Flanders
State of
the Art

Impact of
on Erosion

Comparing different Resolutions in Flanders' WaTEM

DEPARTMENT OF
ENVIRONMENT
& SPATIAL
DEVELOPMENT

Flanders

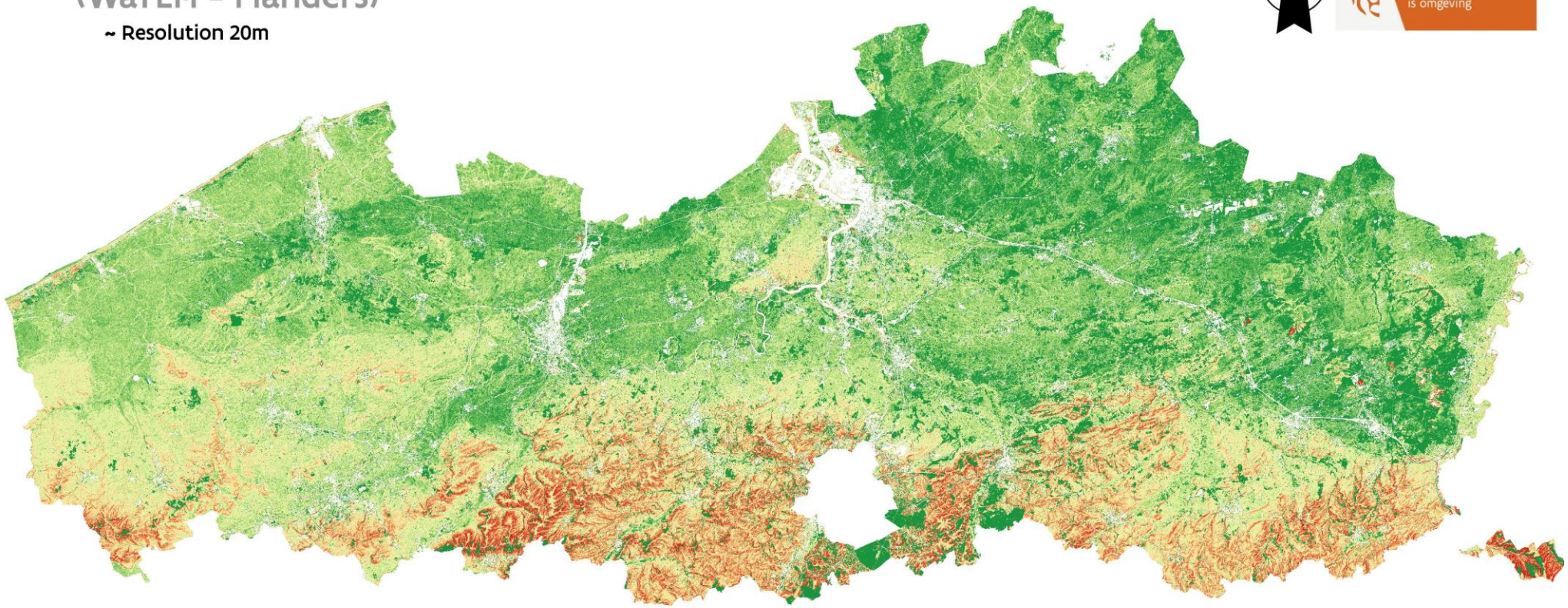
Soil Loss by Water

(WaTEM - Flanders)

~ Resolution 20m

DEPARTEMENT OMGEVING

Vlaanderen is omgeving



Potential Soil Loss Rate

t/ha per year

- <= 0.5
- 0.5 - 1.0
- 1.0 - 2.0
- 2.0 - 5.0
- 5.0 - 10.0
- 10.0 - 20.0
- 20.0 - 50.0
- > 50.0

0 30 60 90 120 150 km

Flanders

Soil Loss by Water

(WaTEM - Flanders)

~ Resolution 100m

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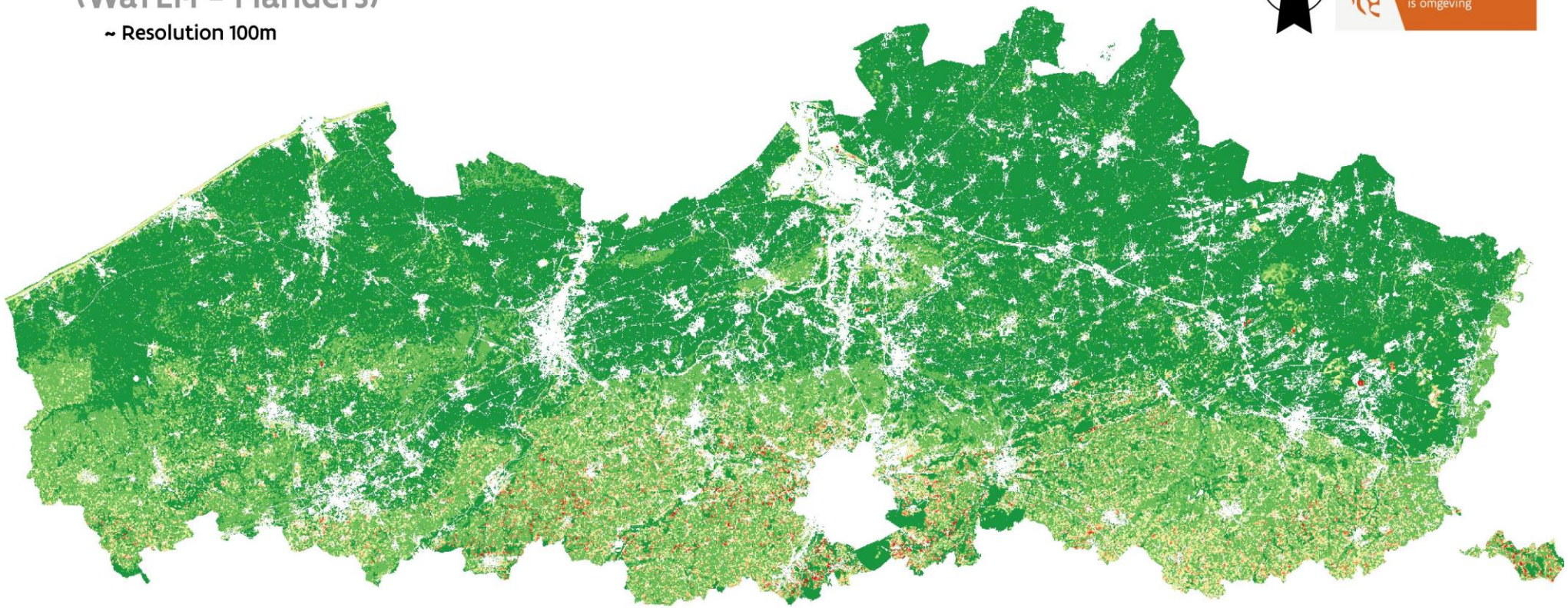

