# Balancing forest ES by adapting their management to the ecological context: a case study in Southern Belgium

ESP Europe 2018 Regional conference Tuesday, October 16

T10b - Towards multifunctional landscapes – assessing and governing synergies between biodiversity conservation and ecosystem services

LIÈGE université
Gembloux
Agro-Bio Tech

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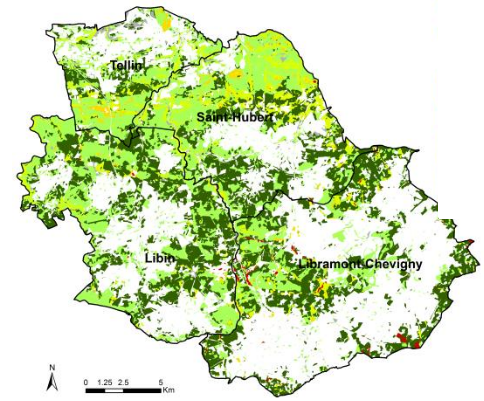
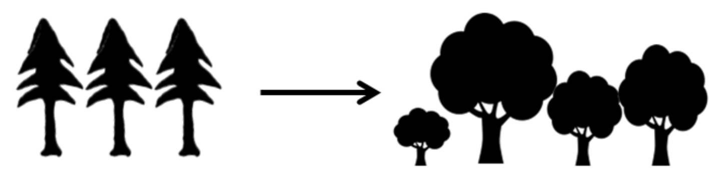
# Objectives



1. Map ES supply depending on the **ecological context** (i.e. natural conditions) and the **management** (i.e. human activities)

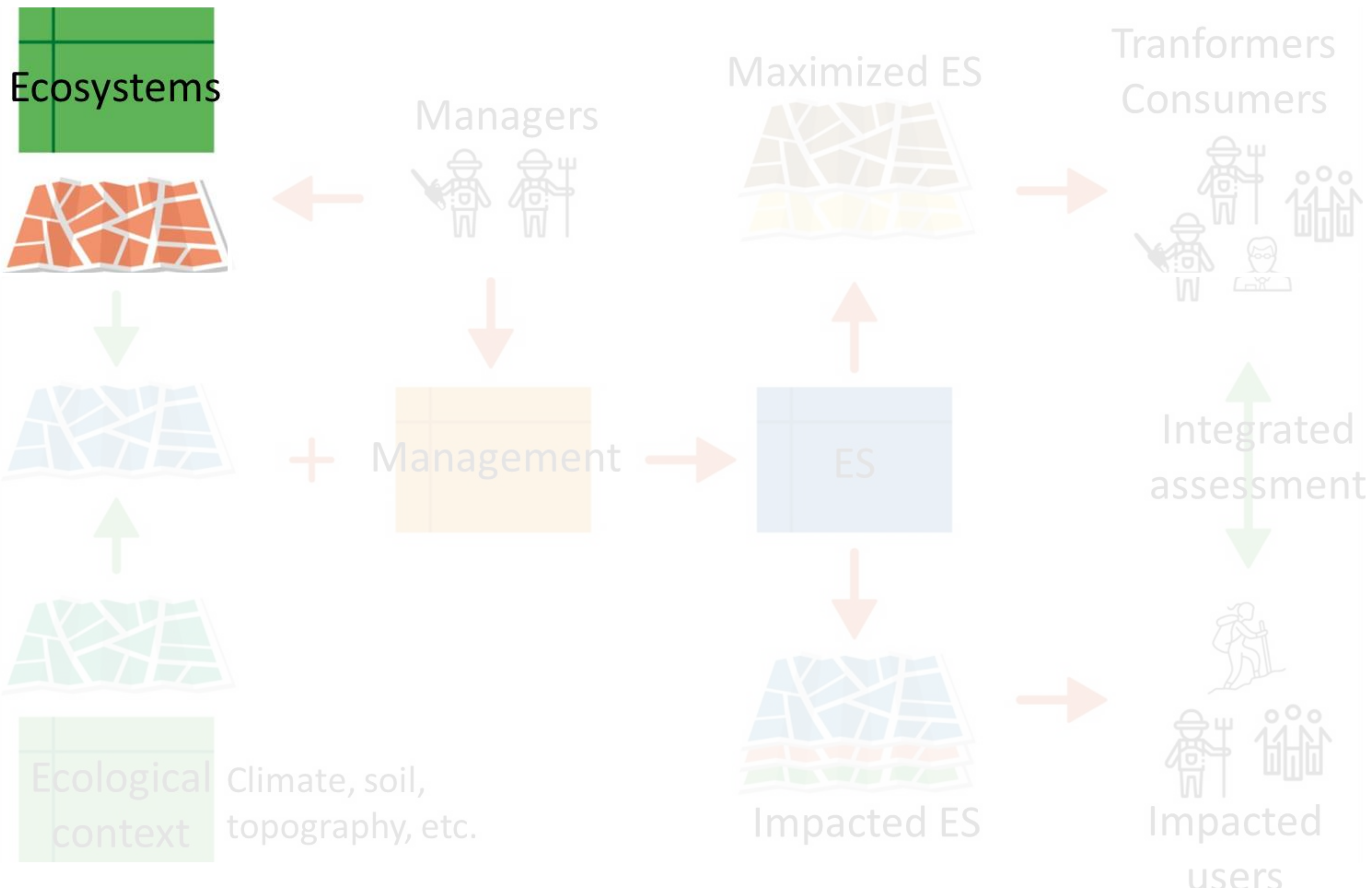



2. Test different management **scenarios** on ES supply depending on the ecological context



# Assessing ES and their interactions





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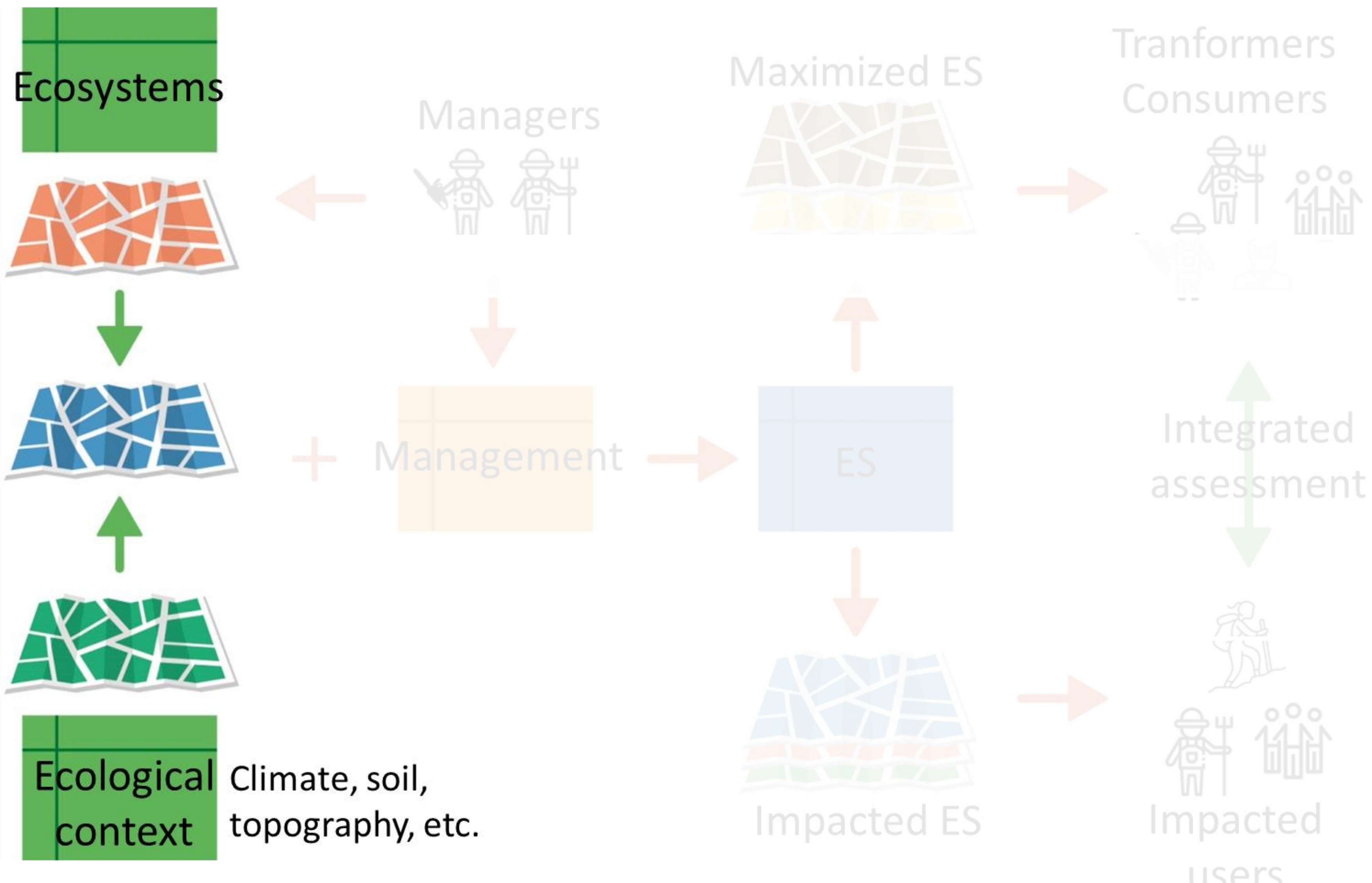

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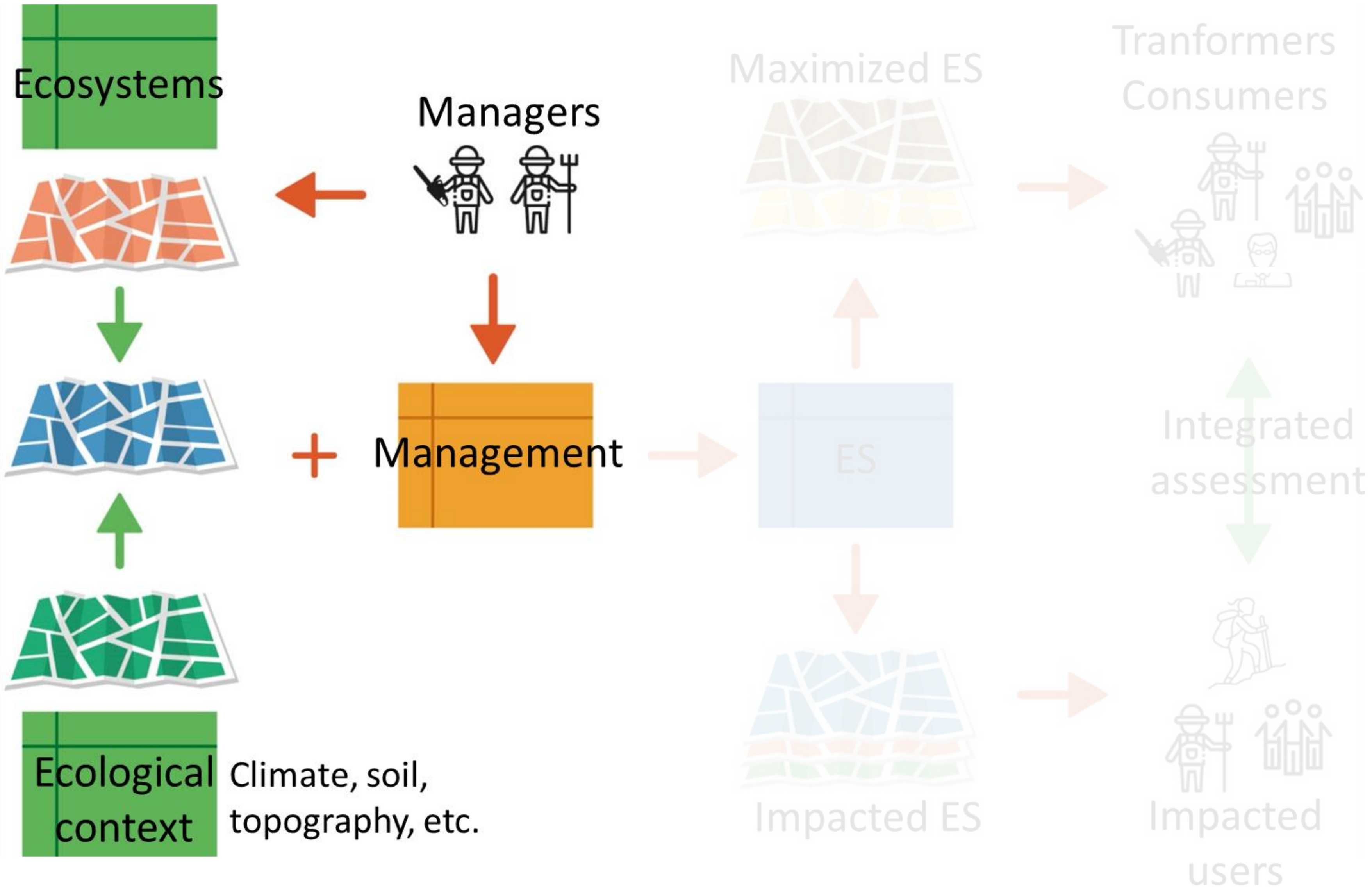

