Ecosystem Services and Assets
Lecture 2: the Netherlands ecosystem accounts and asset accounting

International Seminar on Natural Capital Accounting, Beijing, November 2019

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Contents (Lecture 2)

The Netherlands ecosystem accounts

- Physical ecosystem services account
- Monetary ecosystem services account
- Asset account

The Netherlands ecosystem accounts

- Funded by the Netherlands ministry of Agriculture, Nature conservation and Food & the ministry of Infrastructure and Water
- Project implemented by Statistics the Netherlands (CBS) and Wageningen University
- Around 15-20 man-years
- Over 75 databases used, >10 models developed
- Baseline map (extent account) at resolution of several meters, most ecosystem service and other models at 10m by 10m resolution

The Netherlands ecosystem accounts

- Extent account
- Condition account
- Physical ecosystem services account
- Monetary ecosystem services and asset account
- Carbon account
- Biodiversity account (in prep).

- All accounts published at: https://www.cbs.nl/en-gb/society/nature-and-environment/natural-capital

Ecosystem services in NL SEEA account

Provisioning services

- Crop production
- Fodder production
- Timber production
- Other biomass
- Water supply

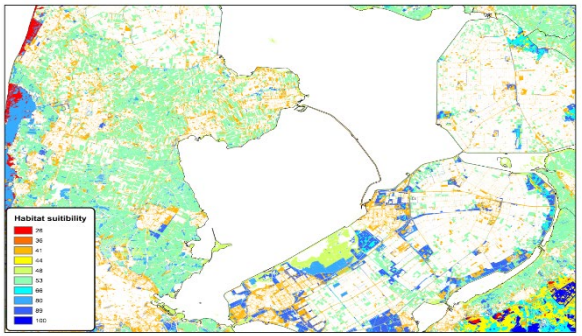
Regulating services

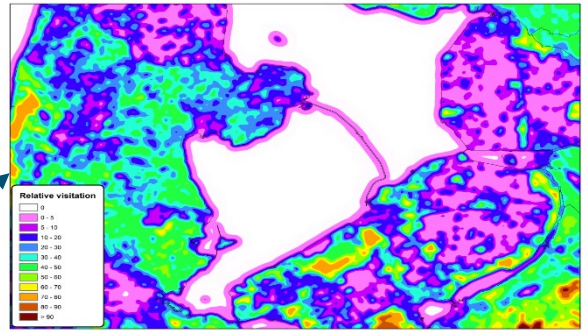
- Carbon sequestration
- Erosion control
- Air filtration
- Water infiltration
- Pollination
- Pest control

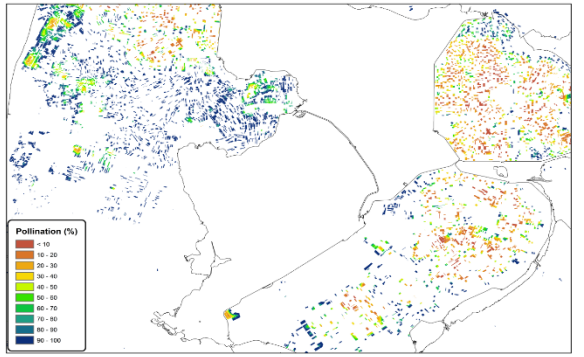
Cultural services

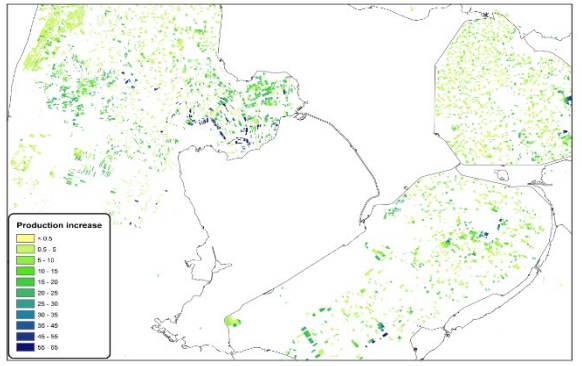
- Nature recreation (hiking)
- Nature tourism

