Ecosystem Services and Assets
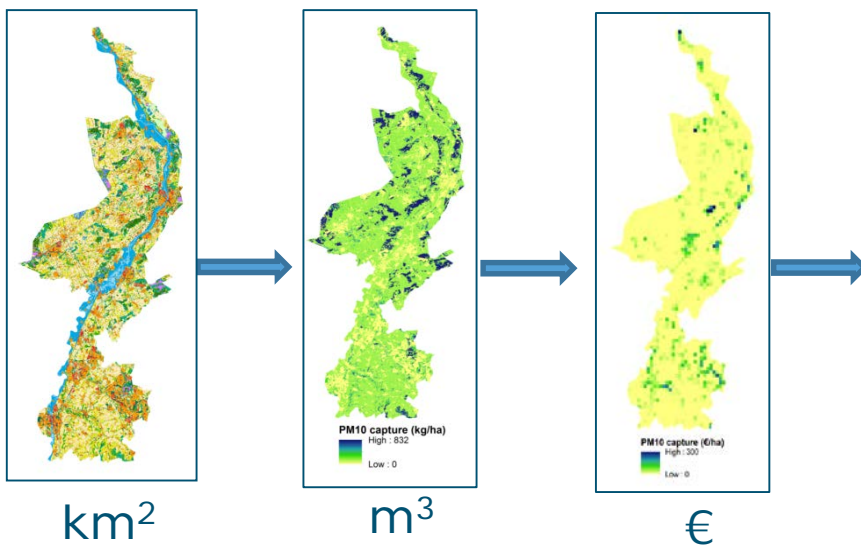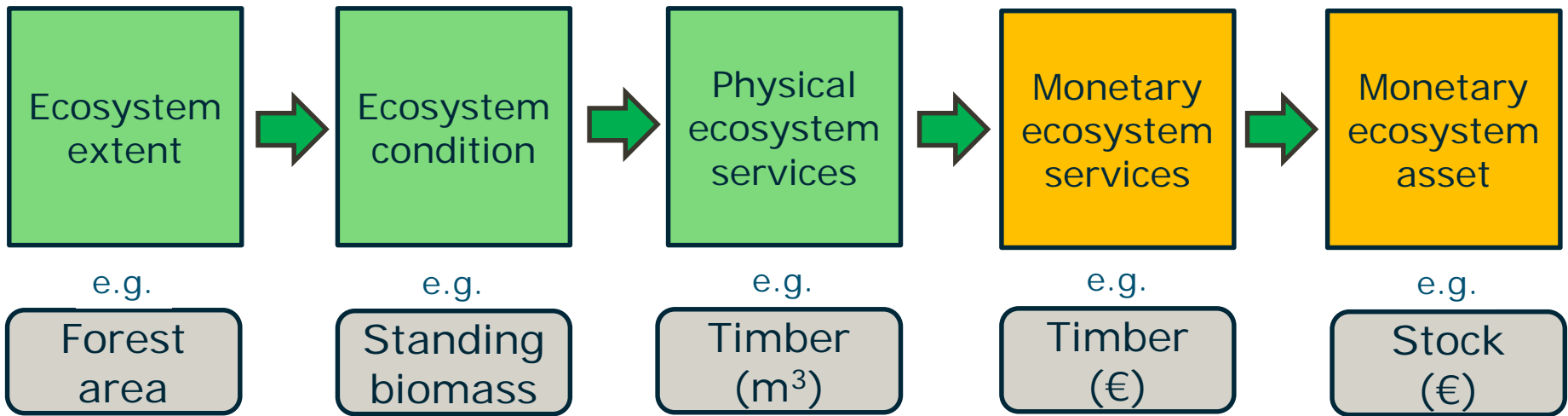## Presentation 1: Ecosystem service accounting

International Seminar on Natural Capital Accounting, Beijing, November 2019
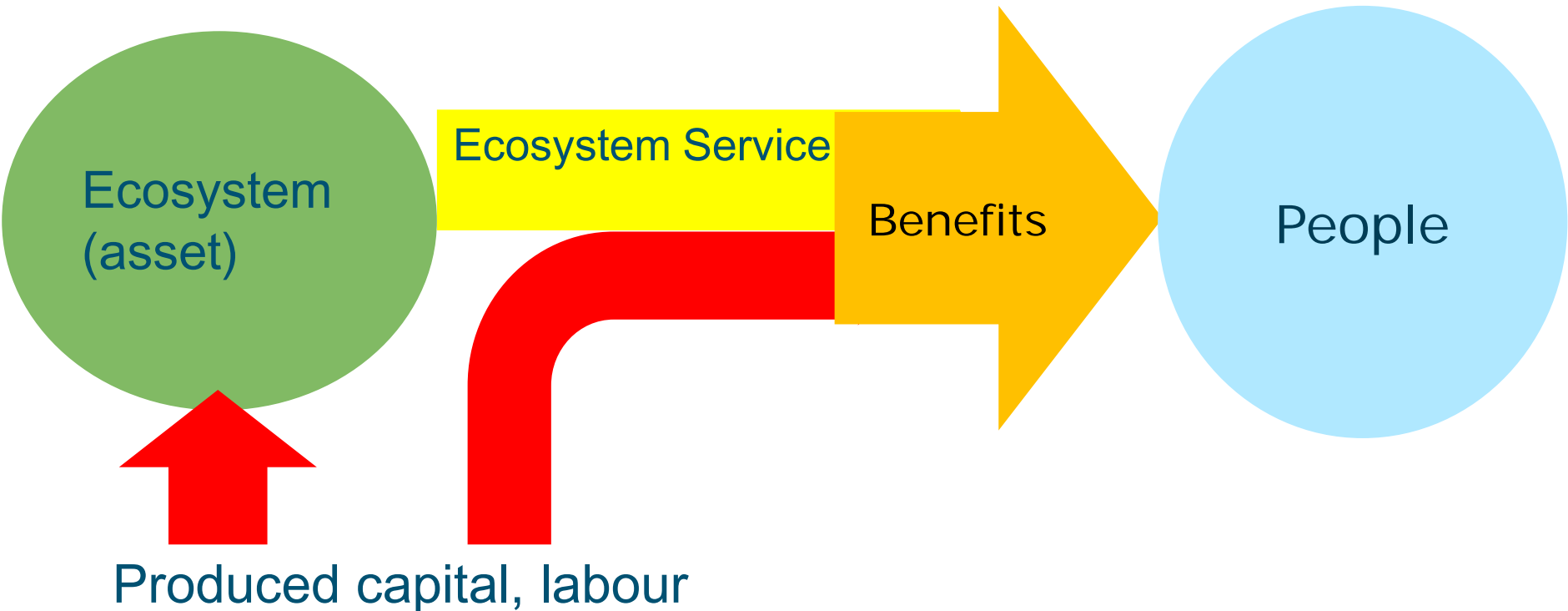
Prof. Dr Lars Hein

