Research Group
Ecosystem Management
University of Antwerp

Indicators for changes in ecosystem service delivery – is it supply or demand?

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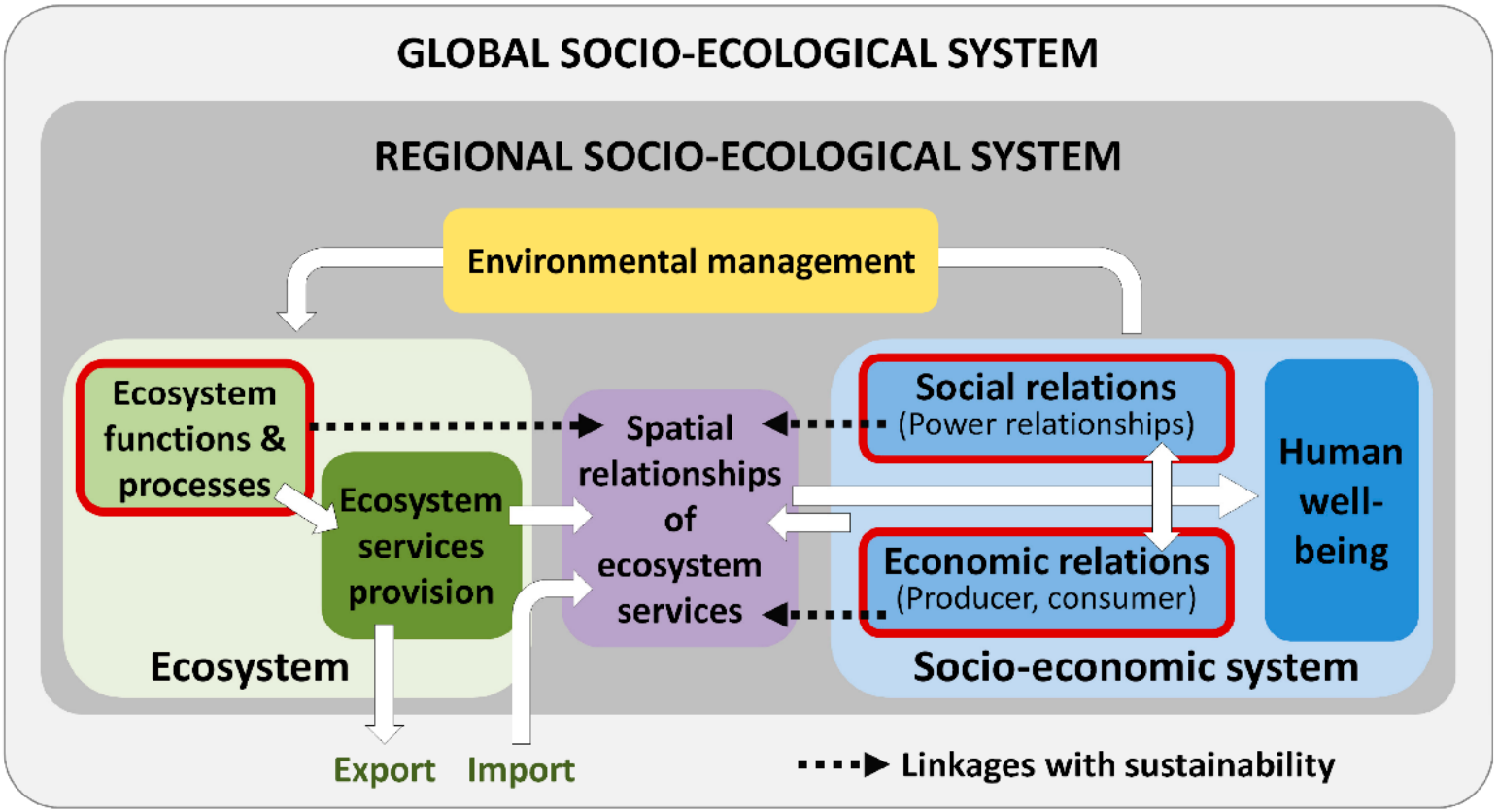
ECOPLAN
Planning for Ecosystem Services

University
of Antwerp

Ecosystem services

= Ecosystem services are the various benefits that soil, water, plants and animals in the landscape deliver to society



ES supply | ES flow | ES demand

ES use

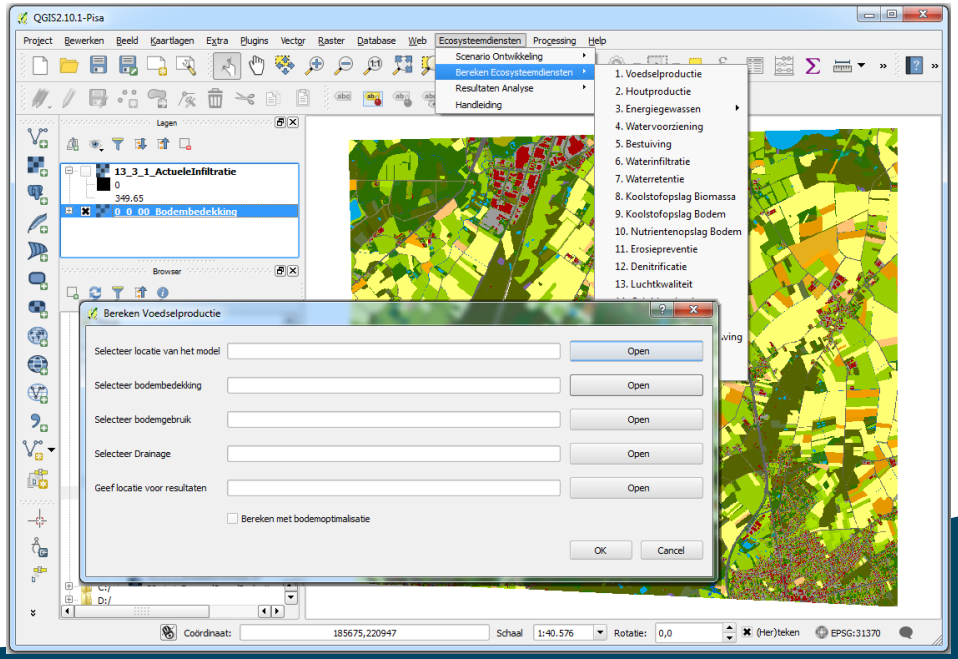
The ECOPLAN-project

Aim: develop information, tools and methods for the implementation of the ES-concept in various planning and policy processes.

