BIOWATER

Alternative scenarios for a Nordic bio-economic shift: effects on our waters

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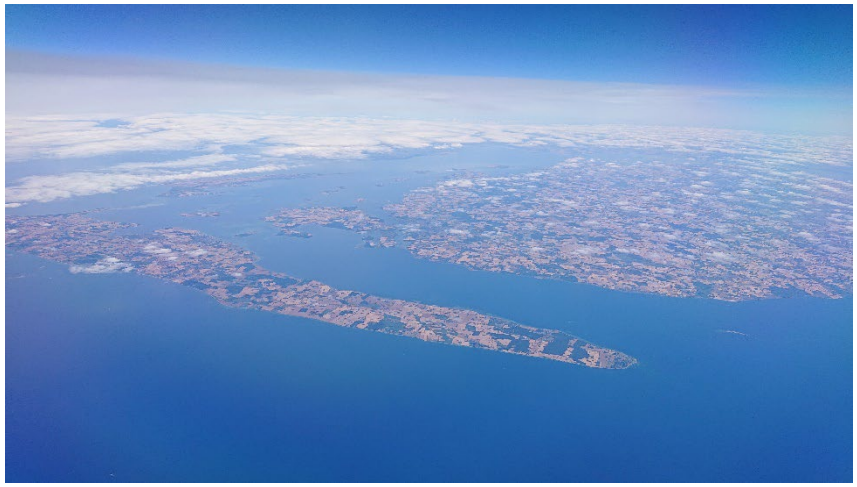
content

- The Nordic countries: not really homogeneous
- Bio-economy can mean so much: therefore scenarios
- BIOWATER's approach: empirics, scenarios and modelling
- Our research questions and answers
- Take-home message

The ‘Nordics’



Danmark …… Finnmark

(205 km^{-2}) (1 km^{-2})

BIOWATERs overall question: what is the effect of ‘a bio-economy’ on land use, water quantity and water quality?

Expectation : more intensive exploitation will lead to higher sediment and nutrient loads with subsequent consequences for biodiversity.

THE bio-economy does not exist

NBP0	NBP1	NBP2	NBP3	NBP4	NBP5
'now'	Sustainability first	Business as usual	Trade borders, global fragmentation: 'pull up the drawbridge'	Cities first, increasing rural-urban gap	Maximum growth, 'technology solves all'

- A loose concept, or hope for a green shift where renewable biological resources will replace fossil fuel.
- So we do not know: how to catch the 'unknown'?
- Our choice: contrasting scenarios for society's development toward 2050.
- We based 5 Nordic Bio-economy Pathways (NBPs) on benchmark Shared Socio-economic Pathways (SSPs) of the IPCC.
- Why not geophysical climate? RCP scenarios not so different yet in 2050.

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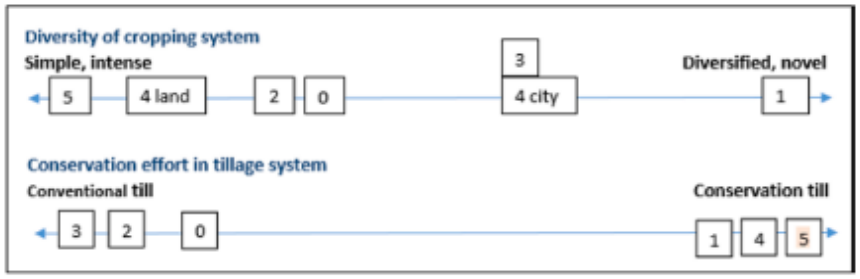
Scenarios and the development of a bio-economy

Brukerworkshop i Finland

NBP0	NBP1	NBP2	NBP3	NBP4	NBP5
'now'	Sustainability first	Business as usual	Trade borders, global fragmentation: 'pull up the drawbridge'	Cities first, increasing rural-urban gap	Maximum growth, 'technology solves all'




ENVIRONMENTAL EFFECTS OF A GREEN BIO-ECONOMY

Nordic Bioeconomy Pathways: Future narratives for assessment of water-related ecosystem services in agricultural and forest management

Jelena Rakovic, Martyn N. Futter, Katarina Kyllmar, Katri Rankinen, Marc I. Stutter, Jan Vermaat, Dennis Collentine


Land-use change in a Nordic future towards bioeconomy: A methodological framework to compare and merge stakeholder and expert opinions on qualitative scenarios

Stepwise process:

- we articulated NBPs for Nordic catchments in dialogue with stakeholder representatives in 4 countries,
- We deliberated many different aspects of societal change and land use
- Detailed tables, often narrative where we ranked the NBPs
- Then our modellers converted these to numbers as input into their models
- Took far more time than we expected in our proposal

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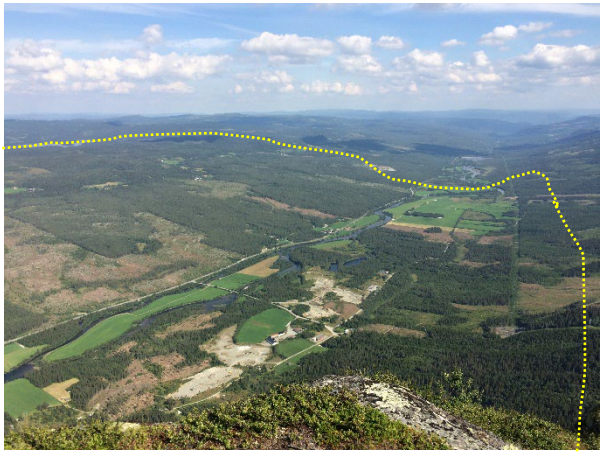
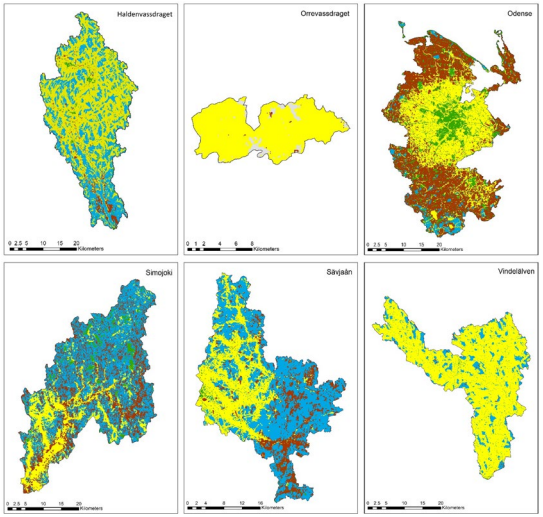
Further on our approach





From Immerzeel et al (2021), PLOS ONE

- Catchments are our natural landscape units: strong contrasts
- Empirical work
  - data mining from existing national monitoring programs*
  - Biodiversity effects
- Modelling, two types, both with NBP scenarios as input:
  - 'classical' hydrogeochemical (output: m^3, kg ha^{-1} y^{-1})
  - Ecosystem services: estimating Total Economic Value from all final services provided in a catchment (output: € ha^{-1} y^{-1})

* De Wit et al.(2020) Hydrol Proc; Wenng et al. (2021a, b) Hydrol Res, Agr Ecosys Env

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Our questions and answers

1. How much land would we need to produce sufficient biomass?
2. Will this ‘bio-economy’ change the distribution of land cover: forest – agricultural – marginal lands?
3. How much more intensive will forestry and agriculture get?
4. What will be the effects on water quantity, quality and biodiversity? How about remedial/mitigating measures?
5. Will the summed value of ecosystem services differ among scenarios? Who could be winners and loosers?

You already guessed the answer of the researcher: it depends! (scenario, catchment, geography) … but I have more answers

* Adjusted from Skarbovik et al (2020) Ambio;