The SEEA Ecosystem Accounts

Ecosystem extent	→	Ecosystem condition	→	Physical ecosystem services	→	Monetary ecosystem services	→	Monetary ecosystem asset
e.g.		e.g.		e.g.		e.g.		e.g.
Forest area		Standing biomass		Timber (m^3)		Timber (€)		Stock (€)

Accounting tables

km^2 m^3 €

Physical supply, totals

Ecosystem services	Ecosystem Units	1 Non-perennial plants	2 Perennial plants	4 Meadows (for grazing)	5 Hedgerows	21 Deciduous forest	22 Coniferous forest	23 Mixed forest	24 Heath land	26 Fresh water wetlands	27 Natural grassland	28 Public green space	31 River flood basin	Totals
	extent (ha)	53.600	8.100	27.100	2.900	11.400	7.100	10.400	2.100	900	3.100	4.800	14.100	220.900
Crops	tonnes/yr	1.427.300	65.000	-		-	-	-	-	-	-	-	-	1.492.400
Fodder	tonnes/yr	140.800	4.700	328.700	-								66.900	541.100
Meat (from game)	kg/yr	11.500	1.500	5.900	800	2.500	1.700	2.900	600	200	800	900	2.400	36.800
Ground water (drinking water only)	in 1000 m3/yr	9.000	1.400	4.200	500	1.900	100	500	100	-	700	400	1.300	27.000
capture of PM10	tonnes/yr	400	100	200		300	400	500	-	-		100	100	2.900
Carbon sequestration	tonnes C/yr	-	2.400	4.900	500	16.500	10.300	15.100	400	200	600	1.200	2.800	59.000
Recreation (cycling)	1000s of bike trips/yr	1.800	300	1.000	100	600	200	400	-	-	100	200	600	9.100
Nature tourism	# tourists/yr	94.000	22.000	136.800	57.000	160.300	93.800	147.400	22.700	11.600	55.400	11.800	94.500	974.300

Ecosystem services (1)

Ecosystem (asset)

Ecosystem Service

Benefits

People

Produced capital, labour

Benefit versus service
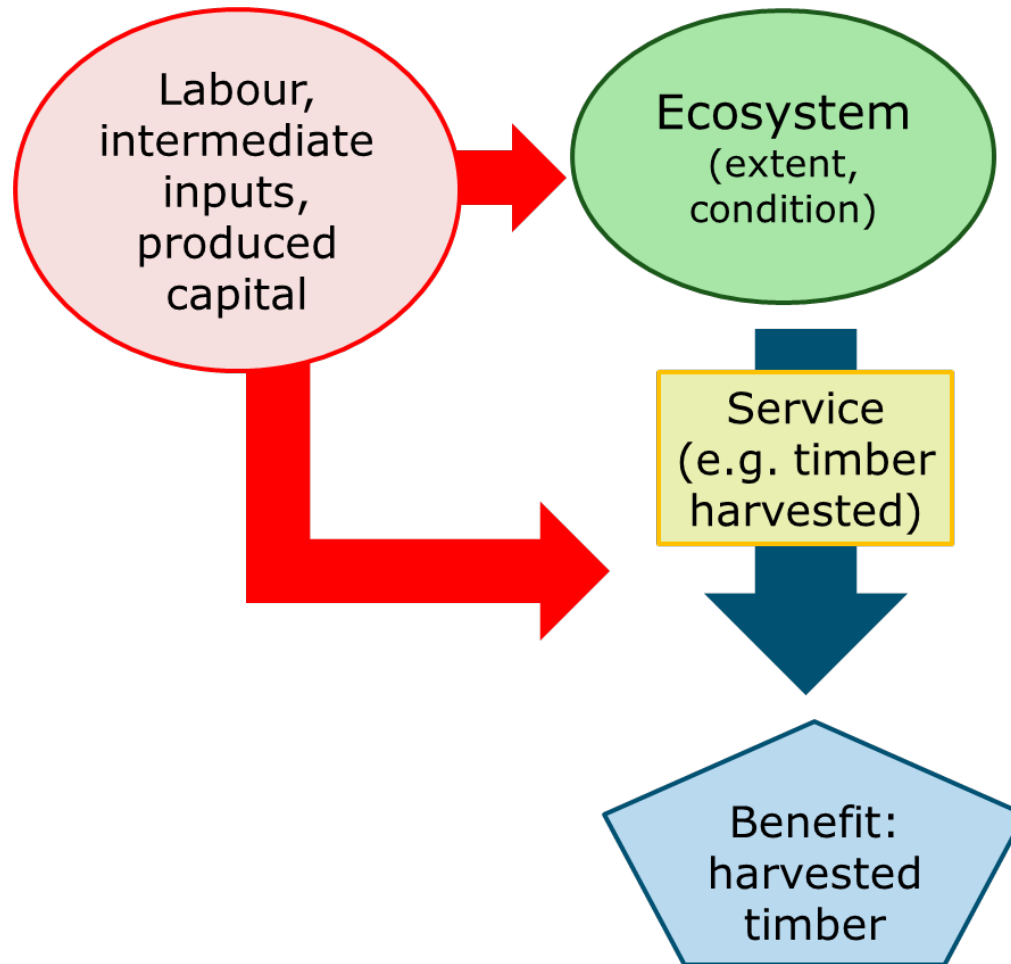
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Types of ecosystem services (SEEA)