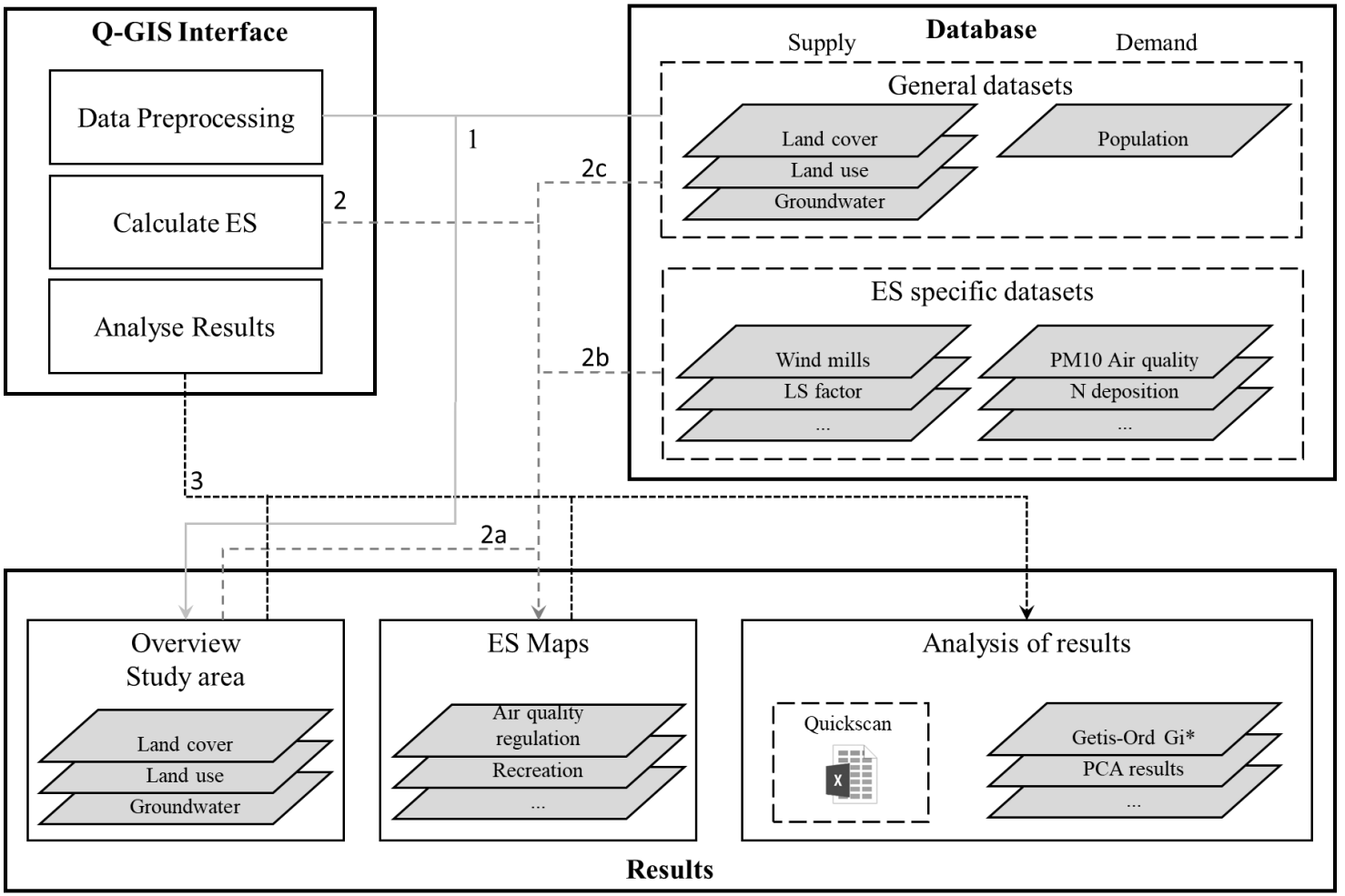
ECOPLAN Scenario-Evaluator (ECOPLAN-SE)

A Q-GIS plug-in to evaluate ES **USE** in Flanders (Belgium)

- 18 region-specific ES models on 5 meter resolution.



ECOPLAN Scenario-Evaluator (ECOPLAN-SE)



Ecosystems provide resources/material to society

	Ecosystem service	Output maps	Unit
1	**Food production**	**Yearly added value of agricultural activities**	**€/ha*year**
2	**Wood production**	**Yearly added harvestable wood volume**	**m^3/ha*year**
		Yearly monetary value of harvestable volume	**€/ha*year**
3	**Energy crops**		
	a.Agricultue	**Yearly energy benefits LHV**	**Gj/ha*year**
		Yearly added value of agricultural activities	**€/ha*year**
	b. Forestry	**Yearly energy benefits LHV**	**Gj/ha*year**
	c. Mowing	**Yearly energy benefits LHV**	**Gj/ha*year**
4	**Water provisioning**	**Yearly extracted volume from freatic groundwater**	**m^3/ha*year**
5	Pollination	Qualitative indicator of pollination availability	Kwalitatief
6	Water infiltration	Yearly infiltration volume	m^3/ha*year
7	Water retention	Seasonal retention	m^3/ha
		Permanent retention	m^3/ha
8	Carbon sequestration wood	Yearly carbon sequestration in forests	ton C/ha*year
9	Carbon sequestration soil	Total carbon storage in soils	ton C/ha
10	Nutrient storage soil	Total nitrogen storage in soils	ton N/ha
		Total fosforus storage in soils	ton P/ha
12	Nitrogen removal	Yearly denitrification in soils	kg/ha*year
11	Erosion prevention	Yearly avoided erosion	ton/ha*year
13	Air quality regulation	Yearly deposition of PM10 on vegetation	kg/ha*year
14	Sound regulation	Yearly added value to houses	€/year
15	City climate regulation	Avoided temperature rise	°C
16	Recreation	Number of recreationists	number
17	Quality living surroundings	Yearly added value to houses	€/ha*year
18	Health effects	Received health benefits	DALY/ha

Ecosystems regulate (negative) societal/economic effects

	Ecosystem service	Output maps	Unit
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Ecosystems provide benefits based on our cultural preferences

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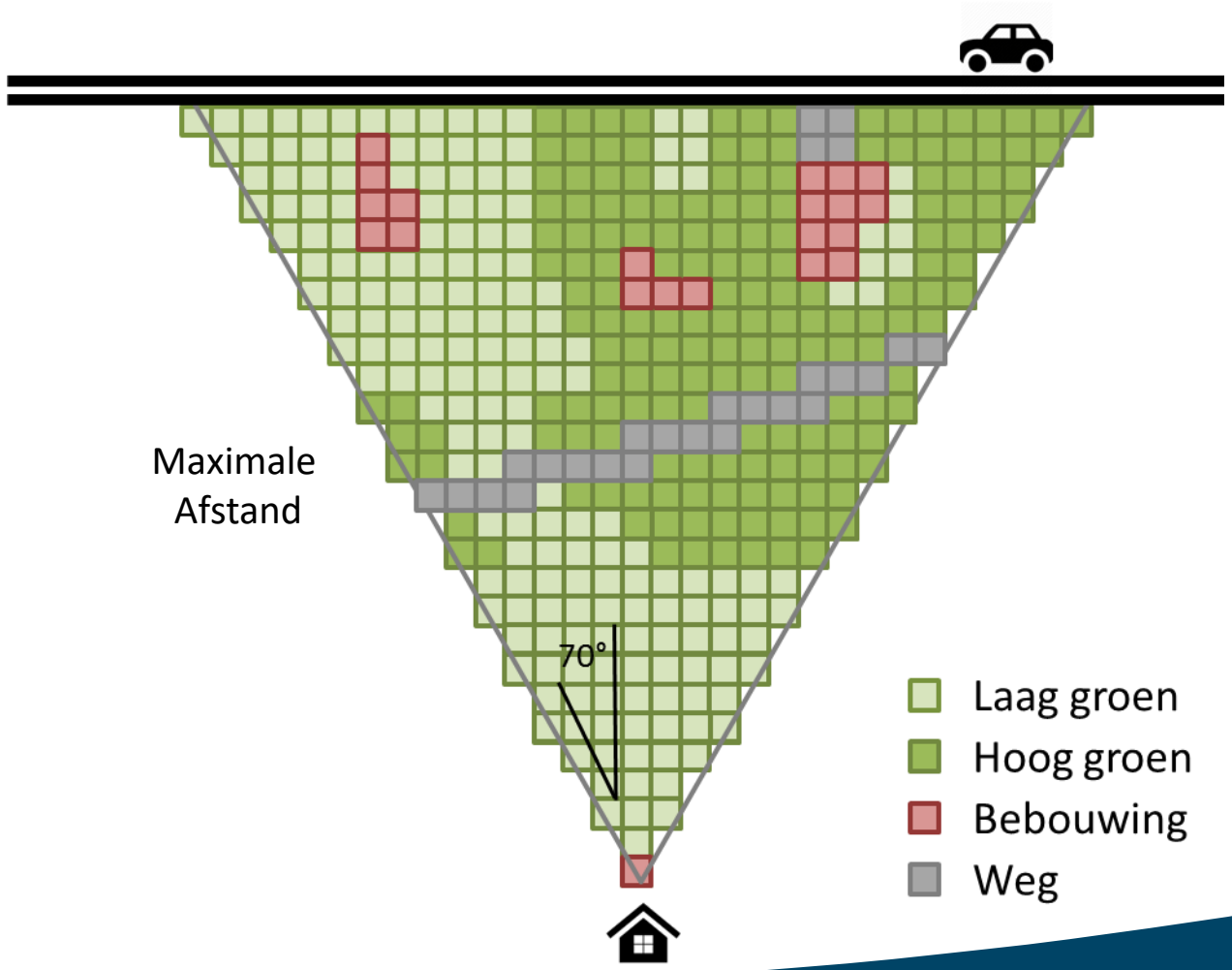
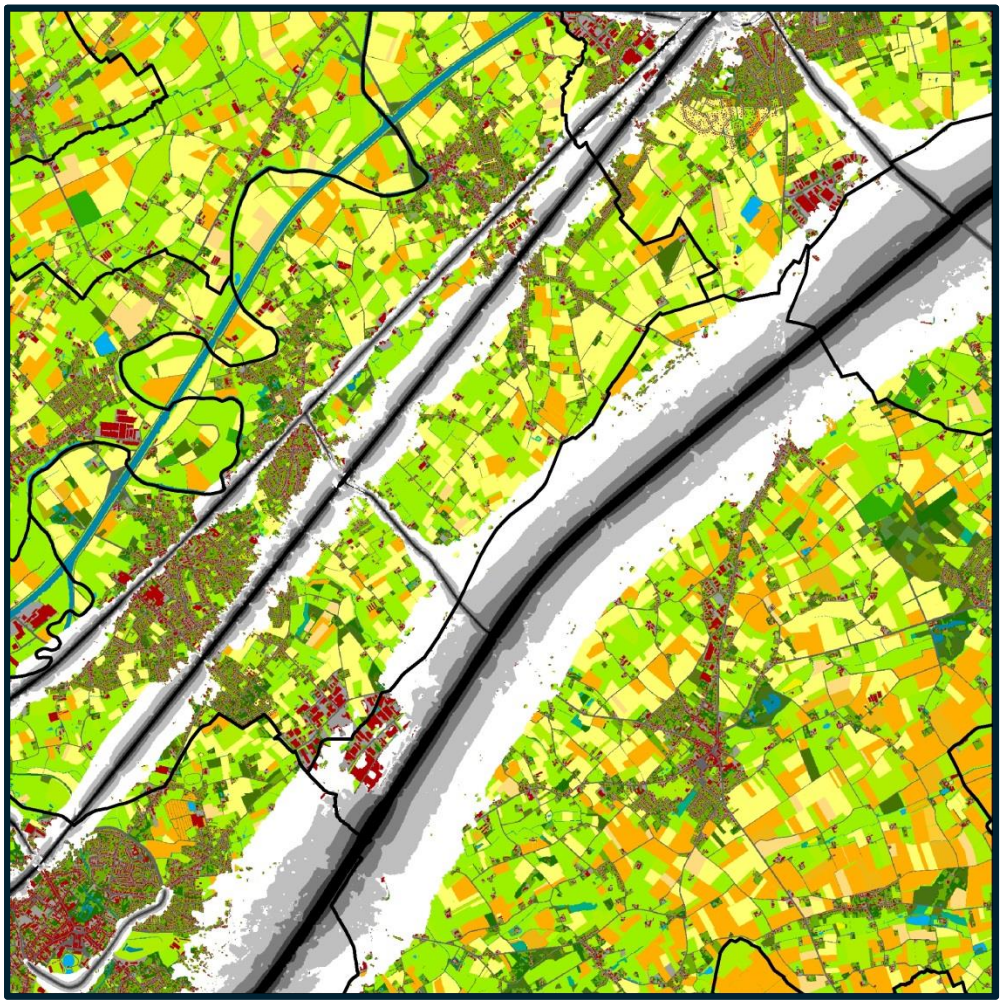
Example - Noise reduction through green infrastructure