Multiple datasets and models per service



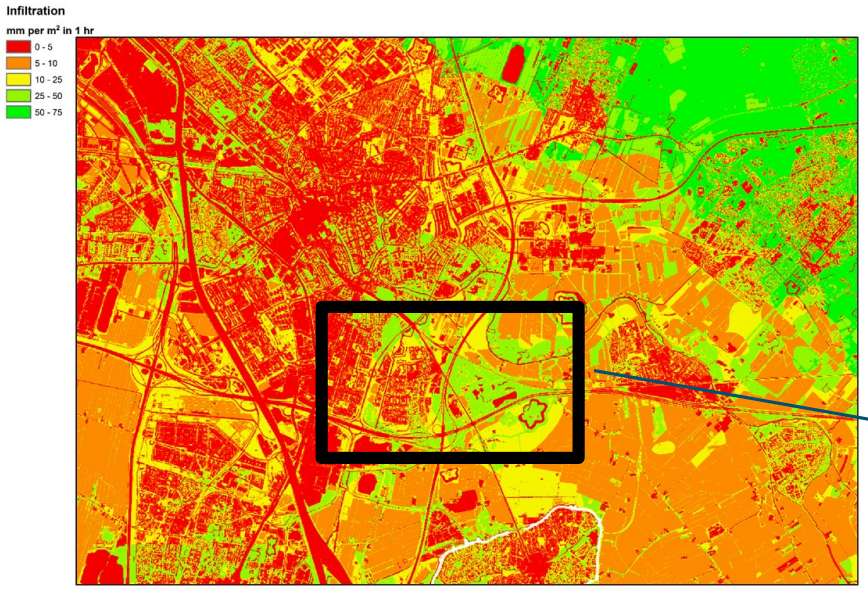


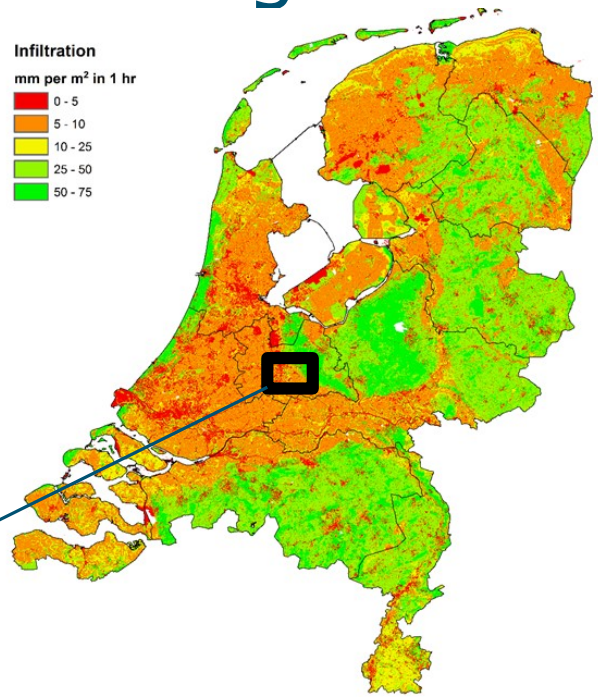


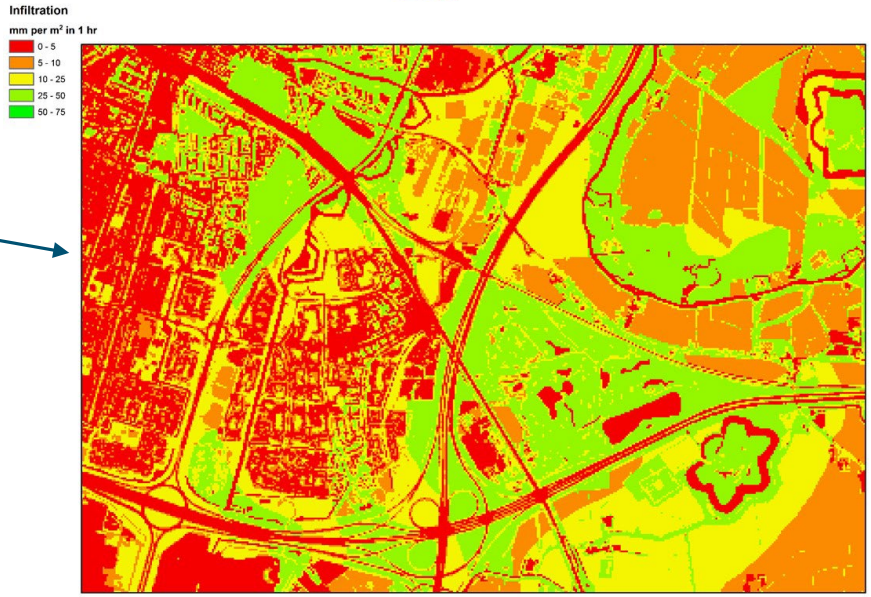


High resolution allows zooming in locally

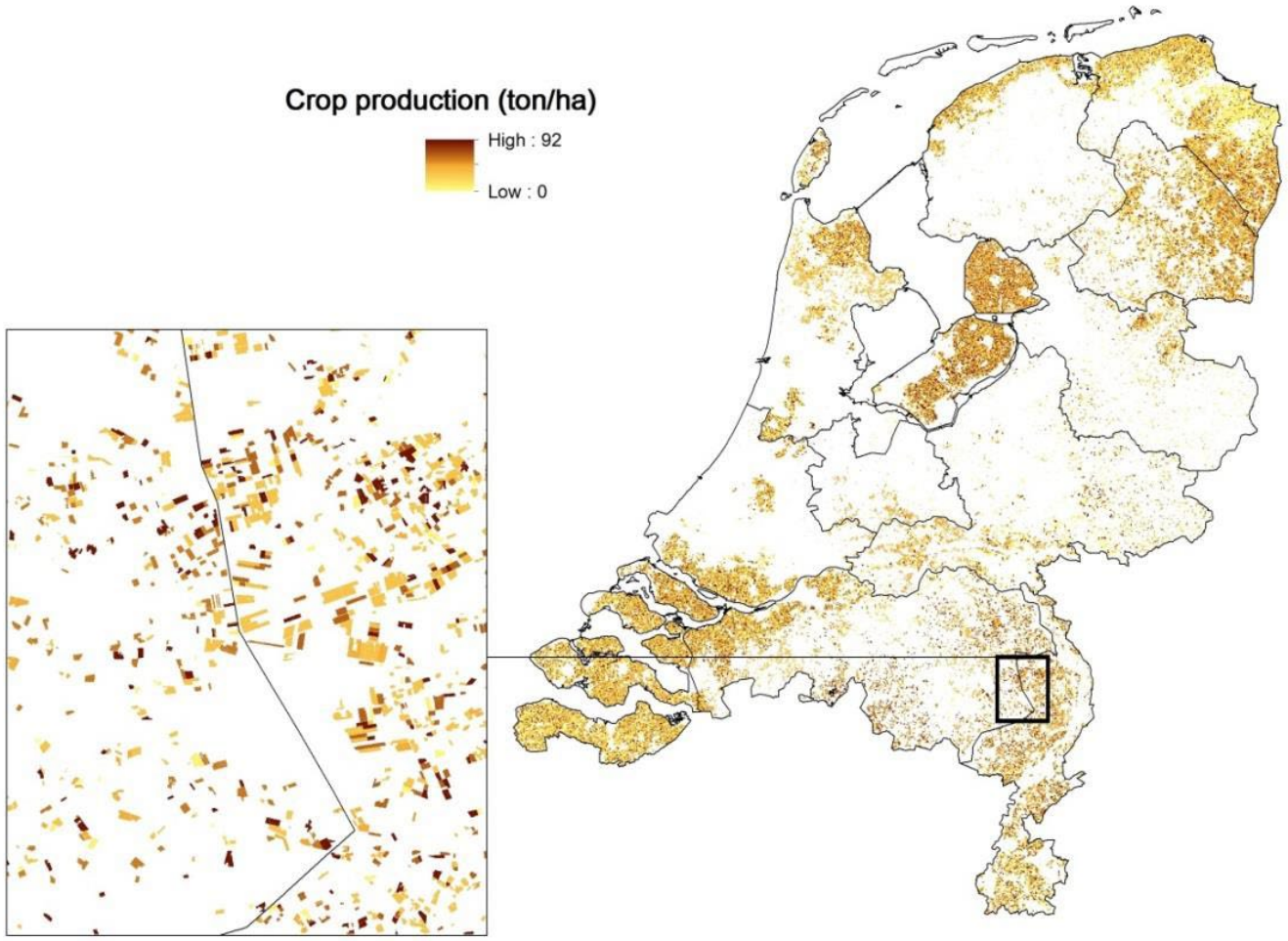
Example: water infiltration



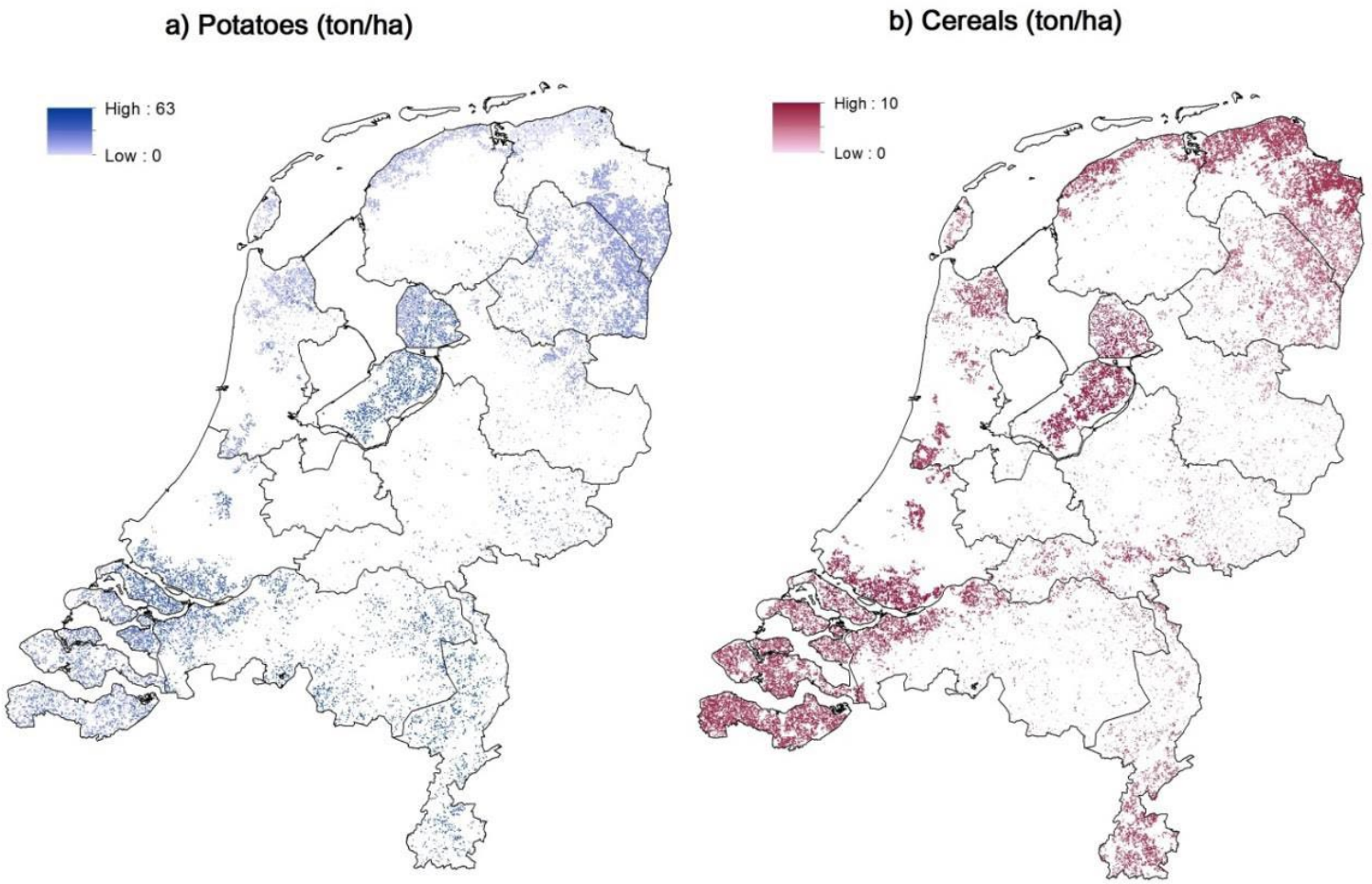




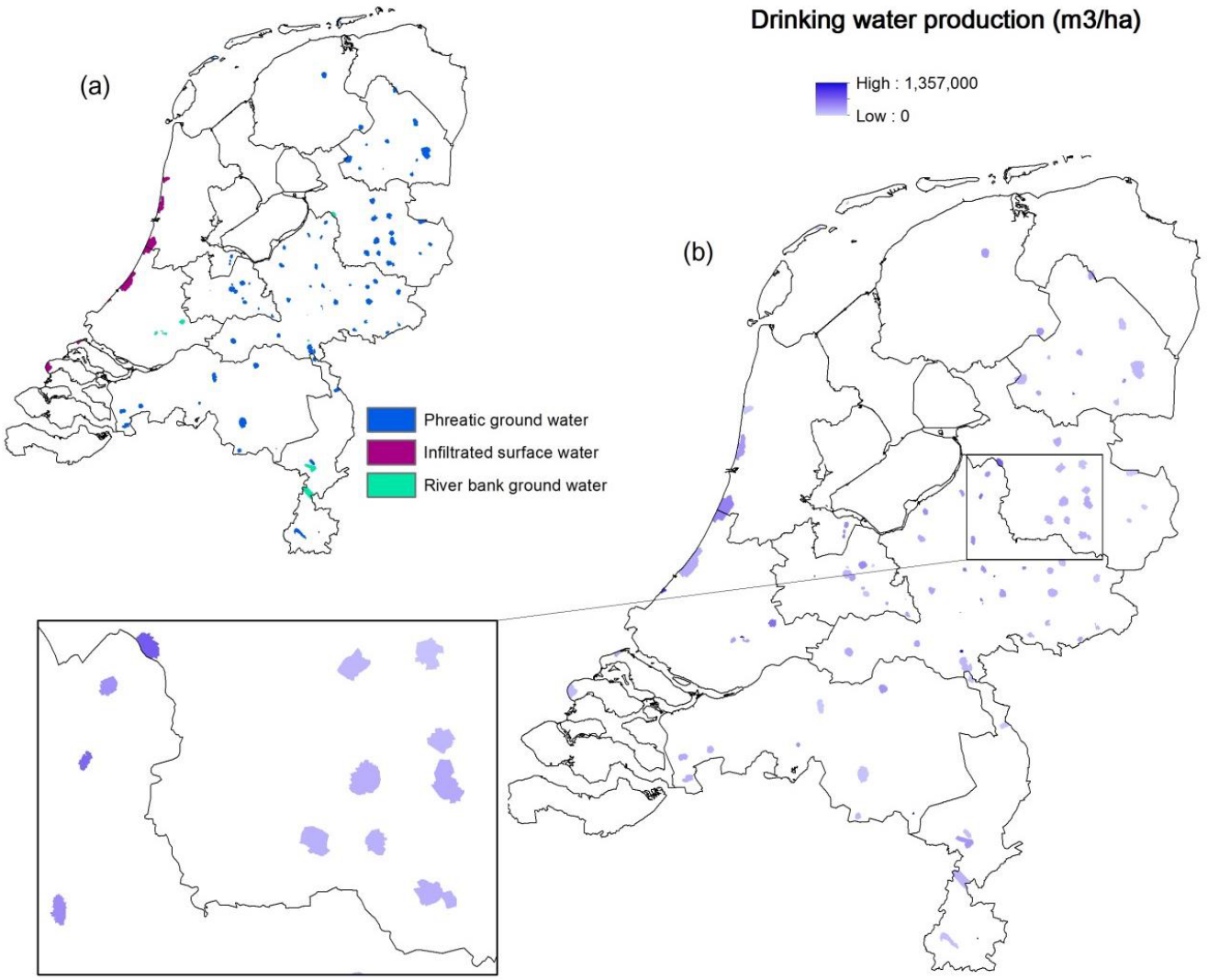
Crop production



Information available by crop

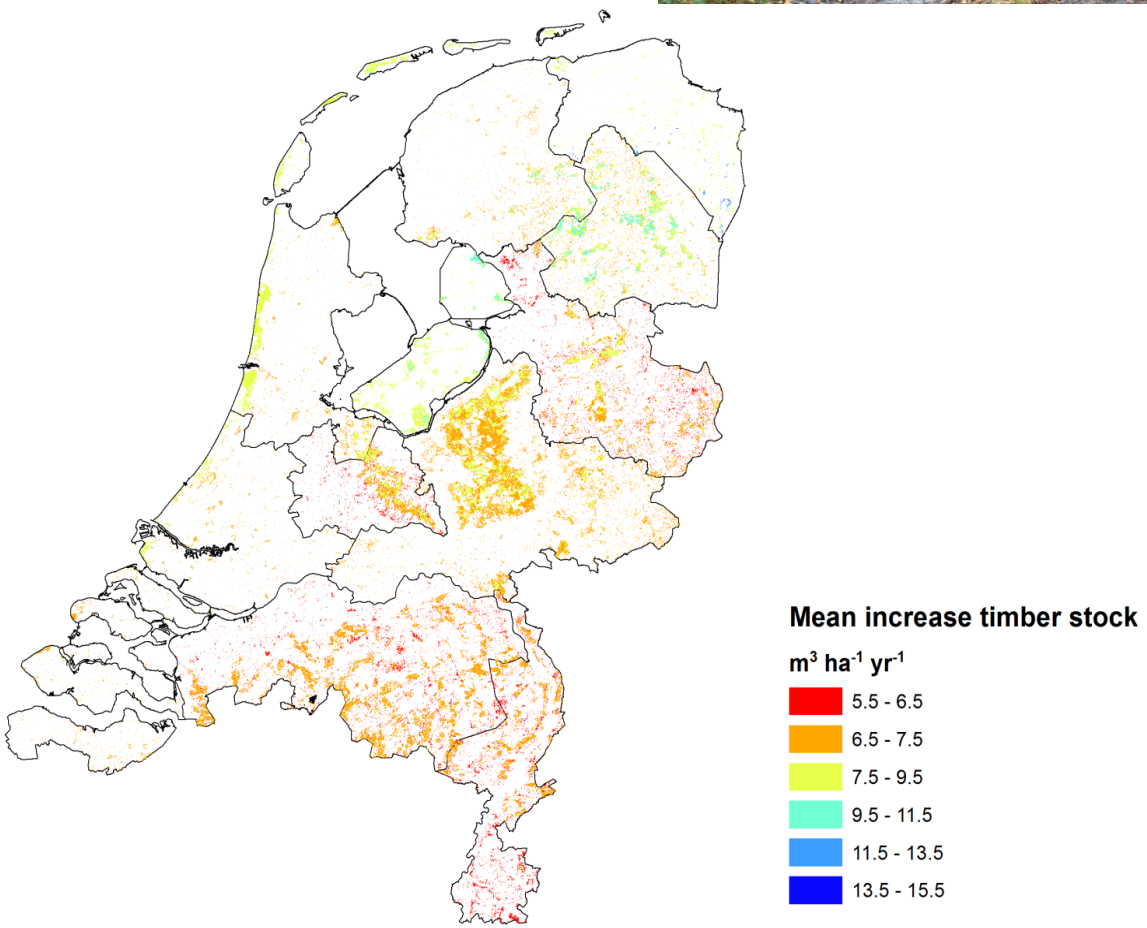


Drinking water



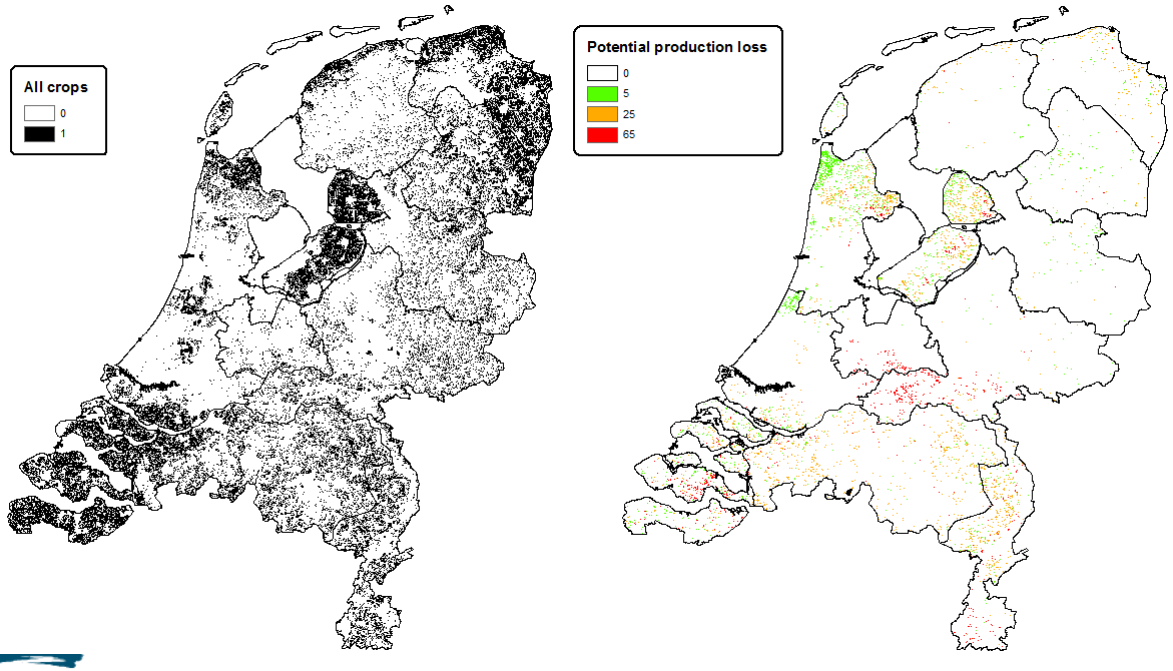
Timber production

	Total area	stock	Harvest
	(1000ha)	(1000m3)	(1000m3/yr)
Groningen	6	1,221	19
Friesland	14	2,918	40
Drenthe	31	6,633	129
Overijssel	34	7,723	106
Flevoland	14	2,910	73
Gelderland	88	20,411	308
Utrecht	17	3,526	53
Noord-Holland	17	4,478	38
Zuid-Holland	8	1,420	18
Zeeland	4	553	11
Noord-Brabant	65	12,358	215
Limburg	24	5,147	73
Zuid-Limburg	5	1,436	13
Netherlands	326	70,726	1,097