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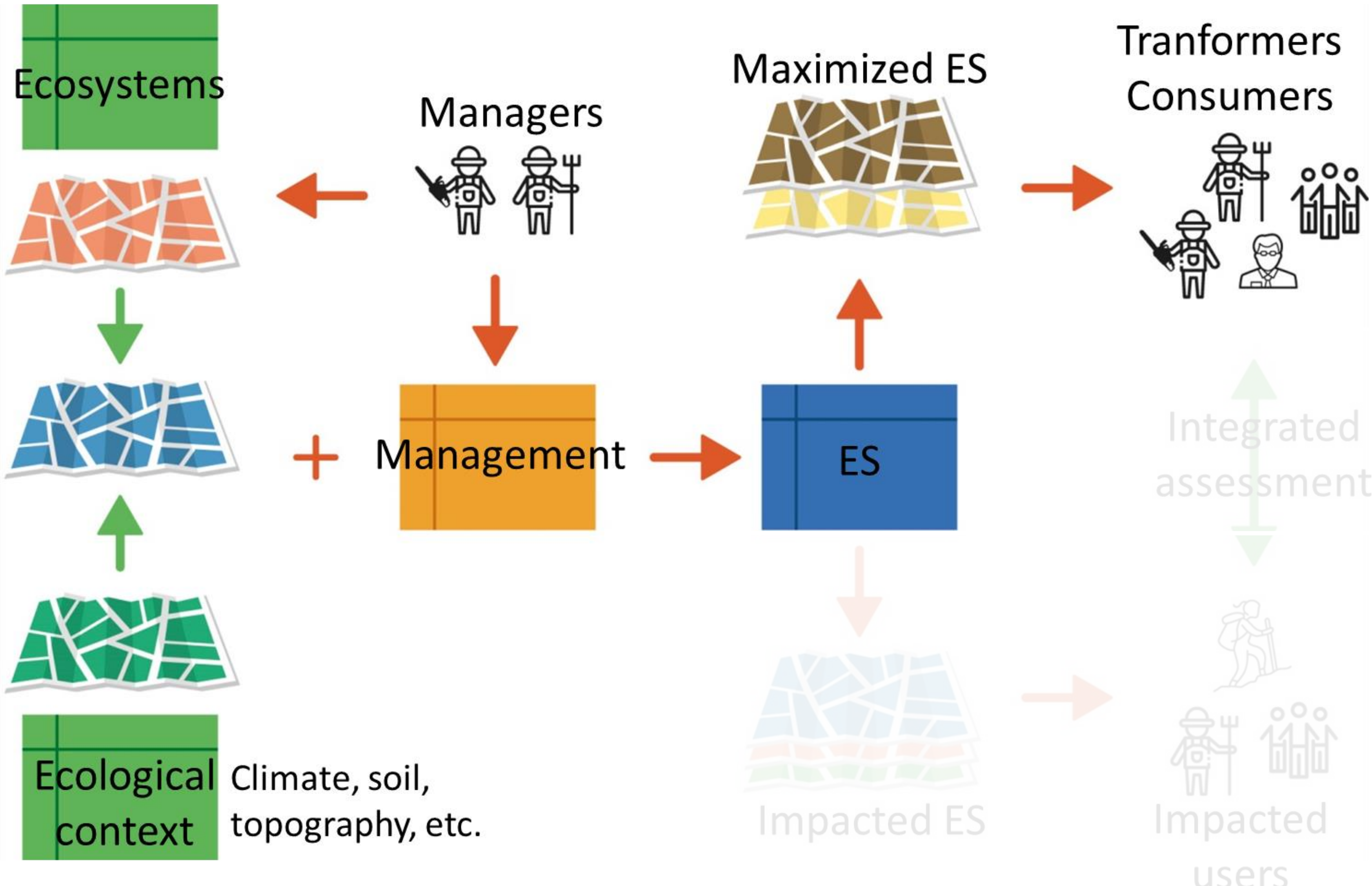
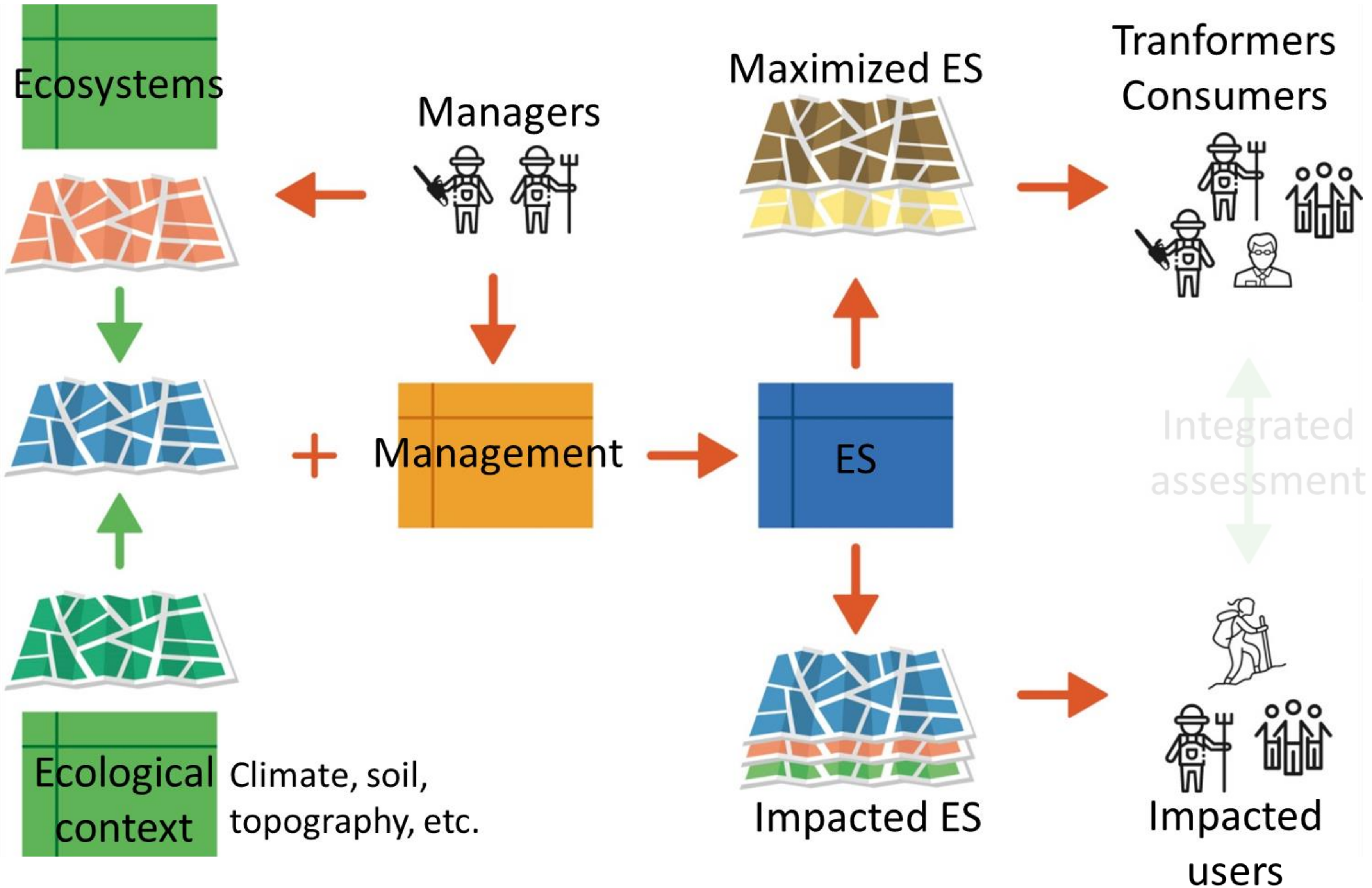


# Assessing ES and their interactions





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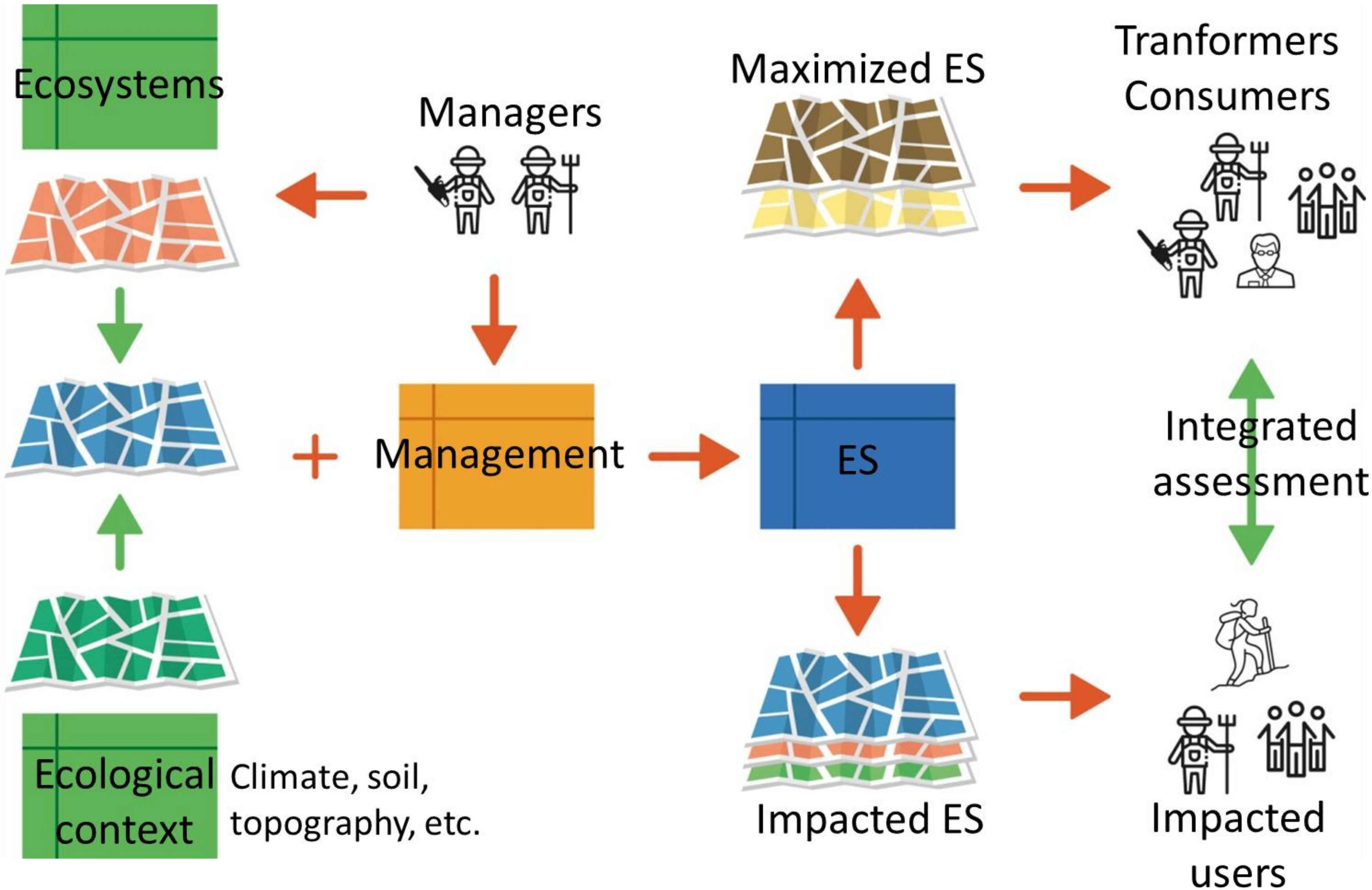
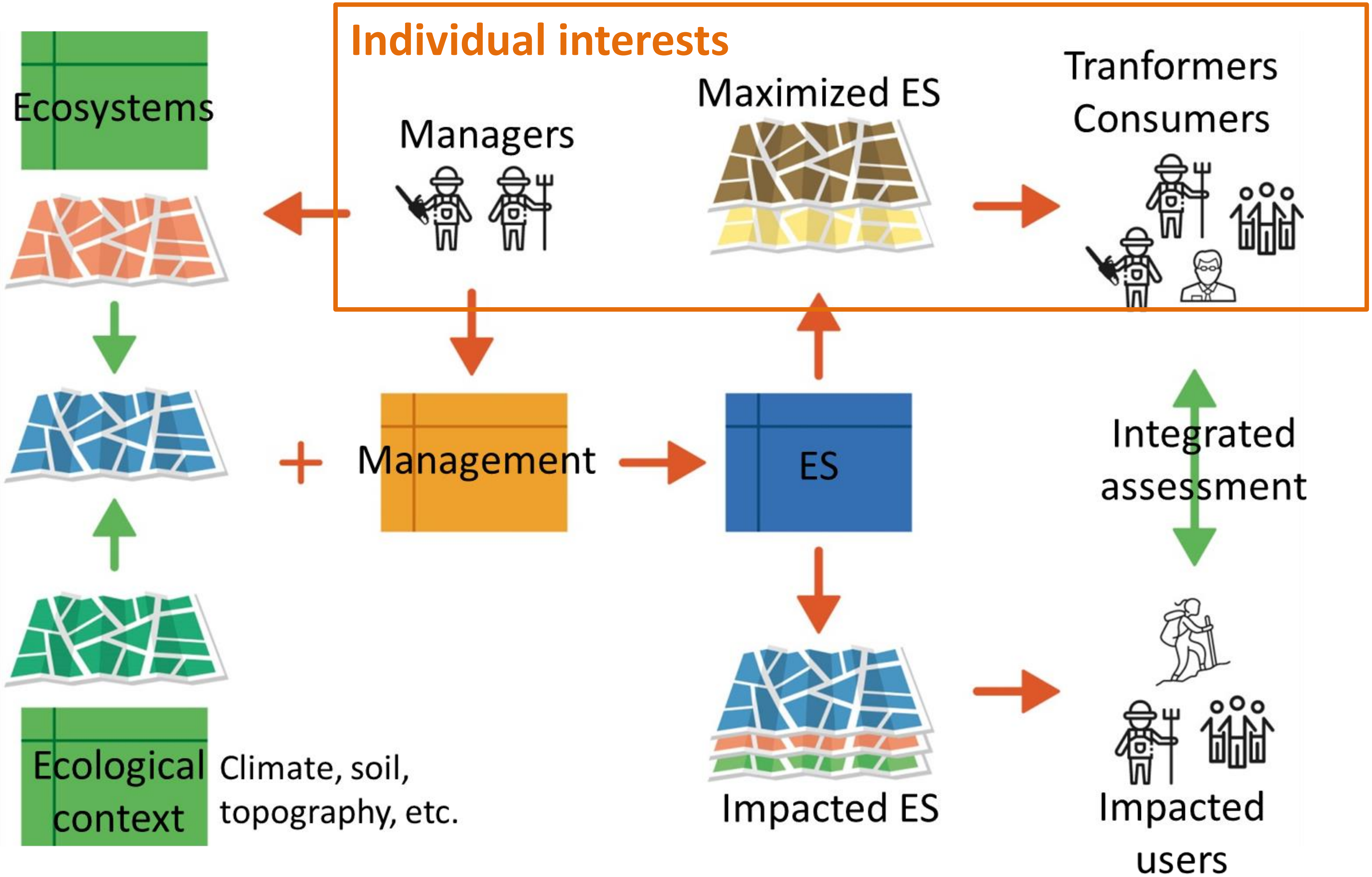