Definition: Presence of green infrastructure reduces noise nuisance.

- Only in areas with noise pollution.
- Between house and road - at least 100m.



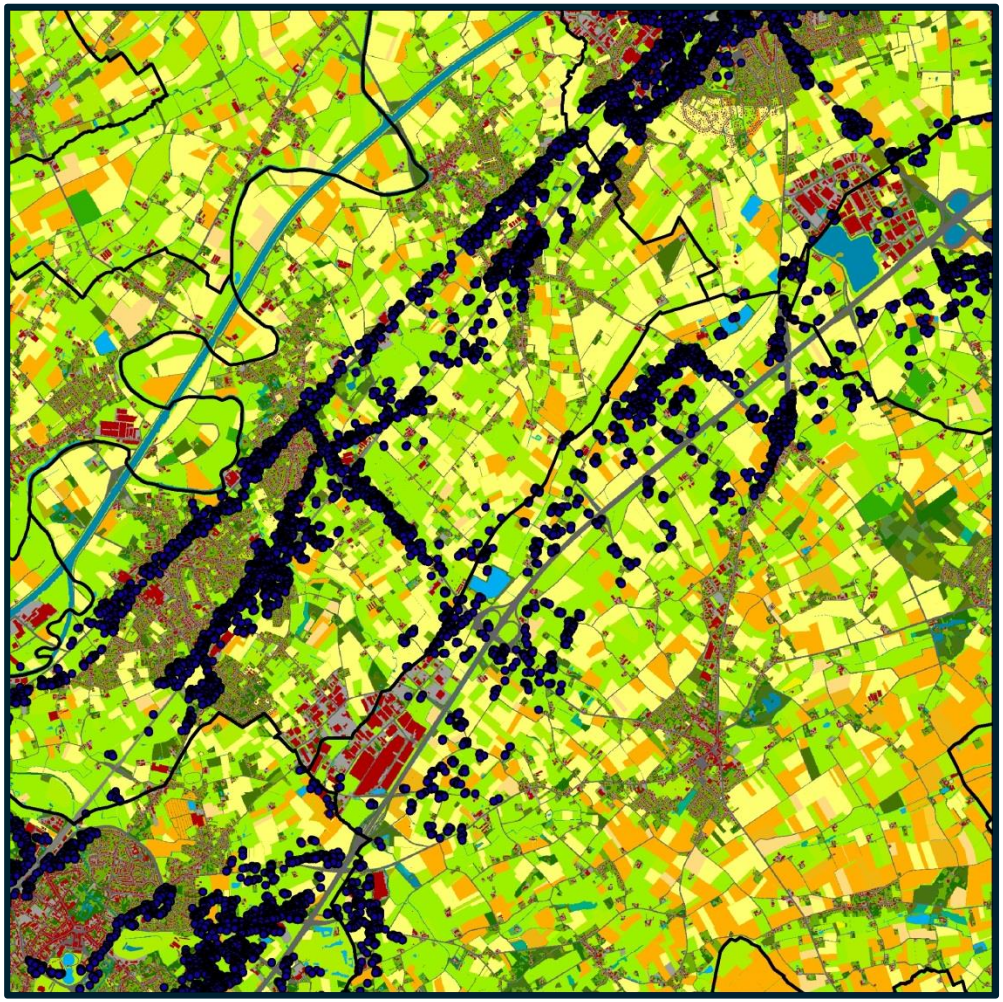
Example - Noise reduction through green infrastructure