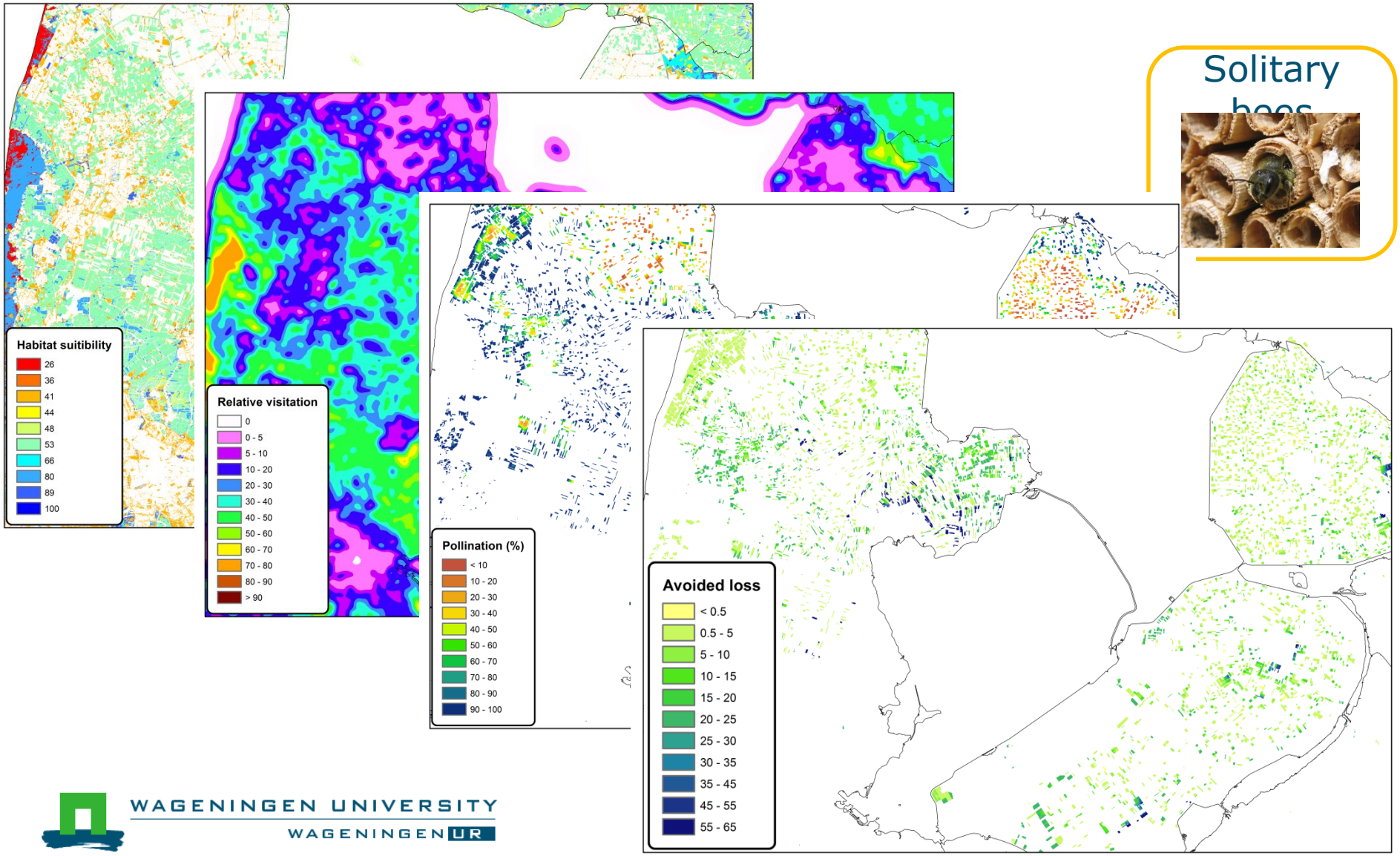


Pollination - material

- Map position crops in 2013
- LUT Pollination dependence crops
- LUT Habitat suitability per ecosystem unit



Pollination-spatial modelling



Solitary bees

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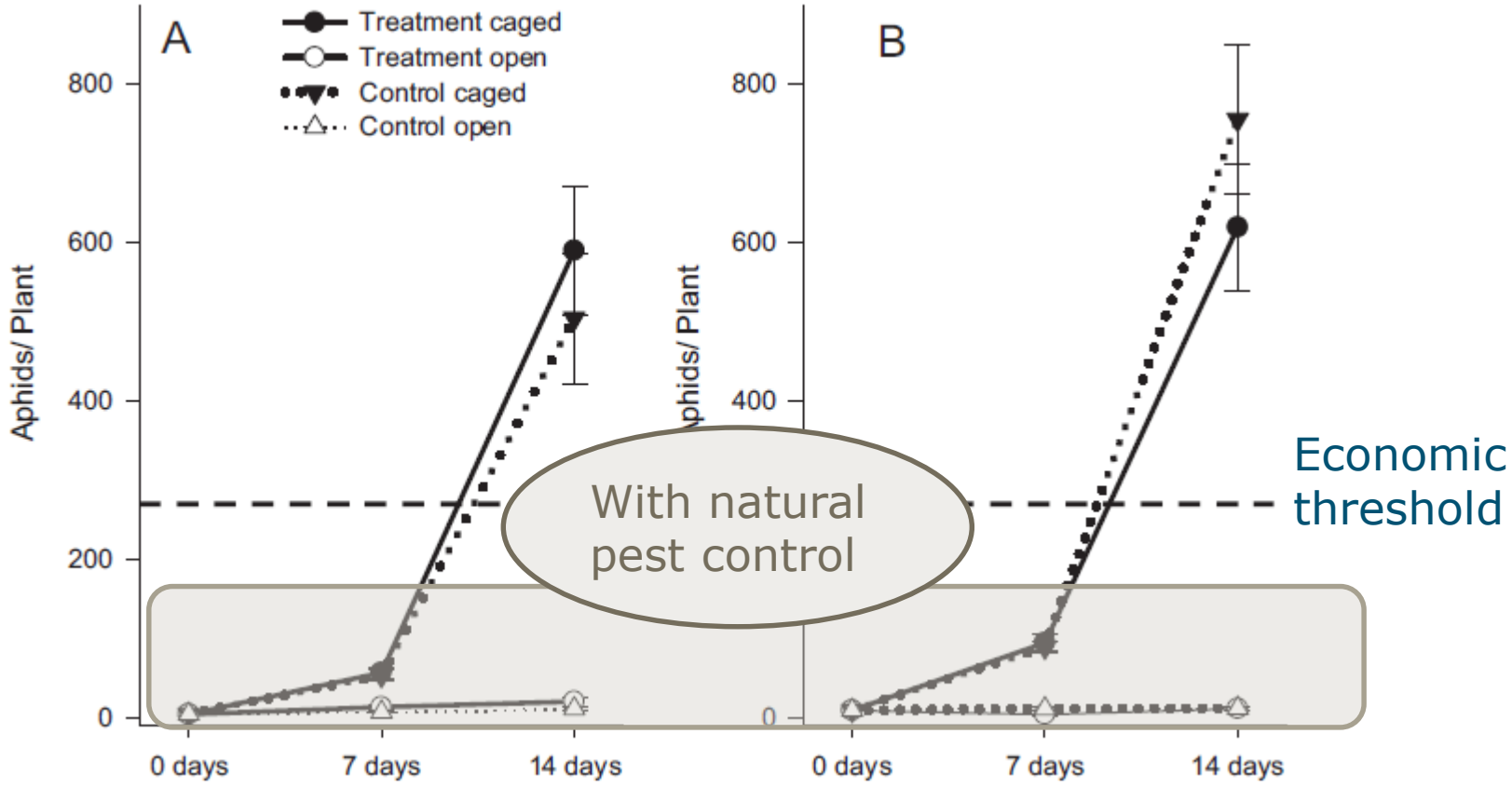
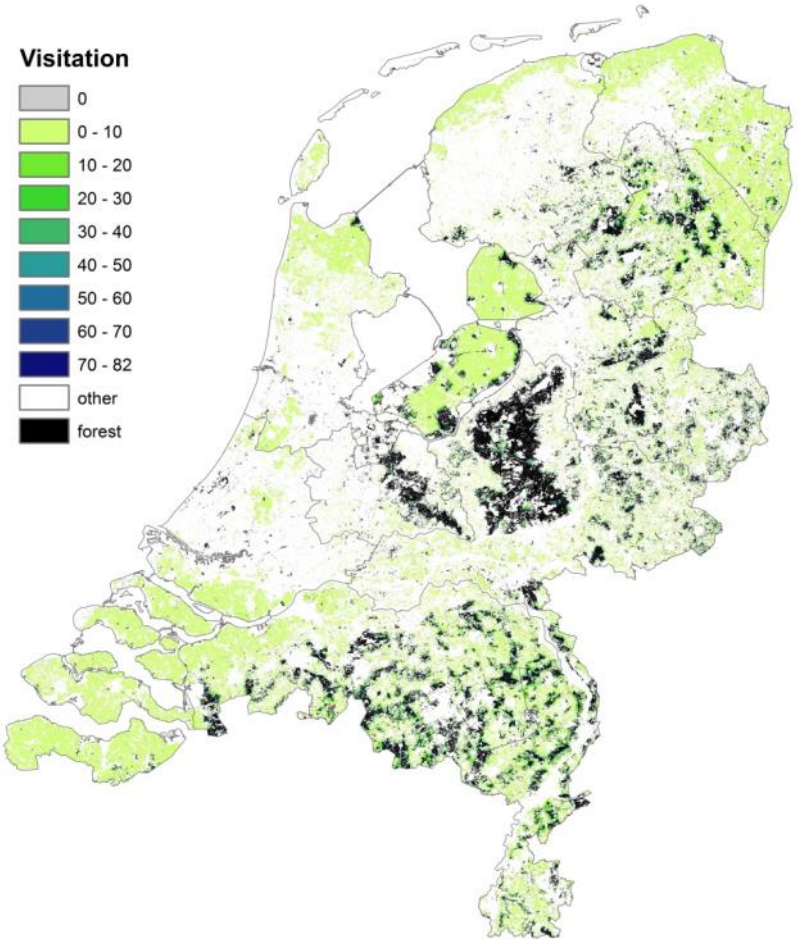
Large effect natural pest control



Visitation natural enemy



	ha	Mean visitation
Groningen	993	1.9
Friesland	425	2.8
Drenthe	868	6.8
Overijssel	586	7.2
Flevoland	768	3.1
Gelderland	750	7.1
Utrecht	96	7.4
Noord Holland	556	1.0
Zuid Holland	505	1.0
Zeeland	1027	1.0
Noord Brabant	1411	7.7
	ha	Mean visitation
Annual crop	7814	4.6
Perennial crop	792	5.8