Potential Soil Loss Rate

t/ha per year

<= 0.5	5.0 - 10.0
0.5 - 1.0	10.0 - 20.0
1.0 - 2.0	20.0 - 50.0
2.0 - 5.0	> 50.0

0 30 60 90 120 150 km

Table of Contents

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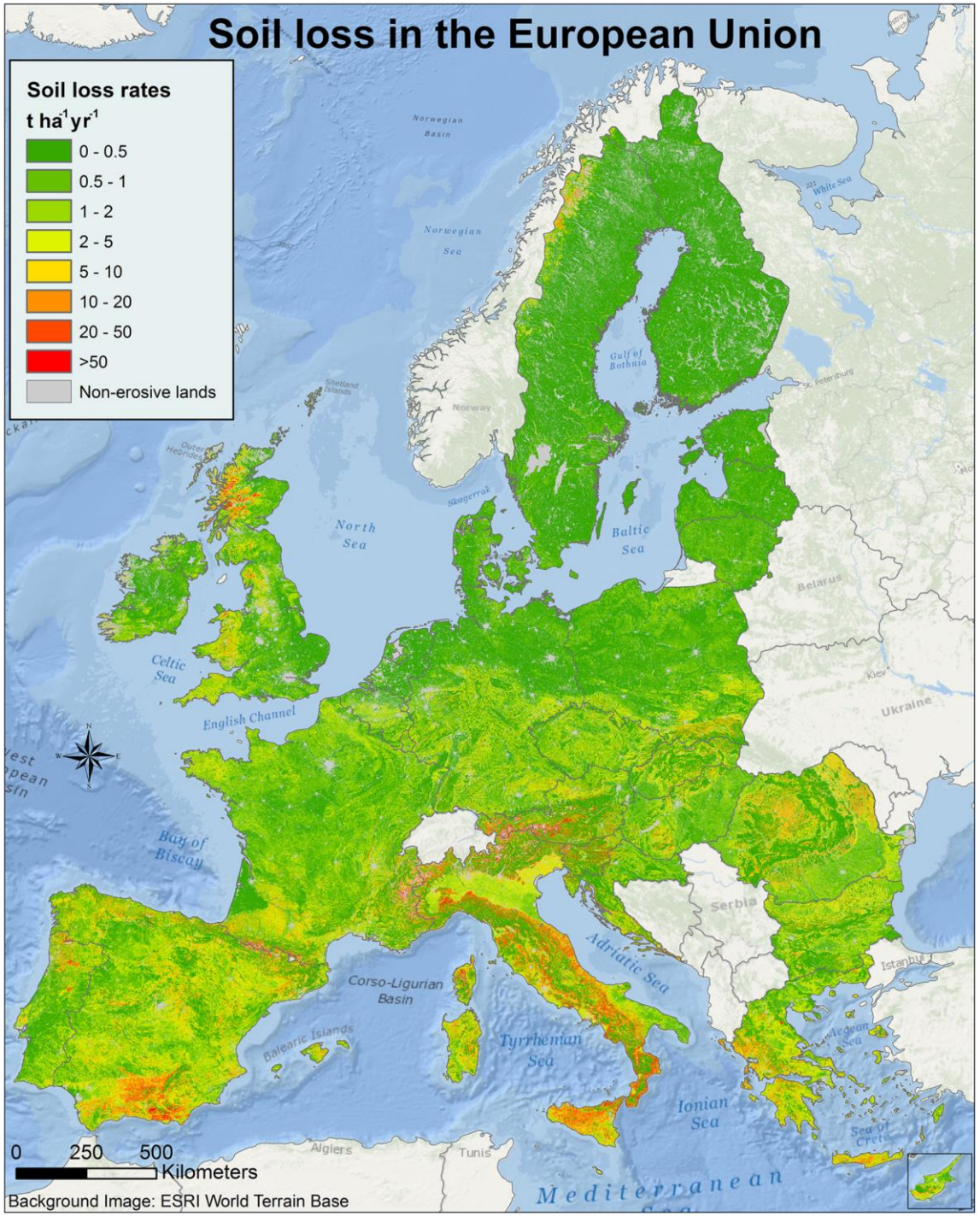
Problem Statement

What & Why of Resolution Issues

- Erosion Maps
  - → Different use cases:
    - Policy
    - Research
    - Practical
    - Indicators
  - → Different Scales:
    - Catchment
    - Regional/National
    - Pan-European (e.g. Panagos et al.)
    - Global (e.g. GSP)
- Different Uses <-> Different Scales
  - → Different Resolutions
  - → Different Story



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Problem Statement

Objectives of this Case Study

- Main Objectives:
  - → Show Impact Resolution on Erosion Maps
  - → Compare different Methods
- Side Objectives
  - → Find driving Factors for Differences
  - → Raise awareness of the Importance of Resolution

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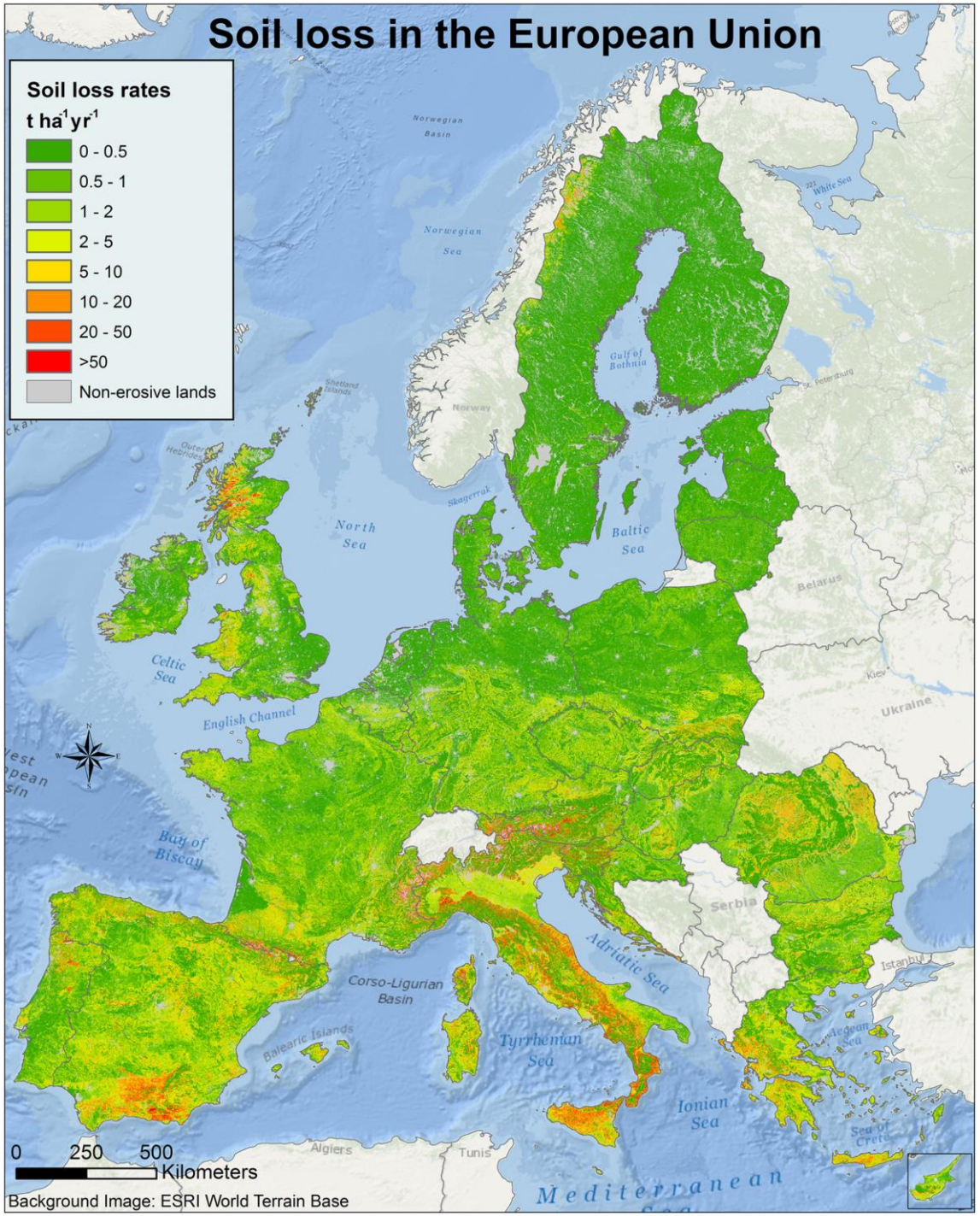

Methodology

Analysis Methods: 3-types

- **Model**
  - → WaTEM for Flanders
    - → SAGA-GIS toolbox
    - → Used for legislation in Flanders
    - → Basic Model
      - RUSLE : $A = R \cdot K \cdot LS \cdot C \cdot P$
      - Uses simple input
      - Calculates Potential Erosion Rates

- **Methods for comparison**
  1. Changing Resolution of the Initial Input
     - → Regional datasets (5 m)
     - → Resampled files: Landuse, DEM and K-Factor
  2. Changing Resolution of Final Input for WaTEM
     - → Calculations done on 5 m resolution
     - → Resampled files: K-Factor, C-Factor and LS-Factor
  3. Changing Resolution of output
     - → Calculate Erosion Rates for 5 m resolution
     - → Resampled file: Erosion Rates