Noise exposure: modelled without taking GI into account

Zulte	Meeuwen - Geertrode

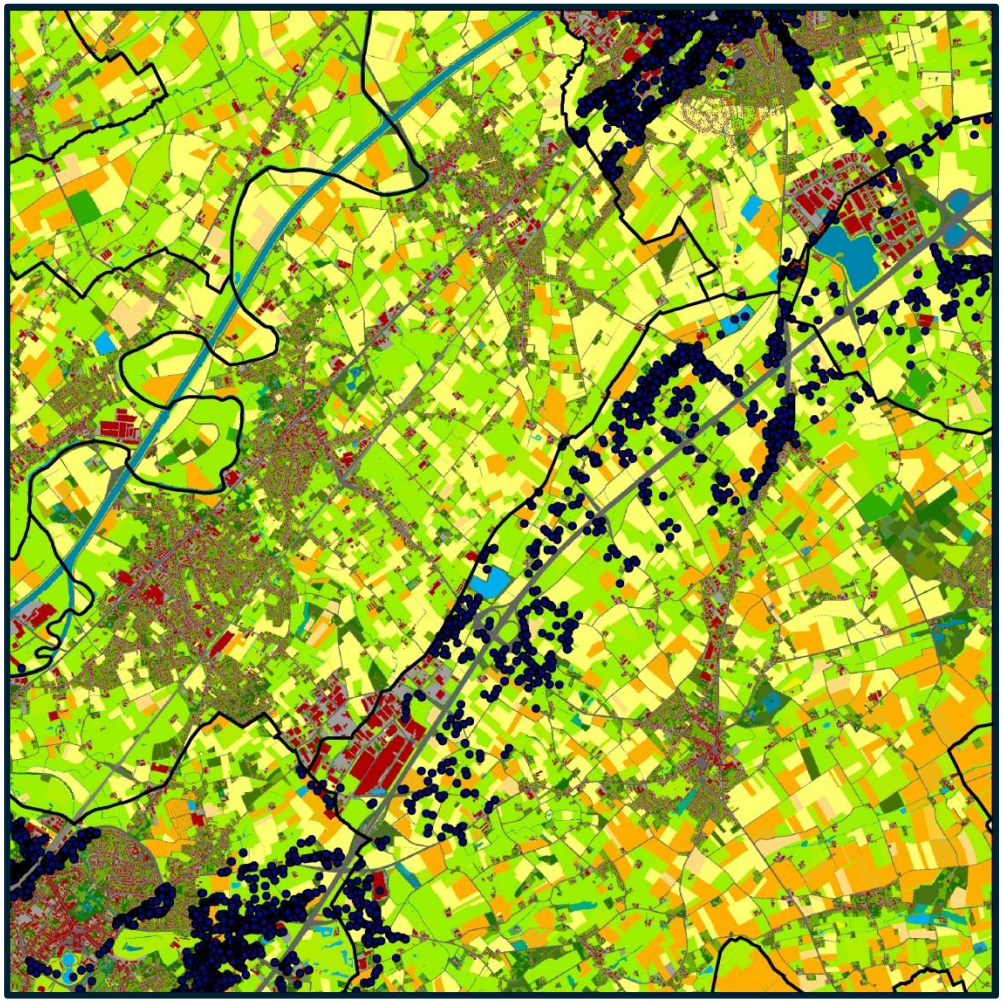
Example - Noise reduction through green infrastructure



Houses that are exposed to noise

	Zulte	Meeuwen - Geertrode

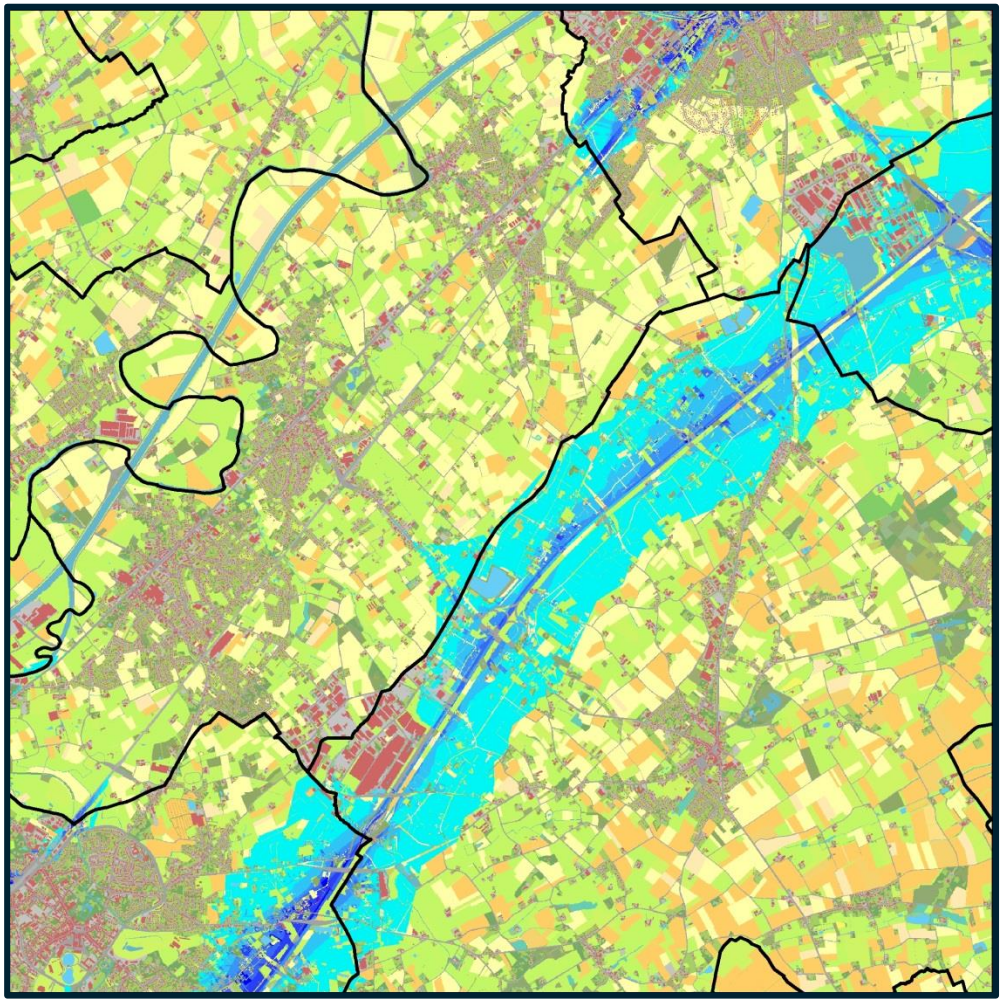
Example - Noise reduction through green infrastructure



Houses that have minimal 100 m of GI between emittor and receptor

	Zulte	Meeuwen - Geertrode

Example - Noise reduction through green infrastructure



Supply of noise attenuation

Zulte	Meeuwen - Geertrode
€ / ha * green area	
1 - 9	25 - 169

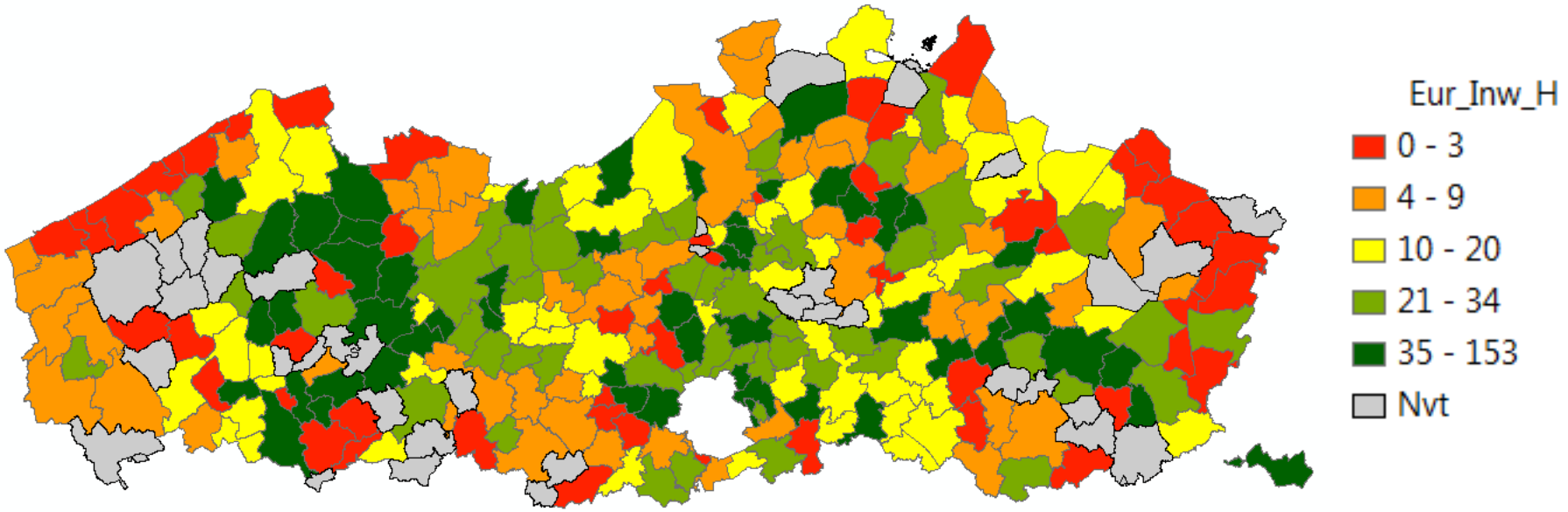
Results of each ES is aggregated at a spatial unit