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Pollination service

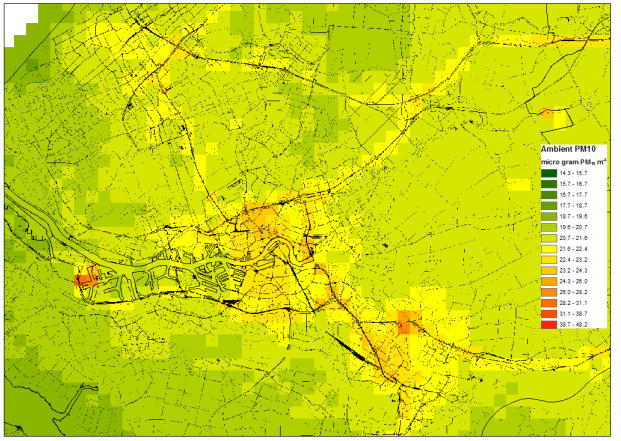
Solitary bees

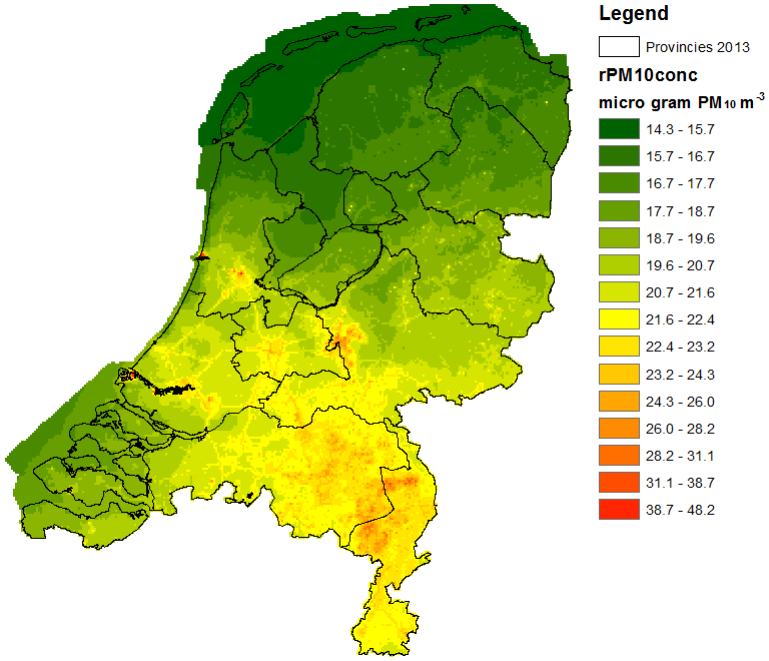
		Potential production loss		Avoided production loss		
	ha	Total potential loss	Mean potential loss	Total avoided loss	Mean avoided loss	Avoided loss %
Groningen	3,840	79,561	20.7	45,105	11.7	56.7
Friesland	1,673	31,540	18.9	21,507	12.9	68.2
Drenthe	2,257	32,076	14.2	23,818	10.6	74.3
Overijssel	1,390	19,190	13.8	18,561	13.3	96.7
Flevoland	14,905	316,808	21.3	124,582	8.4	39.3
Gelderland	6,973	363,654	52.1	319,043	45.8	87.7
Utrecht	1,715	106,320	62.0	99,069	57.8	93.2
Noord Holland	20,124	283,596	14.1	214,760	10.7	75.7
Zuid Holland	7,594	149,341	19.7	87,745	11.6	58.8
Zeeland	11,959	391,367	32.7	178,417	14.9	45.6
Noord Brabant	15,502	402,566	26.0	310,990	20.1	77.3

Air filtration - material

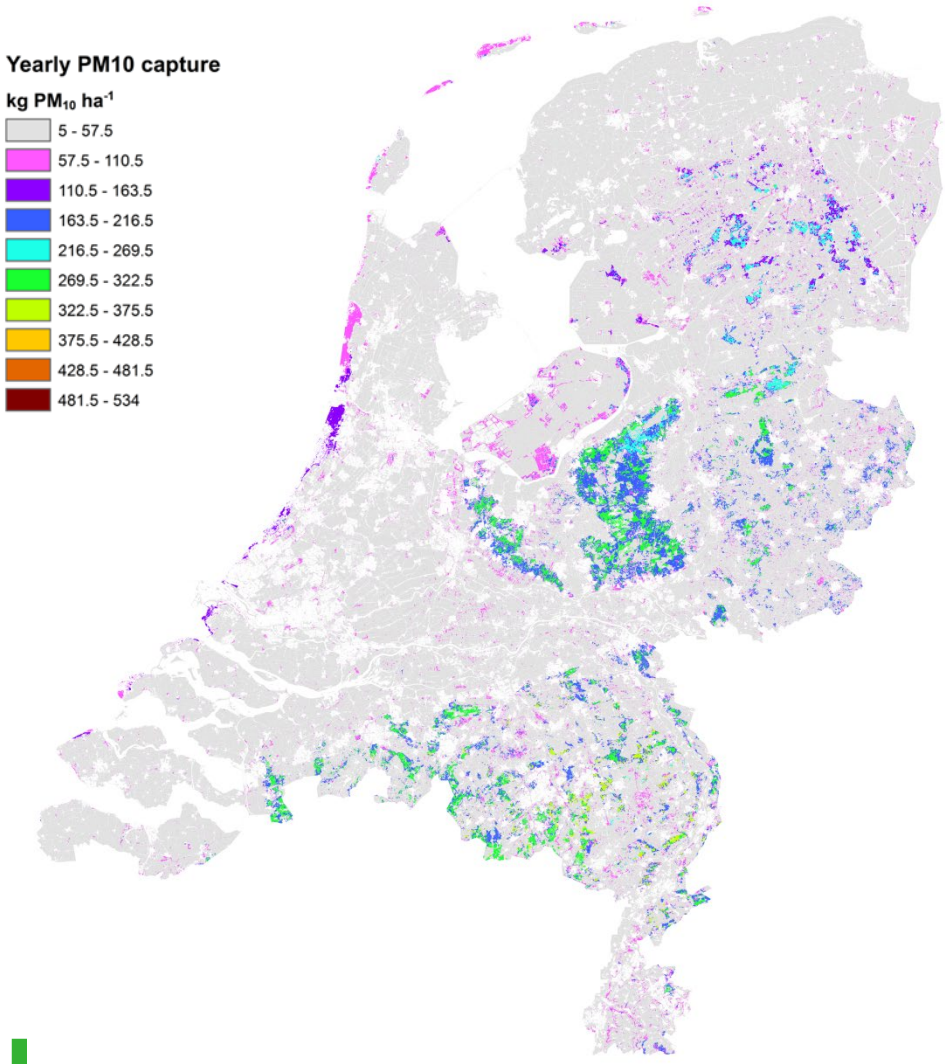
- Ambient PM_{10} concentration
- Ecosystem unit map

- Modelinput:
  - LUT deposition velocity (EU)
  - LUT surface area (EU)
  - Length growth season (EU)
  - Rainy days



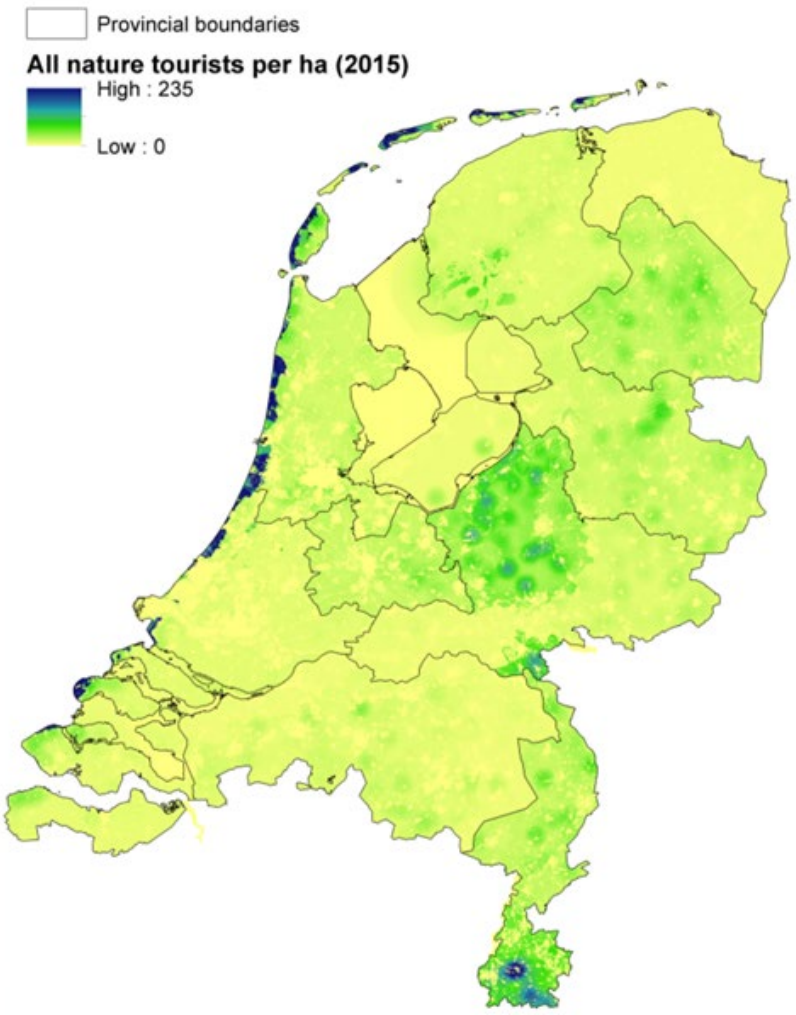


Air filtration



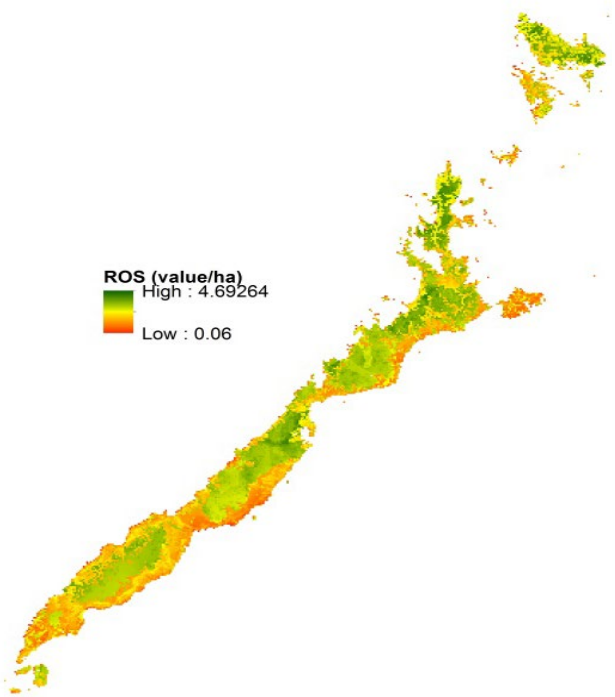
- Average PM deposition in forests: 27 kg PM_{10} jr^{-1} ha^{-1}

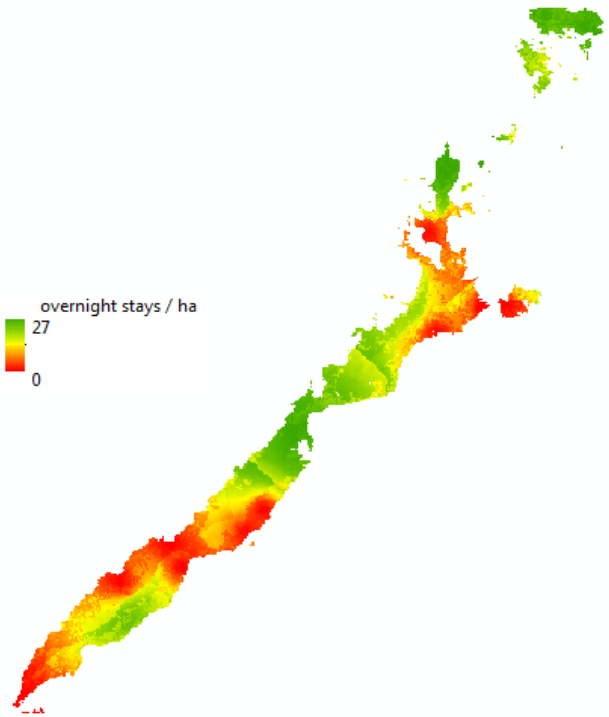
Nature tourism

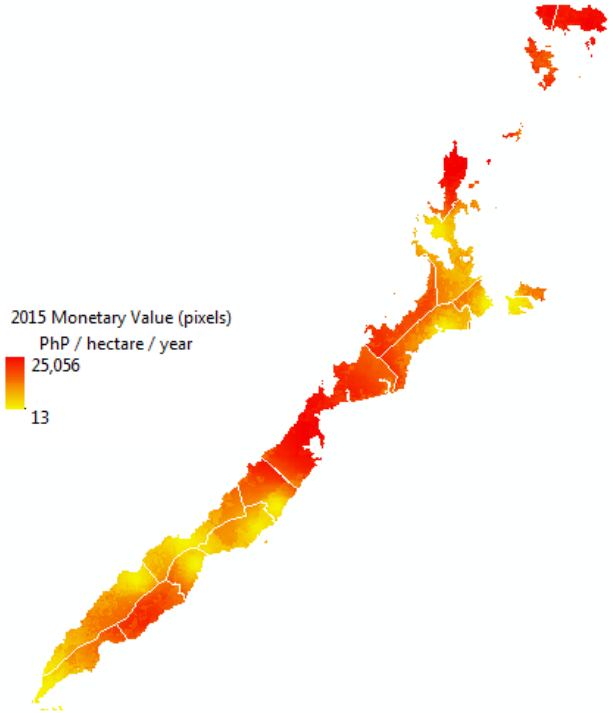


Number of overnight stays x 1000	Hiking	Beach	Water sport	Total
Groningen	66	2	1	69
Friesland	263	135	66	464
Drenthe	378	11	0	389
Overijssel	353	6	5	364
Flevoland	61	8	8	77
Gelderland	797	12	0	809
Utrecht	151	3	0	154
Noord Holland	293	343	6	642
Zuid-Holland	151	150	18	319
Zeeland	145	356	16	517
Noord Brabant	278	6	0	284
Limburg	446	22	8	476
Totaal	**3382**	**1054**	**128**	**4564**