# Assessing ES and their interactions



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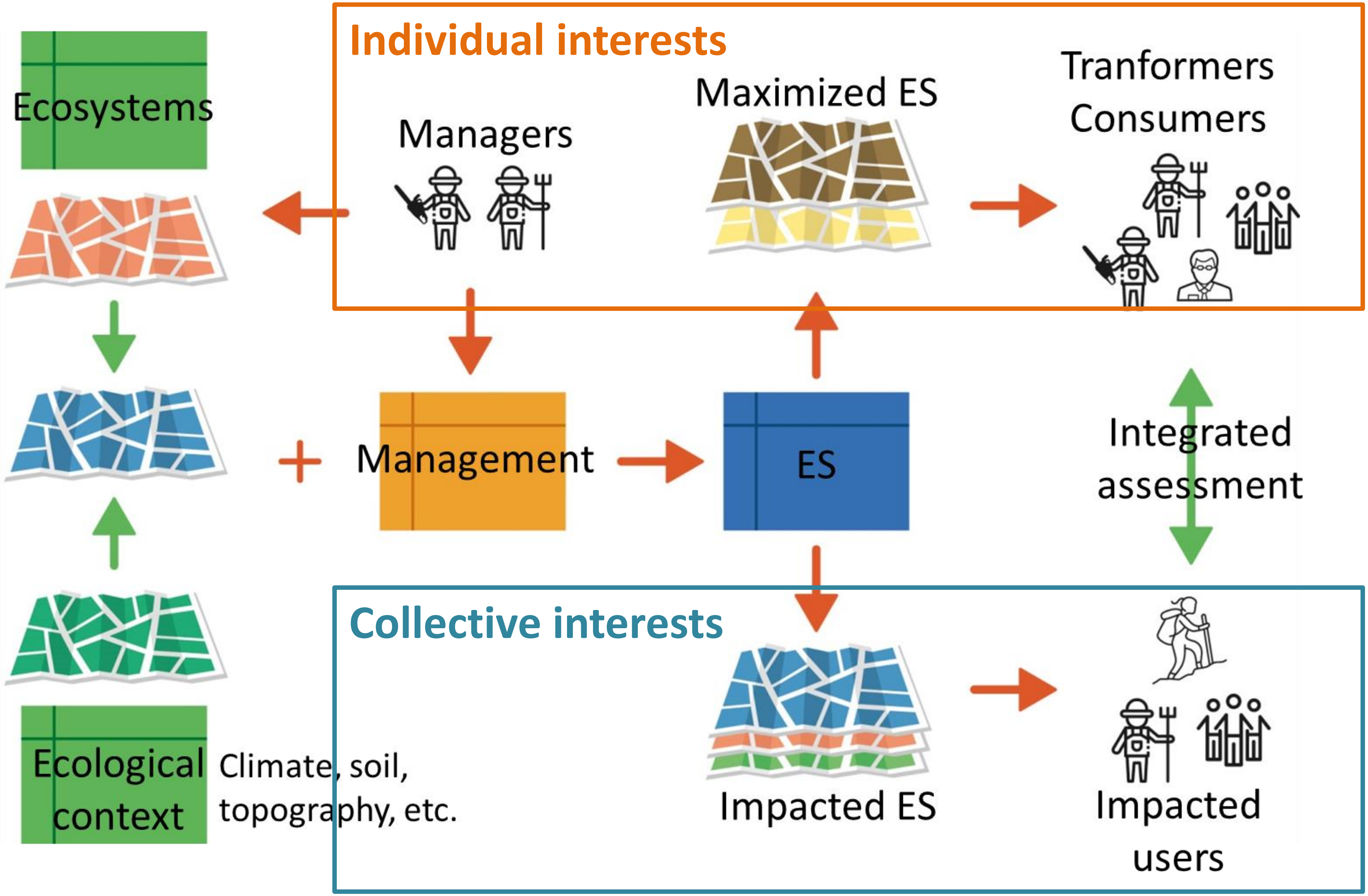
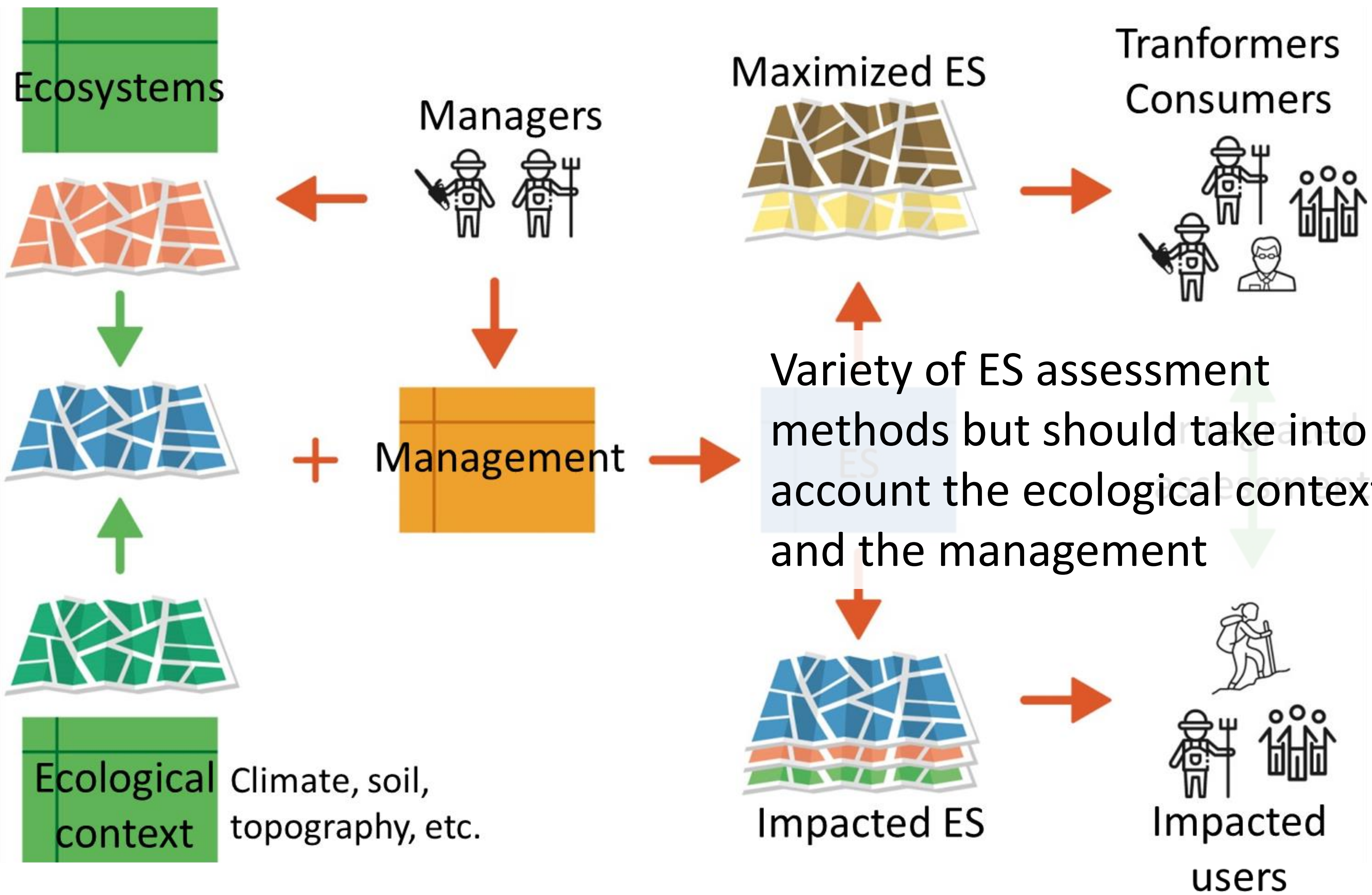


# Assessing ES and their interactions






Variety of ES assessment methods but should take into account the ecological context and the management

# Assessing ES and their interactions



| Scale of the ES ranking | |
|---|---|
| 1 | Minimal capacity |
| 2 | Very low capacity |
| 3 | Low capacity |
| 4 | Medium capacity |
| 5 | Good capacity |
| 6 | Very good capacity |
| 7 | Maximum capacity |

ES matrix (Burkhard et al., 2009)

| | ES 1 | ES 2 | ES 3 | ES 4 |
|---|---|---|---|---|
| LUCL 1 | 7 | 6 | 6 | 6 |
| LUCL 2 | 5 | 4 | 3 | 2 |
| LUCL 3 | 7 | 4 | 3 | 1 |
| LUCL 4 | 4 | 3 | 2 | 2 |

## ES Matrix

Improvements:

- Consider the management

Pure even-aged spruce forest

## ES Matrix

Improvements:

- Consider the management

Irregular broadleaved forest

## ES Matrix

Improvements:

- Consider the management
- Take into account the ecological context

| Ecological context |
|---|
| Brown soil |
| Steep slope |
| Alluvial soil |
| Wet soil |
| Podzolic soil |
| Peat soil |
| |
| Brown soil |
| Steep slope |
| Alluvial soil |
| Wet soil |
| Podzolic soil |
| Peat soil |

## ES Matrix

Improvements:

- Consider the management
- Take into account the ecological context

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| Steep slope |
| Alluvial soil |
| Wet soil |
| Podzolic soil |
| Peat soil |

**Good soils**

**Sensitive soils** = (1) non productive soils or
(2) high ecological issues

## ES Matrix

Six ES ranked

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |
| | | | | | | |
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |

## ES Matrix

Six ES ranked

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
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| Steep slope | | | | | | |
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| | | | | | | |
| Brown soil | | | | | | |
| Steep slope | | | | | | |
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| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |

# ES Matrix

Six ES ranked

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |
| | | | | | | |
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |

## ES Matrix

Six ES ranked based on literature review revised by experts

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | | | | | | |
| Steep slope | | | | | | |
| Alluvial soil | | | | | | |
| Wet soil | | | | | | |
| Podzolic soil | | | | | | |
| Peat soil | | | | | | |

Forestry Commission
231 Corstorphine Road
Edinburgh
EH12 7AT

Forests, Carbon and Climate Change:

*Plant and Soil* **264:** 13–24, 2004.
 13

**Effects of changes in tree species composition on water flow dynamics – Model applications and their limitations**

*Environmental Pollution*, Vol. 90, No. 1, pp. 111–120, 1995
Elsevier Science Limited
Printed in Great Britain.
0269-7491/95 $09.50 + 0.00
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0269-7491(94)00081-6

AN INVESTIGATION OF THE IMPACT OF AFFORESTATION ON STREAM-WATER CHEMISTRY IN THE LOCH DEE CATCHMENT, SW SCOTLAND

T. R. Nisbet,[a] D. Fowler[b] & R. I. Smith[b]

# Methodology



## ES Matrix

| Scale of the ES ranking | |
|---|---|
| 1 | Minimal capacity |
| 2 | Very low capacity |
| 3 | Low capacity |
| 4 | Medium capacity |
| 5 | Good capacity |
| 6 | Very good capacity |
| 7 | Maximum capacity |

Pure even-aged spruce forest

- High wood production except on some sensitive soils

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | 5 | 7 | 7 | 7 | 7 | 6 |
| Steep slope | 4 | 5 | 6 | 5 | 6 | 5 |
| Alluvial soil | 5 | 7 | 7 | 7 | 7 | 7 |
| Wet soil | 3 | 4 | 6 | 6 | 6 | 6 |
| Podzolic soil | 4 | 5 | 6 | 6 | 4 | 6 |
| Peat soil | 1 | 5 | 5 | 6 | 6 | 5 |

# Methodology

## ES Matrix

Pure even-aged spruce forest

- Low regulating and cultural ES especially on sensitive soils

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | 5 | 7 | 7 | 7 | 7 | 6 |
| Steep slope | 4 | 5 | 6 | 5 | 6 | 5 |
| Alluvial soil | 5 | 7 | 7 | 7 | 7 | 7 |
| Wet soil | 3 | 4 | 6 | 6 | 6 | 6 |
| Podzolic soil | 4 | 5 | 6 | 6 | 4 | 6 |
| Peat soil | 1 | 5 | 5 | 6 | 6 | 5 |

## ES Matrix

Irregular broadleaved forest

- Medium wood production but lower on some sensitive soils

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | 5 | 7 | 7 | 7 | 7 | 6 |
| Steep slope | 4 | 5 | 6 | 5 | 6 | 5 |
| Alluvial soil | 5 | 7 | 7 | 7 | 7 | 7 |
| Wet soil | 3 | 4 | 6 | 6 | 6 | 6 |
| Podzolic soil | 4 | 5 | 6 | 6 | 4 | 6 |
| Peat soil | 1 | 5 | 5 | 6 | 6 | 5 |