		Quantification		Monetization (1000 €/year)		€ / ha non-urban area by year	
	Ecosystem function/service		Unit	Low estimate	High estimate	Low estimate	High estimate
Producing	Food production	88.85	k€ added value by year	88.85		280.90	
	Wood production	459.93	m³ harvested wood	15.98		50.53	
	Energy crops - agriculture	0.00	Gj Low Heat value	0		0.00	0.00
	Energy crops - forestry	0.00	Gj Low Heat value	no data available			
	Energy crops - nature management	0.00	Gj Low Heat value	no data available			
	Water provisioning	122.91	1000 m³ water	9.22	24.58	29.15	77.72
Supporting and regulating	Pollination	0.44	Mean indicatorvalue by ha	supporting function			
	Water infiltration	521.51	1000 m³ infiltration capacity	supporting function			
	Water retention	519.56	1000 m³ waterretention capacity	supporting function			
	Carbon in biomass	243.51	ton C opslag biomass by year	53.57		169.37	
	Carbon in soil	62151.10	ton C stock	136.73		432.29	
	Nitrogen in soil	3575.74	ton N stock	supporting function			
	Phosphorus in soil	238.38	ton P stock	supporting function			
	Nitrogen removal	175.33	kg N removal	0.88	12.97	2.77	41.02
	Erosion prevention	9504.38	ton soil	no data available			
	Air quality regulation	3.23	ton PM removed	184.14		582.18	
	Noise attenuation	0.00	number of houses	0.00	0.00	0.00	0.00
	Cooling effects from green infrastructure	0.00	decrease °C / ha non-urban	no data available			
Cultural	Recreation	46.41	1000 visitors each year	139.23	417.69	440.19	1320.57
	Added value to houses due to a green environment	0.57	1000 inhabitants within 100m	9.38		29.66	
	Health effects of nature	7.92	1000 inhabitants within 1km	1431.61		4526.14	
			Total value	2069.59	2375.52	6543.19	7510.39

What do these values tell us?

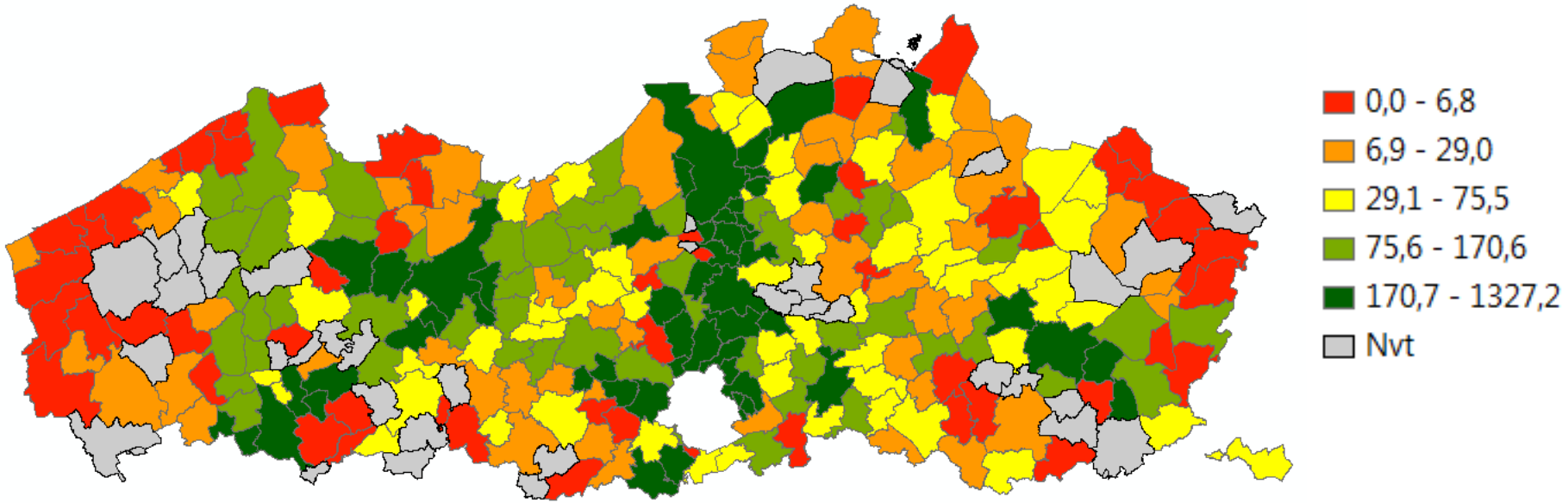
Example - Noise reduction through green infrastructure

Difference in real estate value per inhabitant (recipient) due to green buffers.



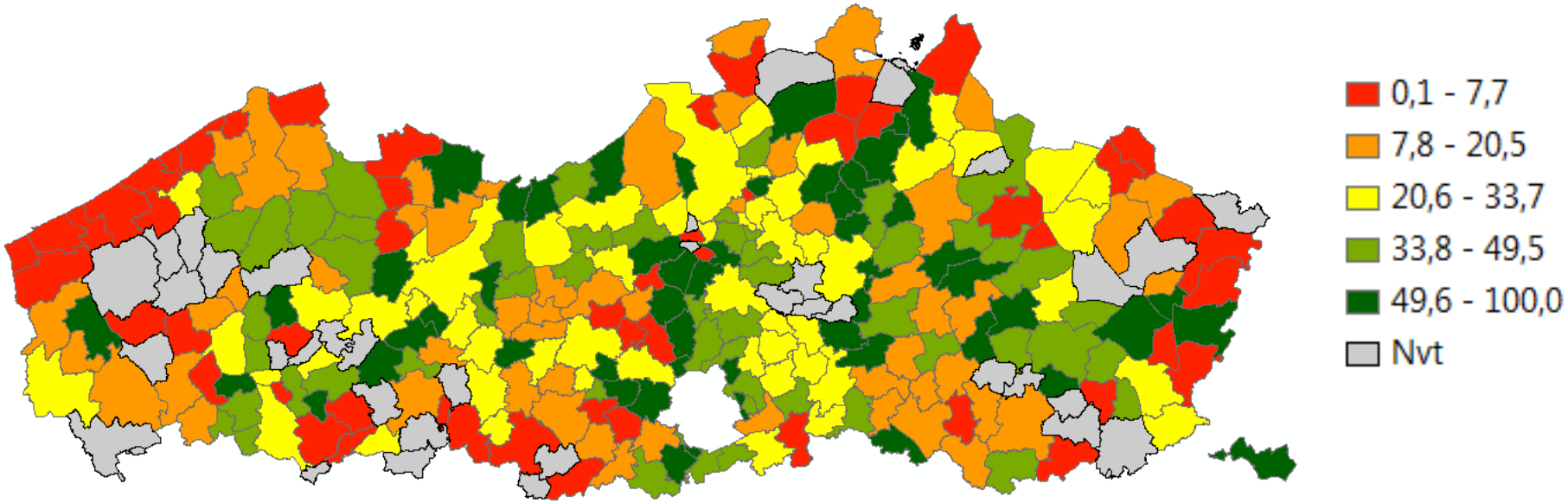
Example - Noise reduction through green infrastructure

Avoided “loss of real estate value” per hectare of green (supplier).



Example - Noise reduction through green infrastructure

Number of houses with reduction / Total number of houses exposed to noise



Nitrogen removal through denitrification in Natura 2000

In 2016: 80.828 kg N removal / year

In 2018: 81.422 kg N removal / year

Is this increase positive?