Ecotourism in Palawan (Philippines)







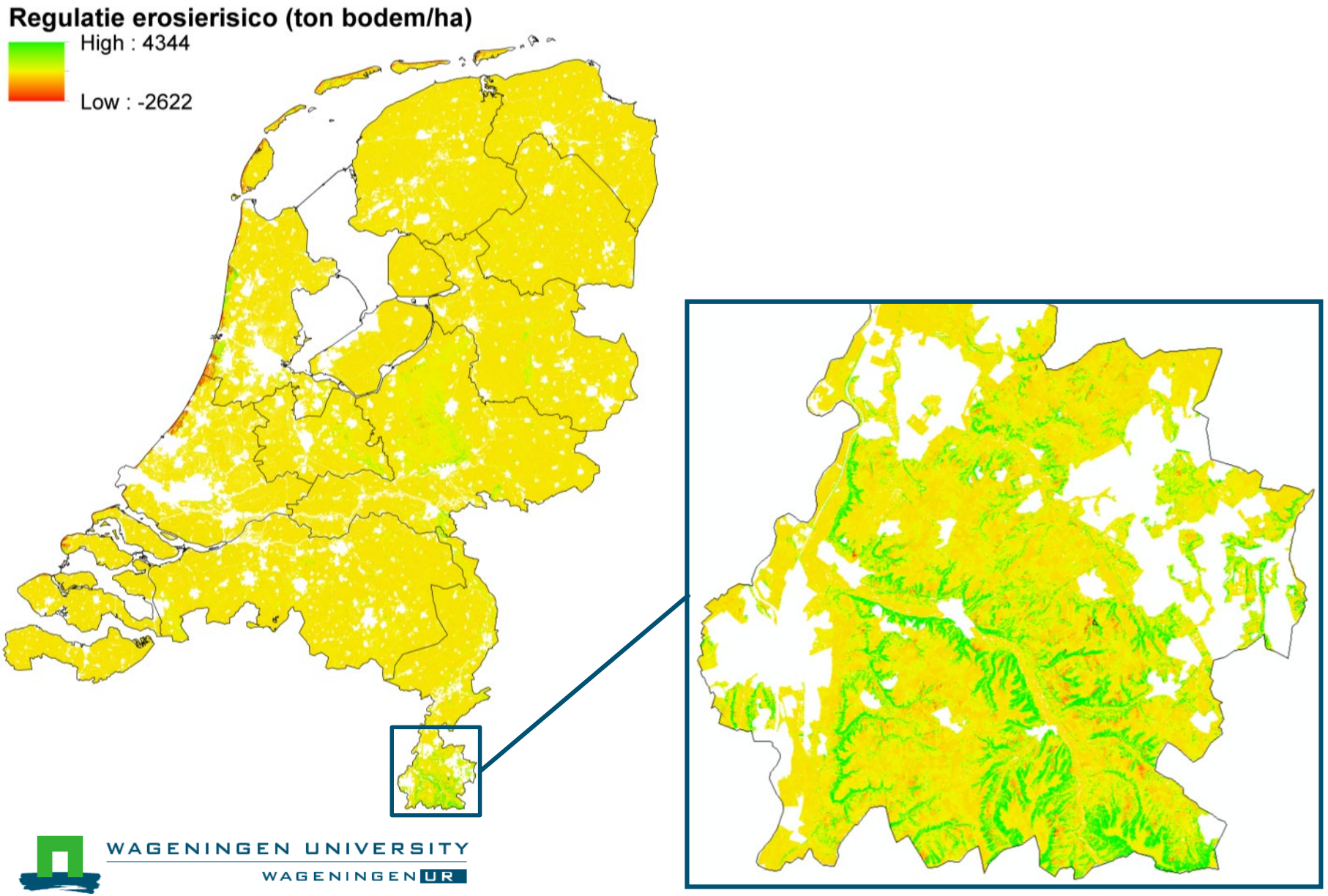
WAVES

- Palawan is a key tourism destination yet is subject to rapid deforestation and coral loss
- The ecosystem account shows:
  - Where tourism takes place
  - The revenue generated with tourism
  - Untapped areas with high potential

Regulating services: reducing erosion risk

- Based on Revised Universal Soil Loss Equation (RUSLE)
- Considering slope, rainfall erosivity, soil erodibility
- Compare reduced erosion rates with a situation without vegetation cover
- Protection against erosion by vegetation
- Relevant for elevated areas

Service: Reduction of erosion risk



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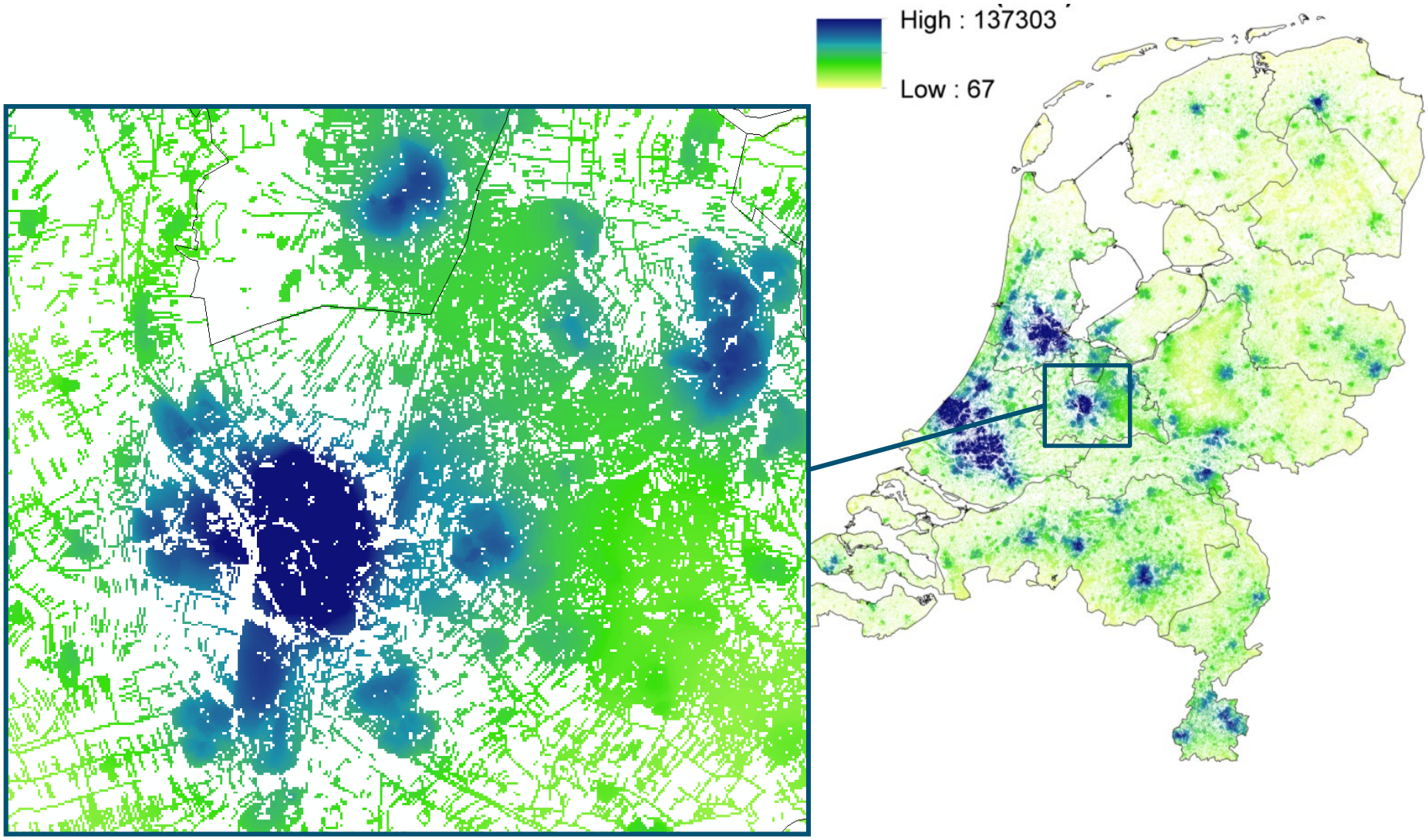
Recreation – walking

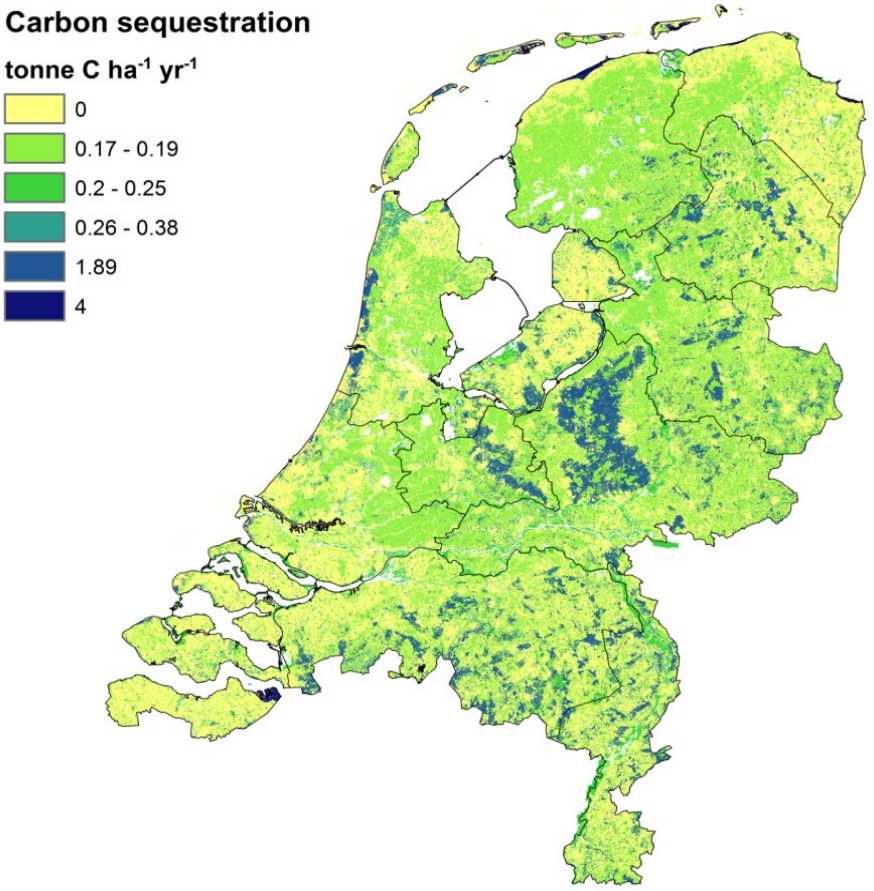
- Average number of hikes pp per province
- In and around own living area
    - Buffers with distance effect
- Population data
- Hiking lanes (NWB)
    - 100 m buffer (line of sight)

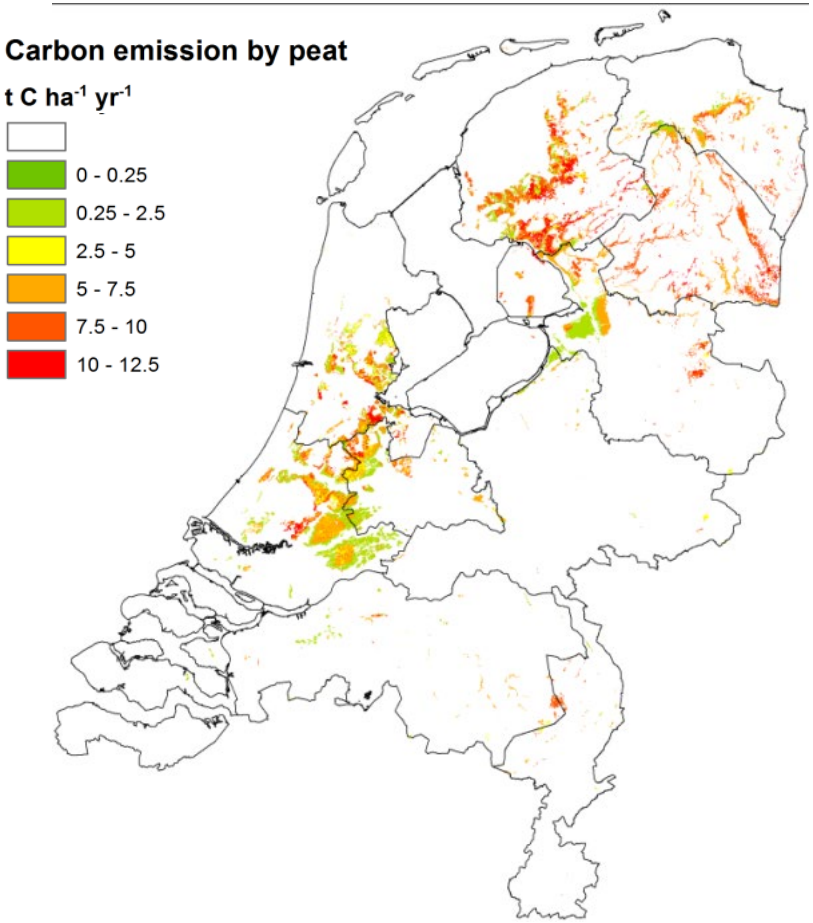
Recreation – walking (hikes/hectare/year)