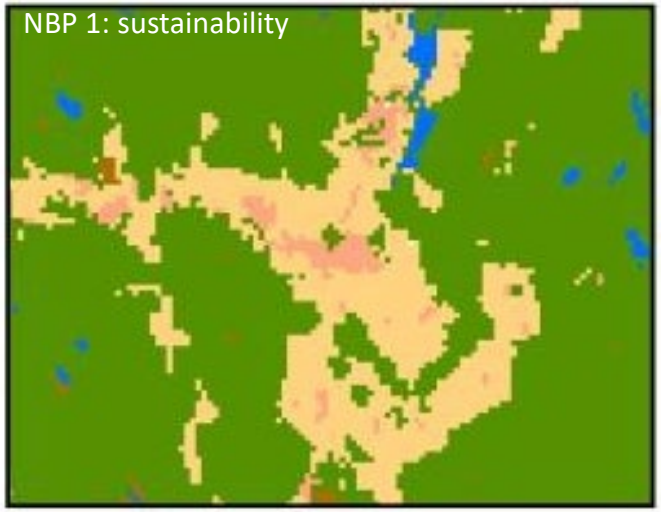
Our questions and answers

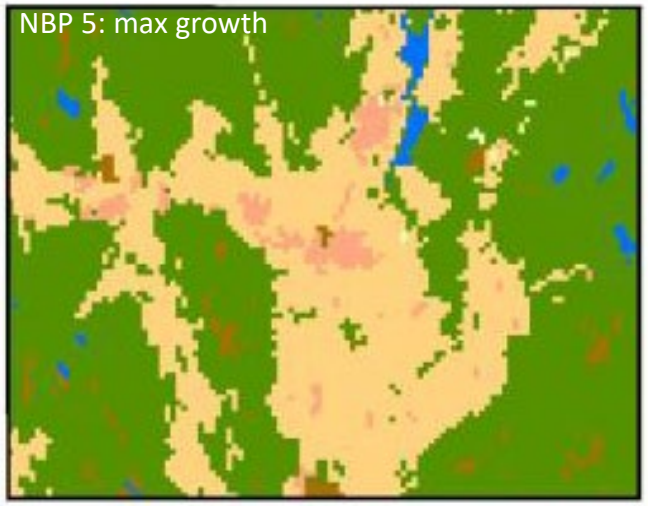
1. How much land would we need to produce sufficient biomass?
   - There will never be enough land to cover today's energy use. And the timber can be used far better (forestry science, outside BIOWATER)
2. Will this 'bio-economy' change the distribution of land cover: forest – agricultural – marginal lands?
   - Yes, depending on the scenario
3. How much more intensive will forestry and agriculture get?
   - 'Little' to 'a lot', both in forest and agriculture, depending on scenario
4. What will be the effects on water quantity, quality and biodiversity? How about remedial/mitigating measures?
   - Depends on scenario
5. Will the summed value of ecosystem services differ among scenarios? Who could be winners and loosers?
   - The distribution differs considerably, but the summed value may be similar

Answers in detail: change in land use

Scenario matters: example from Norway with contrast between NBP1 and NBP5, all within realistic bounds set by geology and climate

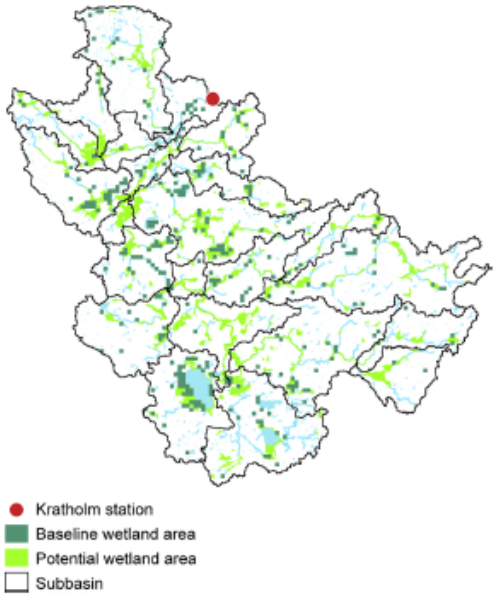
	NBP 1: sustainability		NBP 5: max growth	
→	Agriculture	7.8% ▼	Agriculture	15.6% ▲
	Bog	3.0% ▼	Bog	5.3% ▼
	Buildings and infrastructure	1.2% ▲	Buildings and infrastructure	1.3% ▲
→	Forest	80.1% ▲	Forest	69.9% ▼
	Freshwater	7.8% -	Freshwater	7.8% -
	Natural grassland or shrubbery	0.0% ▼	Natural grassland or shrubbery	0.1% ▼