Not really:

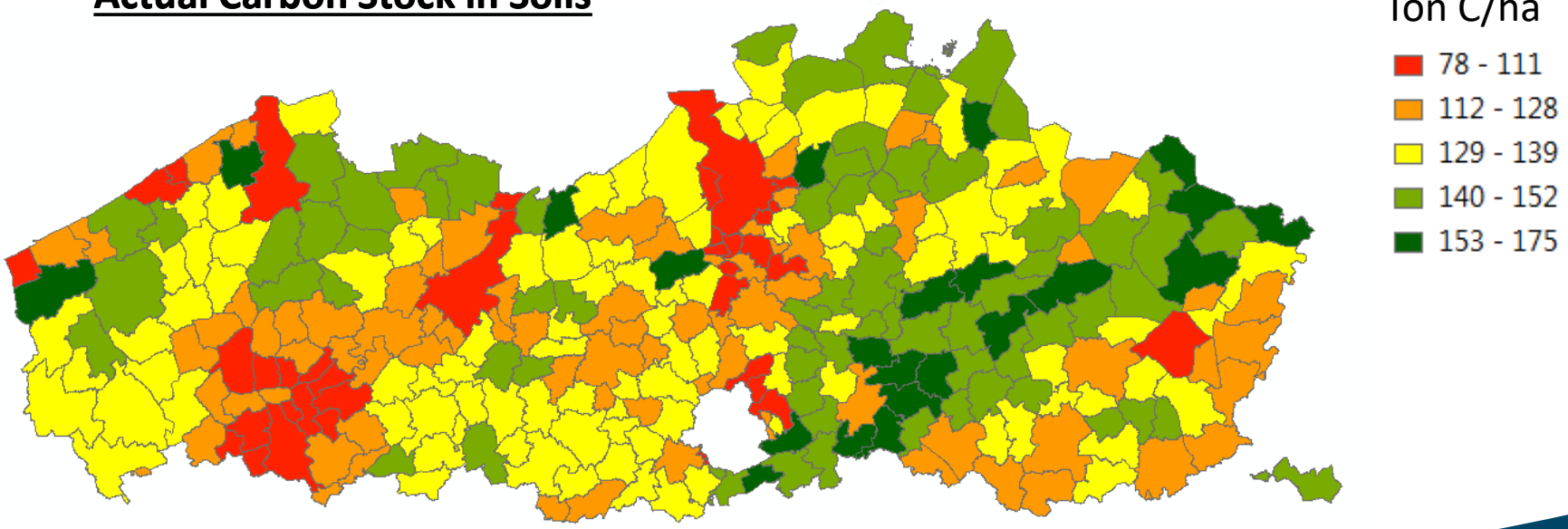
- Grasslands are converted to arable land.
- Demand increased, not the supply.

% removal would be more meaningful.

Carbon stocks in soils

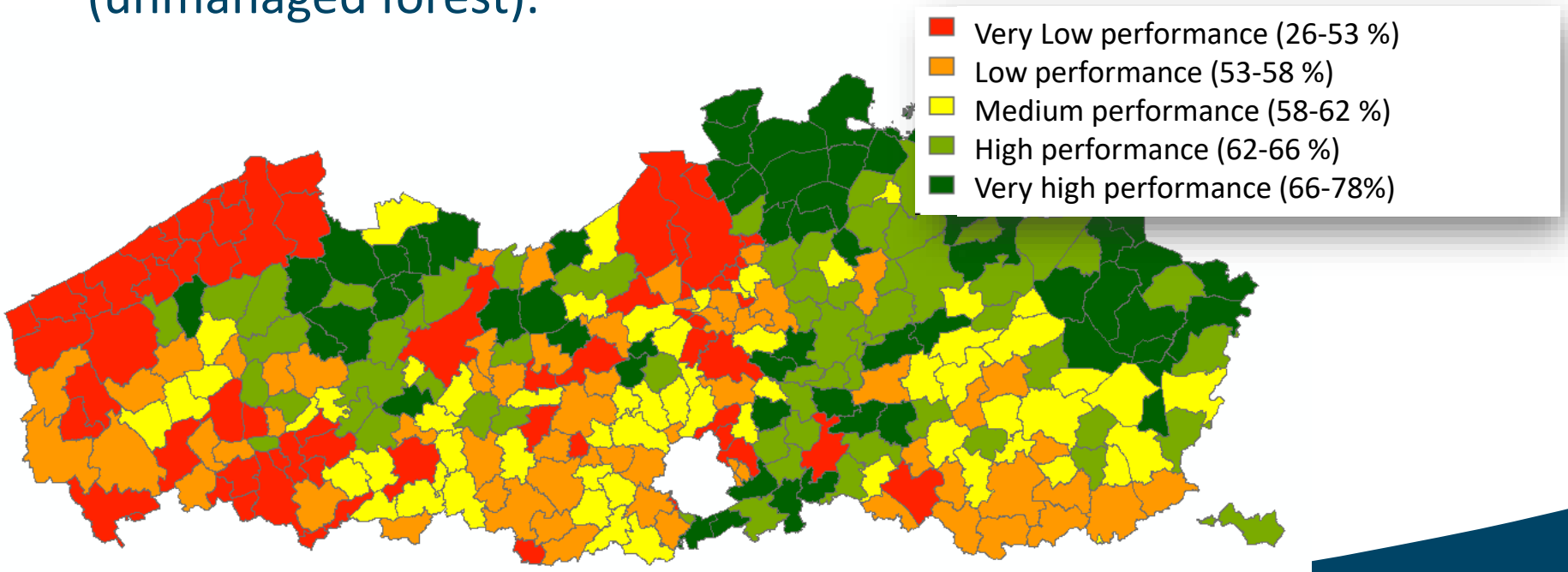
- In the case of carbon storage in the soil there are intrinsic limitations.
- For example, the carbon storage in a dry sandy soil will be very limited and the potential is therefore lower than in other areas.

Actual Carbon Stock in Soils



Carbon stocks

- The potential for building up carbon in the soil is largely determined by soil properties & hydrology.
- We determine the “performance” by comparing the current carbon storage in the soil with the maximum achievable.
- A situation without drainage and with natural vegetation (unmanaged forest).

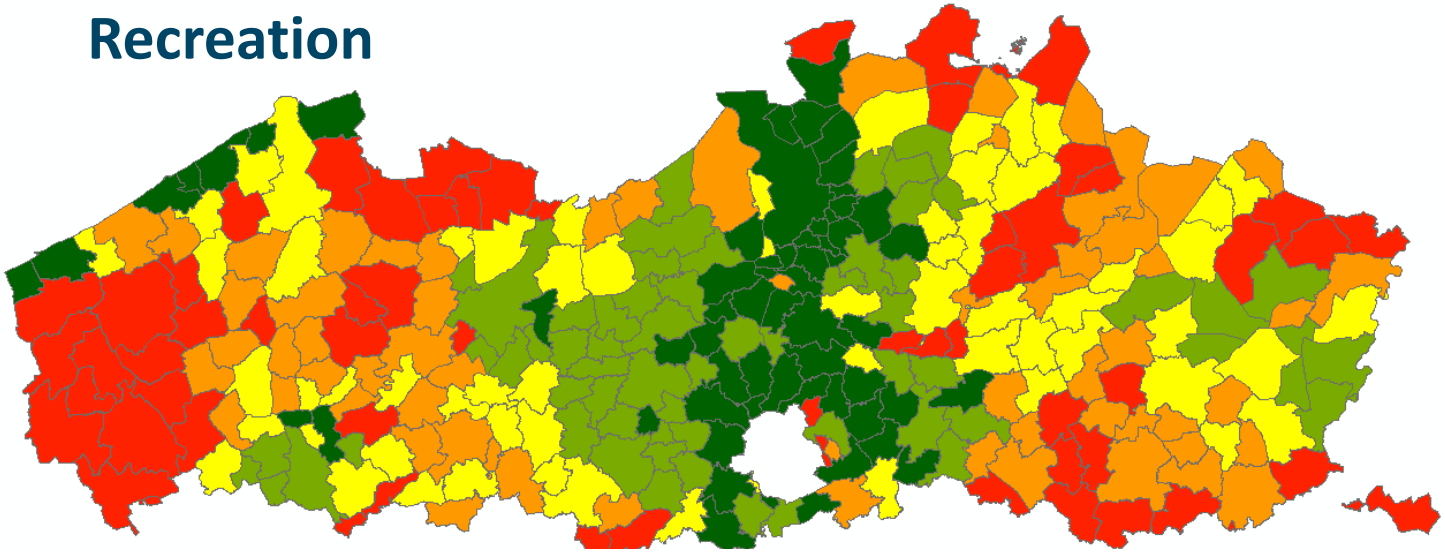


Regulated ecosystem services are often defined by a undesirable demand.