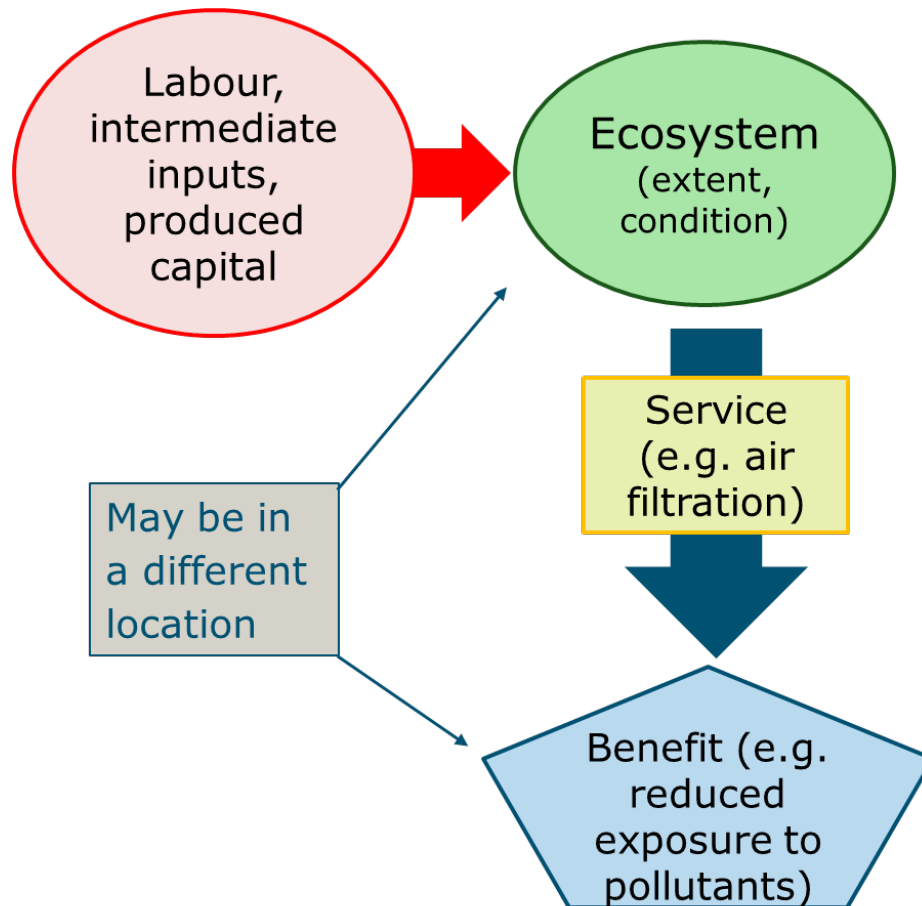Ecosystem services = the benefits provided by ecosystems to people

- **Provisioning services**: the products that can be extracted from or harvested in ecosystems

- **Regulating Services**: the regulation of ecological, hydrological and climate processes