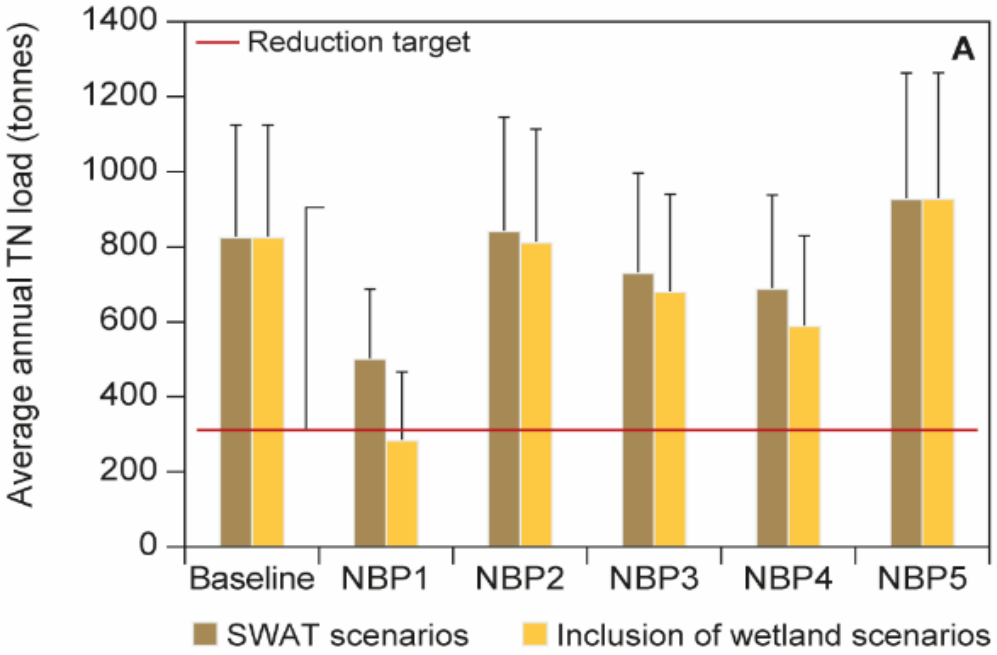




Source: Immerzeel et al. (2023) Catena

Answer in detail: water quality





Odense Å:

- None of the 5 NBPs meets the Water Framework Directive requirement on annual Nitrogen load of Odense Fjord. NBP1 comes closest.
- Extra wetlands placed ‘smartly’ across the catchment contribute the last bit.

Source Carstensen et al. (2023) Catena

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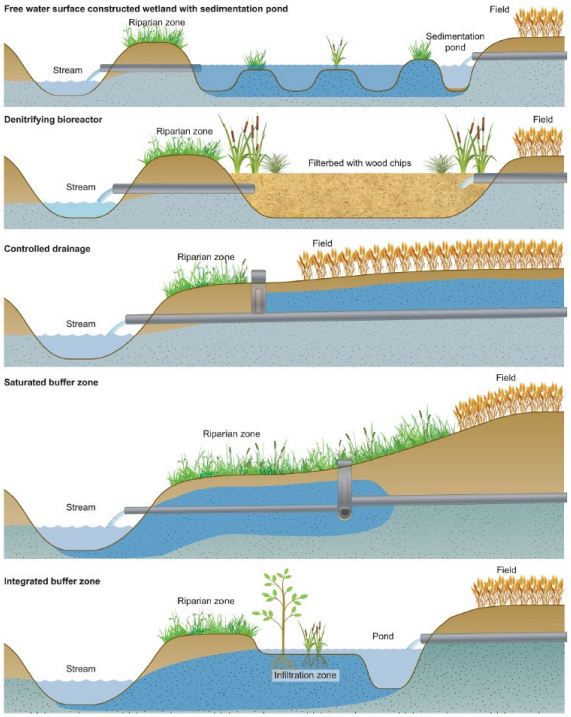
Answer in detail: mitigating measures?



Both in forestry and agriculture:

- Riparian buffer zones improve water quality and raise biodiversity.
- Shading reduces heating of the water: improves salmonid survival.

Engineered riparian buffers in agriculture:

- Nitrogen and Phosphorus loads are reduced.

Sources a.o. Carstensen et al. (2023, Catena); Rajakallio et al (2021, J Appl Ecol)