- **No** use of these ES is actually the most preferred, but only if there is no demand.

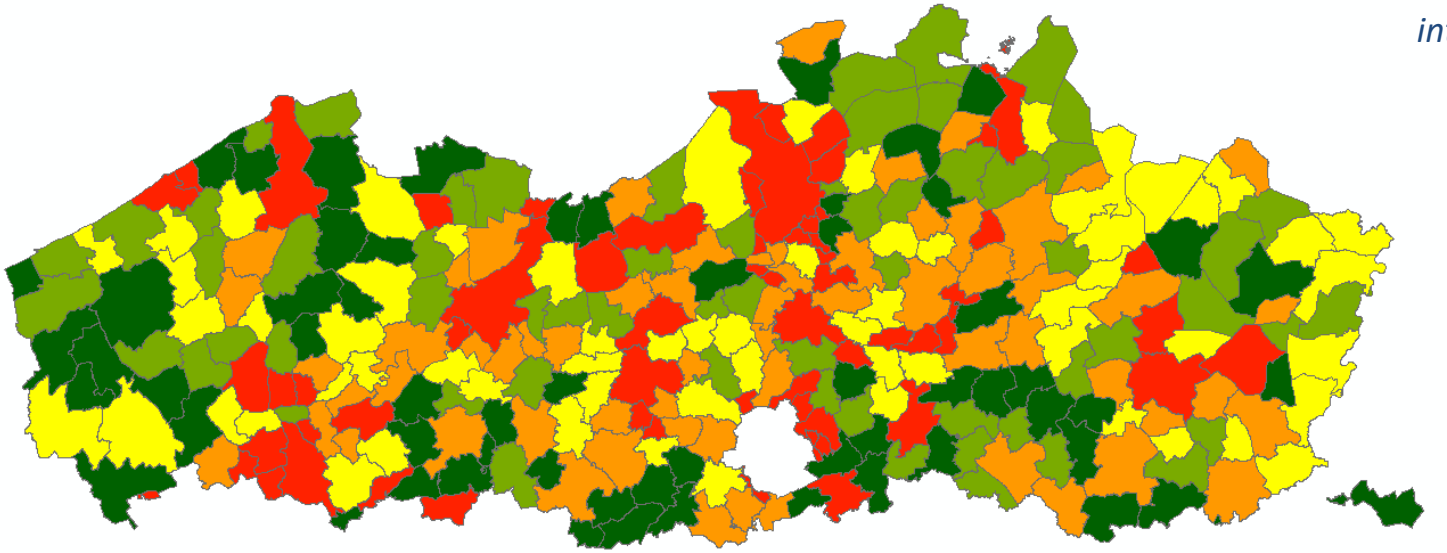
- Understanding differences and changes in the use of these services requires specific indicators where ES use is compared to both (potential) supply and demand.

Recreation



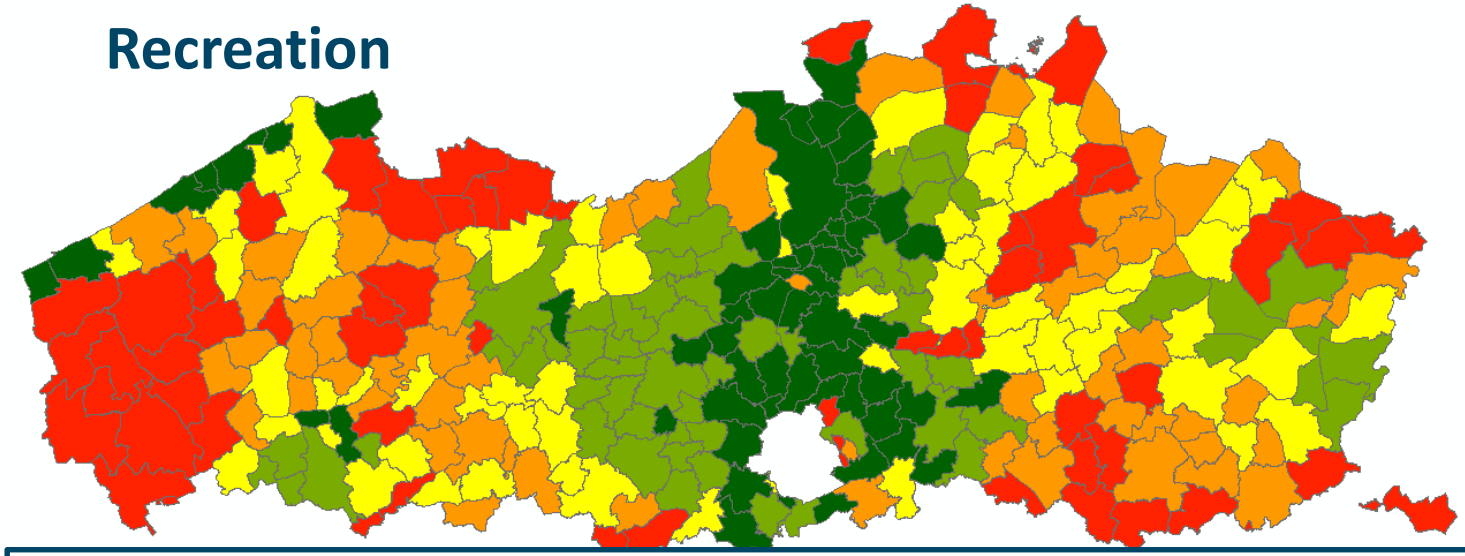
Number of recreational visits per hectare of green.

For the legend, the municipalities were divided into 5 equal groups.



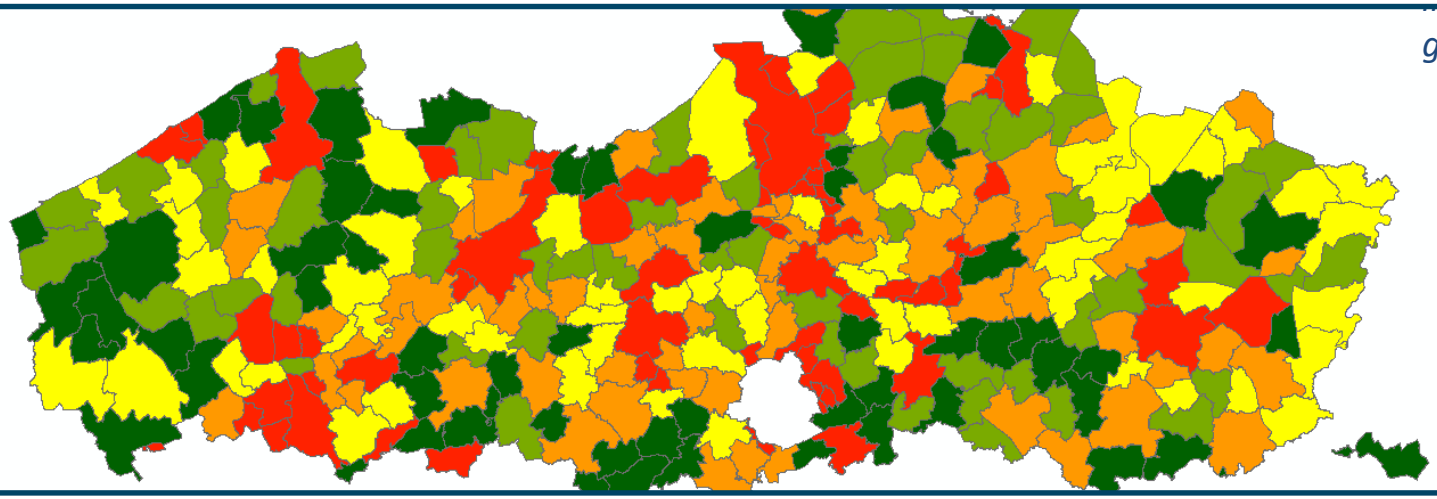
Number of recreational visits per inhabitant as a measure of the amount of green and recreational attractiveness available.