## ES Matrix

Irregular broadleaved forest

- High regulating and cultural ES

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | 5 | 7 | 7 | 7 | 7 | 6 |
| Steep slope | 4 | 5 | 6 | 5 | 6 | 5 |
| Alluvial soil | 5 | 7 | 7 | 7 | 7 | 7 |
| Wet soil | 3 | 4 | 6 | 6 | 6 | 6 |
| Podzolic soil | 4 | 5 | 6 | 6 | 4 | 6 |
| Peat soil | 1 | 5 | 5 | 6 | 6 | 5 |

# Objectives



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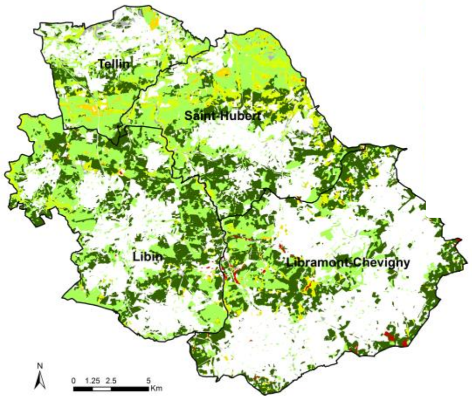
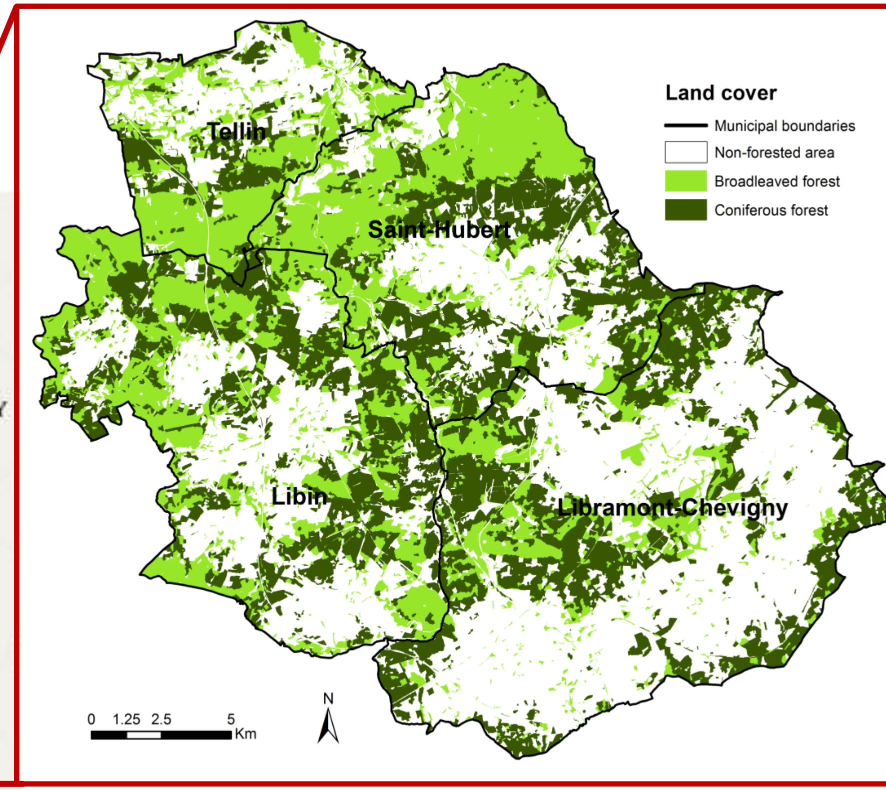


# Methodology

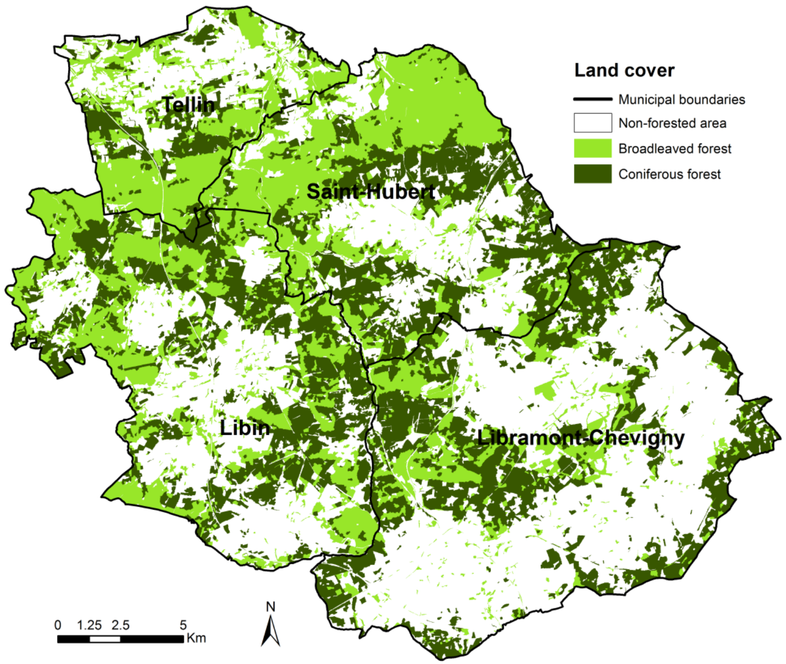
## Case study

# Methodology

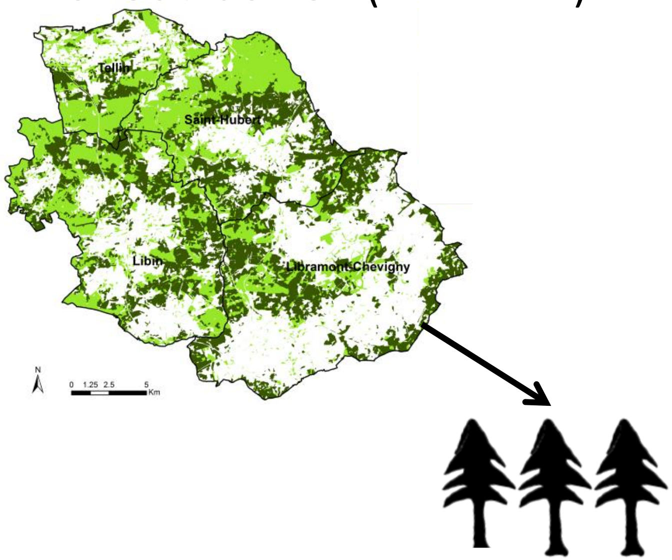
## Case study

- 54% of forests
- **Half** of **broadleaved** forest , mostly **beech** and **oak** in **irregular** stand
- Half of **coniferous** forest, mostly **spruce**, Douglas fir, larch and Scots pine in **pure even-aged** stand




## ES Mapping

Forest cover (LifeWatch)



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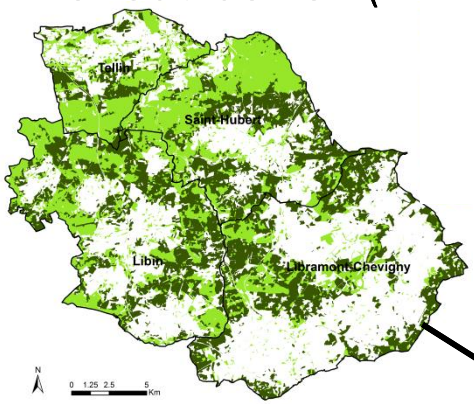
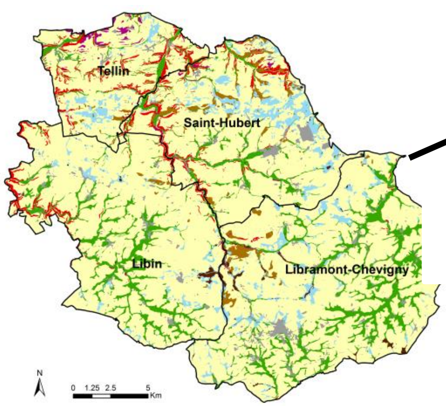
Forest cover (LifeWatch)




**Ecological context**

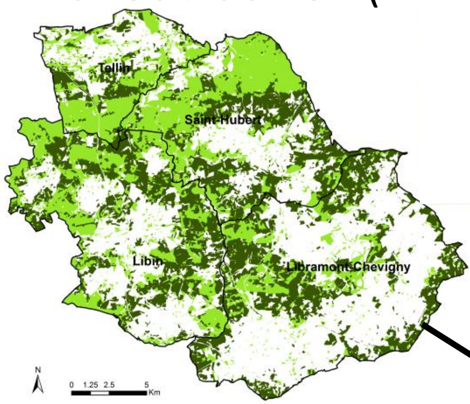
Brown soil
Steep slope
Alluvial soil
Wet soil
Podzolic soil
Peat soil



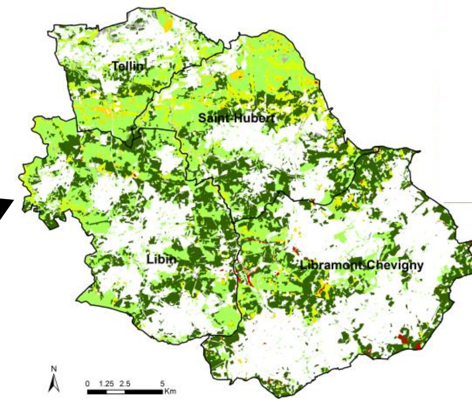

Soil Sensitivity Map (Jacquemin, 2015)

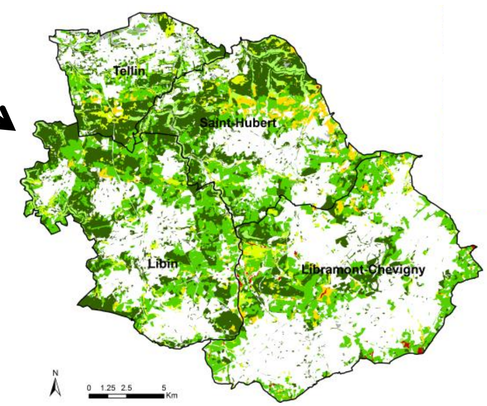
## ES Mapping

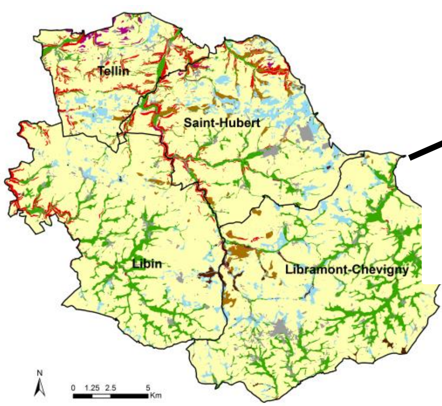
Forest cover (LifeWatch)




| Ecological context | Wood | Carbon |
| --- | --- | --- |
| Brown soil | 7 | 6 |
| Steep slope | 5 | 4 |
| Alluvial soil | 7 | 4 |
| Wet soil | 4 | 3 |
| Podzolic soil | 5 | 4 |
| Peat soil | 1 | 1 |



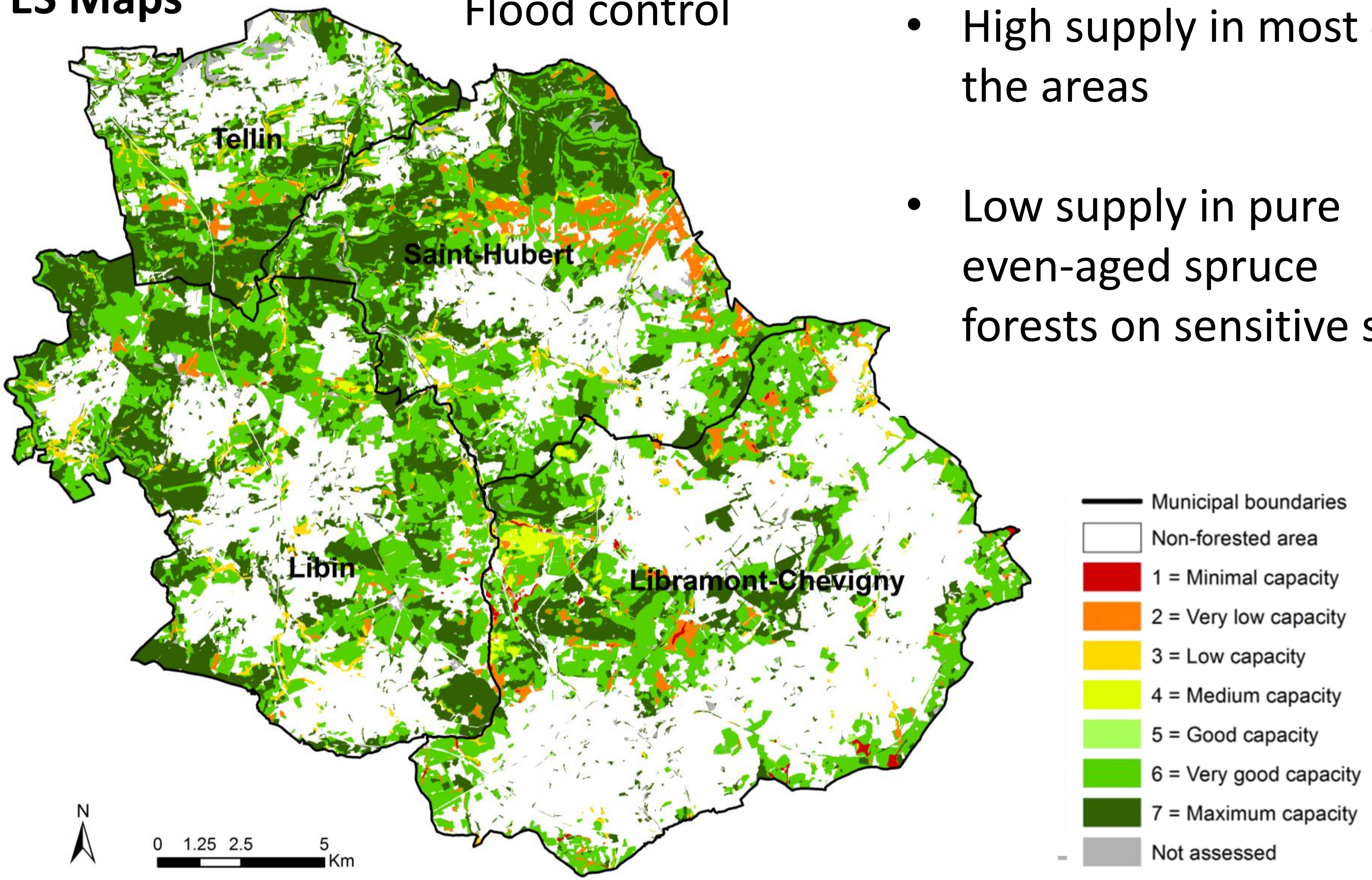




Soil Sensitivity Map (Jacquemin, 2015)

