in case of vector based approach

  - The BSU is the smallest working unit
    - This could be 5m to 500m, depending on resolution
    - Higher resolution usually better, TR advice 25m to 100 m grid size
  - 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)

Raster versus vector

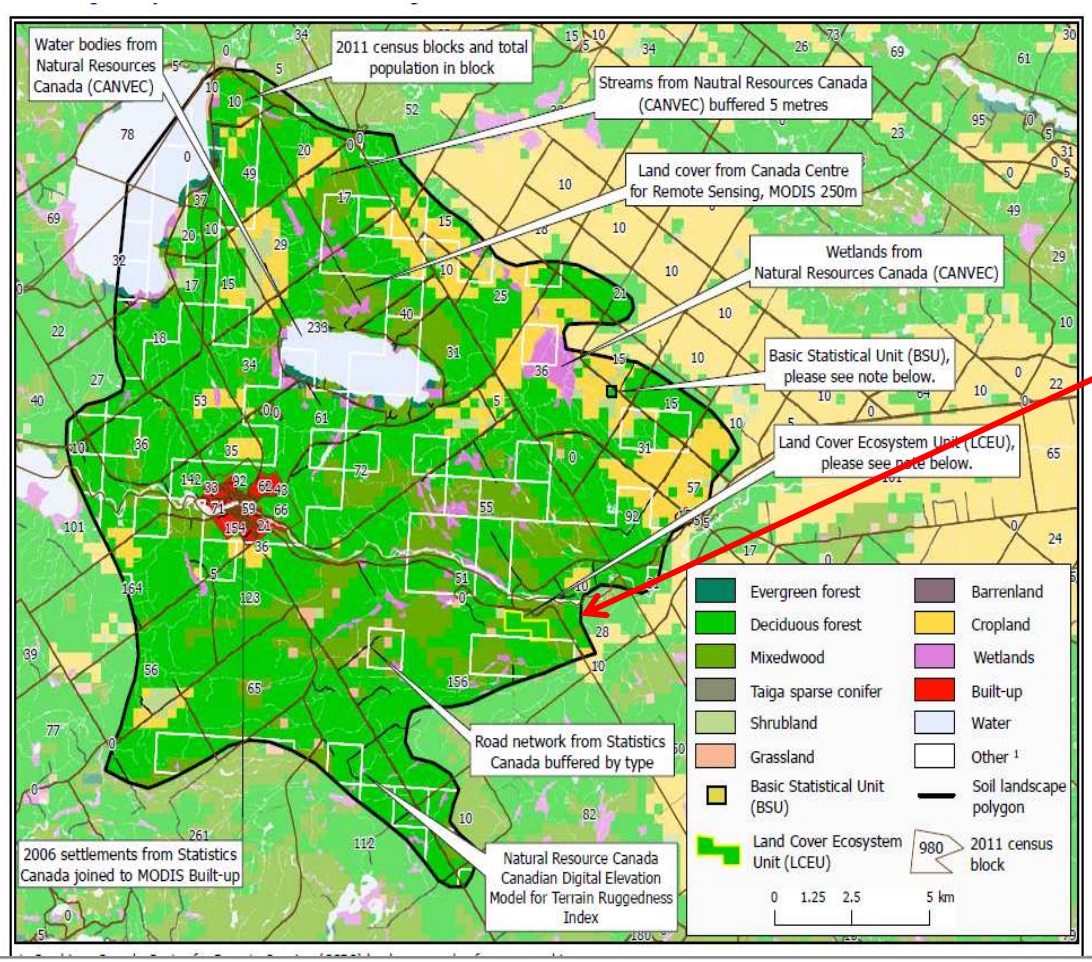


Vector



Raster

Canada's MEGS Project



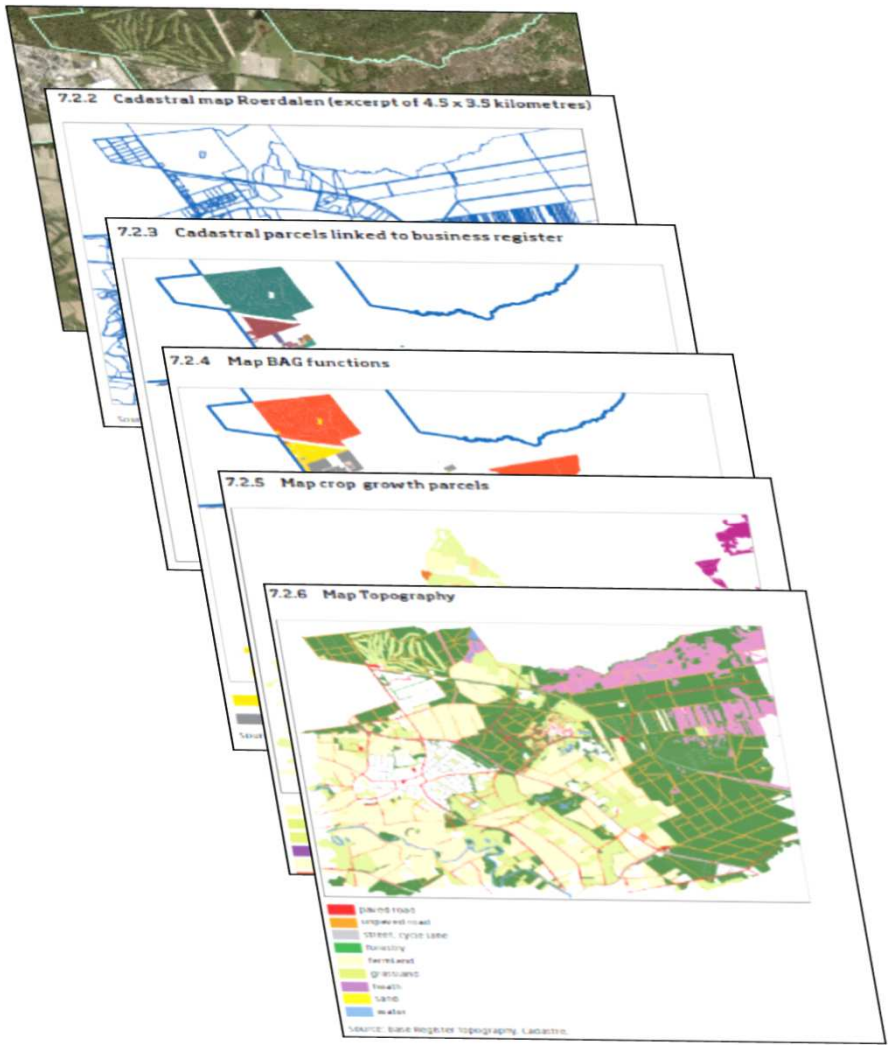