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Methodology

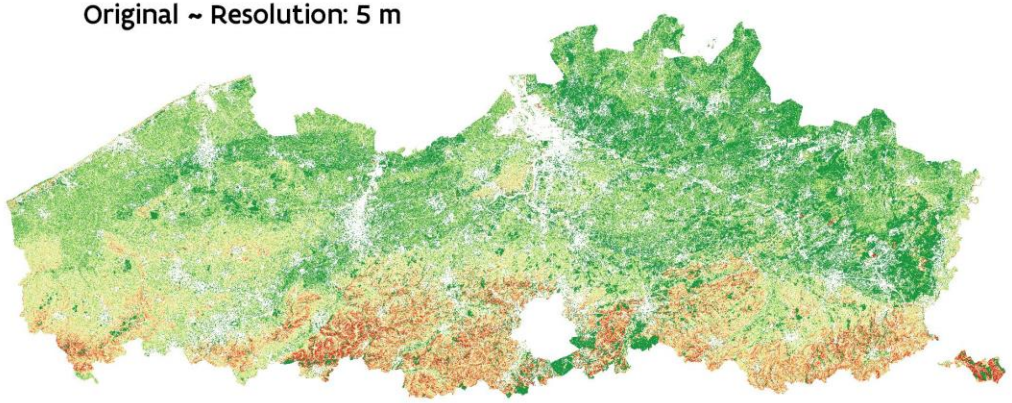
Resampling Methods

- **Resampling depends on Data**
  - → Average Resampling
    - → Takes weighted average of pixels inside new pixel
    - → Used for:
      - Continuous Variables:
        - DEM
        - LS-Factor
        - Erosion Rates
  - → Mode Resampling
    - → Takes most common value inside new pixel
    - → Used for:
      - Discrete and Categorical Variables:
        - K-Factor
        - Landuse
        - C-Factor
  - → Other Resampling types:
    - → Nearest Neighbour, Bilinear/Cubic, Min/Max
    - → Not used in this study

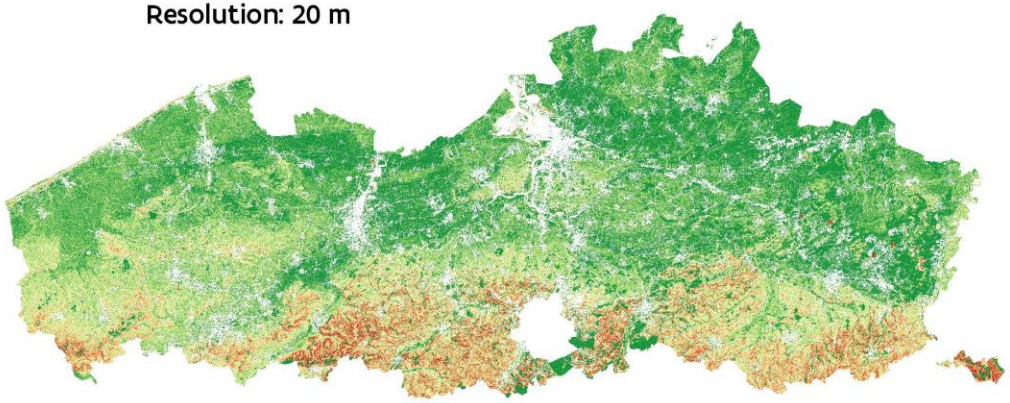
Results

Method 1

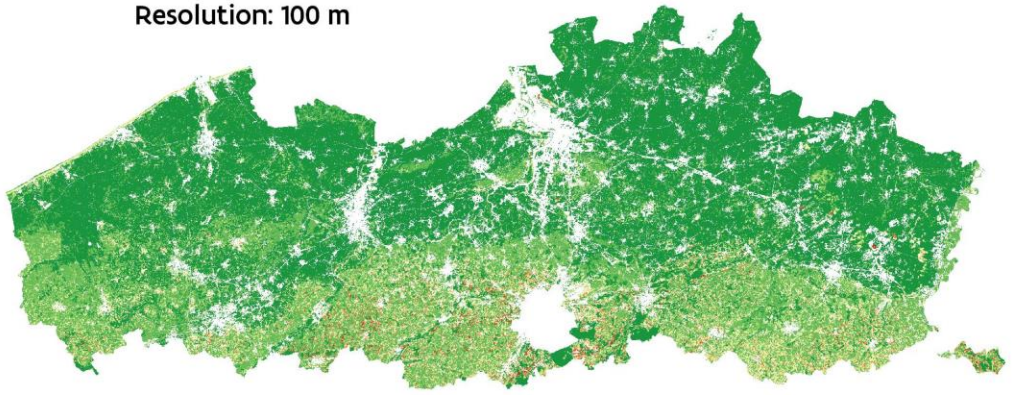
Original ~ Resolution: 5 m



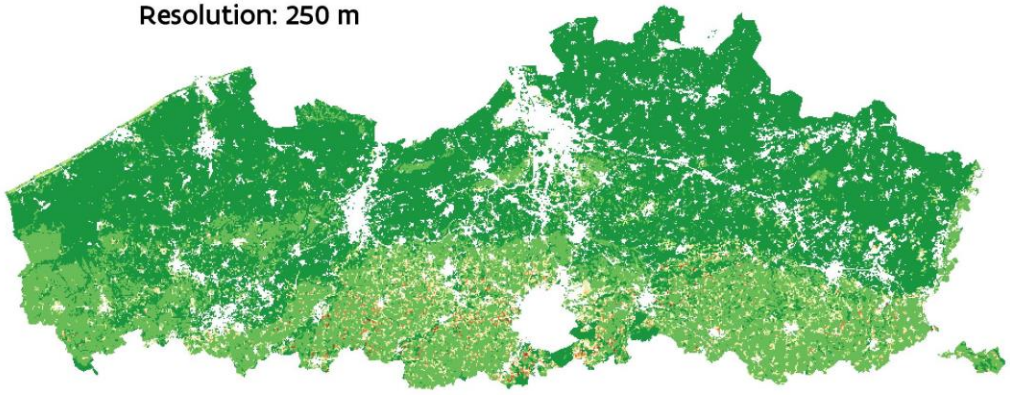
Resolution: 20 m



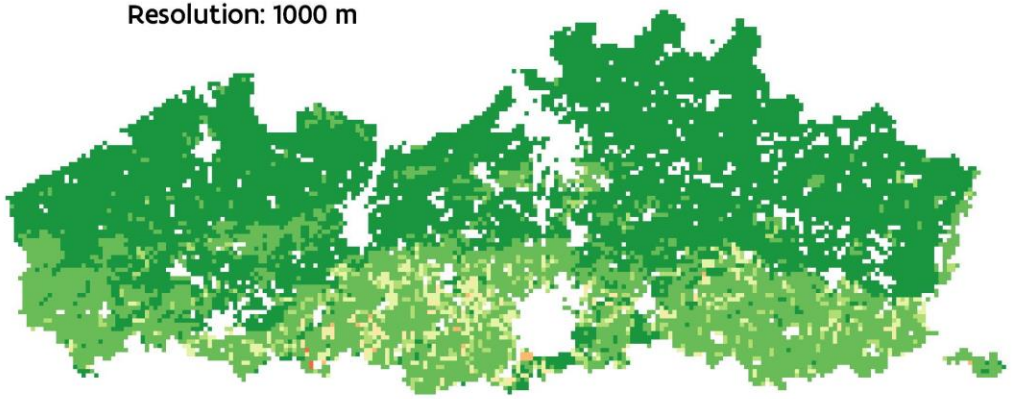
Resolution: 100 m



Resolution: 250 m



Resolution: 1000 m



Summary Map:

Initial Input Method

Soil Loss Rate

t/ha per year

<= 0.5	2.0 - 5.0	20.0 - 50.0
0.5 - 1.0	5.0 - 10.0	> 50.0
1.0 - 2.0	10.0 - 20.0	

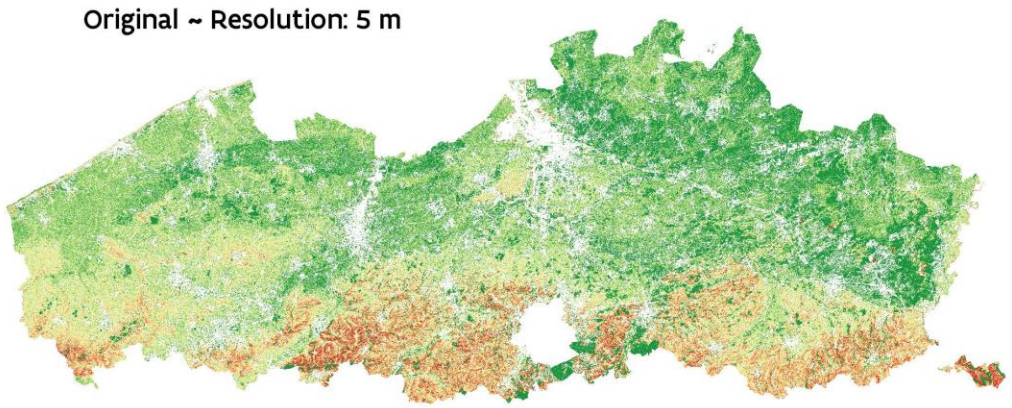
0 25 50 75 100 125 150 km

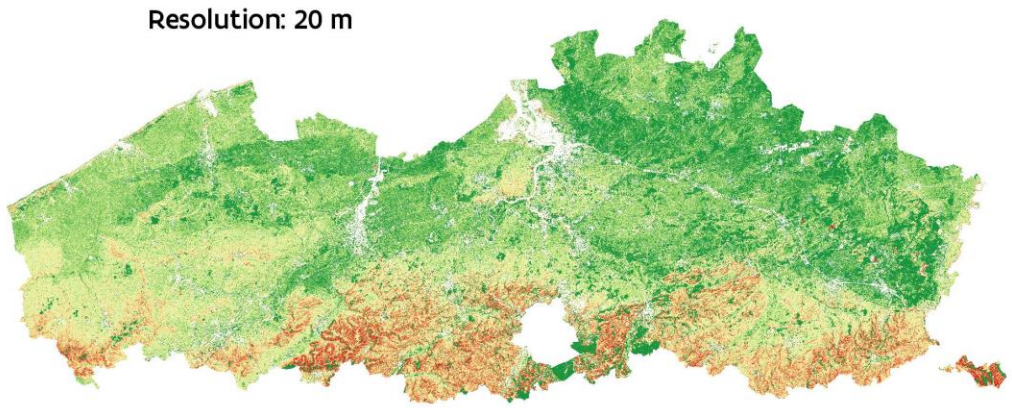
DEPARTEMENT OMGEVING

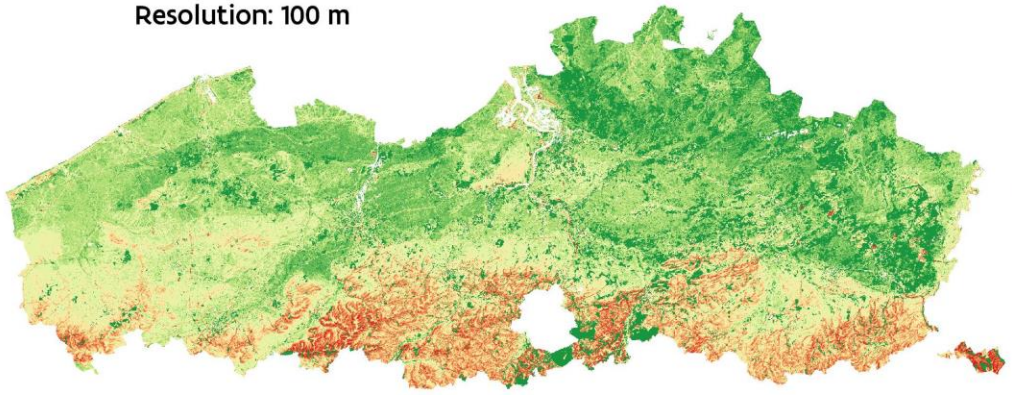
Vlaanderen is omgeving

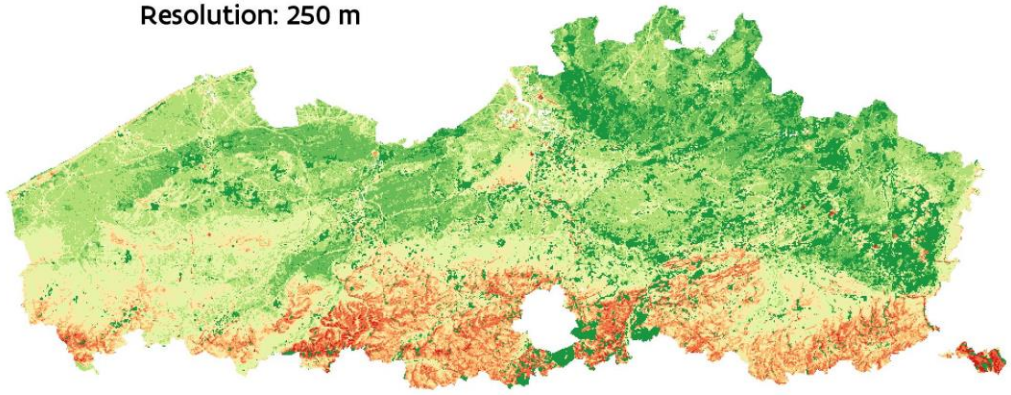
Results

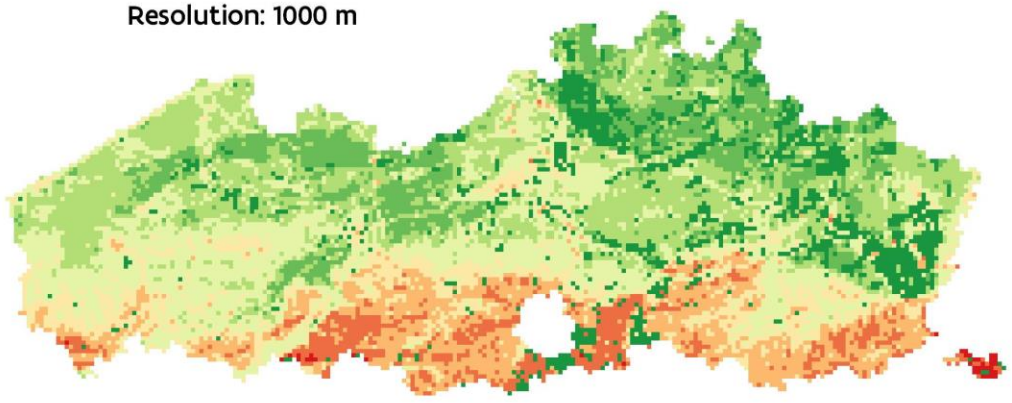
Method 2











Summary Map:

Final Input Method

Soil Loss Rate

t/ha per year

<= 0.5	2.0 - 5.0	20.0 - 50.0
0.5 - 1.0	5.0 - 10.0	> 50.0
1.0 - 2.0	10.0 - 20.0	

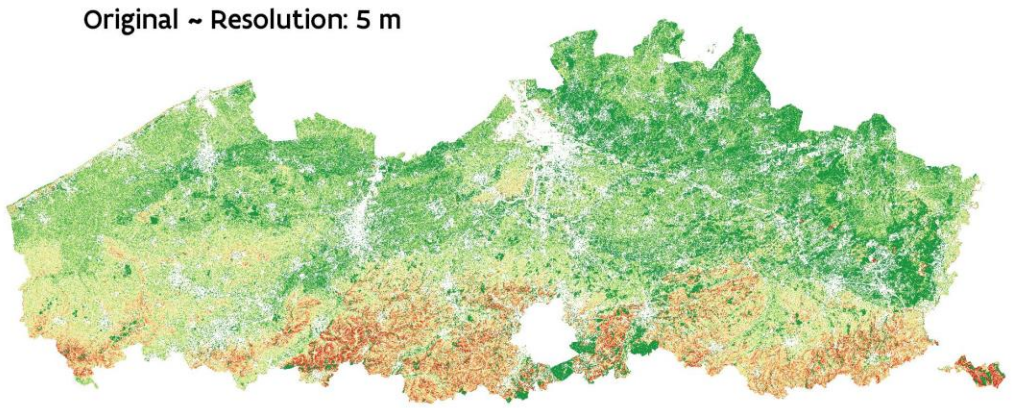
0 25 50 75 100 125 150 km

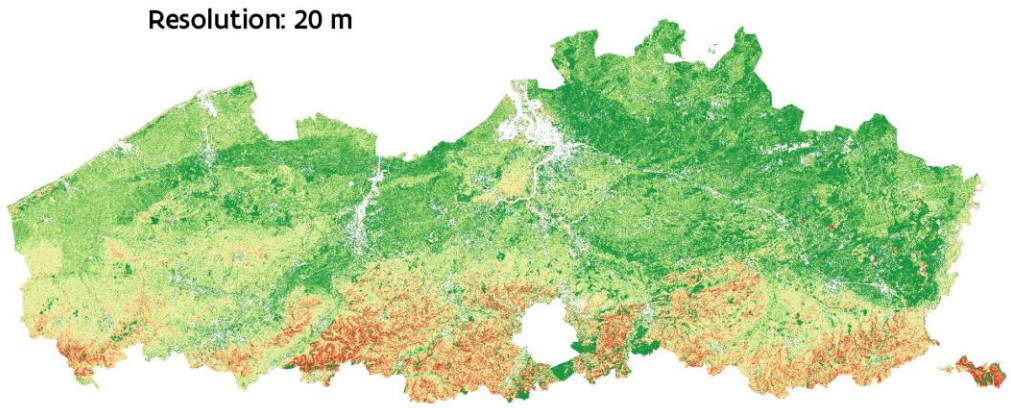
DEPARTEMENT OMGEVING

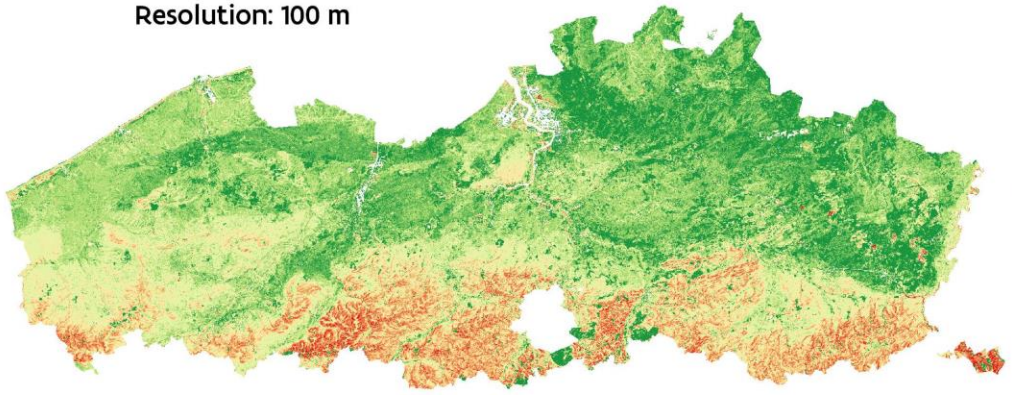
Vlaanderen is omgeving

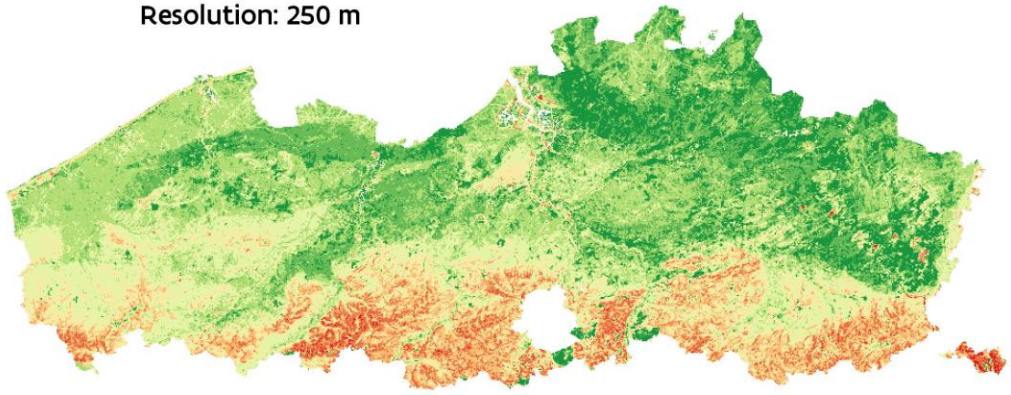
Results

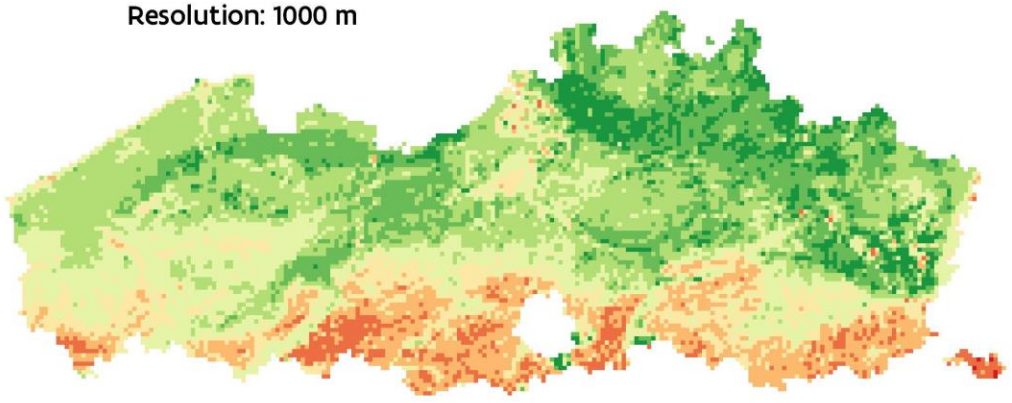
Method 3











Summary Map:

Output Method

Soil Loss Rate

t/ha per year

<= 0.5	2.0 - 5.0	20.0 - 50.0
0.5 - 1.0	5.0 - 10.0	> 50.0
1.0 - 2.0	10.0 - 20.0	

0 25 50 75 100 125 150 km

DEPARTEMENT OMGEVING

Vlaanderen is omgeving

Results

Comparing Methods

	5 m			20 m			100 m			250 m			1000 m		
	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3	M1	M2	M3
Maximum	150	150	150	150	150	150	150	150	145	150	150	126	36	110	61
Mean	4.8	4.8	4.8	3.9	4.6	4.4	1.3	4.8	4.4	0.8	5.0	4.5	0.5	5.4	4.6
Standard deviation	11.3	11.3	11.3	10.0	10.4	9.7	4.8	9.2	8.3	3.1	8.6	7.3	1.0	8.1	6.3