# Results

## ES Maps

Flood control

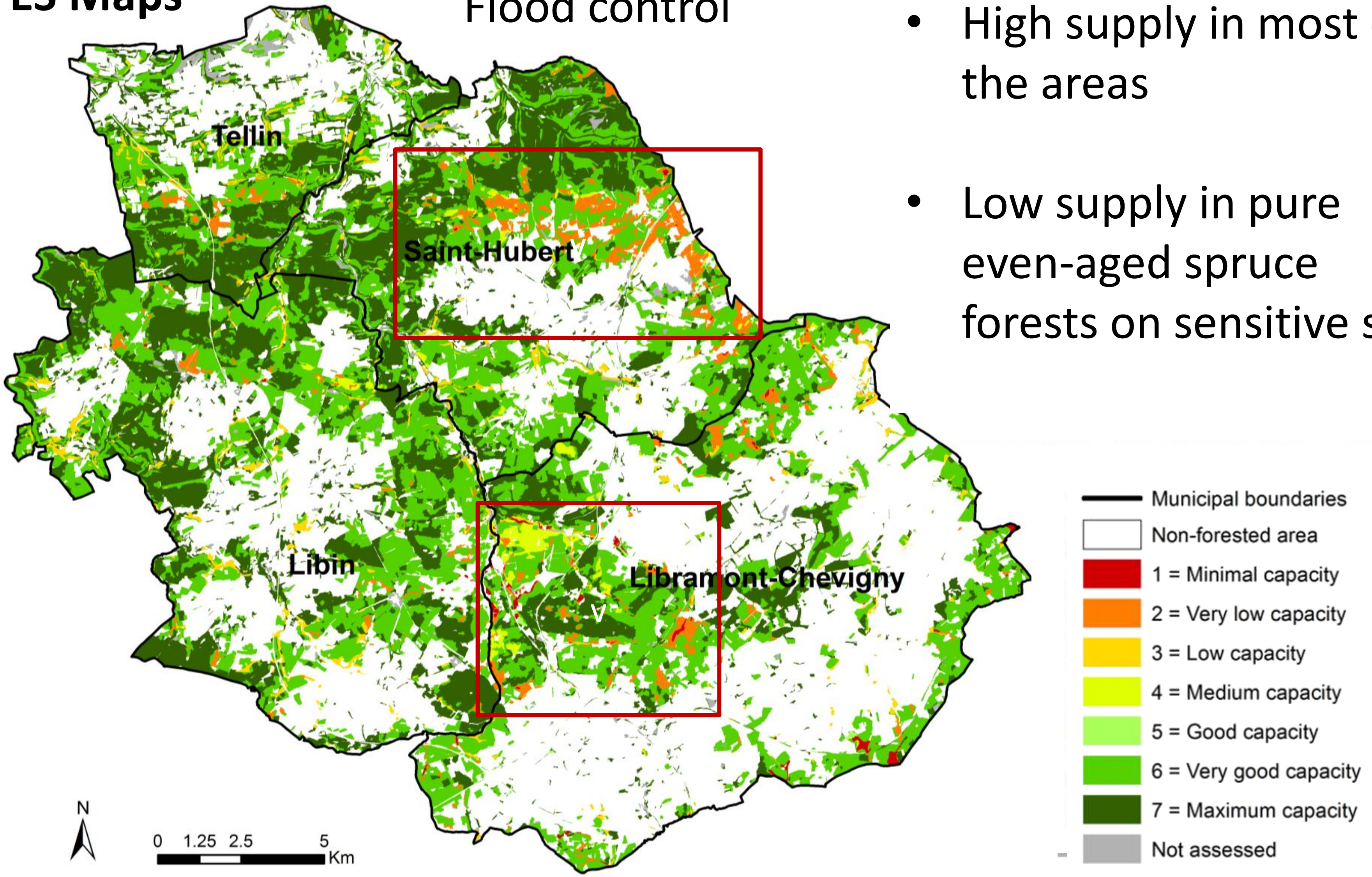



- High supply in most of the areas
- Low supply in pure even-aged spruce forests on sensitive soils

# Results

## ES Maps

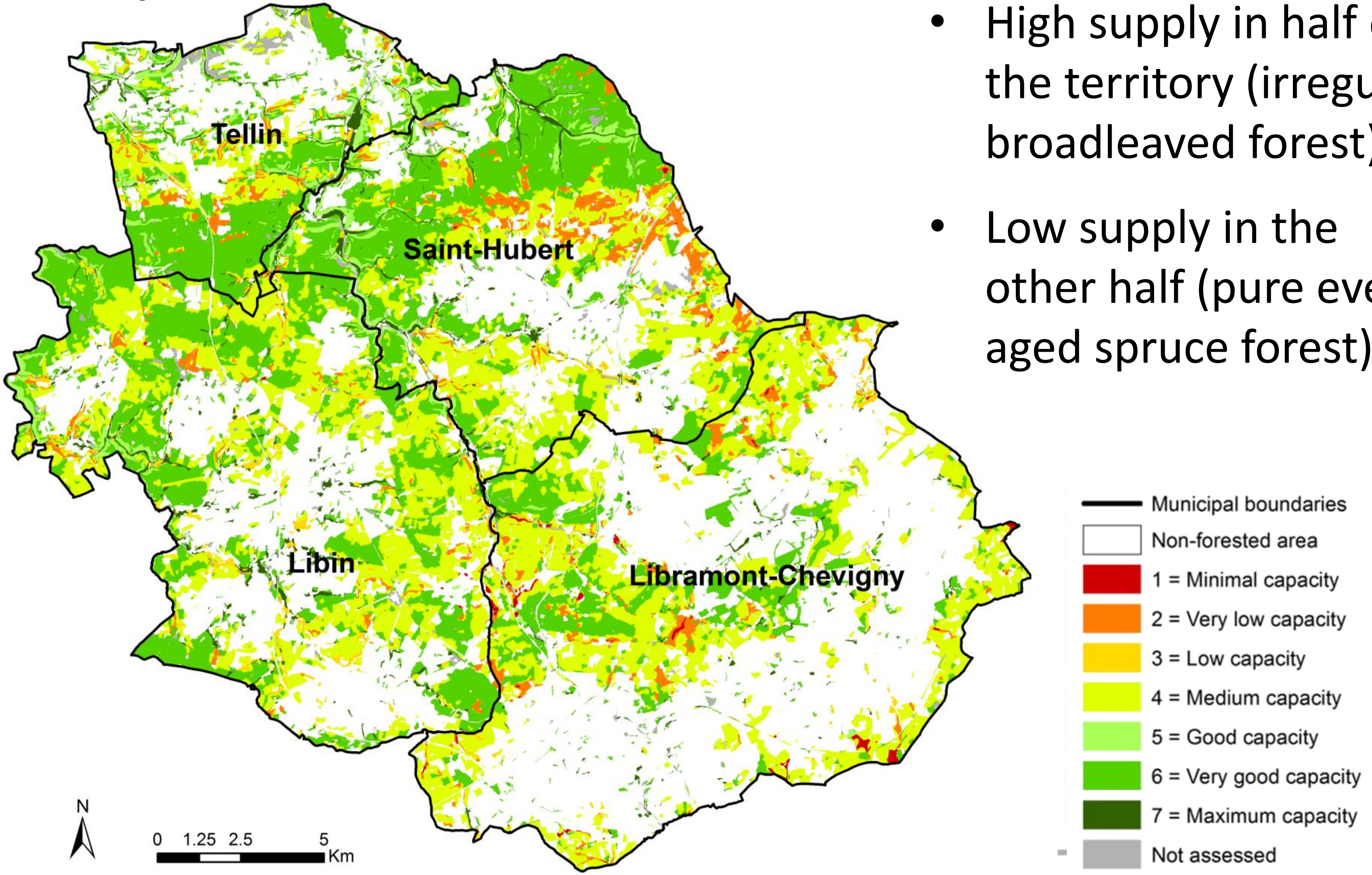
Flood control




- High supply in most of the areas
- Low supply in pure even-aged spruce forests on sensitive soils

## ES Maps

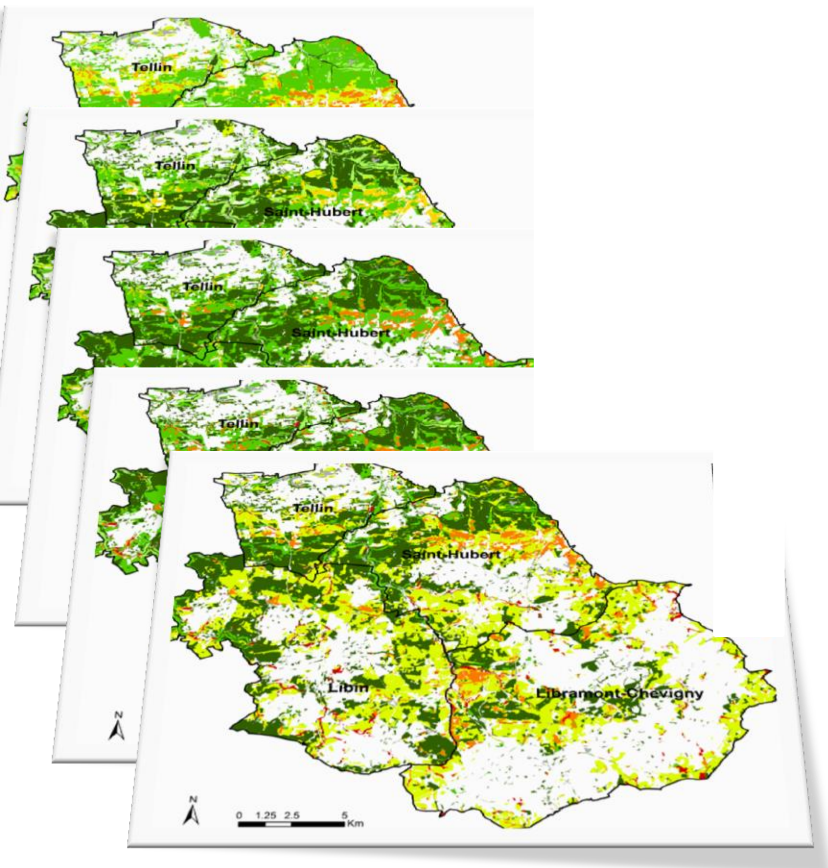
Natural areas for recreation




- High supply in half of the territory (irregular broadleaved forest)
- Low supply in the other half (pure even-aged spruce forest)

## ES Mapping

Average of 5 regulating and cultural ES (collective interests)



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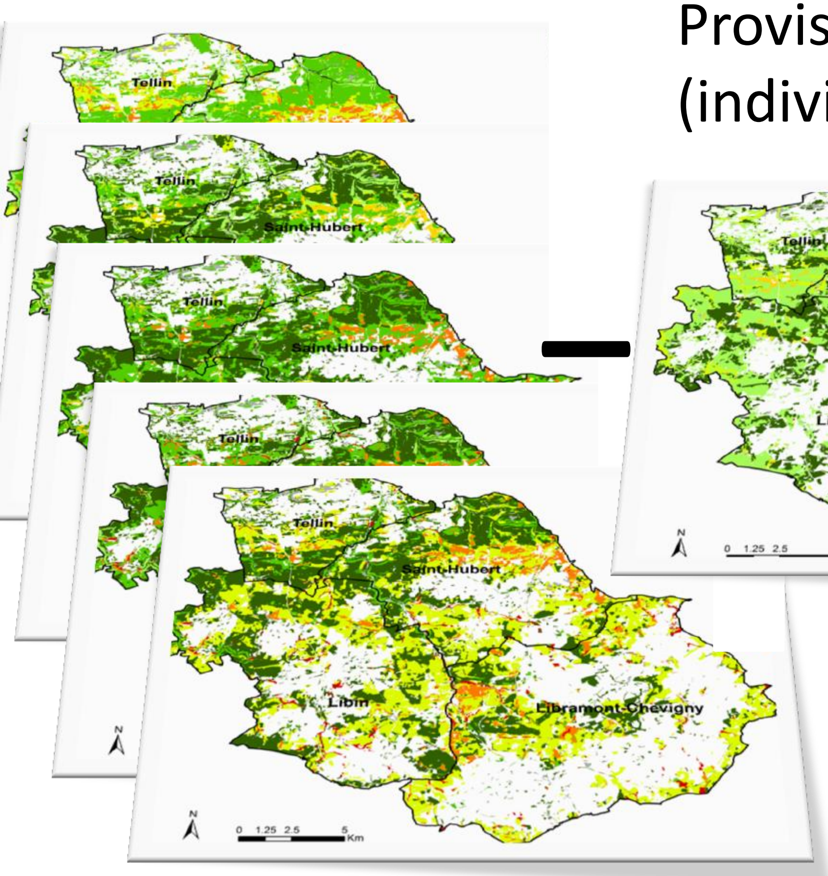
Average of 5 regulating and cultural ES (collective interests)