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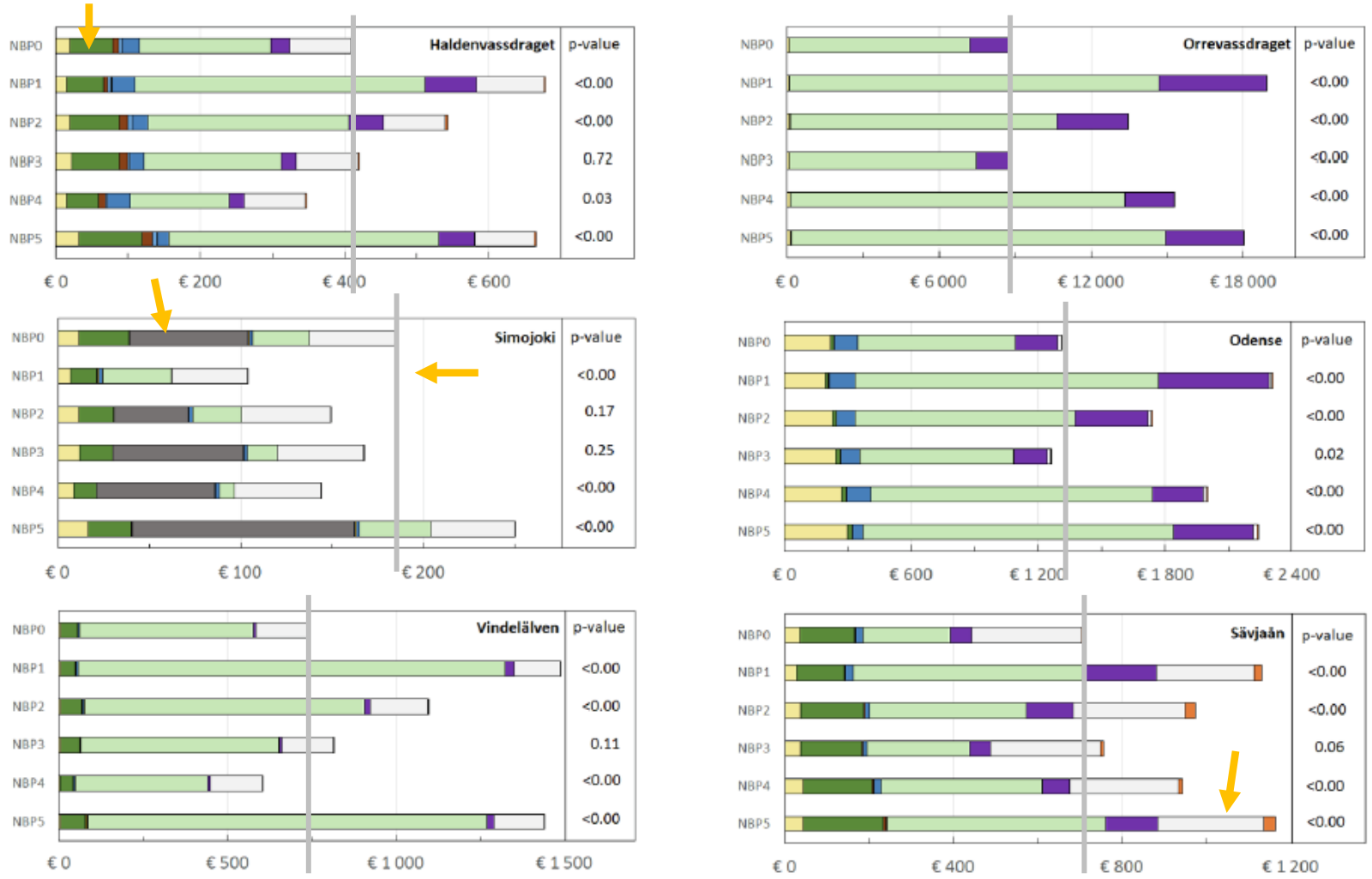
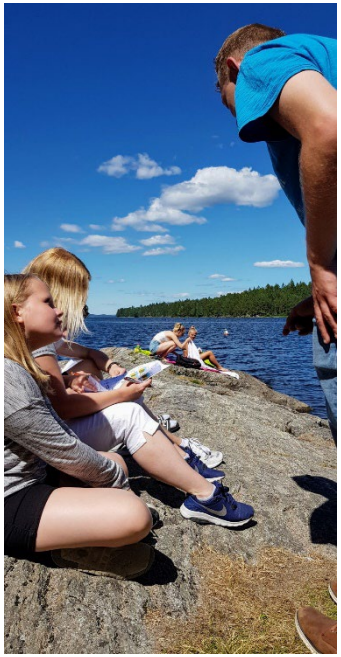
Answer in detail: ecosystem services? (1)



€ ha^{-1} y^{-1}

Answer in detail: ecosystem services? (2)



- Different forms of recreation dominate
- Different NBPs: ‘sustainability first’ or ‘growth first’ have similar summed TEV
- Method: open national stats, low Carbon prices, travel cost from surveys,
- only the ecosystem’s contribution, not the whole value chain: so grass, not the milk in the supermarket.