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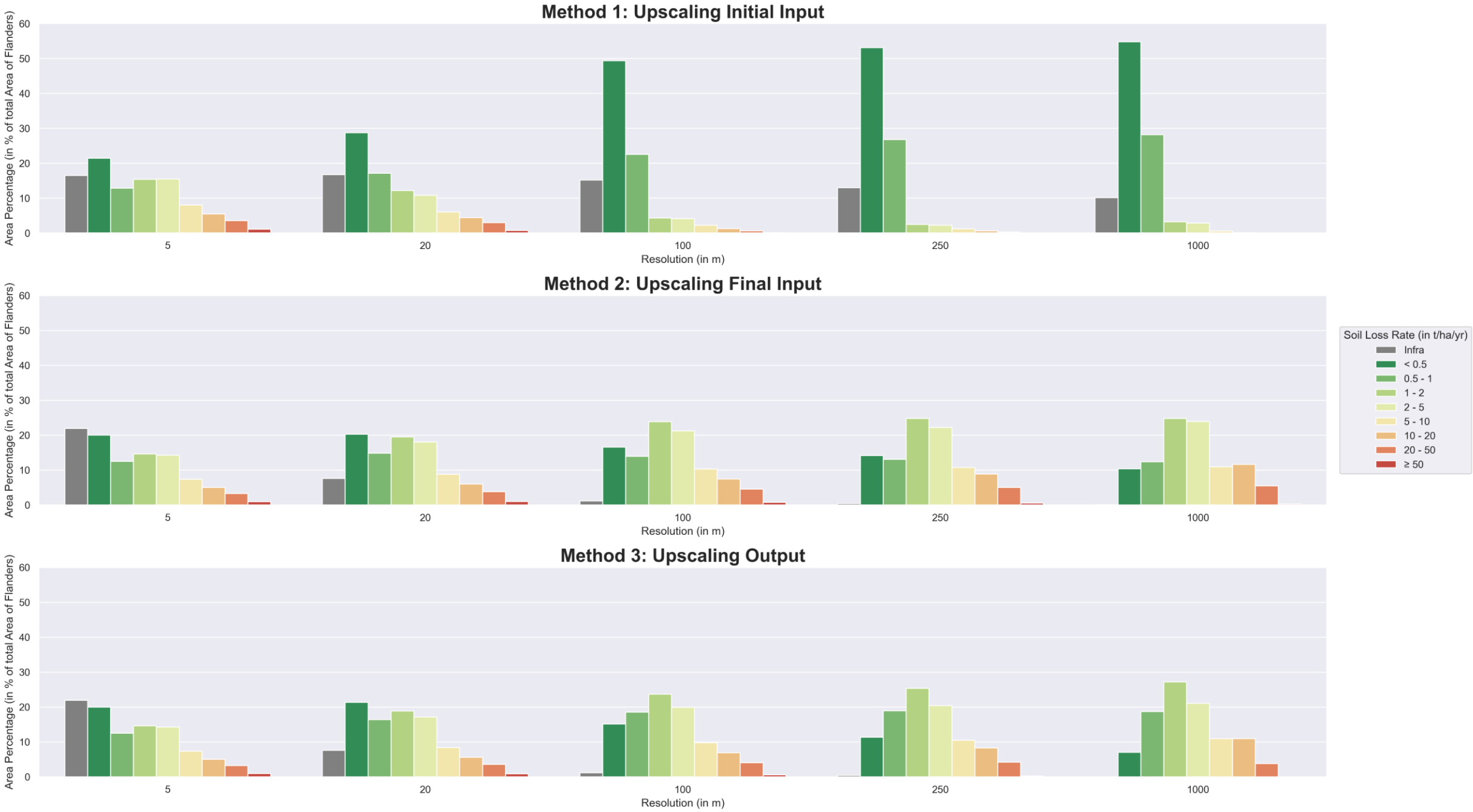
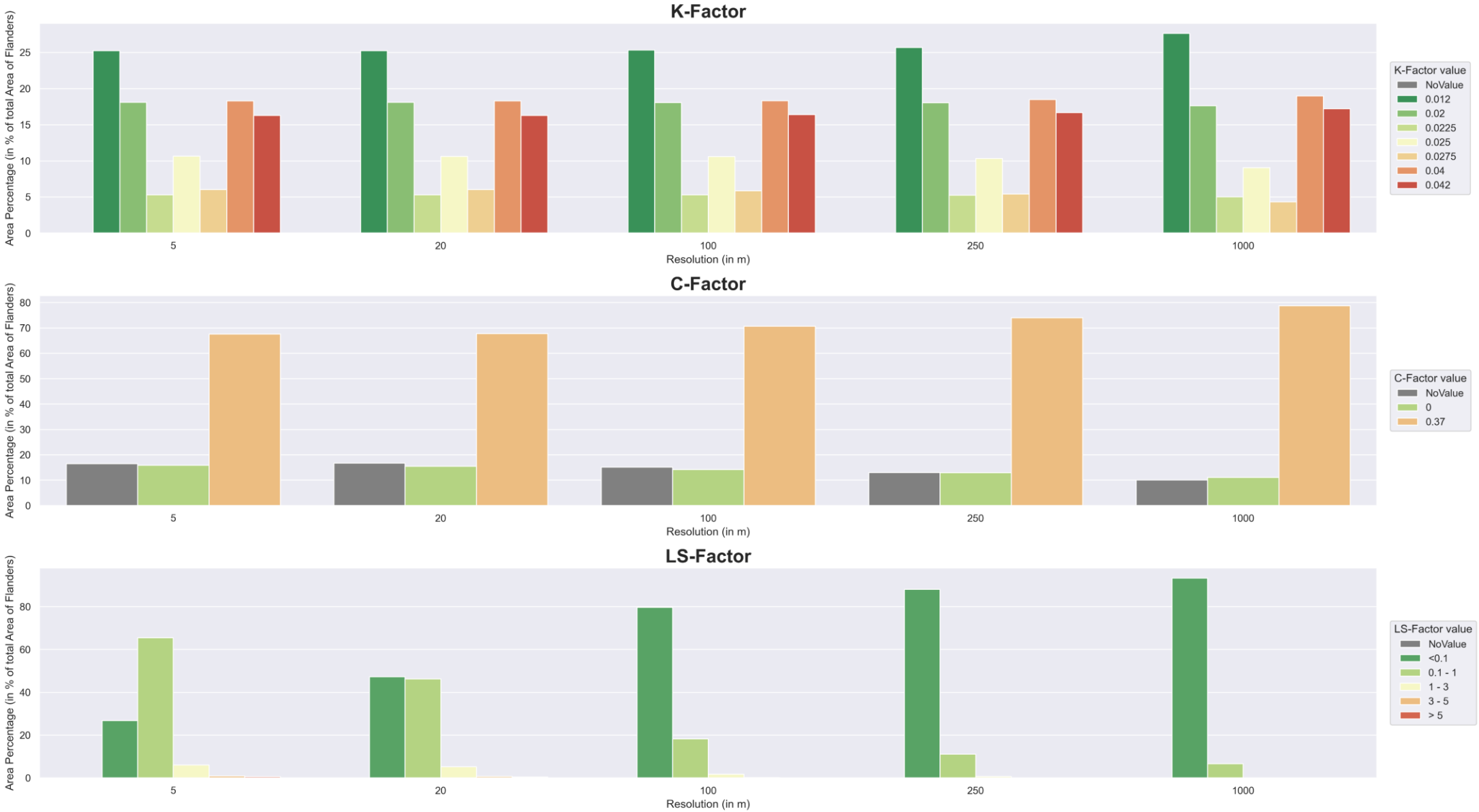
*Units in t/ha/yr


Method 1: Upscaling Initial Input
Area Percentage (in % of total Area of Flanders)
0
10
20
30
40
50
60
5
20
100
250
1000
Resolution (in m)
Method 2: Upscaling Final Input
Area Percentage (in % of total Area of Flanders)
Resolution (in m)
Method 3: Upscaling Output
Area Percentage (in % of total Area of Flanders)
Resolution (in m)
Soil Loss Rate (in t/ha/yr)
Infra
< 0.5
0.5 - 1
1 - 2
2 - 5
5 - 10
10 - 20
20 - 50
≥ 50

Results

Finding the Diverging Factor (for Method 1)



Results

Finding the Diverging Factor (LS-Factor)

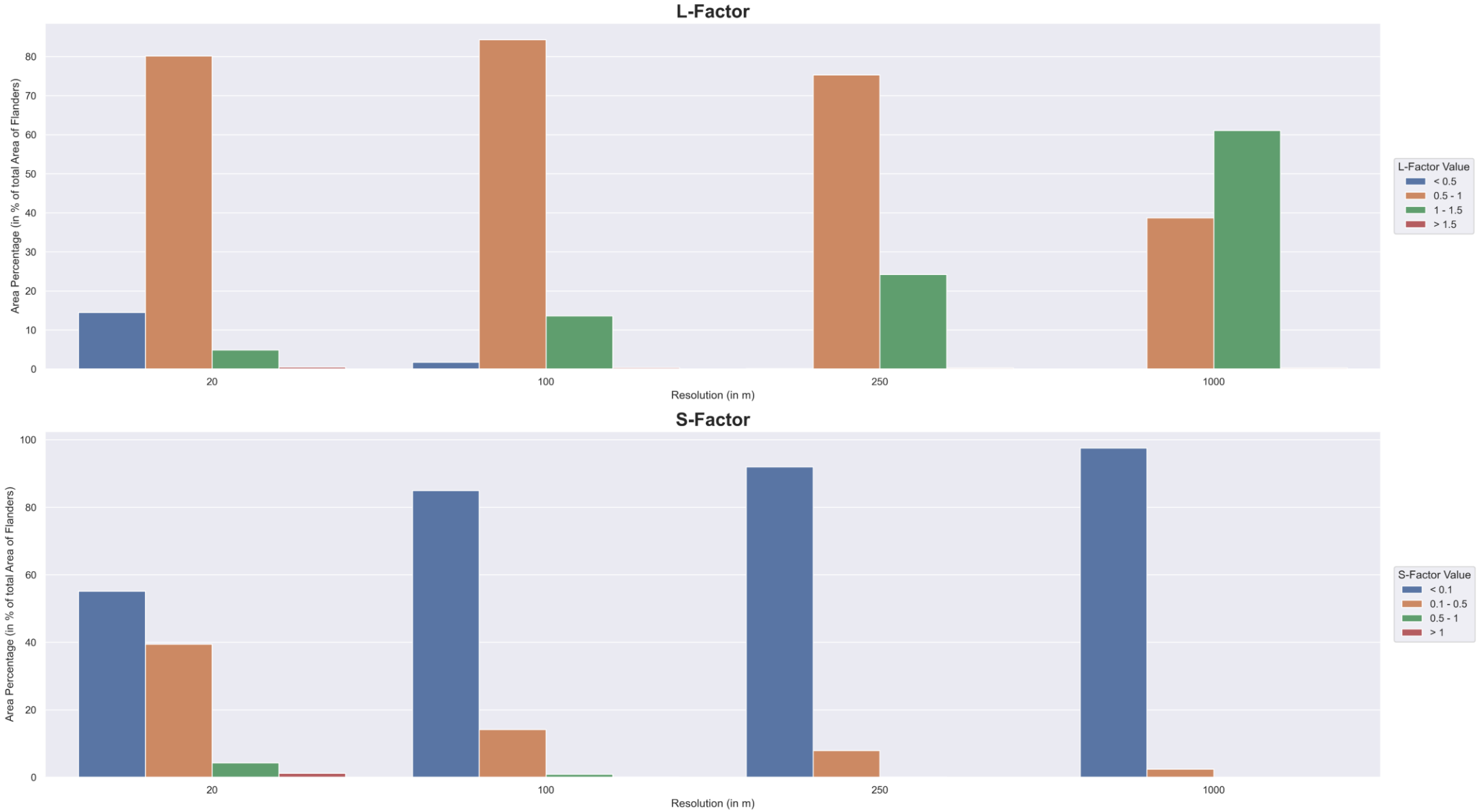
- **L-factor:**
  - → Desmet and Govers (1996)
    - × $L = \frac{(A+D^2)^{m+1} - A^{m+1}}{D^{m+2} \cdot x^2 \cdot 22.13^m}$