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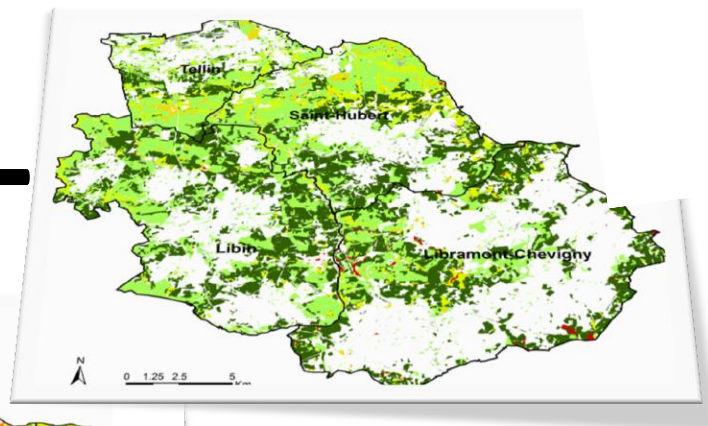
Provisioning ES (individual interests)

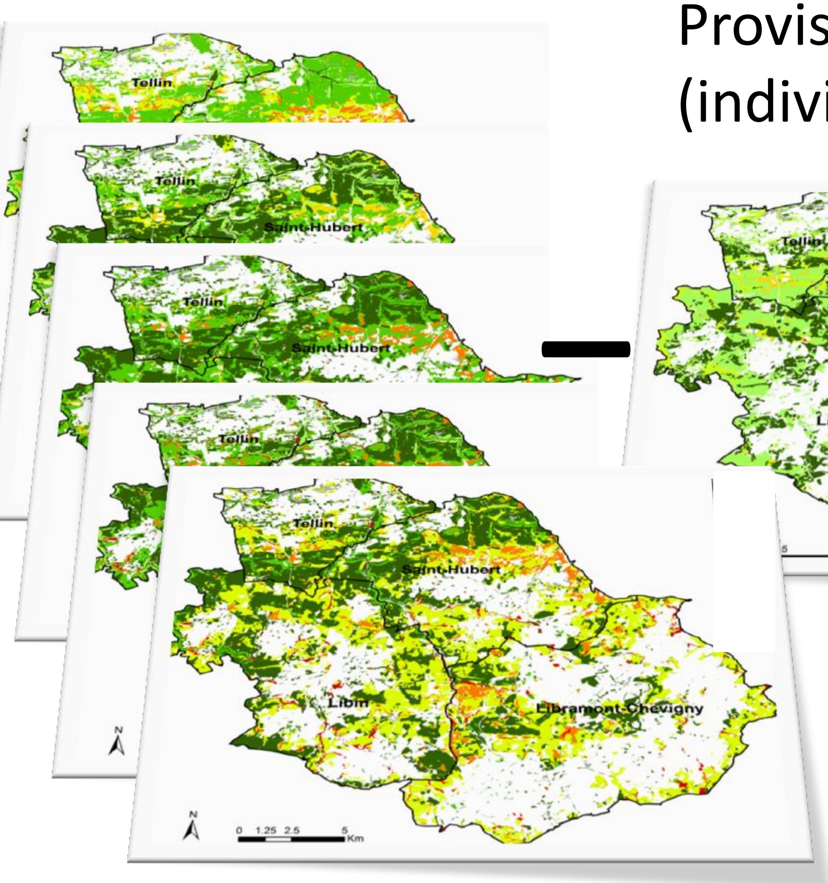


# Methodology



## ES Mapping

Average of 5 regulating and cultural ES (collective interests)

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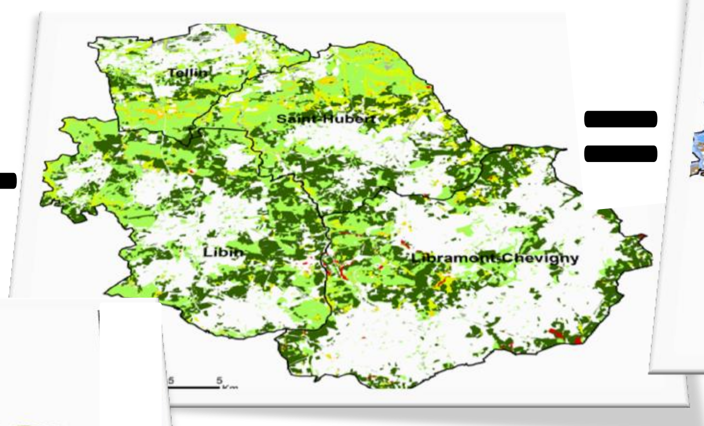
Provisioning ES (individual interests)

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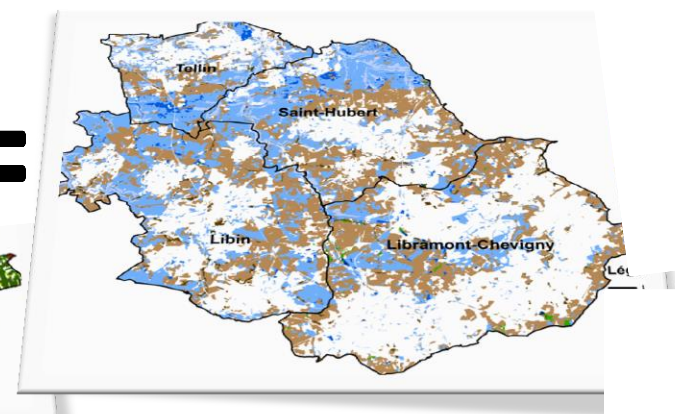
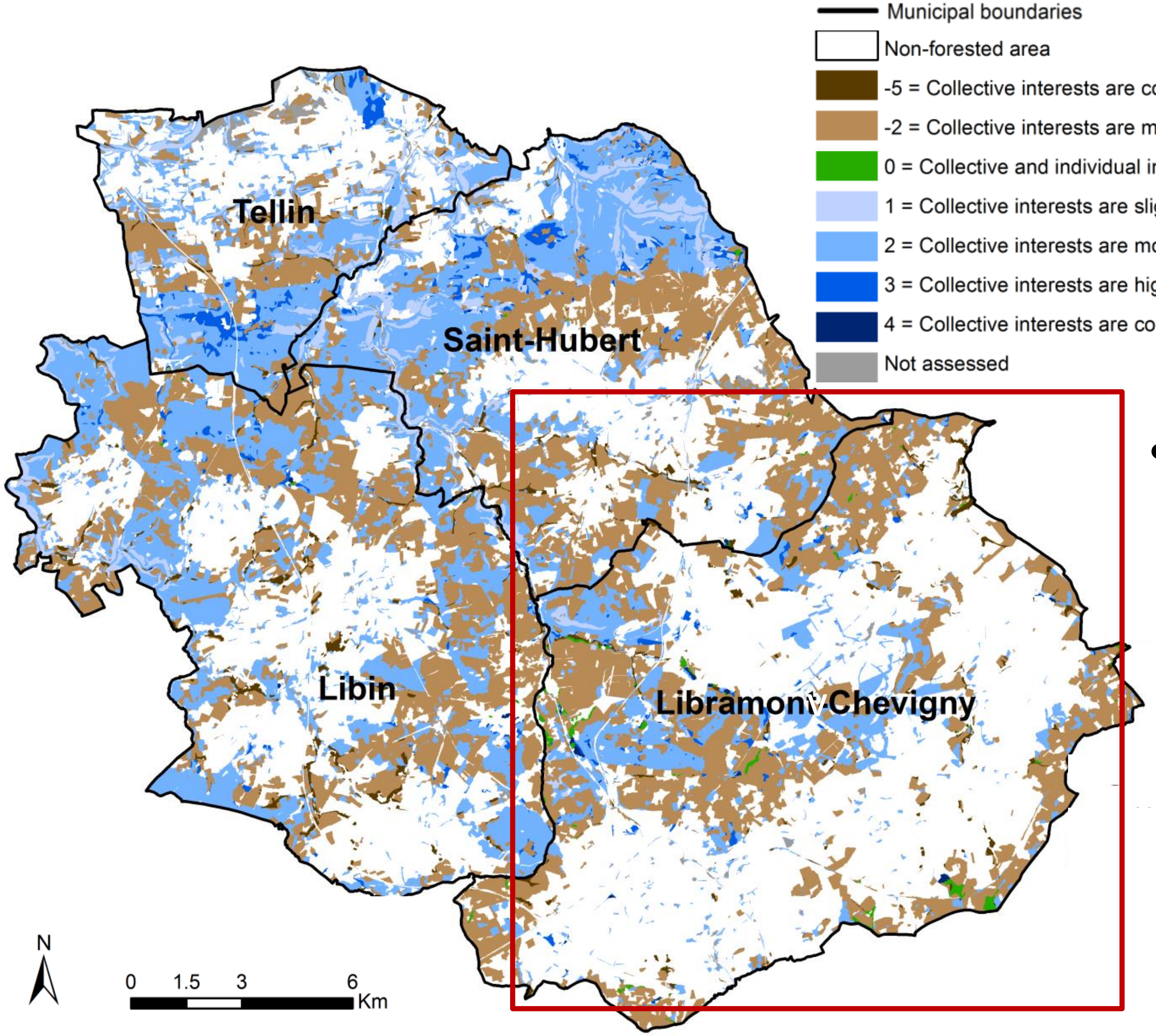
Balance between collective and individual interests

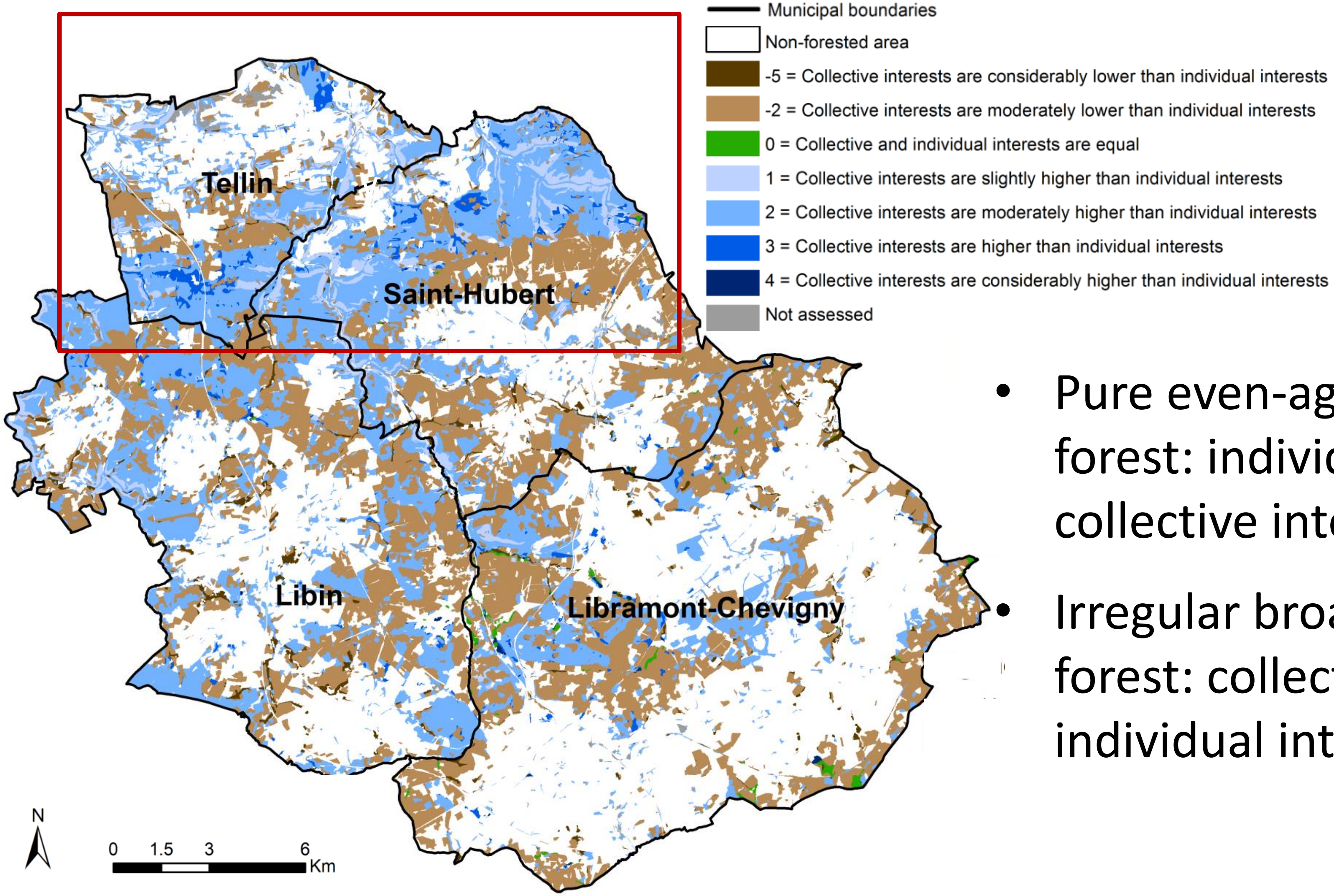


## ES Maps Balance between collective and individual interests




- Pure even-aged spruce forest: individual > collective interests

## ES Maps Balance between collective and individual interests

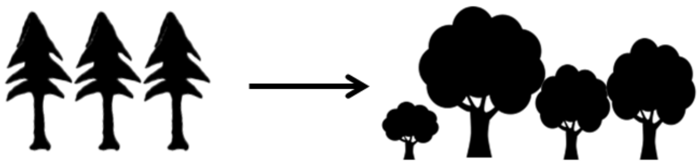



- Pure even-aged spruce forest: individual > collective interests
- Irregular broadleaved forest: collective > individual interests