MEGS (Measuring Ecosystem Goods and Services) used detailed hydrological, topographic, population and road data.

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

This defined 921,000 EUs for Canada.

Statistics Canada, 2013

Netherlands – overlaying maps



Starting point is cadastral map

The cadastrial map is overlayed by various additional maps

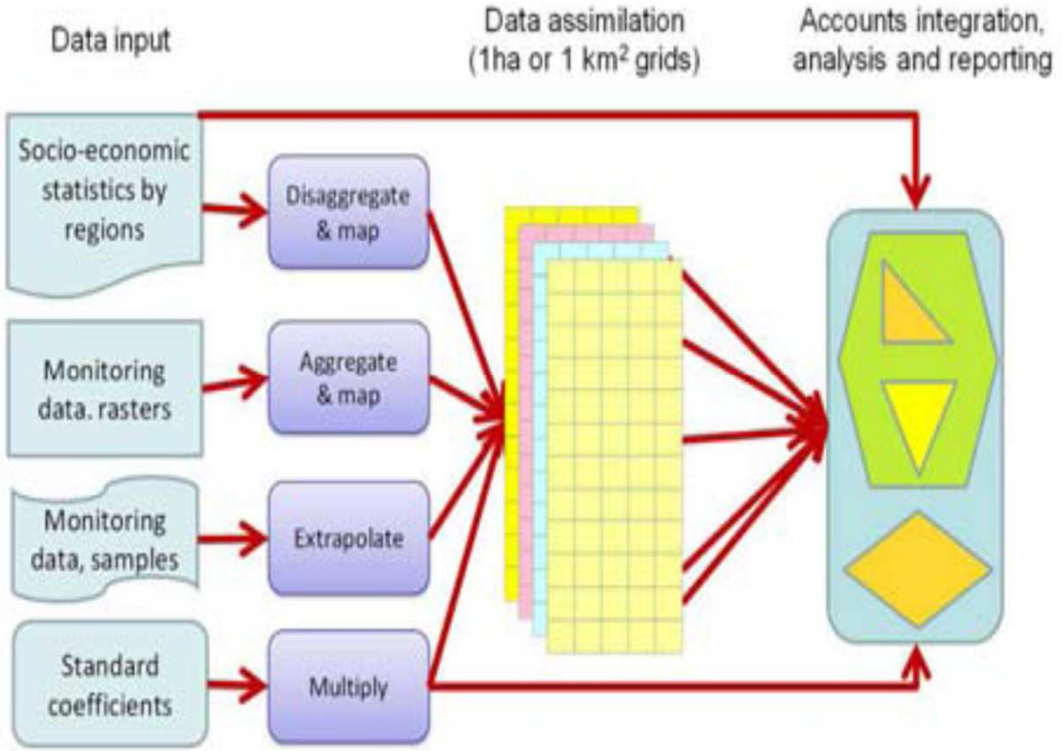
The BSUs are the polygons i.e. the smallest areas that result after multiple crossings