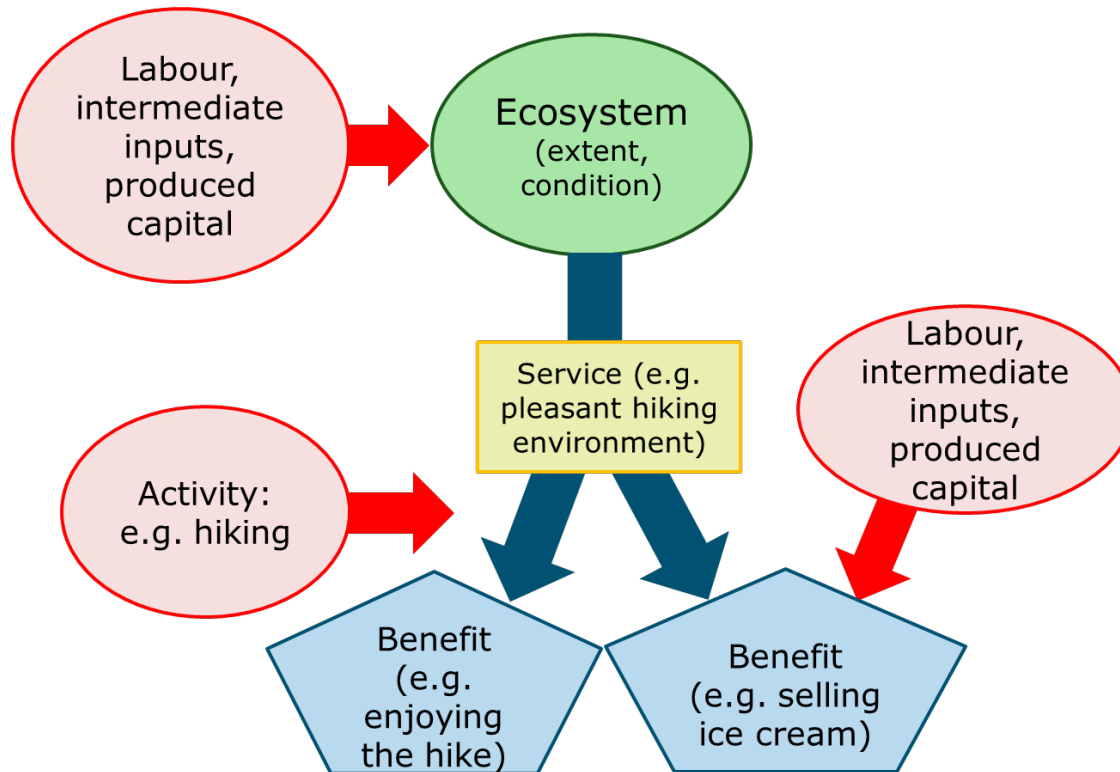- **Cultural services**: the non-material benefits from ecosystems (e.g. recreation)
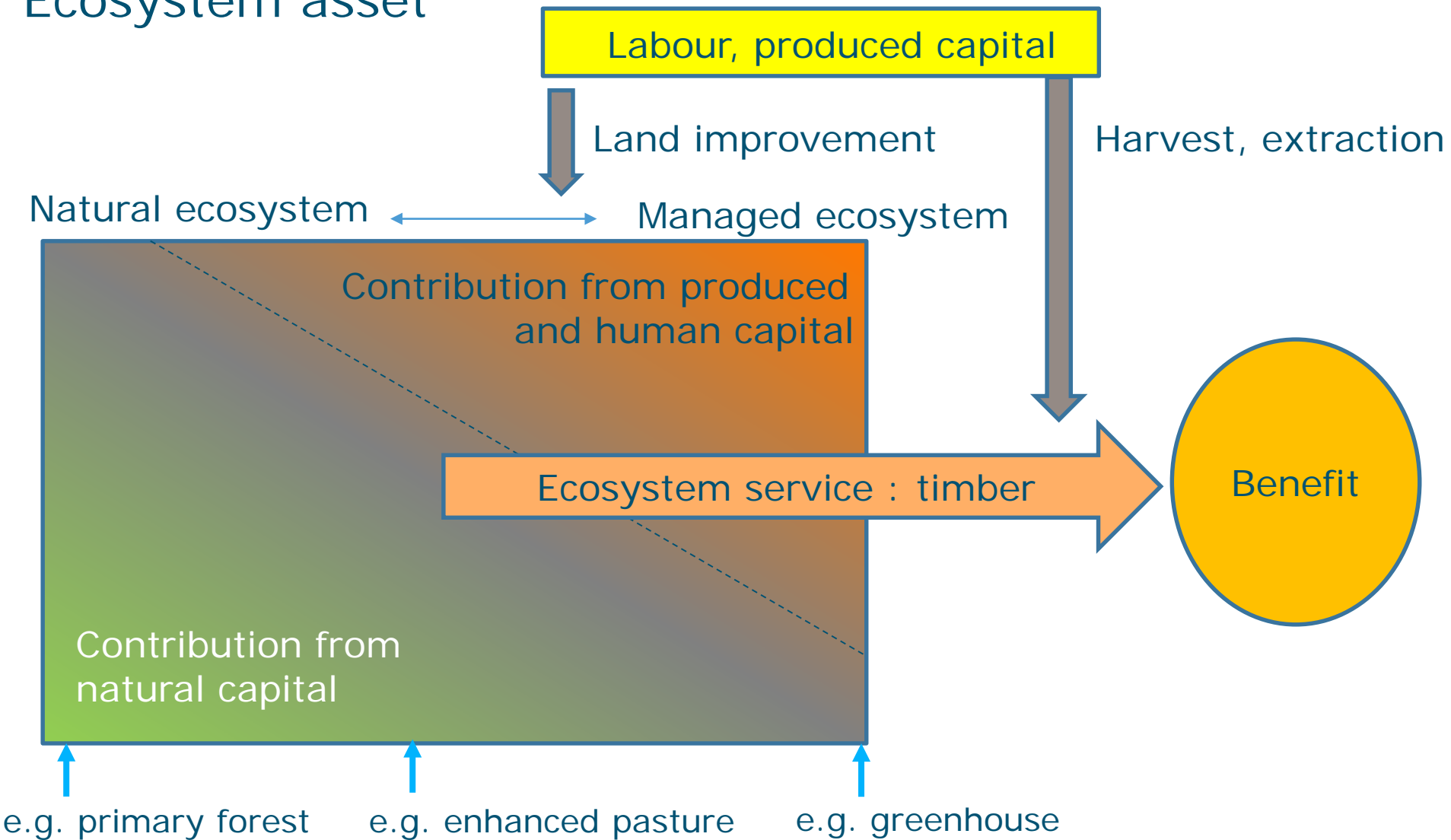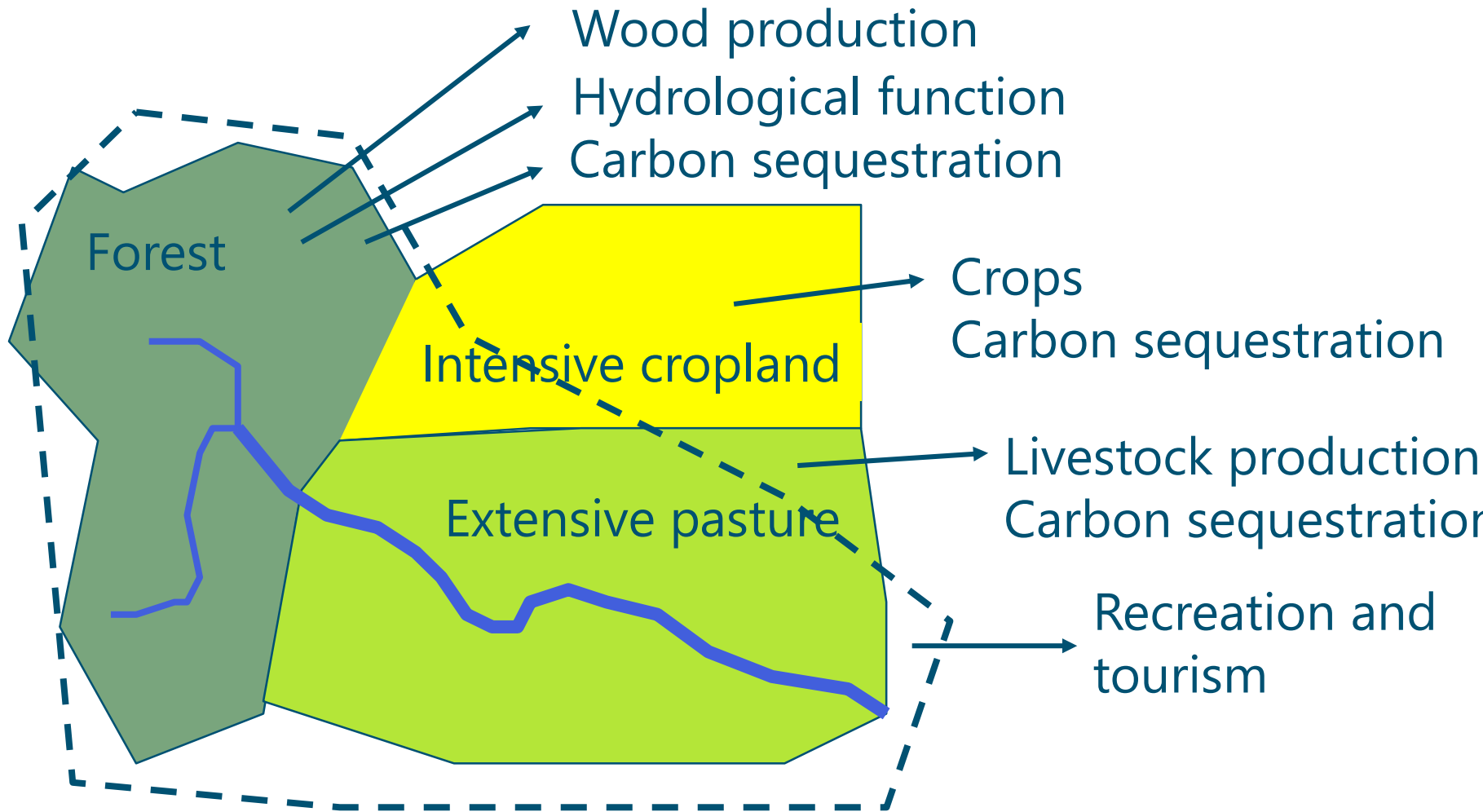
Provisioning services

Regulating services

Labour, intermediate inputs, produced capital

Ecosystem (extent, condition)

May be in a different location

Service (e.g. air filtration)

Benefit (e.g. reduced exposure to pollutants)

Cultural services

Ecosystem asset

Labour, produced capital

Land improvement

Harvest, extraction

Natural ecosystem ⟷ Managed ecosystem

Contribution from produced and human capital

Ecosystem service : timber

Benefit

Contribution from natural capital

e.g. primary forest   e.g. enhanced pasture   e.g. greenhouse

Ecosystem types and ecosystem services

Capacity to provide ecosystem services

- Capacity is an ecological concept that can be modelled based on the extent and condition of the ecosystem

- It indicates the amount of product (e.g. timber, fish) that can be sustainably harvested (i.e. without depleting the ecosystem)

- Maintaining ecosystem's capacity to supply services is important in reaching ecological sustainability

- Constant flows of ecosystem services are possible when there is an increase in harvesting effort – unless harvests are reduced an ecosystem may 'collapse'