# Objectives



2. Test different management **scenarios** on ES supply depending on the ecological context

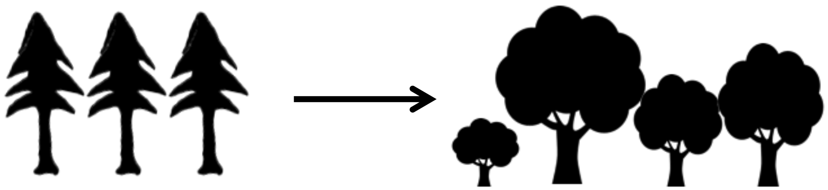


## ES scenarios

Three scenarios to test different **managements** on the supply of ES

1.a. Scenario « restoration »

On all sensitive soils (10%)



# Methodology



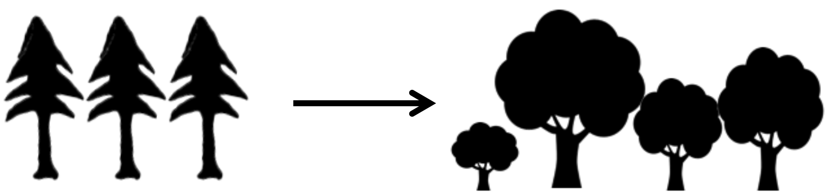
## ES scenarios

Three scenarios to test different **managements** on the supply of ES

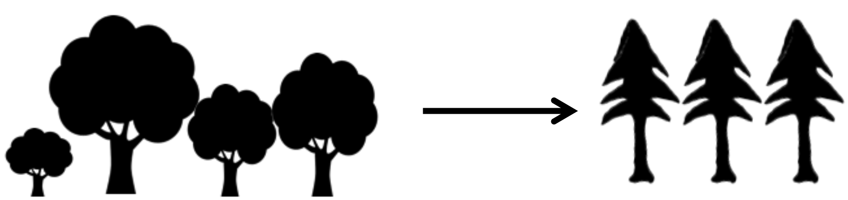
1.a. Scenario « restoration »

1.b. Scenario « restoration + compensation »

On all sensitive soils (10%)



On good soils (10%)



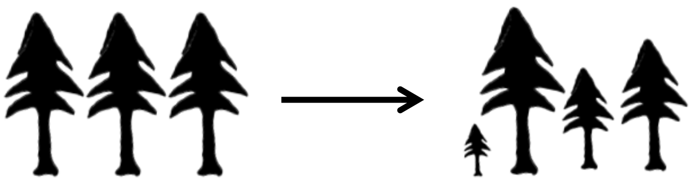
## ES scenarios

Three scenarios to test different **managements** on the supply of ES

1.a. Scenario « restoration »

1.b. Scenario « restoration + compensation »

2. Scenario « continuous forest cover »



(40% + 10%)

# Methodology

## ES scenarios

Three scenarios to test different **managements** on the supply of ES

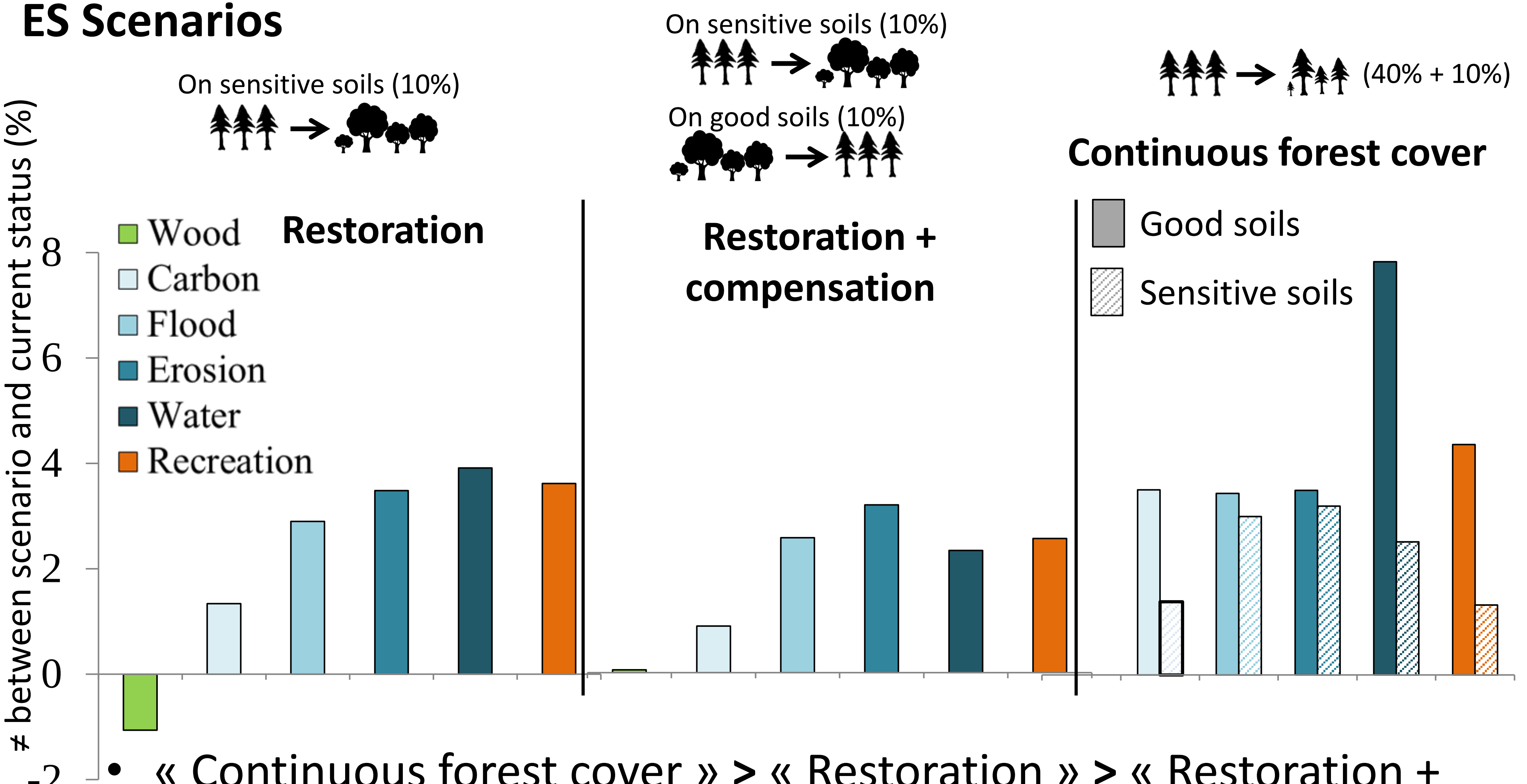
<u>2. Scenario « continuous forest cover »</u>

ES rankings were adapted with literature + experts

| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

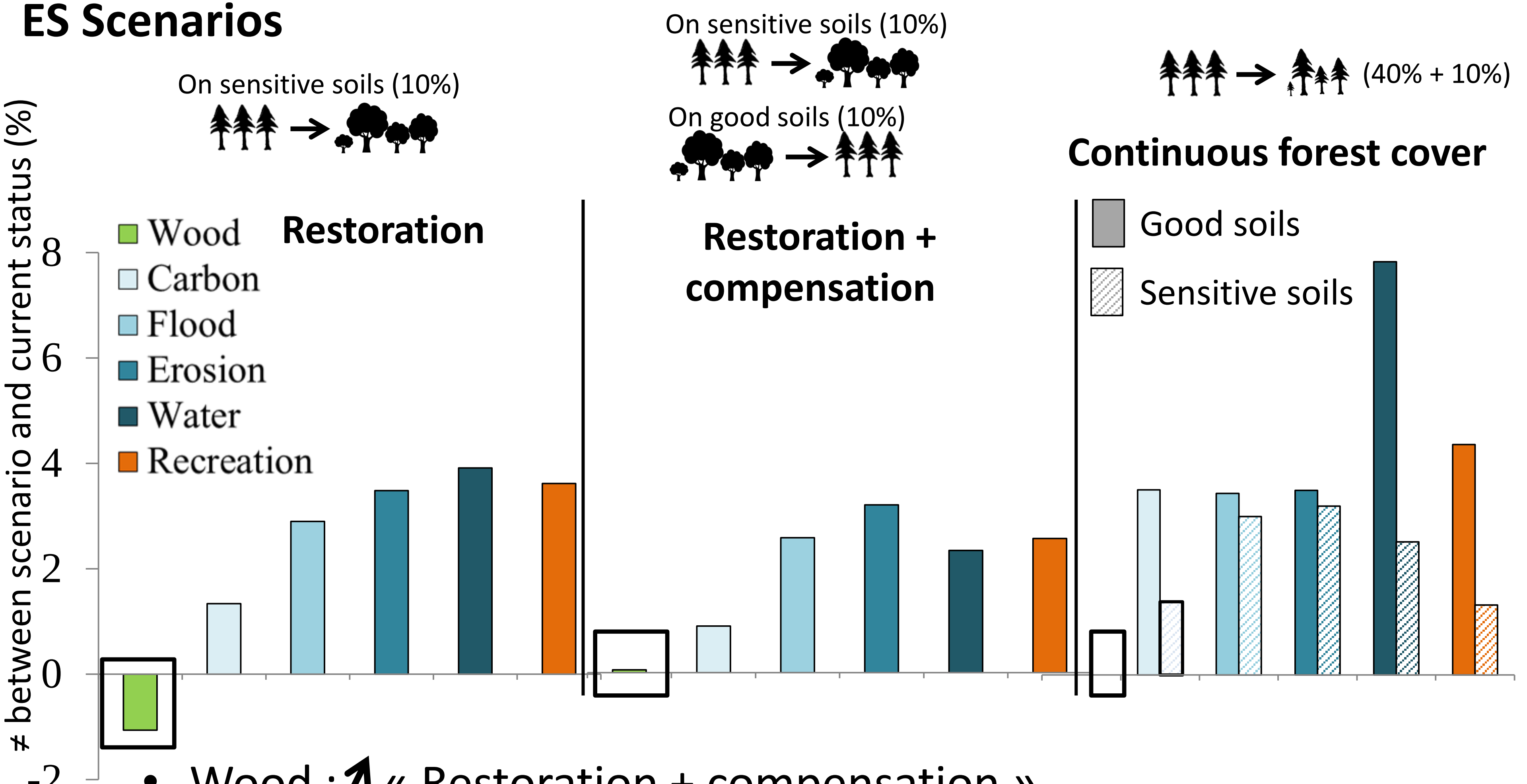
| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 7 | 7 | 7 | 6 | 5 |
| Steep slope | 5 | 5 | 6 | 5 | 5 | 4 |
| Alluvial soil | 7 | 7 | 7 | 5 | 4 | 3 |
| Wet soil | 4 | 4 | 6 | 6 | 5 | 4 |
| Podzolic soil | 5 | 5 | 6 | 6 | 3 | 5 |
| Peat soil | 1 | 5 | 5 | 6 | 5 | 1 |

## ES Scenarios




- « Continuous forest cover » **>** « Restoration » **>** « Restoration + compensation »
- but on sensitive soils « Restoration » **>** « Continuous forest cover »