The carbon account

- Stocks, emissions and sequestration of CO_2





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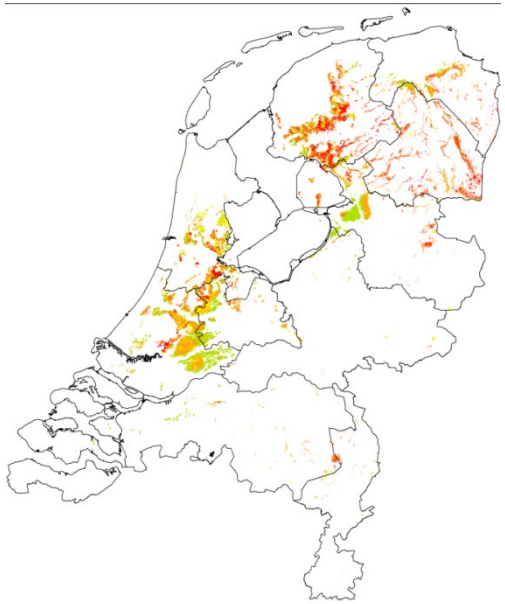
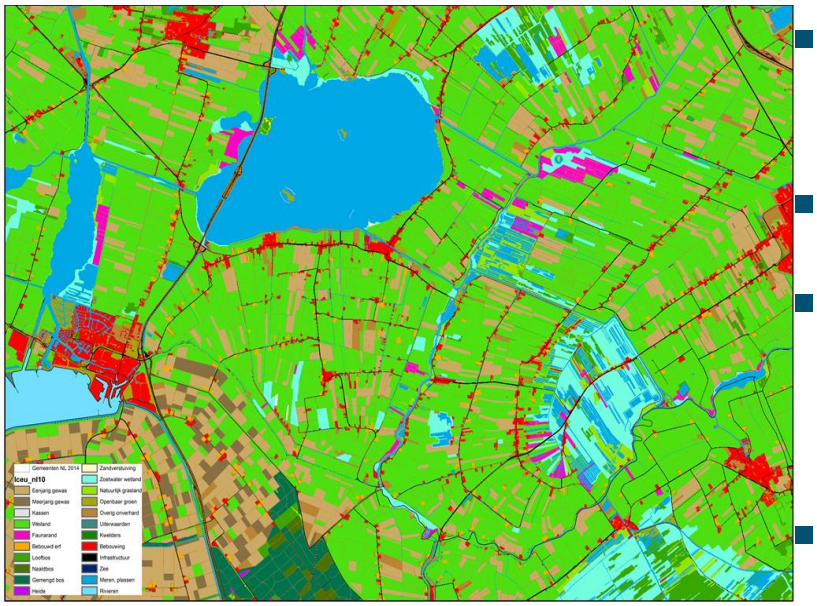
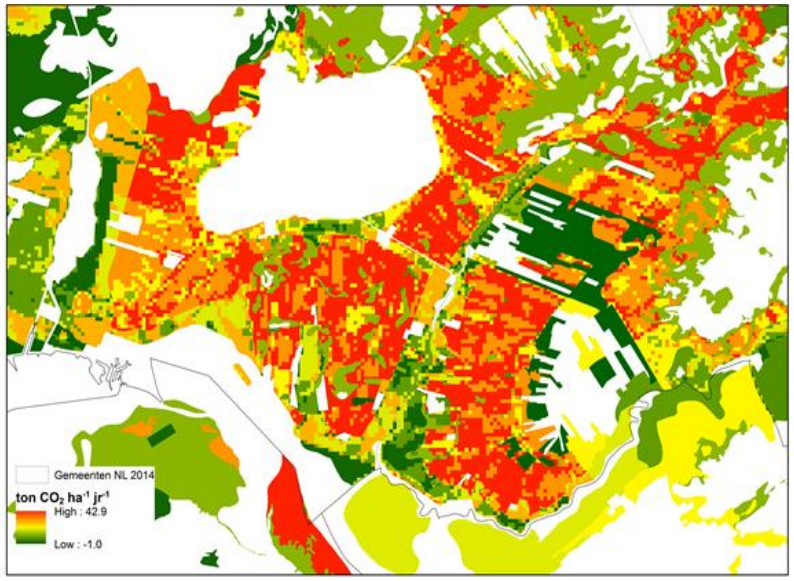
Vastlegging in vegetatie: .. miljoen ton CO_2/jaar

Totale uitstoot uit v

From accounts to policy support







Carbon emission by peat

t C ha^{-1} yr^{-1}

- 0 - 0.25
- 0.25 - 2.5
- 2.5 - 5
- 5 - 7.5
- 7.5 - 10
- 10 - 12.5

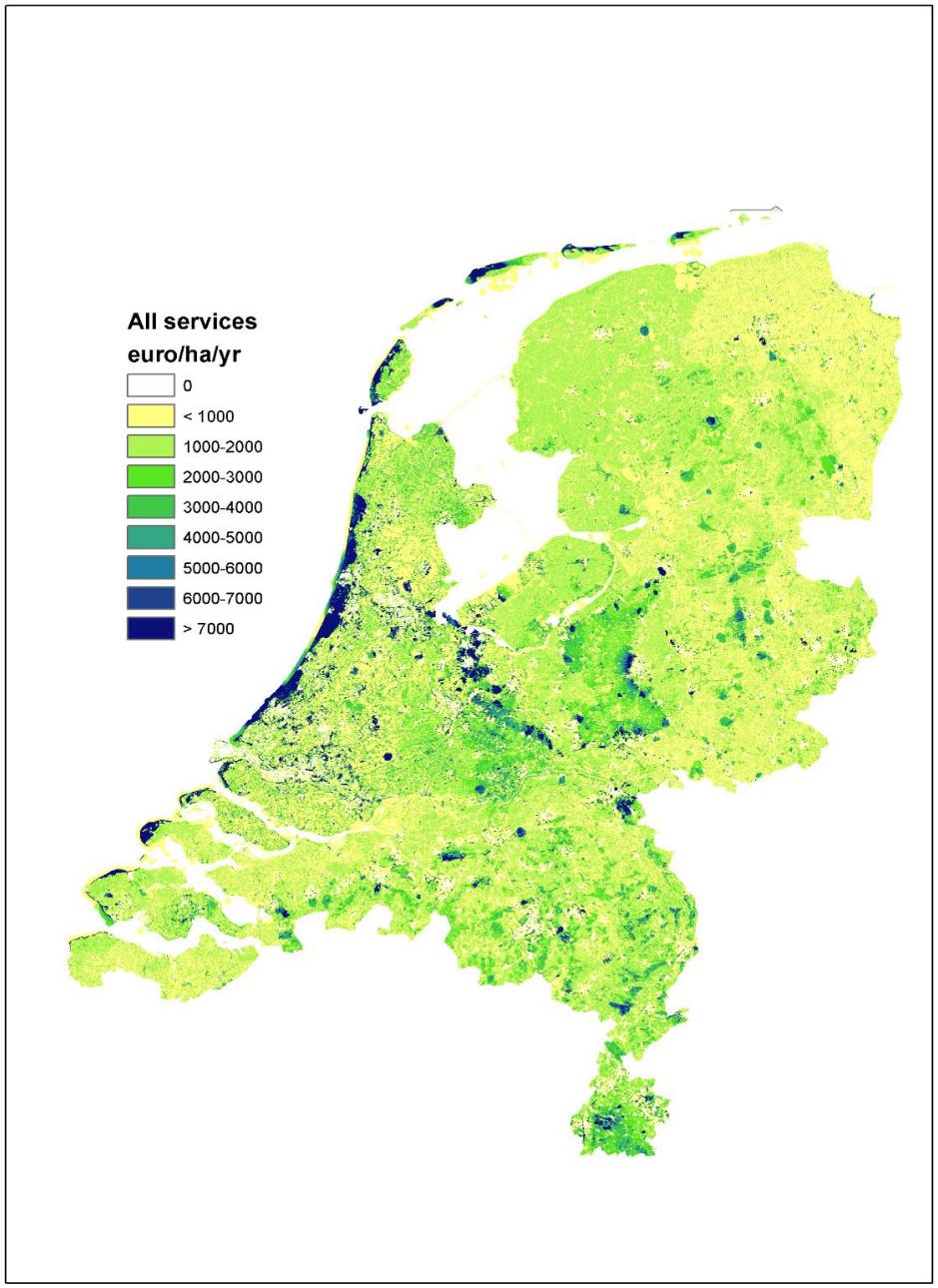
- CO_2 emission eat 7% of national emissions
- Depend upon drainage
- Different management leads to major emission reductions
- Accounts can facilitate local actions

Ecosystem accounting table (Limburg)

EAU	Ecosystem service													
	Crop production		Fodder production		Drinking water extraction		Hunting		Air quality regulation		Forest carbon sequestration		Recreational cycling	
	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)	Total	Mean (SD)
	Mtons MEQ	kg MEQ ha^{-1} yr^{-1}	ktons dm	kg dm ha^{-1} yr^{-1}	10^3 m^3 water	m^3 water ha^{-1} yr^{-1}	kg meat	kg meat km^{-2} yr^{-1}	tons PM_{10}	kg PM_{10} km^{-2} yr^{-1}	ktons C	kg C ha^{-1} yr^{-1}	10^3 trips	trips ha^{-1} yr^{-1}
Pasture	-	-	521	12,041 (1,573)	9,110	3,099 (2,231)	9,100	21 (17)	405	911 (532)	-	-	1,872	103 (78)
Cropland	2.46	36,314 (1,785)	-	-	14,855	3,082 (2,422)	14,732	20 (17)	715	956 (534)	-	-	2,631	99 (73)
Forest	-	-	-	-	4,577	3,214 (2,624)	8,100	24 (20)	686	2,040 (1,221)	55	1,563 (263)	1,472	126 (94)
Water	-	-	-	-	3,289	9,460 (3,698)	-	-	40	624 (569)	-	-	147	110 (92)
Urban	-	-	-	-	7,862	4,321 (3,527)	-	-	285	547 (562)	-	-	2,735	70 (57)
Heath	-	-	-	-	219	1,293 (821)	678	32 (25)	45	2,062 (1,111)	-	-	30	82 (59)
Peat	-	-	-	-	0	0 (0)	70	13 (3)	7	970 (345)	-	-	3	92 (44)
Other nature	-	-	-	-	1,187	3,093 (2,567)	1,513	25 (20)	69	1,155 (710)	-	-	226	128 (93)
Provincial total	2.46		521		41,099		34,193		2,252		55		9,116	

Map

- Value of ecosystem services supply, per hectare per year (10m resolution)
- Values representative at the level of the province, potentially municipality

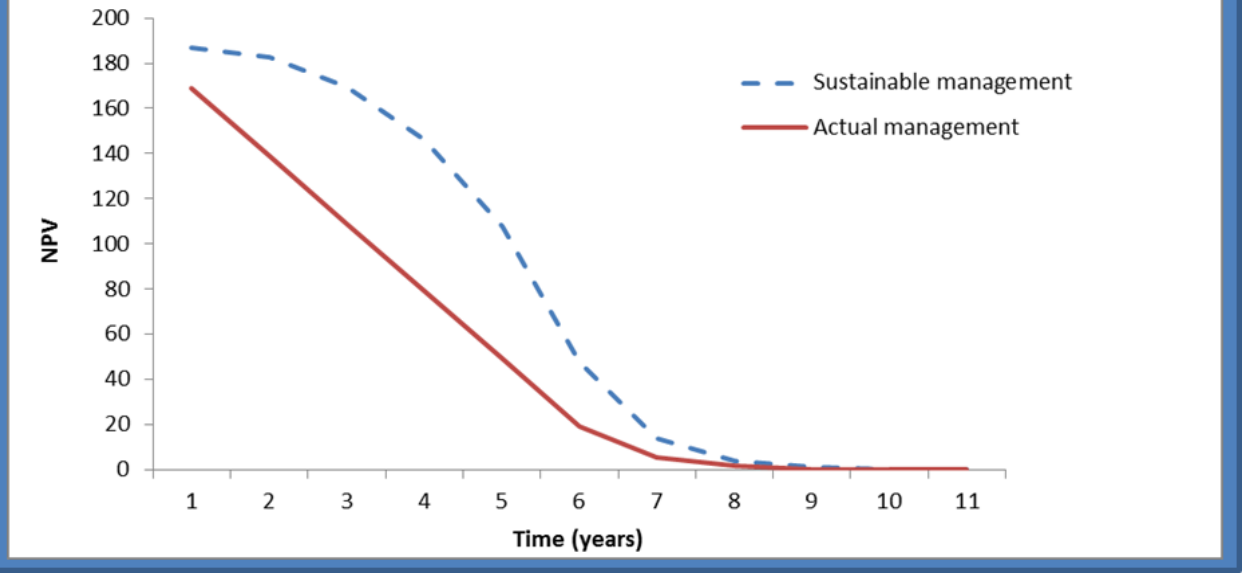


Ecosystem assets

- In physical terms, assets are measured in terms of ecosystem extent and condition
- The SEEA EEA contains the **monetary ecosystem asset account**
- Assets can be monetised on the basis of actual use
    - Asset as traded in the market
    - On the basis of the NPV of the expected flow of services
- Monetisation on the basis of sustainable use leads to different values