- Capacity as a concept is in scope
  of SEEA
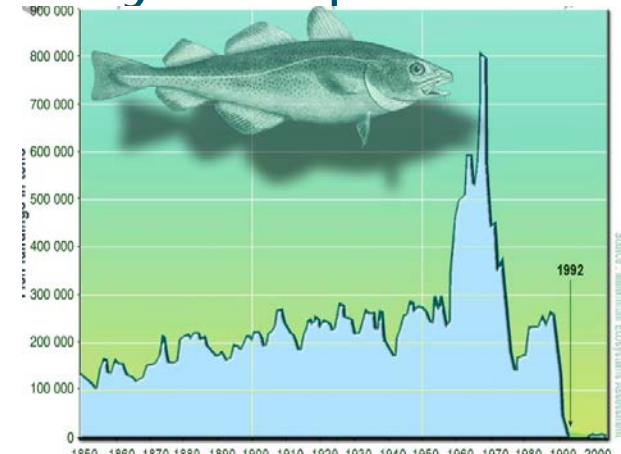
Timber production

	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
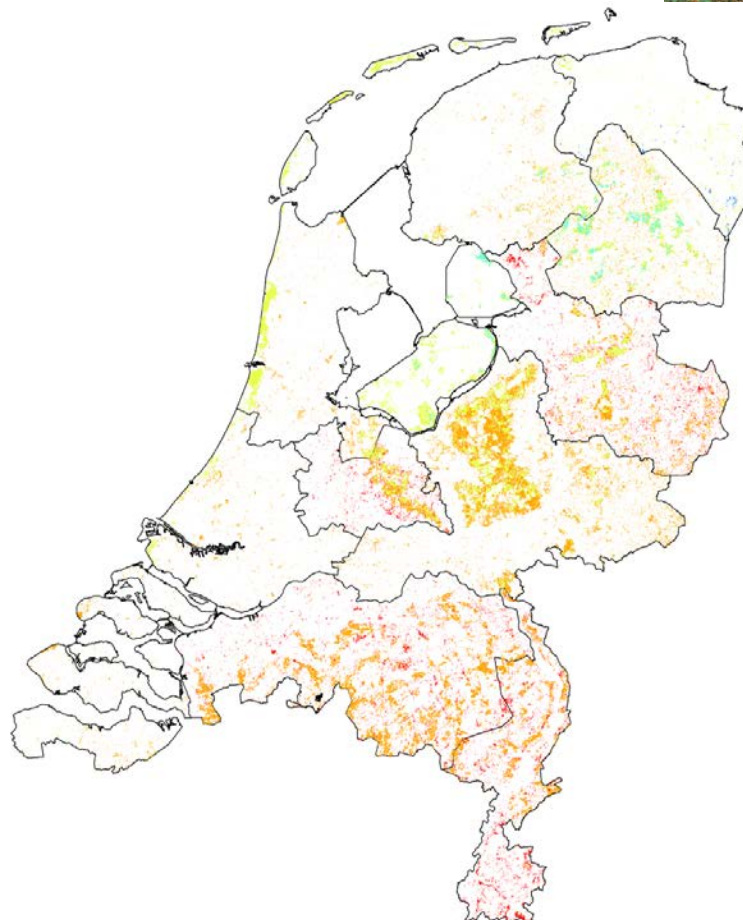
Mean increase timber stock
m³ ha⁻¹ yr⁻¹
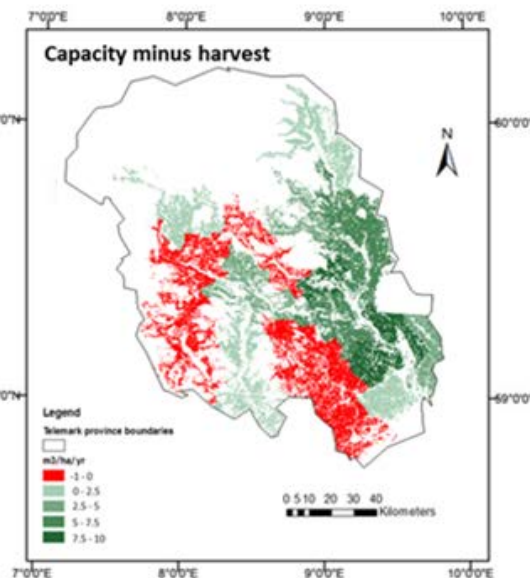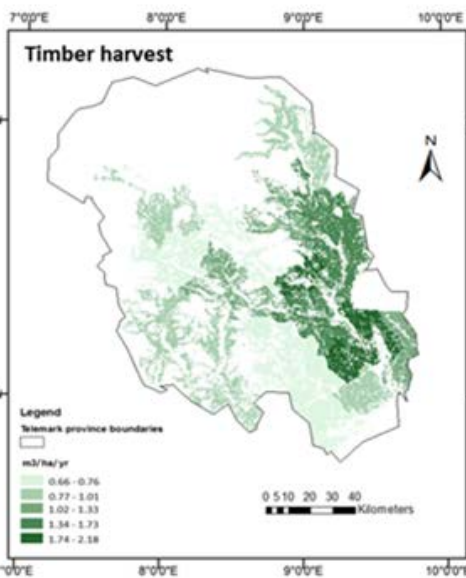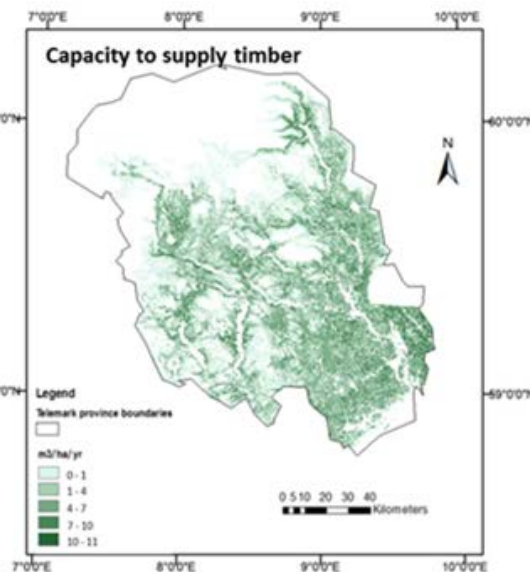- 5.5 - 6.5
- 6.5 - 7.5
- 7.5 - 9.5
- 9.5 - 11.5
- 11.5 - 13.5
- 13.5 - 15.5

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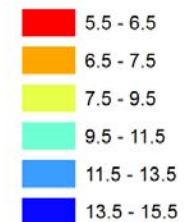
Timber capacity and flow in Telemark

Timber harvest capacity, flow (i.e. timber harvest) and difference between capacity and flow in Telemark, Norway

Mapping and modelling techniques

- **Look-up tables**. A specific value for an ecosystem service or other variable is attributed to every pixel in a certain class,

- **Geostatistical interpolation**. Use of statistical algorithms to predict the value of un-sampled pixels on the basis of nearby pixels in combination with other characteristics of the pixel. (e.g. kriging).