## ES Scenarios

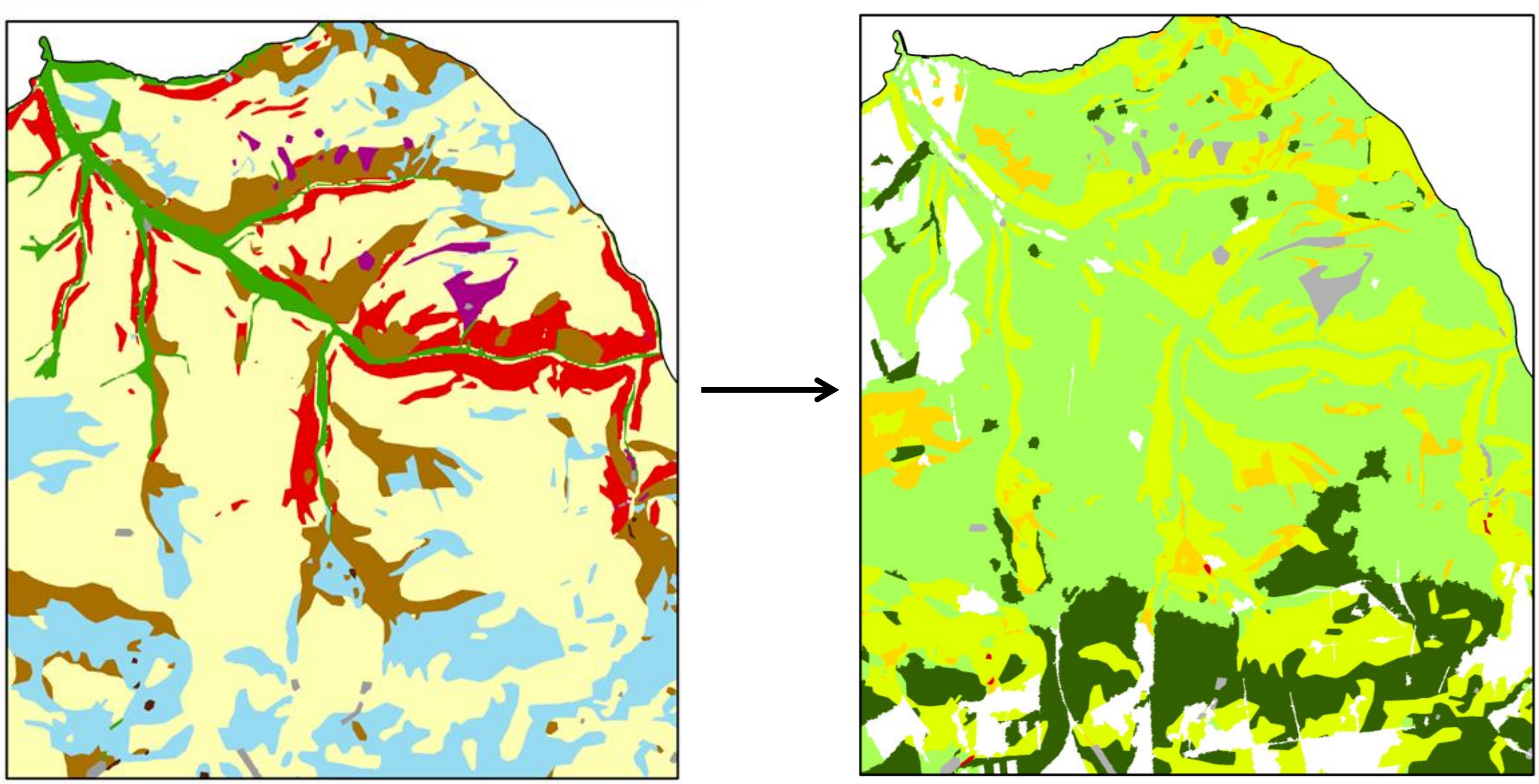



- Wood : ↗ « Restoration + compensation »
 = « Continuous forest cover »
 ↙ « Restoration »

# Discussion

- High spatial variability in maps

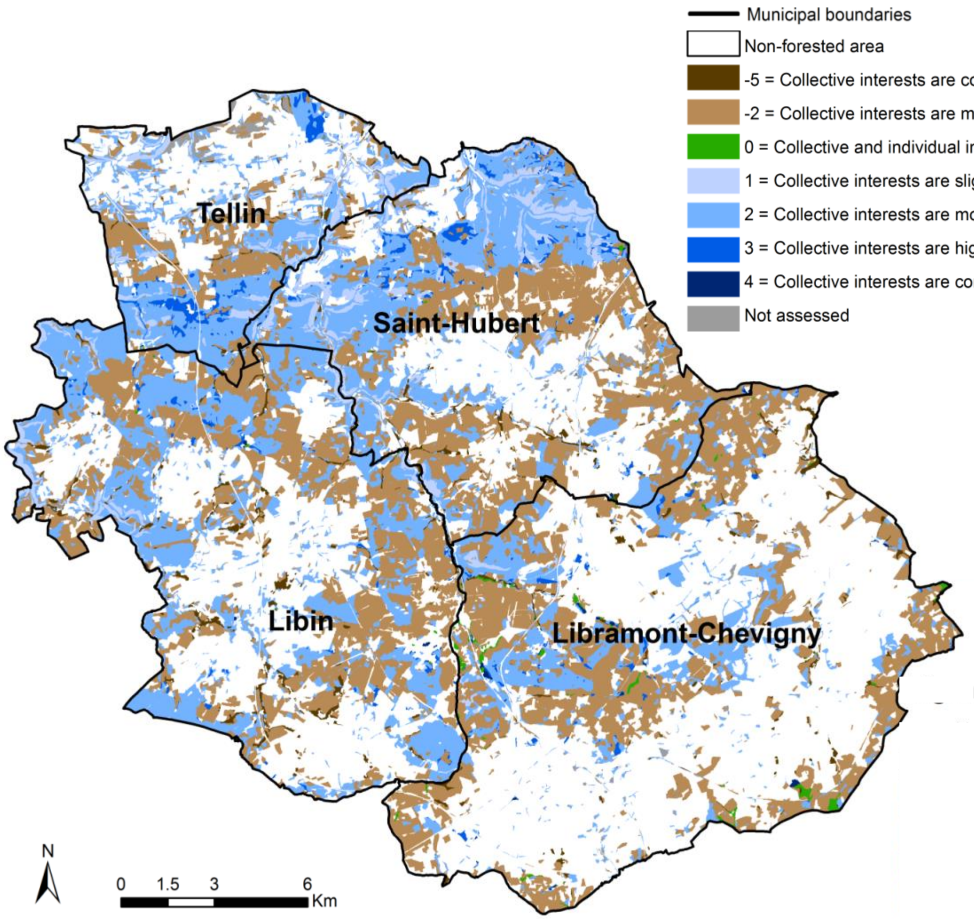
=> ecological context plays an important role in ES supply

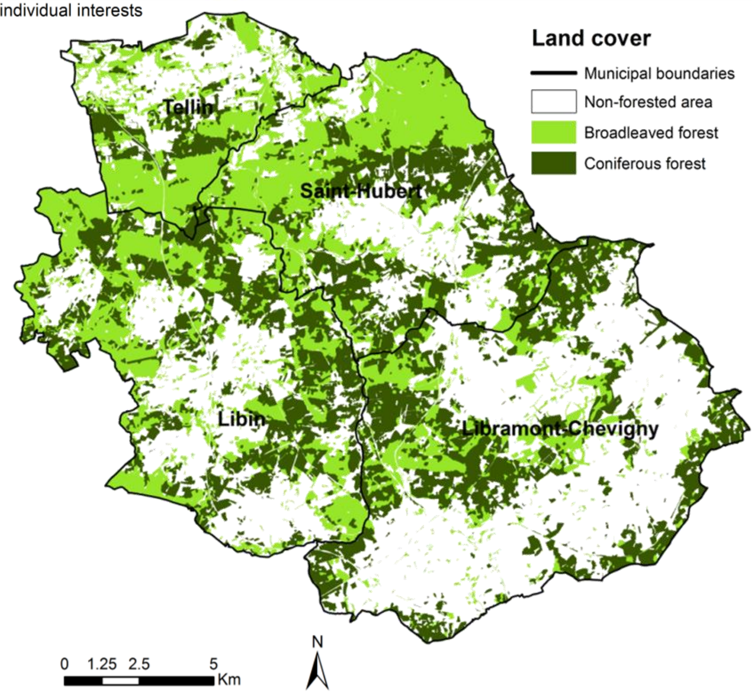


# Discussion

- Intensive management

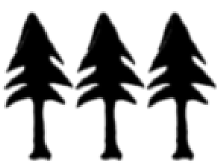
High wood production but low regulating and cultural ES



- Ecological context X management

Effects of the management exacerbated on sensitive soils



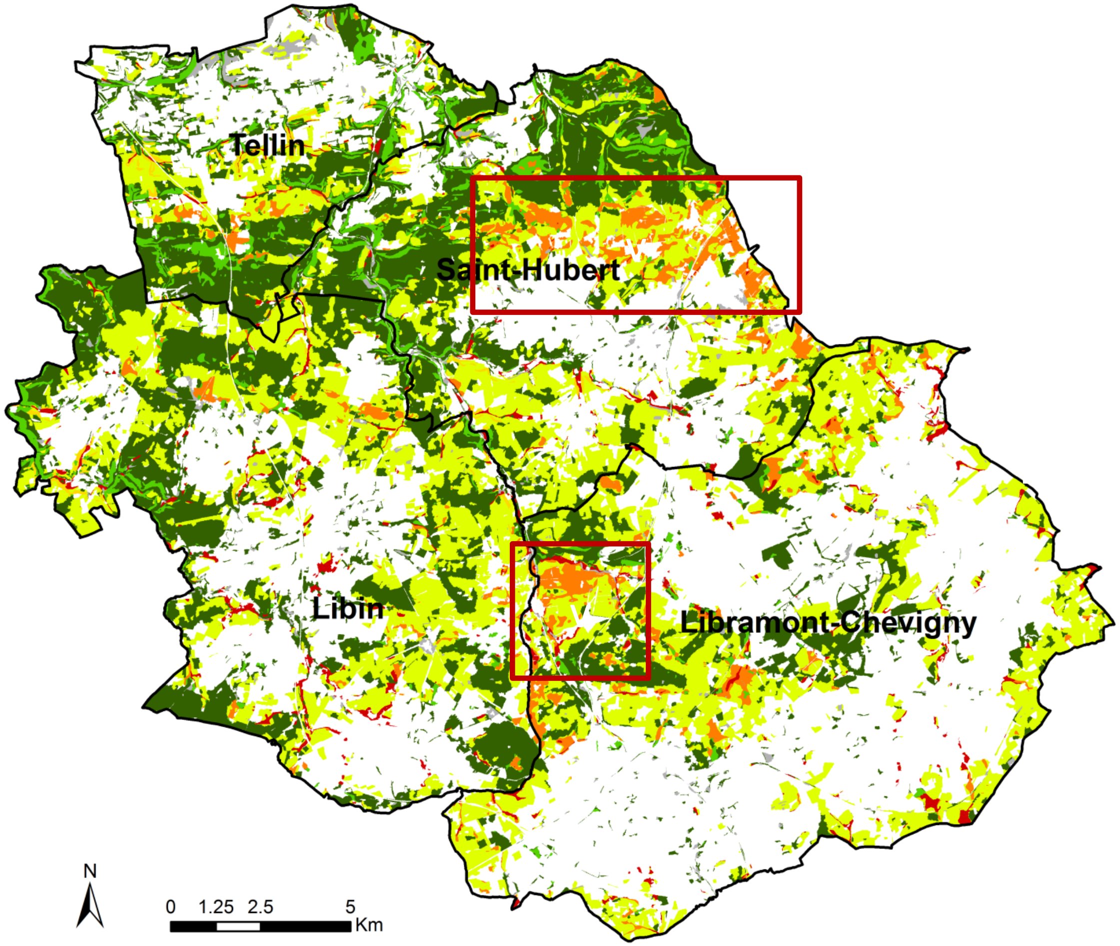
| Ecological context | Wood | Carbon | Flood | Erosion | Water | Recreation |
|---|---|---|---|---|---|---|
| Brown soil | 7 | 6 | 6 | 6 | 4 | 4 |
| Steep slope | 5 | 4 | 3 | 2 | 3 | 2 |
| Alluvial soil | 7 | 4 | 3 | 1 | 1 | 3 |
| Wet soil | 4 | 3 | 2 | 2 | 2 | 2 |
| Podzolic soil | 5 | 4 | 4 | 3 | 2 | 4 |
| Peat soil | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Brown soil | 5 | 7 | 7 | 7 | 7 | 6 |
| Steep slope | 4 | 5 | 6 | 5 | 6 | 5 |
| Alluvial soil | 5 | 7 | 7 | 7 | 7 | 7 |
| Wet soil | 3 | 4 | 6 | 6 | 6 | 6 |
| Podzolic soil | 4 | 5 | 6 | 6 | 4 | 6 |
| Peat soil | 1 | 5 | 5 | 6 | 6 | 5 |

# Discussion

- Management recommendations

- Maps to identify areas of improvement



# Discussion



- Management recommendations

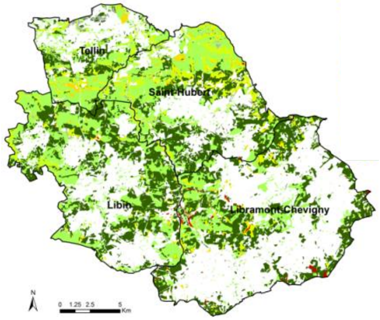
- Maps to identify areas of improvement
- Adapting the management to the ecological context

**Good soils with productive forest**
All ES
Collective ~ individual interests

**Sensitive soils with natural forest**
Regulating and cultural ES
Collective > individual interests

# Conclusion





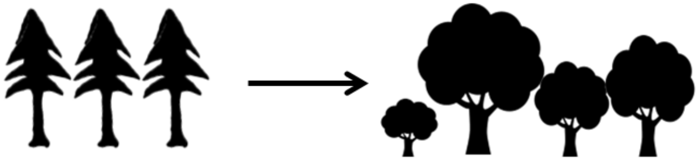

1. Map ES supply depending on the **ecological context** and the **management**

- A forest is not like another: depending on the ecological context and management, a forest provides a different set of ES
- It is important to map the heterogeneity to identify which management can be applied where

# Conclusion



2. Test different management **scenarios** on ES supply depending on the ecological context



- Adapt the management to the ecological context

Good soils

Sensitive soils

# Thank you for your attention Any questions?

Laura Maebe - laura.maebe@uliege.be

# Methodology

## ES scenarios

Three scenarios to test different **managements** on the supply of ES

<u>1.a. Scenario « restoration »</u>

<u>1.b. Scenario « restoration + compensation »</u>

<u>2. Scenario « continuous forest cover »</u>

$$D = \frac{\sum_{i=1}^{12}\left(x_i^{Scenario} * S_i^{Scenario}\right) - \sum_{i=1}^{12}\left(x_i^{Current\ \ status} * S_i^{Curent\ \ status}\right)}{\sum_{i=1}^{12}\left(x_i^{Scenario} * S_i^{Scenario}\right) + \sum_{i=1}^{12}\left(x_i^{Current\ \ status} * S_i^{Curent\ \ status}\right)}$$

D = Difference in the capacity to supply the ES between the scenario and the current status
i = each combination of a type of management with a type of ecological context
x = the ranking of the ES
S = the surface (ha) covered by each combination of a type of management with a type of ecological context