BSUs subsequentially aggregated into EA and ET

- Source: Statistics Netherlands, 2014, 2017

SEEA

SCBD's Quick Start Package (Weber, 2014)



The suggested SCBD (Secretariat for the Convention on Biological Diversity) QSP data framework allocates data to 1km² 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

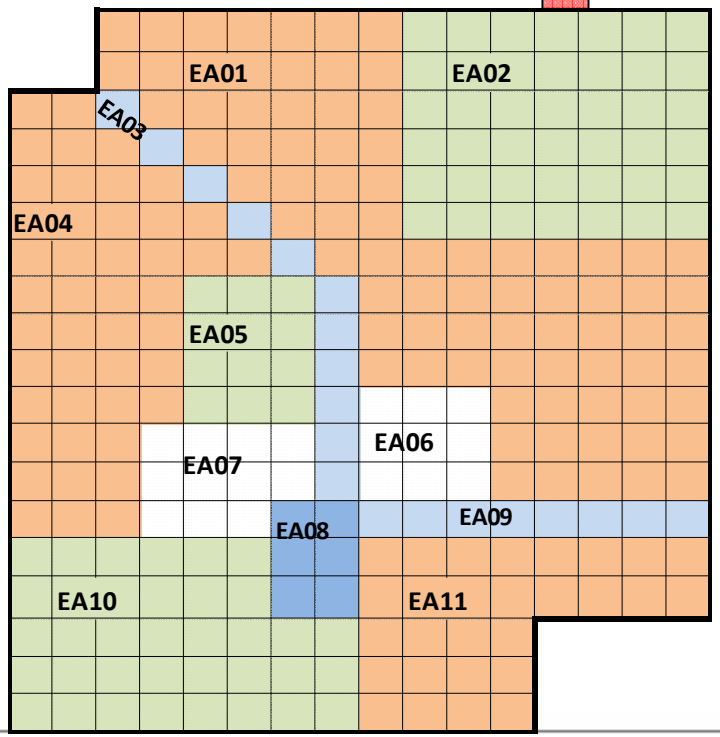
Level 1: Tools 2: Spatial units

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

Level 1: Tools 2: Spatial units

Group exercise: Step 1 – Count area for each EU

Map of BSUs



EA table

EA Table

EA	BSU count	Area (km^2)
EA01 = Herbaceous crops		
EA02 = Tree covered areas		
EA03 = Inland water bodies		
EA04 = Herbaceous crops		
EA05 = Tree covered areas		
EA06 = Artificial surfaces (urban)		
EA07 = Artificial surfaces (urban)		
EA08 = Shrubs..regularly flooded (wetland)		
EA09 = Inland water bodies		
EA10 = Tree covered areas		
EA11 = Herbaceous crops		
Total		