NPV based on actual vs sustainable flows

year	1	2	3	4	5	6	7	8	9	10
Stock (ton)	100	85	70	53	35	14	4	1	0	0
Sustainable yield (ton)	15	15	14	12	9	4	1	0	0	0
Actual harvest (ton)	30	30	30	30	30	14	4	1	0	0
Net value per ton (euro)	1	1	1	1	1	1	1	1	1	1
Revenue sustainable yield (euro)	15	15	14	12	9	4	1	0	0	0
Revenue actual management (euro)	30	30	30	30	30	14	4	1	0	0
NPV at sustainable management (euro)	187	183	170	146	108	48	14	4	1	0
NPV at actual management (euro)	169	139	109	79	49	19	5	2	0	0



Monetising assets

- Usually, expected flows of a **specific service** can be monetised
- The value of the ecosystem asset is the sum of the net present value (NPV) of the expected flow of all ecosystem services provided by the asset
- For example:
  - A forest provides timber, mushrooms and carbon sequestration
  - For each of these services, the NPV can be calculated
  - The sum of the NPVs for each of these services is the value of the ecosystem asset

Services, asset valuation and trade-offs

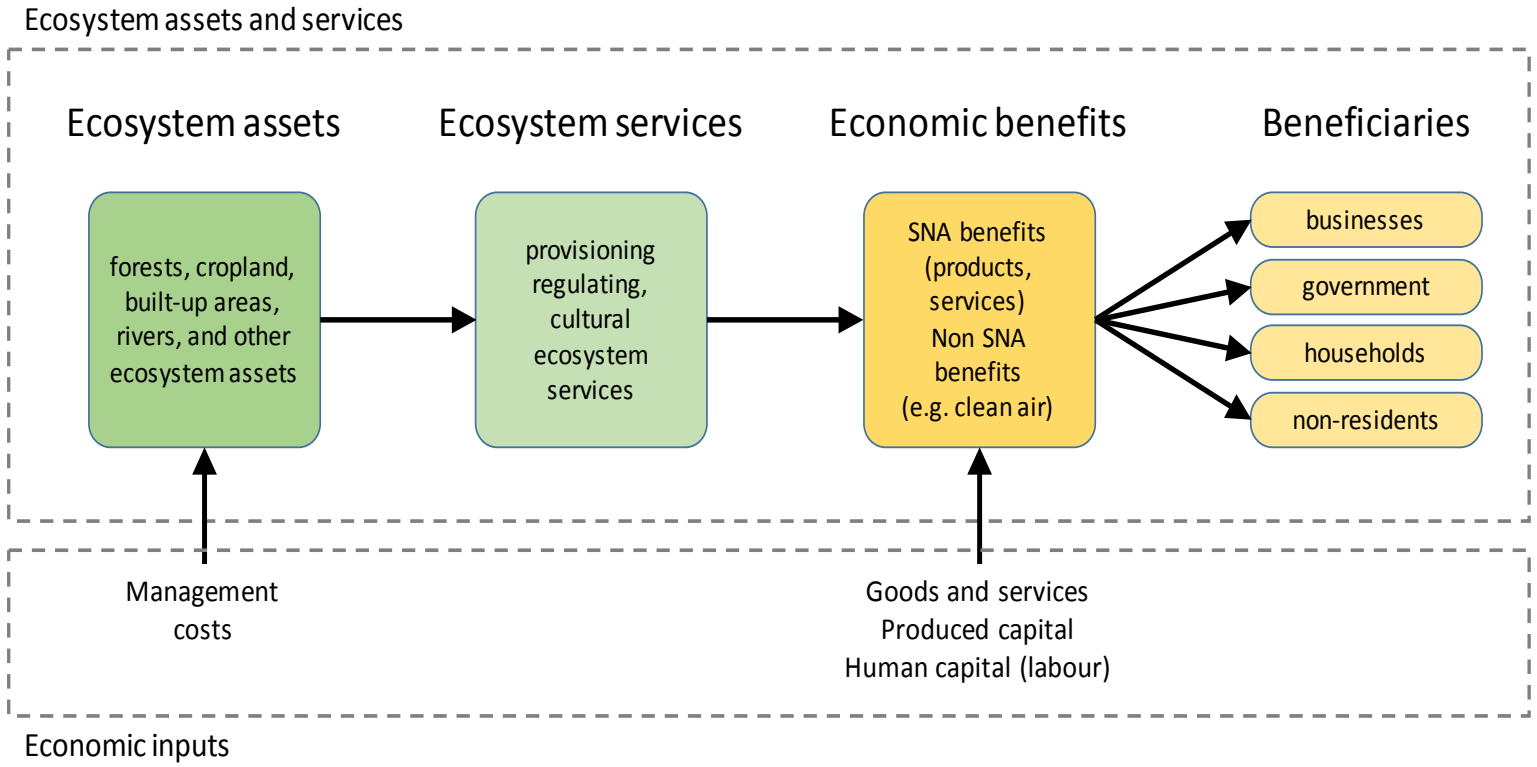
- The supply of some services may not be compatible
- For instance, carbon sequestration and timber supply are not fully compatible: harvest of timber reduced carbon stored in the forest
- In asset accounting: the expected flow of services is considered! Hence if the current management of the forest includes plans to harvest timber in the future, these harvests should be considered when assessing the NPV of the carbon sequestration service.
- Monetary asset accounting is, in this sense, forward looking.

The Netherlands ecosystem asset accounts

The use of exchange values for services and assets is fundamental:

- We need to be able to aggregate the statistical results for all ecosystem services and assets.
- We want to integrate the values for ecosystem services and assets with the other monetary data of the SNA.
- This particular definition of value is the most practical definition to apply for accounting.

From assets to economic benefits



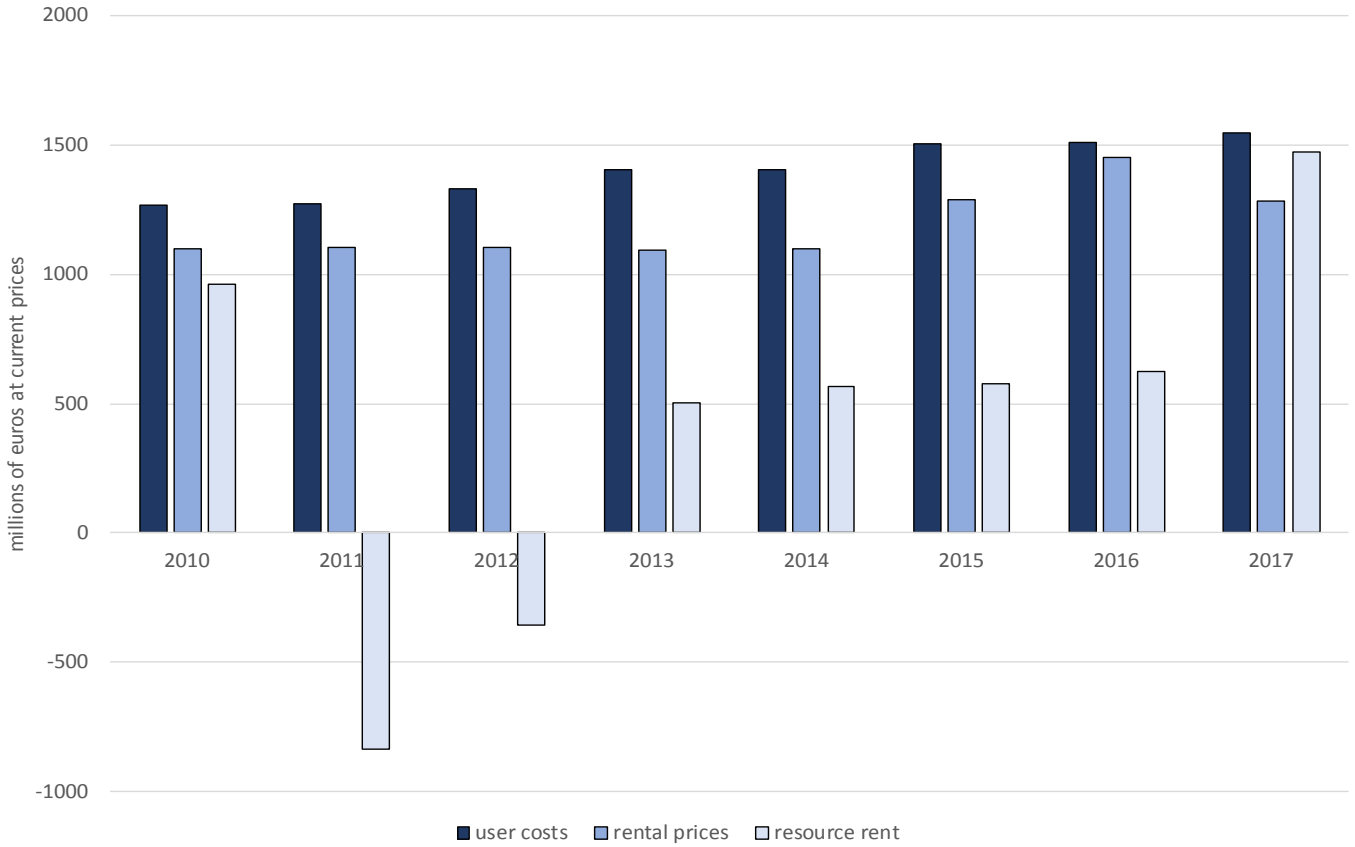
Indicators of value most relevant for the three main classes of ecosystem services

	Exchange values			Welfare values	GVA/ NVA approach
	Exchange values incorporated in GDP of the SNA		Exchange values not incorporated in GDP of the SNA		
	Contribution to production activities	Contribution to consumption activities			
Provisioning ecosystem services	X			x	X
Regulating ecosystem services			X	X	x
Cultural ecosystem services		X	X	X	x?

Valuing crop land

- *Resource rent method.* The resource rent method is often applied to value provisioning services, including crop production and grass/fodder production. The resource rent is calculated by subtracting all costs from the total marketed output.
- *User cost method.* According to this method the value of the ecosystem service is directly derived from the ecosystem asset value. Hence the value of the ecosystem service crop production/fodder production is calculated based on the value of agricultural land, an assumed long-term average rate of return on investment (c. 0.9%, see technical background report for details; Wageningen Research, 2018), and an assumed service life (here 100 years).
- *Rental price method.* Leases (rents) are payments made to a land owner by a tenant for the use of the land over a specified period. Currently, around 30% of agricultural land in the Netherlands is leased. According to the rental price method the total value is calculated based on rent prices and data on the extent of agricultural land (cropland and grassland).