- **Statistical approaches**. For instance Maxent analyses the likelihood of occurrence of a species (or other services) as a function of predictor variables, based on an analysis of the occurrence of that species in those data points where the species occurrence has been recorded.

- **Process based modeling**. This method involves predicting ecosystem services flows or other variables based on a set of environmental properties, management variables and/or other spatial data sources.

Measuring carbon sequestration in ecosystems

Only long term (>100 years) storage in ecosystems counts as carbon sequestration

There are two methods:

- Carbon sequestration = Net Primary Production (NPP) – Autotrophic soil respiration – Carbon loss due to fire – Carbon loss due to wood harvest

- Carbon sequestration = Carbon stock in year$_{(t)}$ – Carbon stock in year$_{(t-1)}$

Both methods have advantages and disadvantages

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Carbon sequestration in Telemark

| Method	total stock in t C (forest)	sequestration tC/ha
1 Forest inventory data and maps	546 578	0.63
2. MODIS NPP minus soil respiration model after Raich et al. (2002)	1 070 123	1.28
3. NEP: MODIS GPP minus TER after Luyssaert et al. (2007)	911 651	1.04

Source: Schröter et al., 2014)

The future: using satellite data: Biomass (and carbon) monitoring
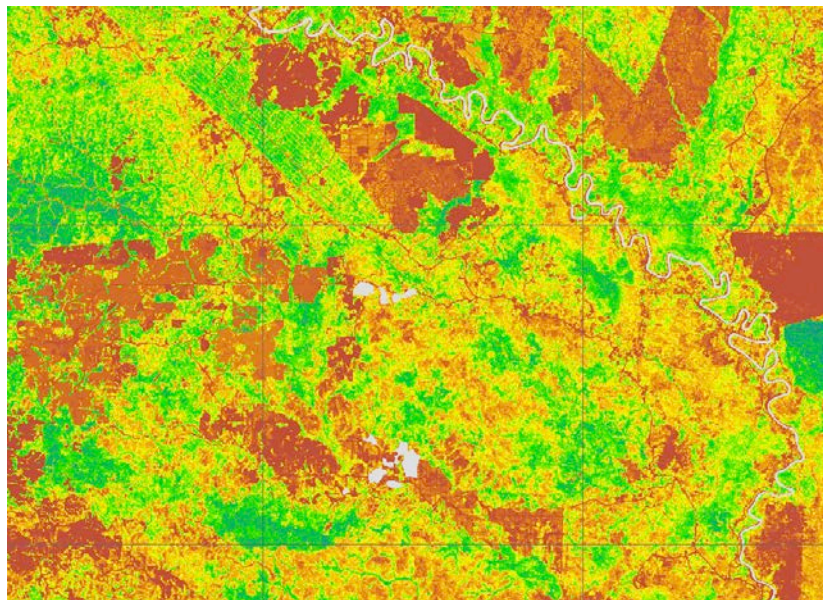
Biomass time series over the years 2000-2012

Small section of the East Kalimantan map (50 km wide).
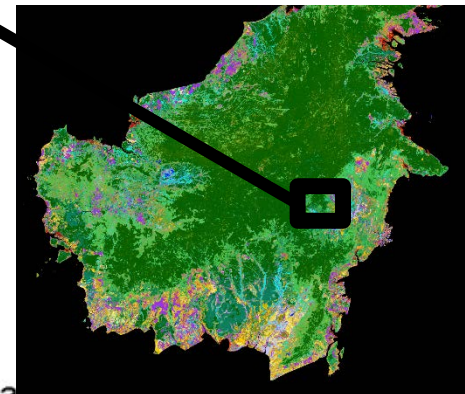
Valuation methods for ecosystem services

- Principle: alignment with System of National Accounts (SNA)

- Not measuring welfare but the contribution to economic activities, i.e. production and consumption

- Key difference: consumption surplus is not included in the SEEA (and SNA)

- Water is valued at market prices, considering costs of production or replacement of water from other sources (e.g. desalinisation) not based on willingness to pay

- Different valuation methods apply!

Valuation methods

- Lease (e.g. for croplands): market price paid by farmers for agricultural land

- Stumpage value: value paid for harvestable timber resources

- Resource rent: provisioning services: residual value when costs of intermediate inputs, labour and capital are deducted from gross revenue

- Market prices: carbon sequestration (but there are several caveats: is forest carbon included? To what degree if the carbon price set by the government?)

- Replacement costs, e.g. for coastal protection from mangroves or dunes (condition: it needs to be credible that the service would be replaced!)

- Avoided damage costs (if the service would not be replaced, e.g. pollination – but context specific!)

Ecosystem services in NL SEEA account

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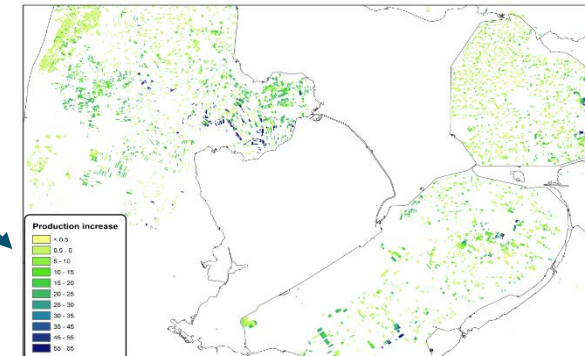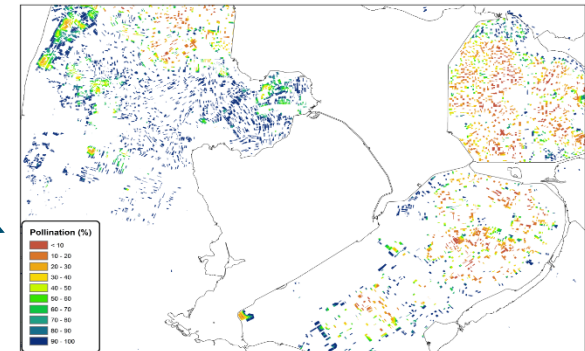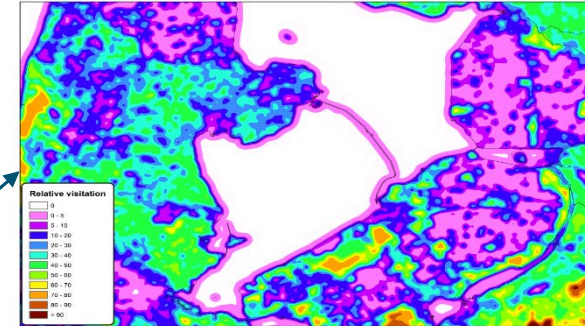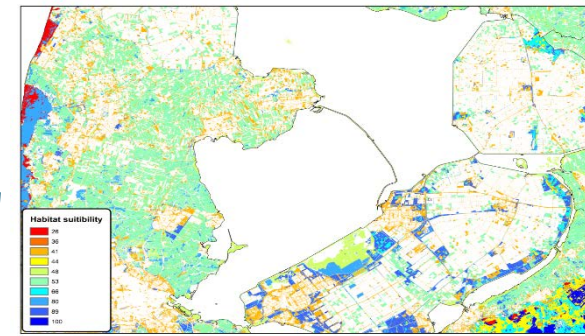- Other biomass
- Water supply