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

Level 1: Tools 2: Spatial units

Group exercise: Step 1 – Count area for each EA

EA table

EA Table

EA	BSU count	Area (km^2)
EA01 = Herbaceous crops		
EA02 = Tree covered areas		
EA03 = Inland water bodies		
EA04 = Herbaceous crops		
EA05 = Tree covered areas		
EA06 = Artificial surfaces (urban)		
EA07 = Artificial surfaces (urban)		
EA08 = Shrubs..regularly flooded (wetland)		
EA09 = Inland water bodies		
EA10 = Tree covered areas		
EA11 = Herbaceous crops		
Total		

Note: 1 Km^2 = BSU count / 16

Summary table

Summary Table

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

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

Level 1: Tool 2: Spatial units

The answers

Summary Table

ET (ecosystem type)	BSU count	Area (km^2)
Artificial surfaces (urban)	20	1.3
Herbaceous crops	153	9.6
Tree covered areas	90	5.6
Inland water bodies	19	1.2
Shrubs..regularly flooded (wetland)	6	0.4
Total	**288**	**18.0**

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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    - Attributing information from smaller areas to larger areas
    - **Caution**: Data need to be representative
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Level 1: Tools 2: Scaling

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

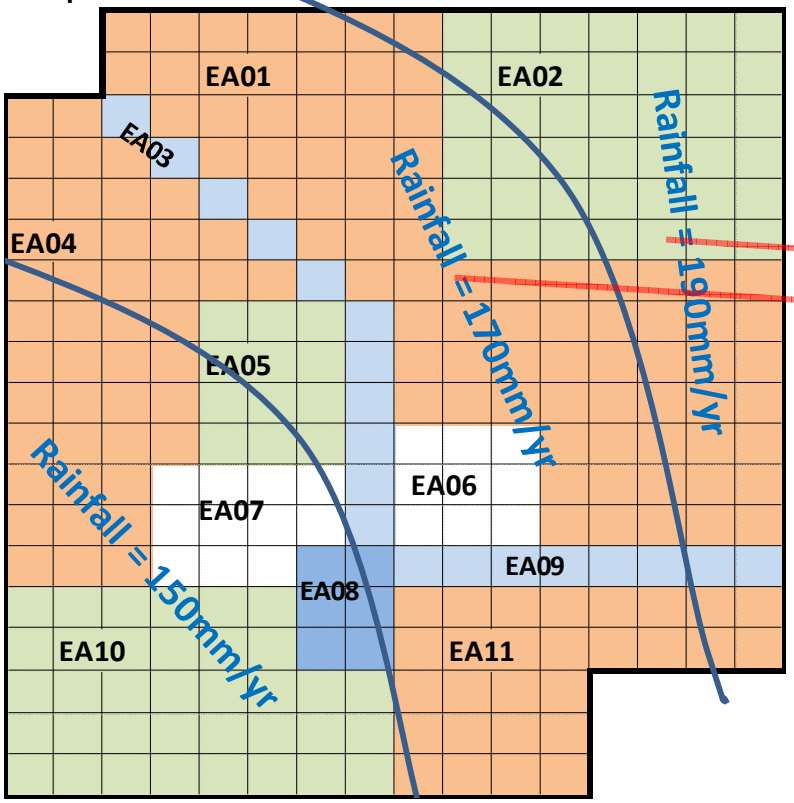
Level 1: Tools 2: Scaling

- Compilation Group exercise (15m)
  - > Situation:
    - Have a map with EA types
    - Have another map with **average** annual rainfall
    - Need to calculate **average** annual rainfall in EA02
  - > Objective (Groups of 3-5)
    1. For EA02
       - •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 EA02