Recreation



The green municipalities at the top have a scarcity of green compared to the need for greenery

n de
n de
n 5
gelijke groepen.



The green municipalities at the bottom attract visitors from far beyond their borders and thus provide recreational services

Cultural ecosystem services are strongly dependent on population density.

- A high number of park visitors is good, but perhaps also a sign of scarcity of alternatives in the area
- The number of visits per inhabitant may be a better indicator.
- Some areas / municipalities attract visitors from across the municipal boundaries ...
- Do the indicators promote living in cities in high densities or living in sub-urban areas and ribbon development?

Cultural ES: Health effects of public green spaces

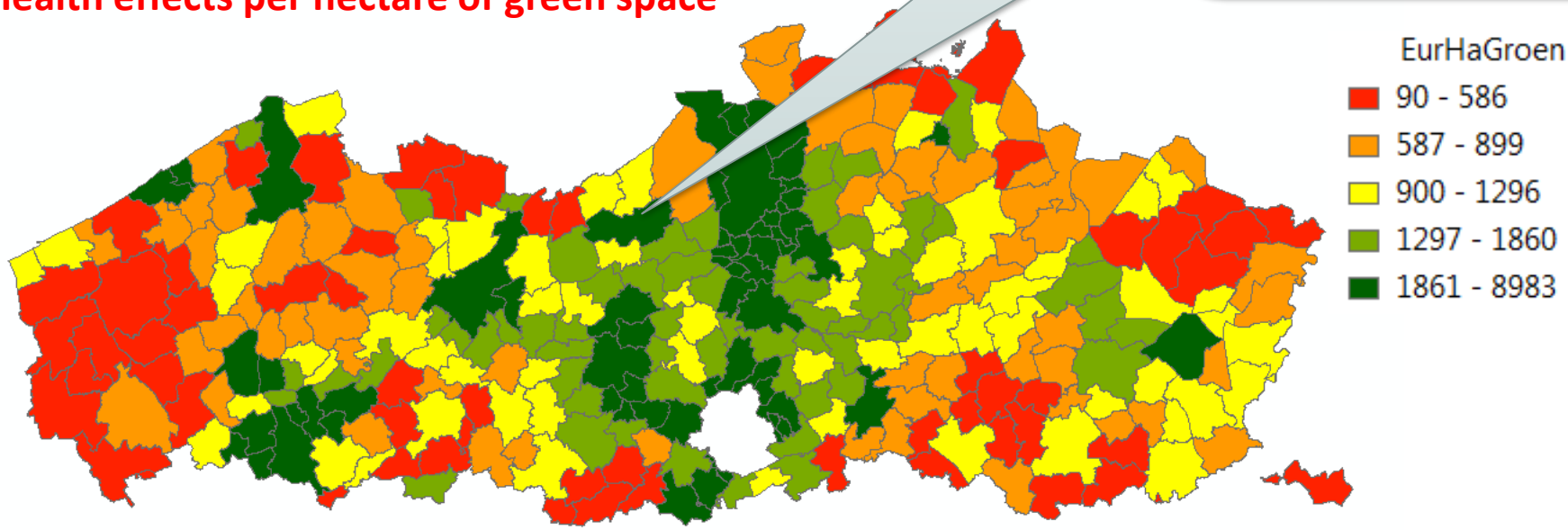
Demand = depends mainly on population density

Supply = depends on the area and distribution of green public space (green at street level and quarter level)

Remaining green is essential, but insufficient to ensure public health for most residents

An argument to halt soil sealing and protect the remaining

Health effects per hectare of green space



Cultural ES: Health effects of public green spaces

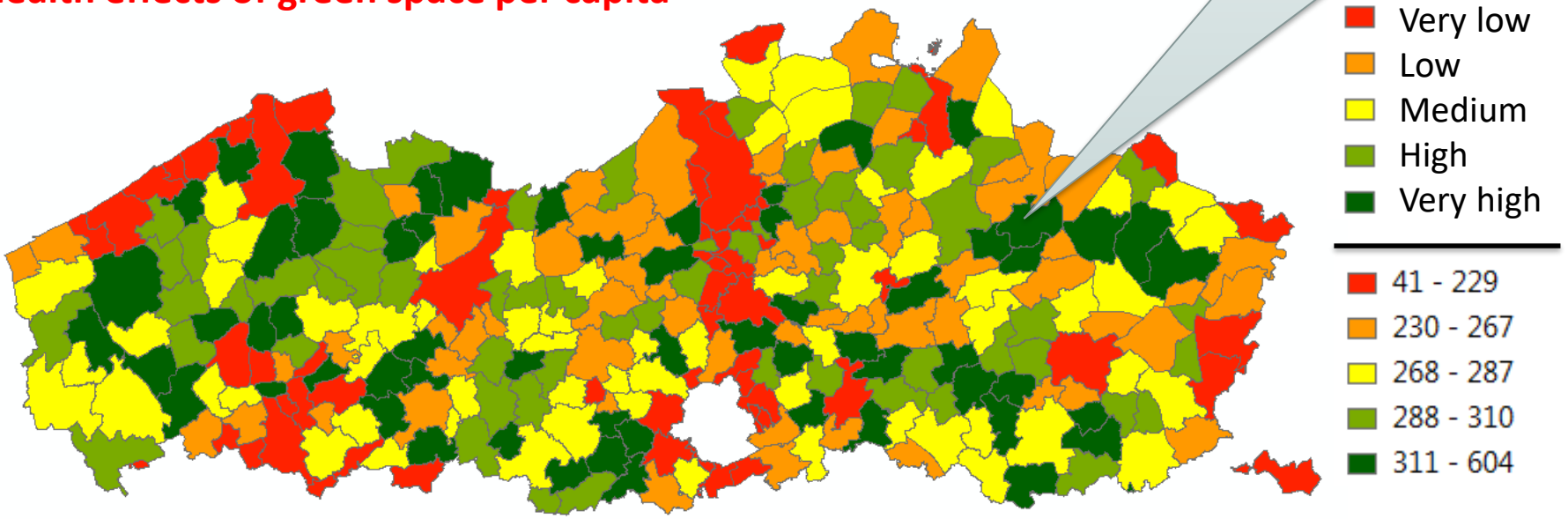
Demand = depends mainly on population density

Supply = depends on the area and distribution of green public space (green at street level and quarter level)

Enough green to ensure a healthy, long life for most residents!

Come over and build your house here?!?

Health effects of green space per capita



What do these values tell us?

- Comparing to other areas can be misleading... not all sites have the same physical potential and/or demand for ES.

- The absolute amount of "ecosystem services" is not always the most important, the extent to which there is a healthy balance with demand and potential delivery, the more.

- Introducing “performance” is needed to provide meaningfull information on the supply of ES...

But what does that tell us?

- The value of one specific green area can be very high and this argument can be used to protect it against the real estate lobby and project developers.

You need a population, so some development is required?

- Often that high value indicates a high demand, which might be negative, or already existing scarcity of public green.

- Important to not only focus on one aspect, the context is equally important.

Conculsions

- The supply of ES is done by green infrastructure (per ha), but in the end the benificiaries are the inhabitants, farmers, consumers, etc (per capita).

- Expressing ES, both by supply unit and beneficiary, provides the necessary nuances we need.

- The type of indicator differs between ecosystem services and type of study, aim of the project, etc.

Conclusions

Indicators should reflect different aspects of the ES:

- The extent to which one can achieve the available potential for ES-supply might be more important than the absolute delivery.

In ES, a similar dilemma unfolds...to which extent do we use the available potential?

- Quantity of quality?
- How efficient do we use these areas and why?
- How do we integrate sustainability?

Is more better?

Often it is, sometimes it isn't.

"Why" is more relevant than the absolute supply.

&

Complex issues cannot be captured in one figure or indicator.

&

By combining ecosystem services and indicators you can promote all kind of environmental planning.

Questions?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