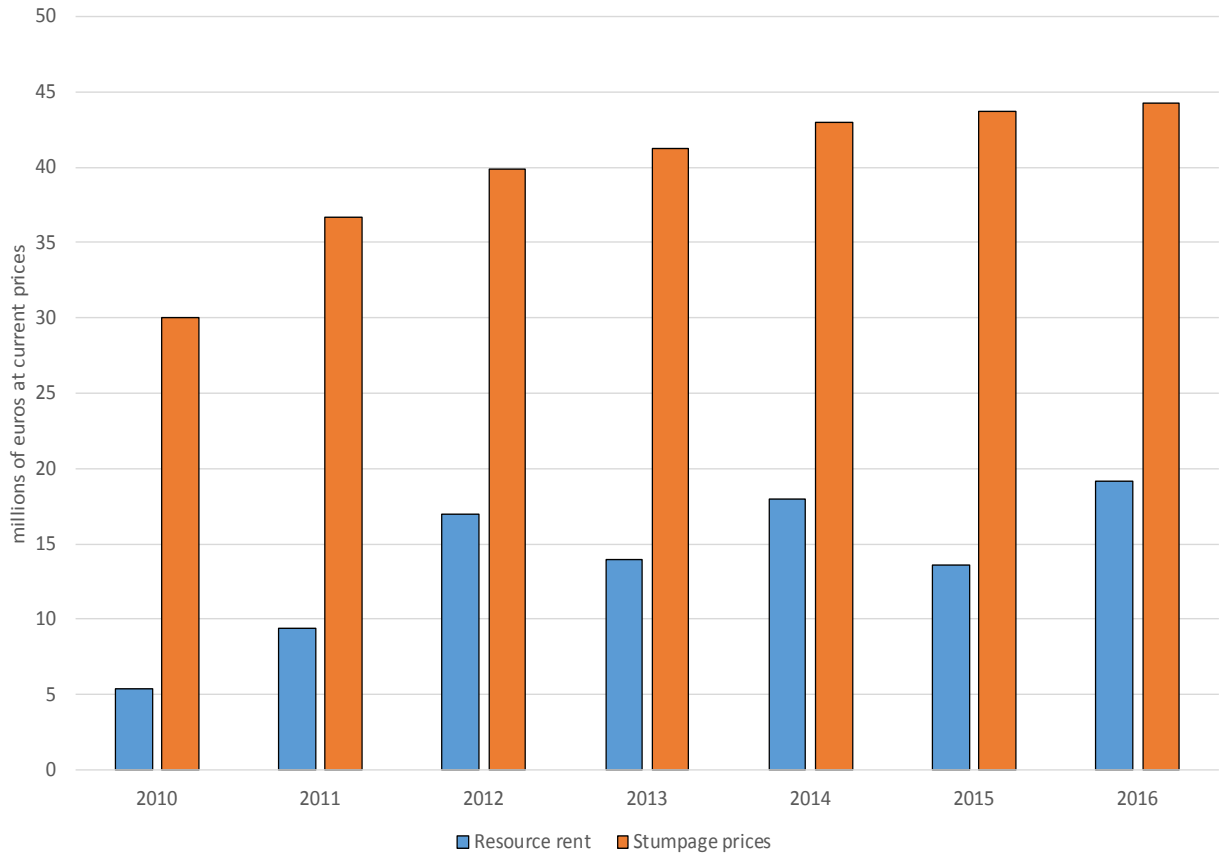
Comparison of methods



- Selected: the land lease method (for agricultural land)

Valuing timber assets

- two options: resource rent and stumpage prices



- Selected: stumpage prices

Valuing water filtration: replacement cost

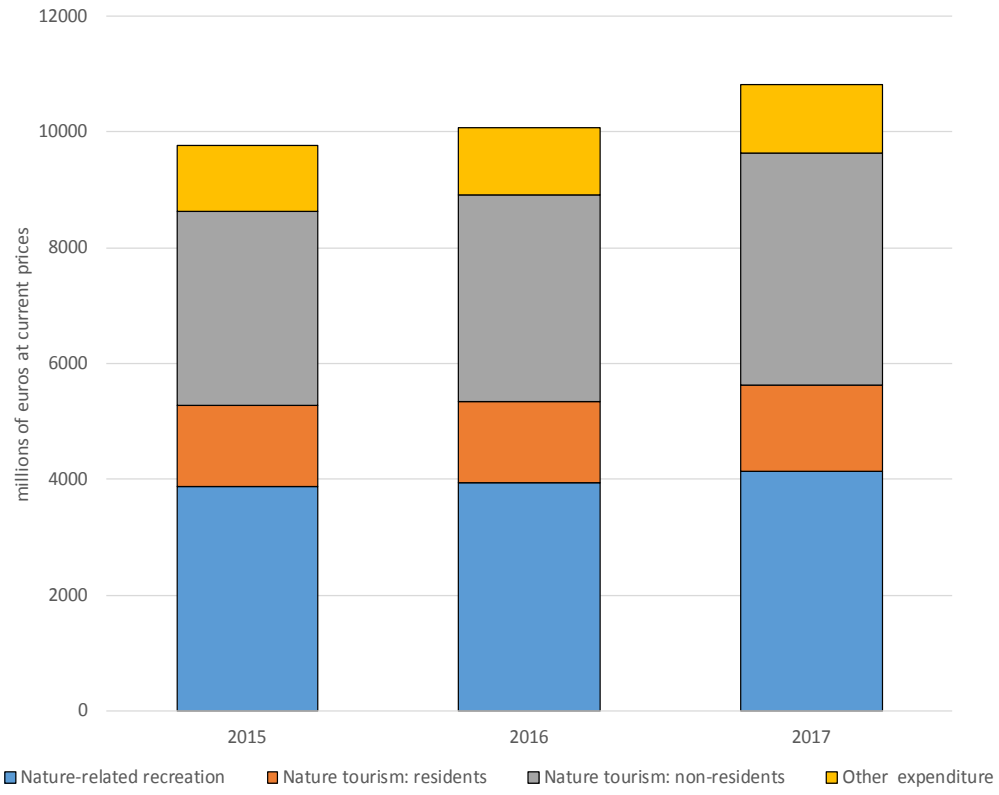
Drinking water production	2012	2013	2014	2015	2016
groundwater companies	1.07	1.09	1.09	1.09	1.01
surface water companies	1.47	1.50	1.53	1.51	1.51
cost difference between surface water and groundwater	0.40	0.41	0.44	0.42	0.49

- Replacement cost method is appropriate and consistent with SNA

Valuing carbon sequestration

- *Social cost of carbon.* The social cost of carbon (SCC) represents the monetary value in the present of damages that occur in the future as a result of an additional ton of carbon emissions in a given year. The SCC represents the future damage *avoided* as a result of one ton of carbon sequestration in a given year
- ***Derived Carbon price****. C*alculate the costs of achieving a policy-defined target of reduction in CO_2 emissions. This calculation produces a carbon price, i.e. an estimate in monetary terms of the contribution of ecosystems to achieving the policy target. For the Netherlands: 48 euro/ton CO_2
- *Carbon market price*. Increasingly there are carbon markets in which a market price is established

Valuing recreation



- Based on expenditure (travel costs, hotel costs, entrance fees)

Critical assumptions

- Discount rate

Type	Ecosystem service	Discount rate used
Provisioning services	Crop production	3 %
	Fodder production	3 %
	Wood production	3 %
Regulating services	Carbon sequestration	2 %
	Pollination	2 %
	Water filtration	2 %
	Air filtration	2 %
Cultural services	Nature recreation	3 %
	Nature-related Tourism	3 %
	Amenity services	3 %

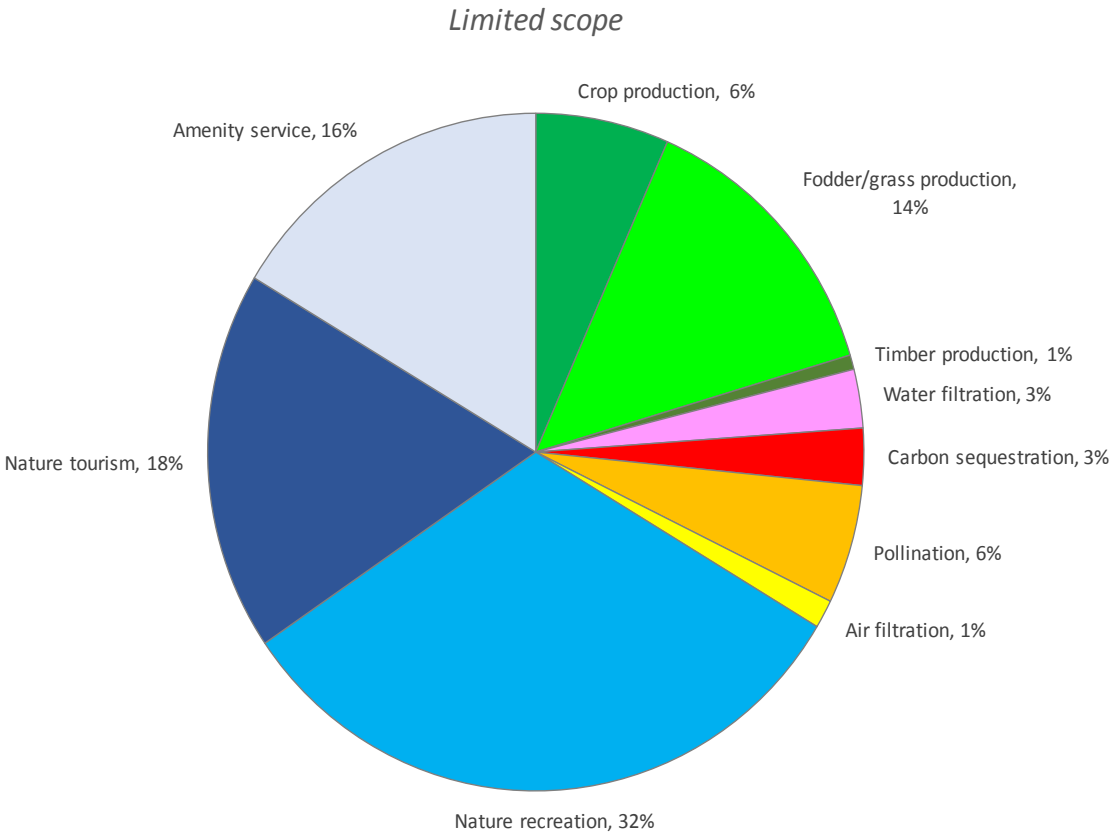
- Asset life: 100 years

Results: Gross Value added of sectors that depend directly on ecosystems (million euro)

	2010	2011	2012	2013	2014	2015	2016	2017
Agriculture	5,700	4,900	5,300	6,200	5,900	5,800	6,200	7,200
Forestry	100	100	100	100	100	100	100	100
Fisheries	300	300	300	200	200	300	400	400
Drinking water production	1,000	1,000	1,000	1,000	1,000	1,100	1,000	1,000
Nature-related tourism and recreation	1,100	1,200	1,200	1,200	1,300	1,500	1,600	1,700
Total	8,200	7,500	7,900	8,700	8,500	8,800	9,300	10,400

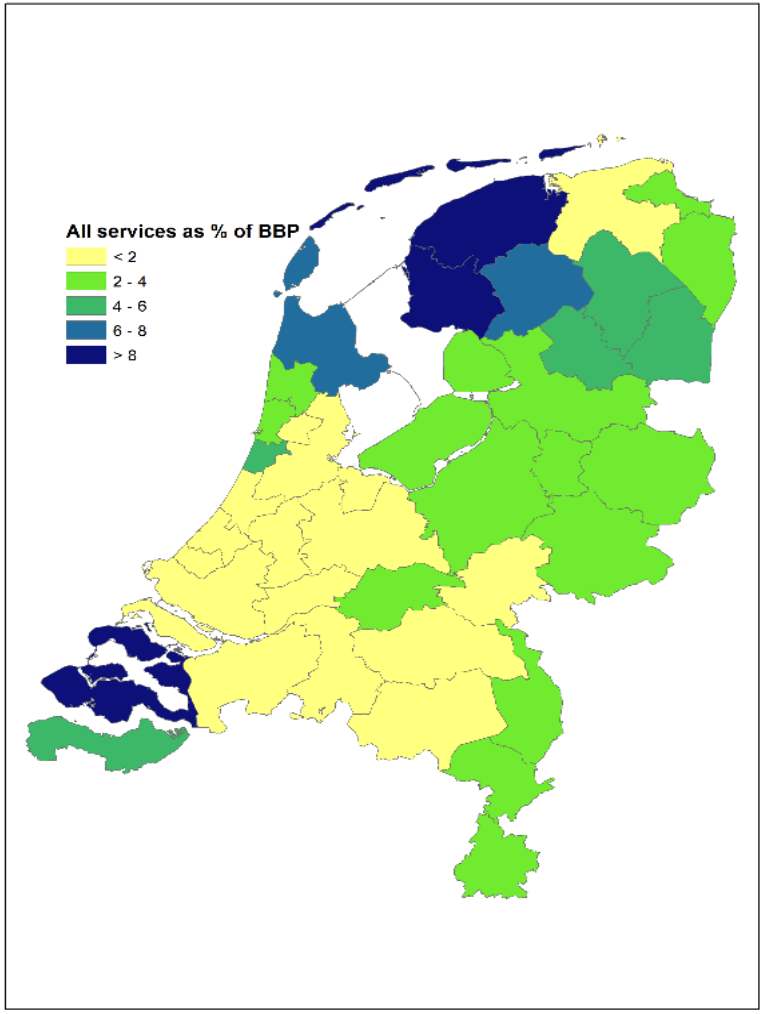
- Not all services can be expressed in gross value added

Asset value of ecosystems, by service



- Note the difference in exchange and welfare values

Share of ecosystem services in BBP



Conclusions

- Accounting for services and assets is doable but data-intensive
- Comparison of different methods – for biophysical modelling and valuation – is useful
- Value-added of the approach is both in individual datasets and in aggregated information
- Spatial (and temporal) resolution, comprehensiveness and accuracy drive policy applications
- Part of the value is in increasing transparency