Map of BSUs and rainfall



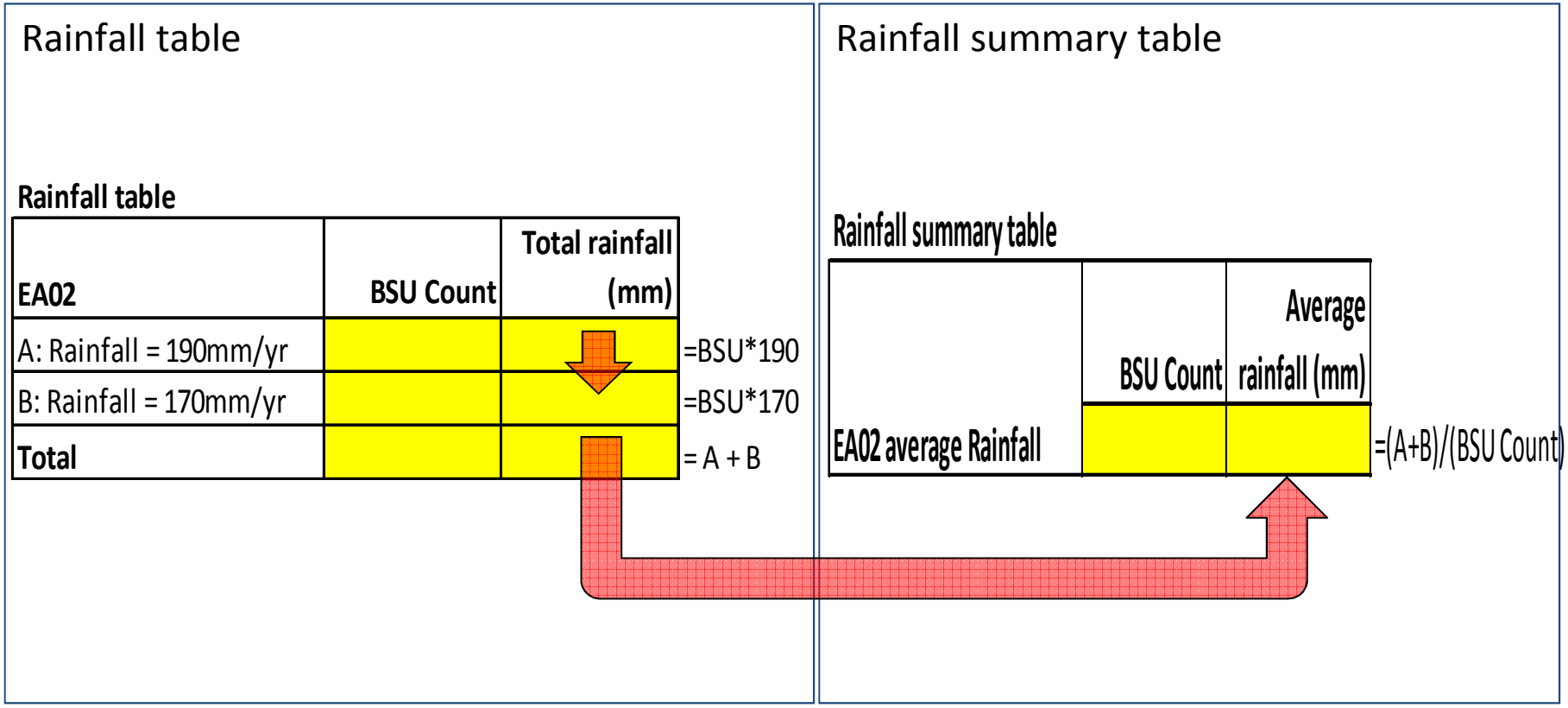
Rainfall Table

Rainfall table

EA02	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: Scaling

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - > Report average annual rainfall for EA02
  - > Are the results "reasonable" (between 170 and 190)?

Rainfall summary table

	BSU Count	Average rainfall (mm)	
EA02 average Rainfall			=(A+B)/(BSU Count)

  - > Why might this not be very precise?

Level 1: Tool 2: Scaling

Answers:

Average rainfall for EA02 = **185mm/yr**

Rainfall table

EA02	BSU Count	Total rainfall (mm)	
A: Rainfall = 190mm/yr	32	6,080	=BSU*190
B: Rainfall = 170mm/yr	10	1,700	=BSU*170
Total	42	7,780	= A + B

Rainfall summary table

	BSU Count	Average rainfall (mm)	
EA02 average Rainfall	**42**	**185**	=(A+B)/(BSU Count)