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

Valuation methods Netherlands accounts

Class	Ecosystem service	Exchange values in the SNA	Exchange values not in the SNA	Value of the benefits
Provisioning services	Crop production	resource rent rent prices user costs		GVA
	Fodder production	resource rent rent prices user costs		GVA
	Timber production	resource rent rent prices		GVA
Regulating services	Air filtration		avoided damage	
	Carbon sequestration in biomass		avoided damage	
	Water filtration		replacement costs	
	Pollination		avoided damage	
Cultural services	Nature recreation	household expenditure		
	Nature tourism	household expenditure resource rent		
	Amenity services	hedonic pricing		

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).
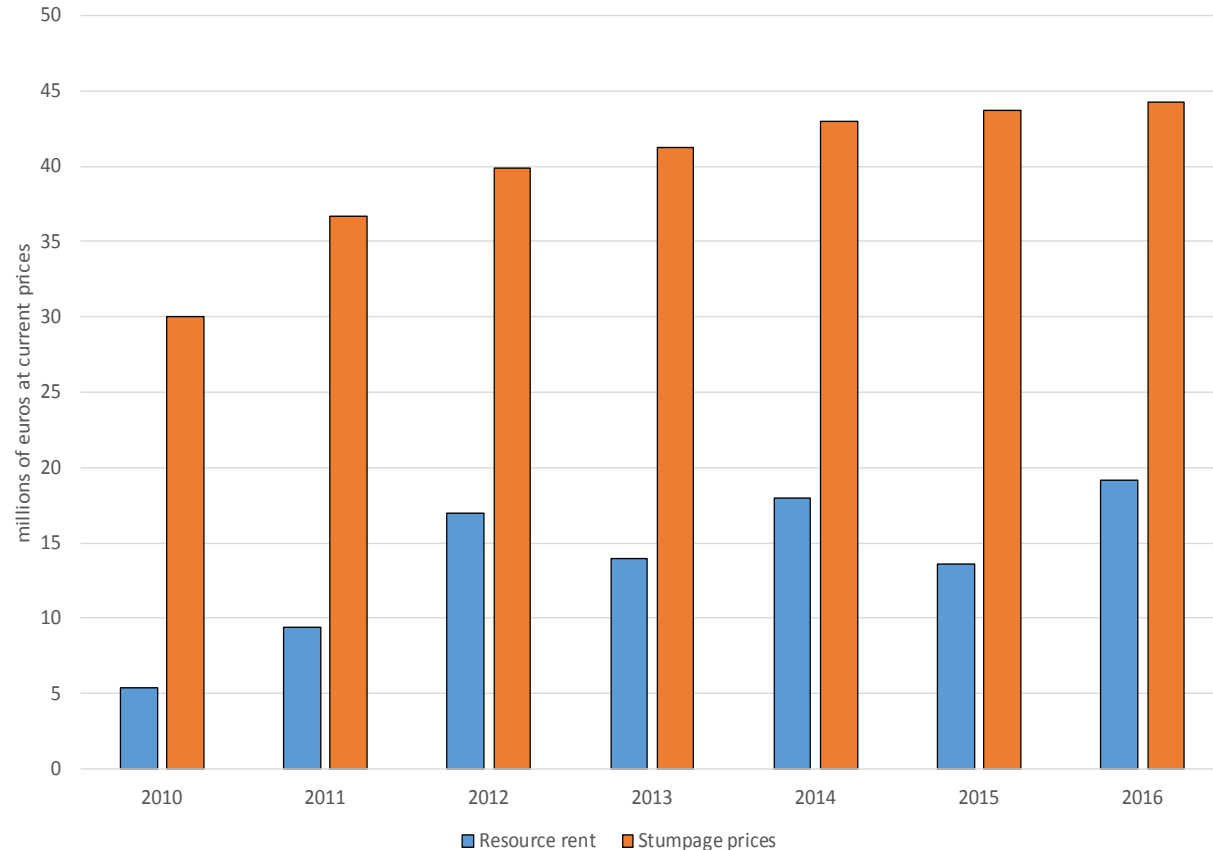
Comparison of methods
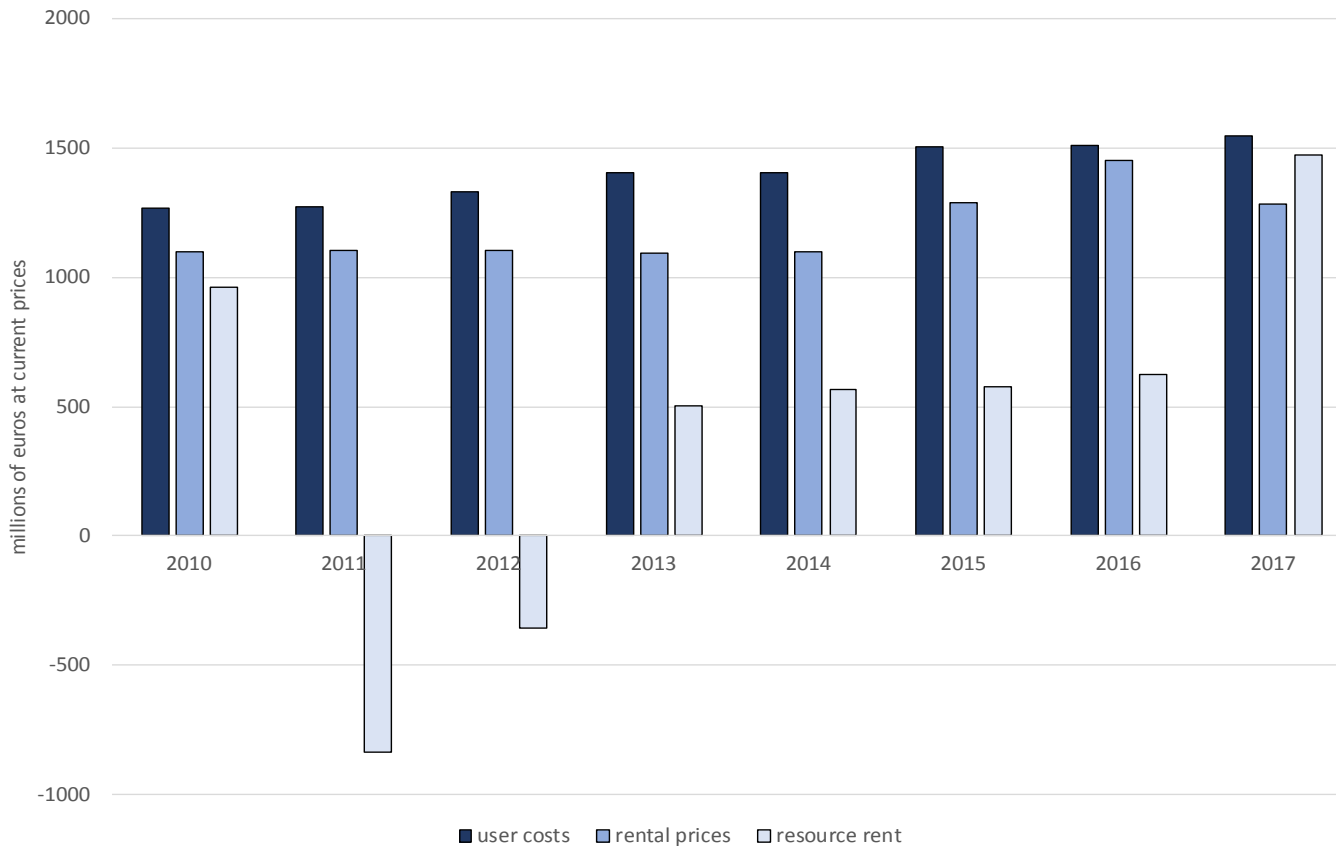
- Selected: the land lease method (for agricultural land)