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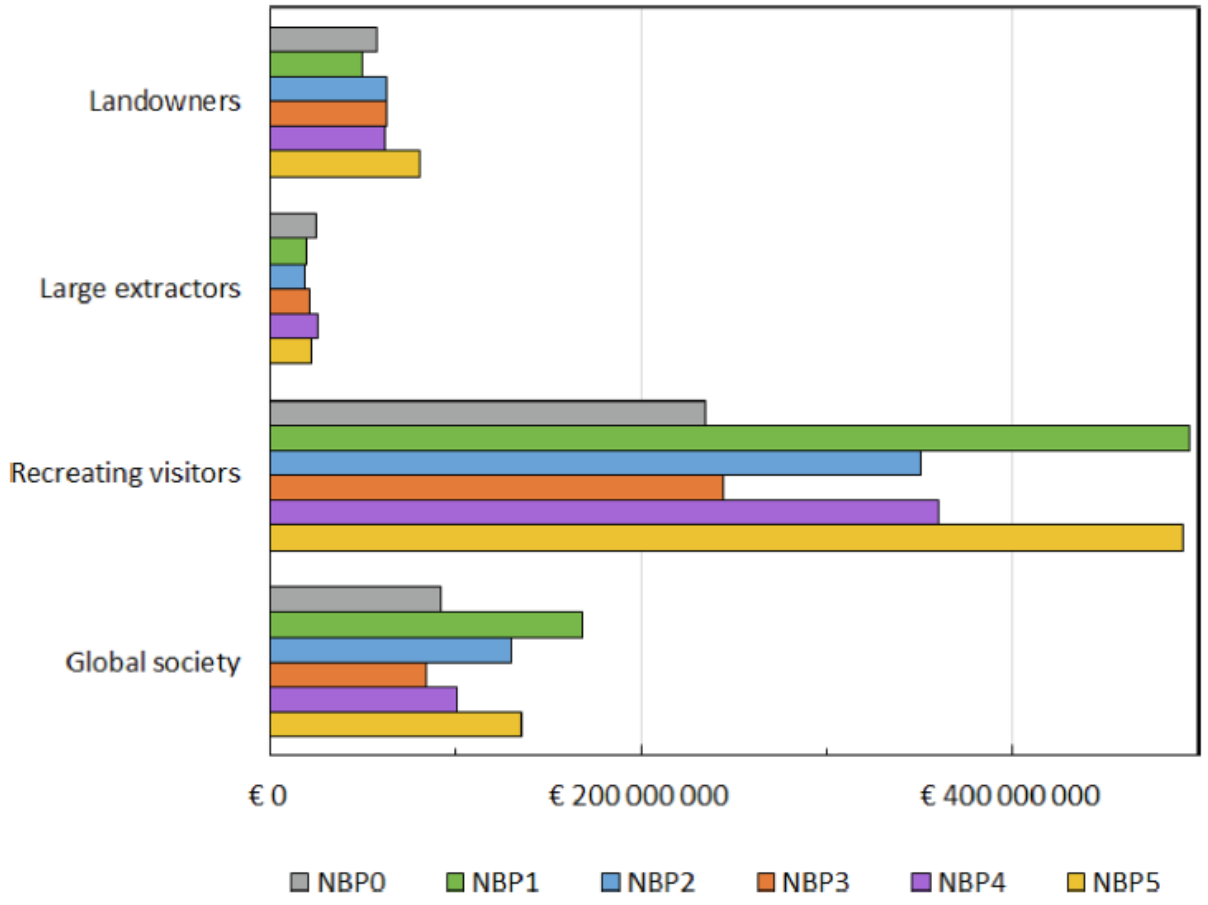
Answer in detail: ecosystem services? (3)



- Winners and loosers? Not the land-owners
- A green, circular and more sustainable Nordic countryside is very well possible.

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take home messages

1. A bioeconomy combined with climate change CAN be a risk for Nordic water resources
2. It is very well possible to combine a green shift away from the use of fossil fuel that brings high welfare, also in a countryside where agriculture produces food.
3. Until 2050 land use and management is more important than climate change, so local actions matter and mitigation measures can make a difference
4. Policy- and lawmakers have the responsibility and the economic and regulatory instruments.

- We feel BIOWATER coped well with CORONA and delivered.
- www.biowater.info, or: https://www.youtube.com/watch?v=DUd2e6Xpp5A

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The long-term monitoring catchment Skuterudfeltet i Ås, with a moose