Level 1: Tools 2: Aggregation

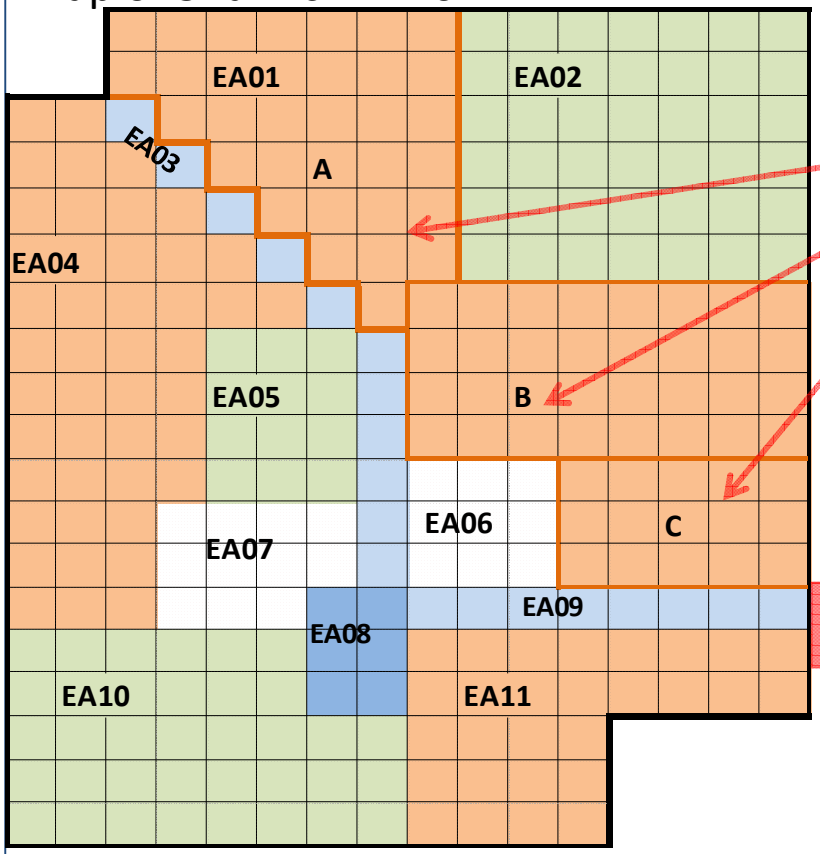
Level 1: Tools 2: Aggregation

- Compilation Group exercise (15m)
  - Situation:
    - Have a map with E types
    - EA01 contains three farms (A, B and C) with different amounts of wheat production
    - Need to calculate **average** wheat production (tonnes/ha) for EA01
  - Objective (Groups of 3-5)
    1. Calculate productivity (tonnes/ha) for each farm in EA01
    2. Calculate total production (tonnes)
    3. Calculate average productivity (tonnes/ha) for EA01
    4. Report your results

Level 1: Tools 2: Aggregation

Group exercise: Step 1 – Count BSUs for each farm

Map of 3 farms in EA01



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

EA01 Productivity

	Total Production	BSU Count	Average Productivity	
EA01				=Production / BSU / 16

Level 1: Tools 2: Aggregation

Group exercise: Step 2 – Calculate productivity for each farm and EA01 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

EA01 Productivity

	Total Production	BSU Count	Average Productivity	
EA01				=Production / BSU / 16

Level 1: Tool 2: Aggregation

- Is everyone clear on the objectives?
- 15 minutes group work
- Please ask questions
- Results:
  - > Report for EA01
    - Total wheat production
    - Total BSU count
    - Average wheat productivity
  - > Are the results "reasonable"?
    - e.g., is EA productivity within the range of productivity for farms?

EA01 Productivity

	Total Production	BSU Count	Average Productivity
EA01			

Level 1: Tool 2: Aggregation

Answers

The average productivity of the three farms in EA01 = 14.61 tonnes/ha

Farm productivity

Farm	Production (tonnes)	BSU Count	Productivity (tonnes/ha)
A	6,500	33	12.31
B	9,000	32	17.58
C	3,200	15	13.33

EA01 Productivity

	Total Production	BSU Count	Average Productivity
EA01	18,700	80	14.61

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.
  - Statistics Netherlands. Ecosystem Unit map, product description Statistics Netherlands, 2017
- Further Information
  - SEEA Experimental Ecosystem Accounting (2012)
  - SEEA-EEA Technical Recommendations
    - Detailed supporting document on "Spatial Units, Scaling and Aggregation" by Michael Bordt

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