Valuing timber assets
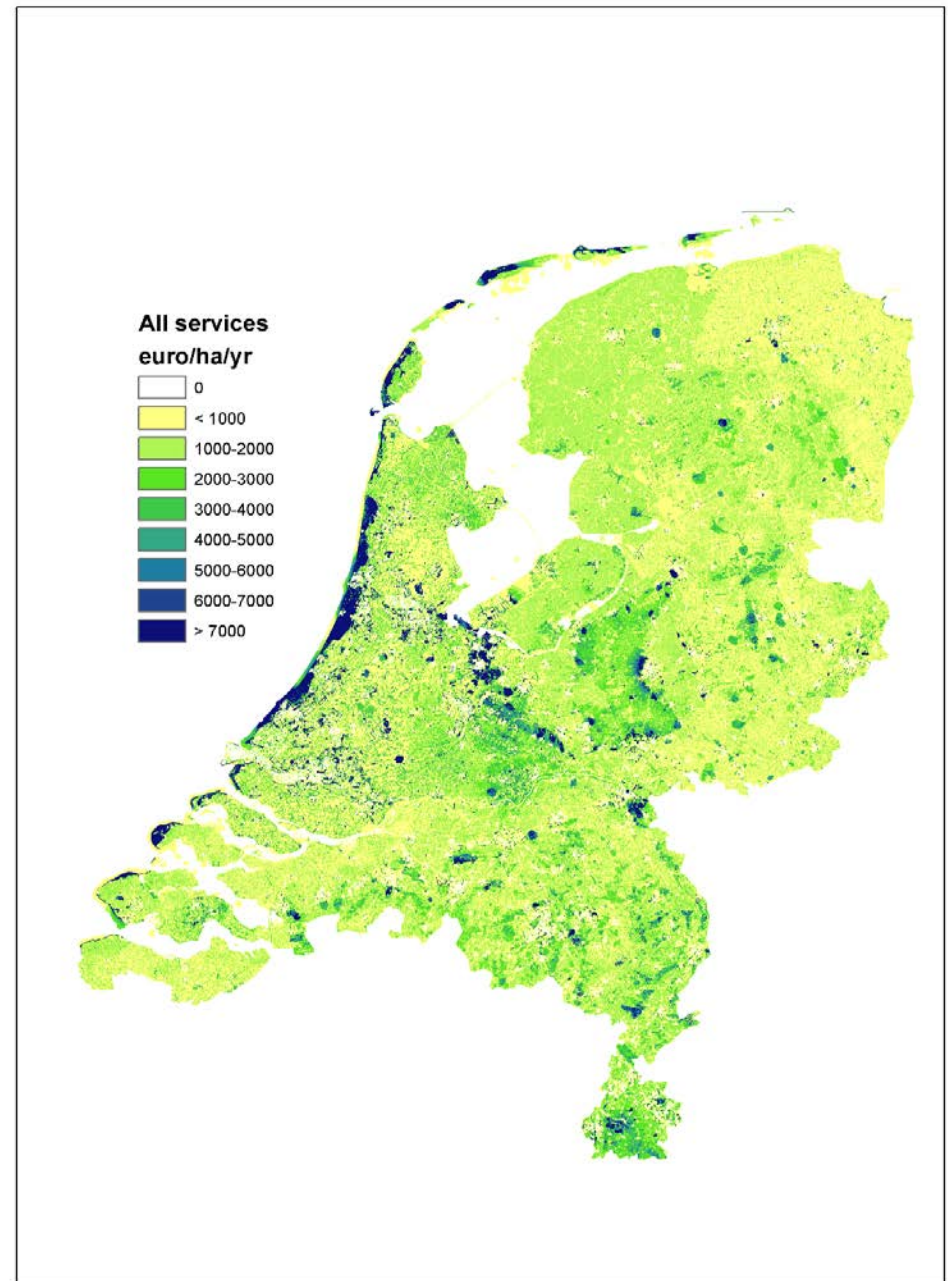
- two options: resource rent and stumpage prices

- Selected: stumpage prices

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Map

- Value of ecosystem services supply, per hectare per year (10m resolution)

- Values representative at the level of the province, potentially municipality

All services
euro/ha/yr
- 0
- < 1000
- 1000-2000
- 2000-3000
- 3000-4000
- 4000-5000
- 5000-6000
- 6000-7000
- > 7000

Take home messages valuation

- Monetary value of ecosystem services values is determined by society's pricing mechanisms.

- The values do not reflect welfare, do not reflect impacts of potential ecological collapse, do not reflect the value of resources if they would have been used sustainably

  - For some services the exchange value may be as low as 25% of welfare value

- (Akin to GDP: does NOT inform us on welfare)

Why is valuation important?

- Aggregation and comparison of services

- Measuring ecosystem capital in a consistent way over time and in different areas

- Taxation

- As a basis for social cost benefit analysis and comprehensive wealth assessments