      - A = Upstream Area in (m^2)
      - D = Resolution (in m)
      - m = Length exponent
        - $m = \frac{\beta}{\beta + 1}$; with $\beta = \frac{\frac{sin\theta}{0.0896}}{3 \cdot sin^{0.8}\theta + 0.56}$; with θ = Local slope gradient
      - x = Flow direction factor ($x = |\sin(\alpha)| + |\cos(\alpha)|$ with α= Aspect

- **S-Factor:**
  - → McCool (1987)
    - × for s < 9% : $S = 10.8 \cdot \sin(\theta) + 0.03$
    - × for s ≥ 9% : $S = 16.8 \cdot \sin(\theta) - 0.5$
      - θ = Slope in radians (based on Zevenbergen and Thorne, 1987)

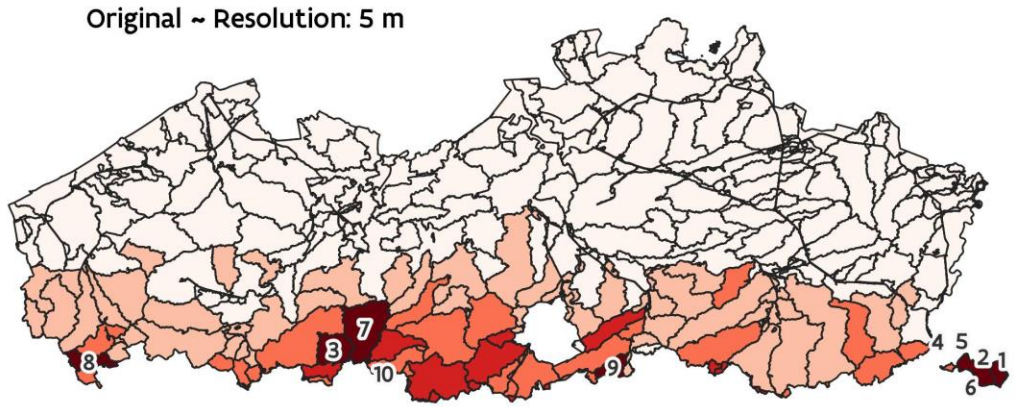
Results

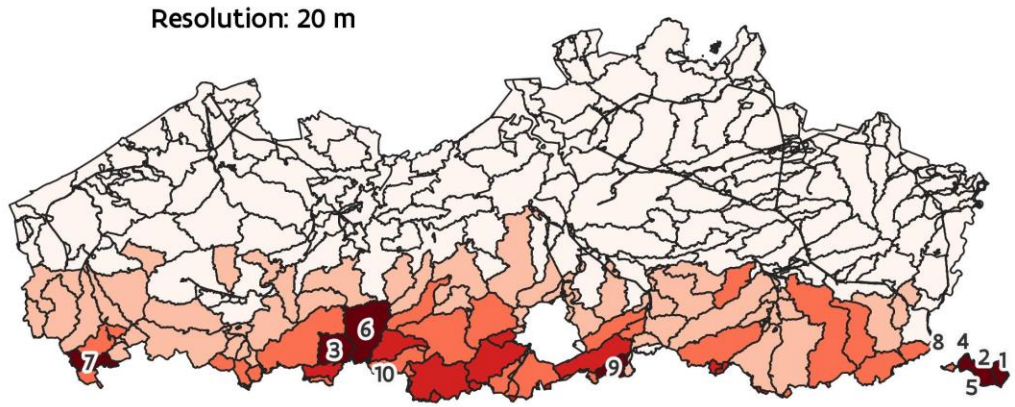
Finding the Diverging Factor (LS-Factor)

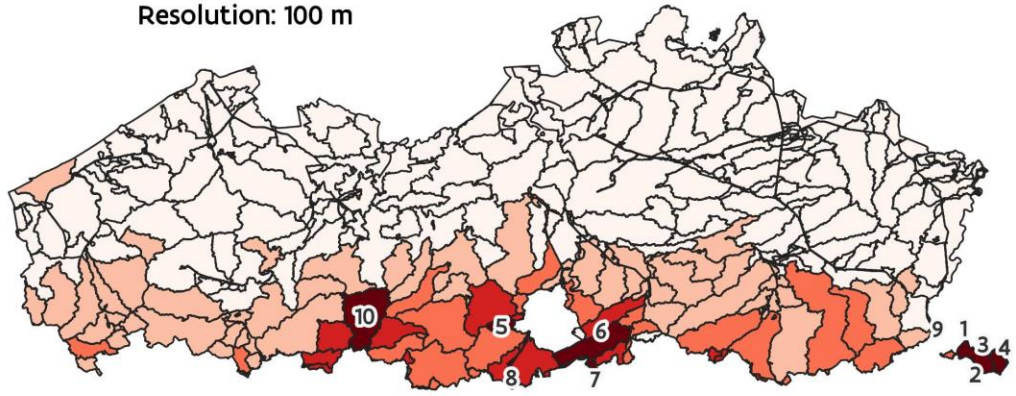


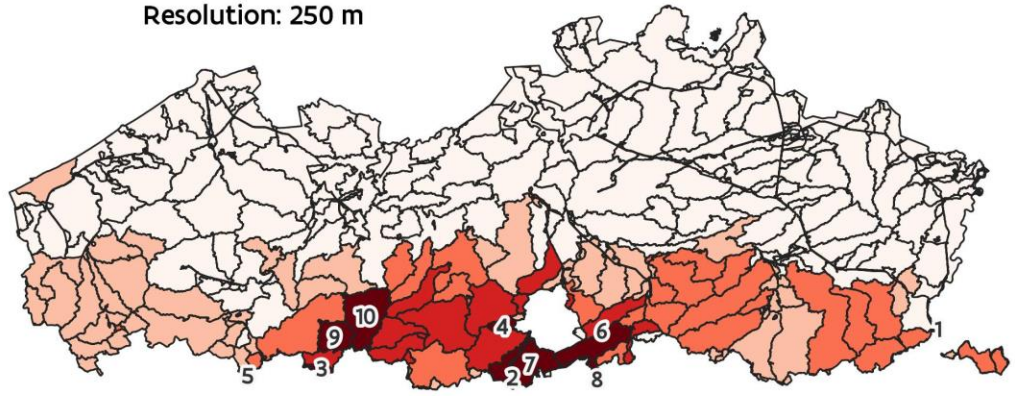
Results

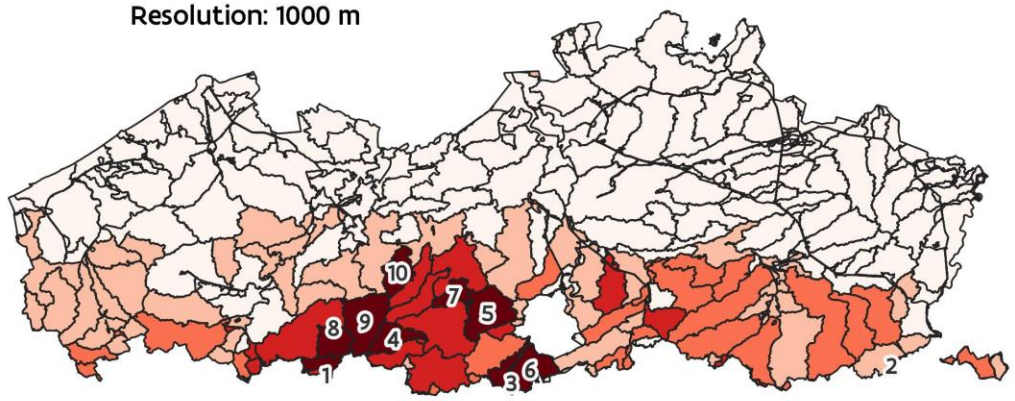
Distribution Patterns for Method 1











Spatial Distribution Map:

Initial Input Method

DEPARTEMENT OMGEVING

Vlaanderen is omgeving

Soil Loss Ranking

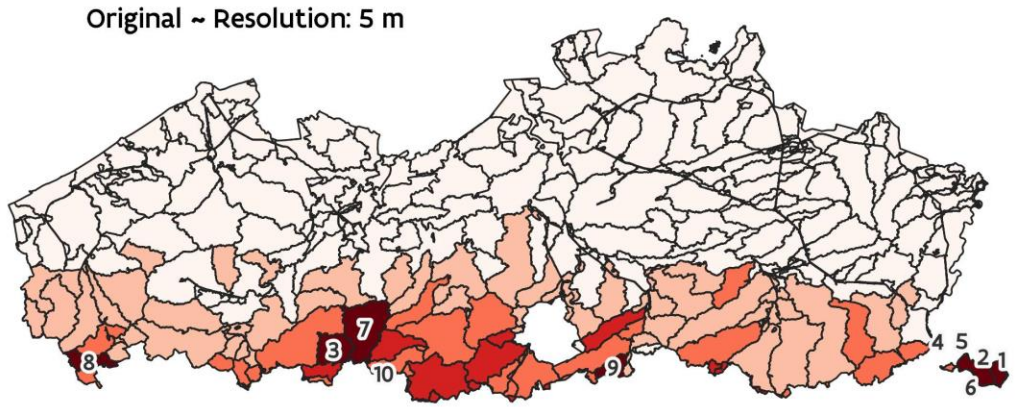
- 1 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

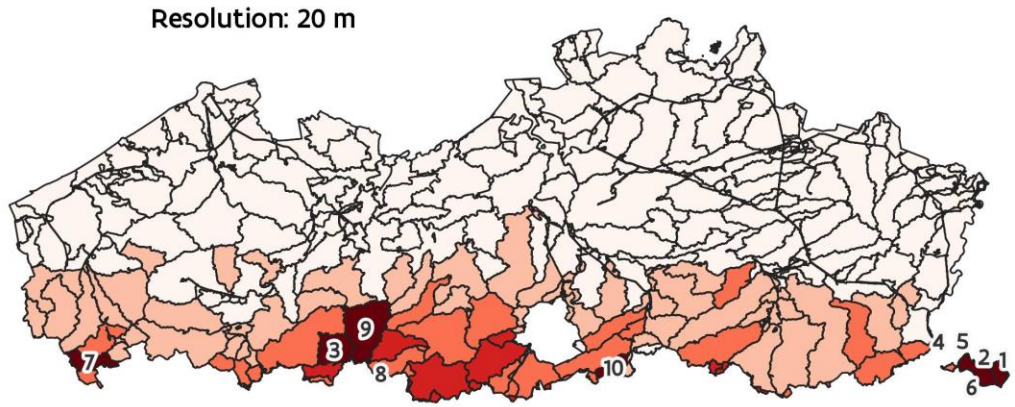
0 25 50 75 100 125 150 km

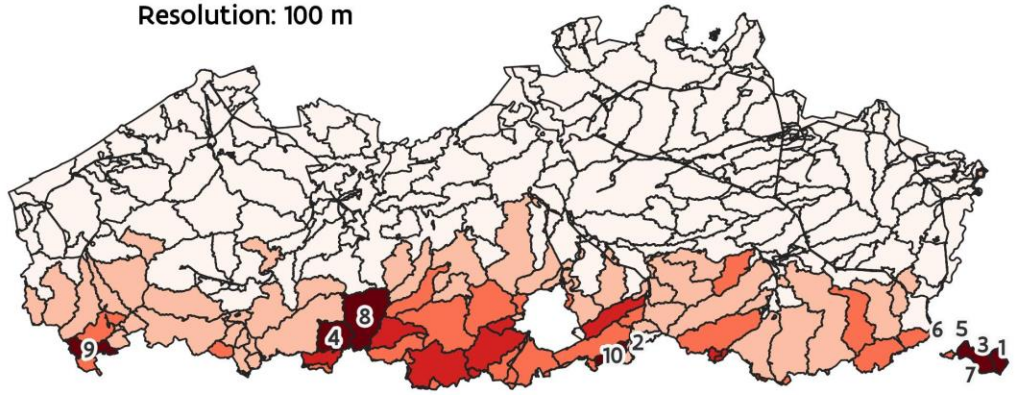
N

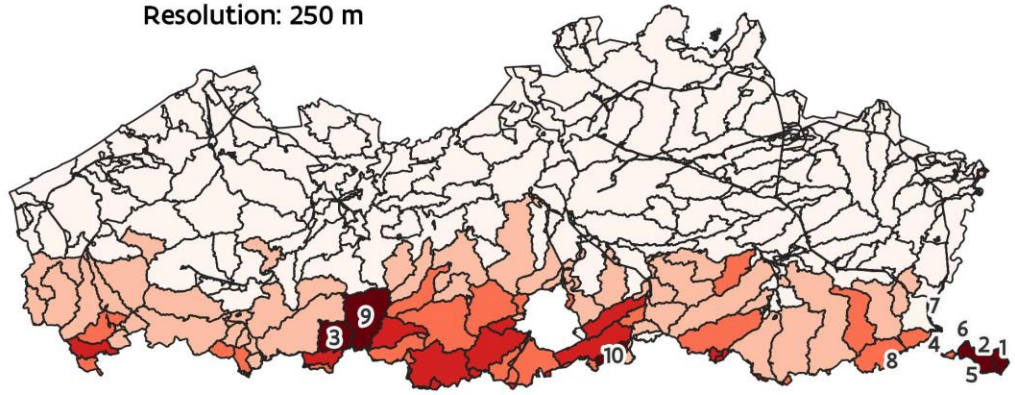
Results

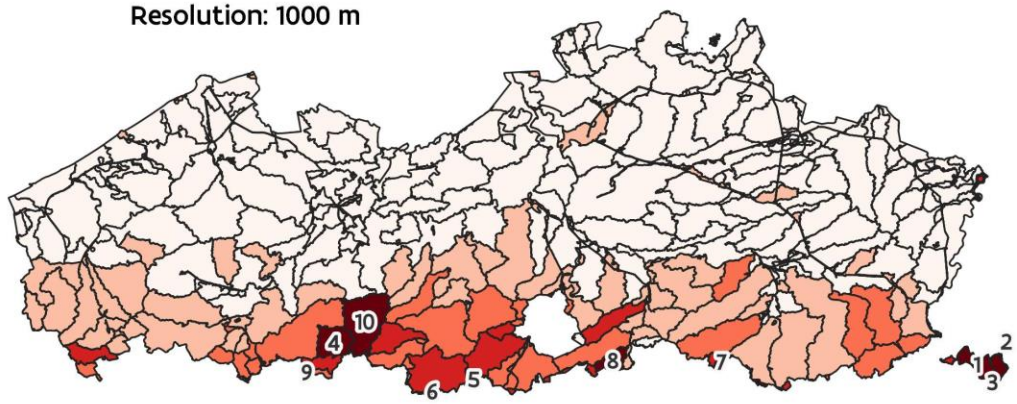
Distribution Patterns for Method 3











Spatial Distribution Map:

Erosion Map Method

DEPARTEMENT OMGEVING

Vlaanderen is omgeving

Soil Loss Ranking

- 1 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- > 100

0 25 50 75 100 125 150 km

Conclusions

Main Findings

- **Methods**
  - → Changing Initial Resolution has big Impact
  - → Difference in Method 2 and Method 3 minimal
- **Factors**
  - → Topographical Factor (LS) is most affected
    - → Resolution flattens slope values
- **Values**
  - → Great Variation in Quantitative Values
    - × Pot. Erosion Values are difficult to measure
      - → Validation and calibration issues
  - → Quantitative (ranks) influenced as well
    - × Selection of most important regions

Conclusions

Cautions & Suggestions

- **Cautions**
  - ✕ **All Models are wrong**
    - → Validation = Necessary, however Difficult
    - → Relative Values <-> Absolute Values
  - ✕ **Model Resolution not the only problem**
    - → Data Resolution and Accuracy
    - → Model assumptions/simplifications
    - → Formula choices
- **Suggestions**
  - ✓ **Use most detailed Dataset**
    - → Upscaling: as late as possible
  - ✓ **Consider Use of the Map**
    - → Not all purposes need highest resolution
    - → BUT, different maps = different story → mistrust