Potential effects of intensified forestry on surface water acidification at Birkenes, Norway

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Photo: F. Clayer, NIVA

Background

- Many countries, incl. Norway, have identified intensified forestry as an effective **climate mitigation measure**
    - **afforestation** on new areas
    - **densification** of existing forests
    - **fertilisation** prior to harvest
    - **whole-tree-harvest** to produce biofuels
- **But,** intensified forestry might also have **negative environmental effects**, e.g., on **surface water quality** in sensitive areas

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The SURFER project

Surface wat**er**s: The overlooked factor in the forestry climate mitigation debate?

Main objectives:

- Assess the effects of intensified forestry as a climate mitigation measure on **freshwater quality** and **biodiversity**
- Examine the conflicts between **climate and freshwater policies and targets**.

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Our work task

To study potential effects of intensified forestry on surface water re-acidification

Problem:

- Very few **long-term studies** on effects of different forest management practices on water quality, and no one from Norway

Proposed solution:

- Utilise long-term data from the Birkenes calibrated catchment
- Apply the **MAGIC** biogeochemical model to simulate possible effects of different forest management practises on soil and surface water quality

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The Birkenes catchment

- Small catchment (0.41 km2), located 20 km from the south coast of Norway
- Nearly 50-year complete time record on precipitation, hydrology, and surface water chemistry, together with long-term soil and forest monitoring data
- Severely acidified although substantial recovery has taken place since the S deposition peaked
- 130-year old and slow growing spruce forest on acid-sensitive soils

Photo: NIVA

Photo: NIBIO

Modelling approach

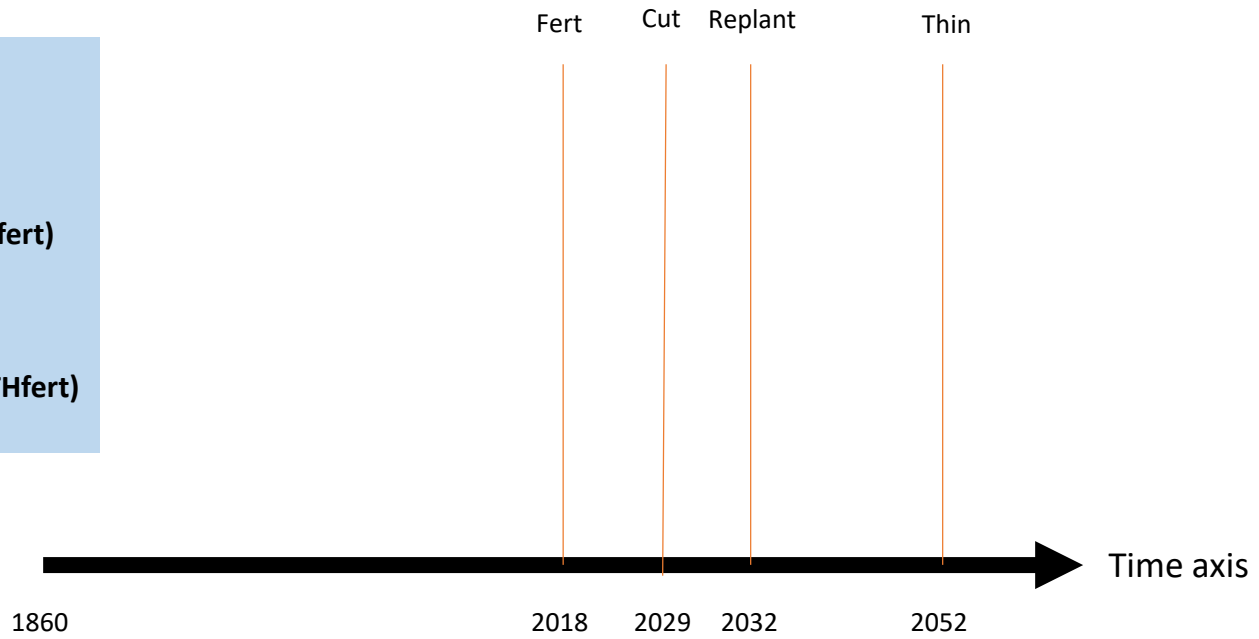
Scenarios:

Stem-only harvest **(SOH)**

Stem-only harvest, N-fert **(SOHfert)**

Whole-tree harvest **(WTH)**

Whole-tree harvest, N-fert **(WTHfert)**

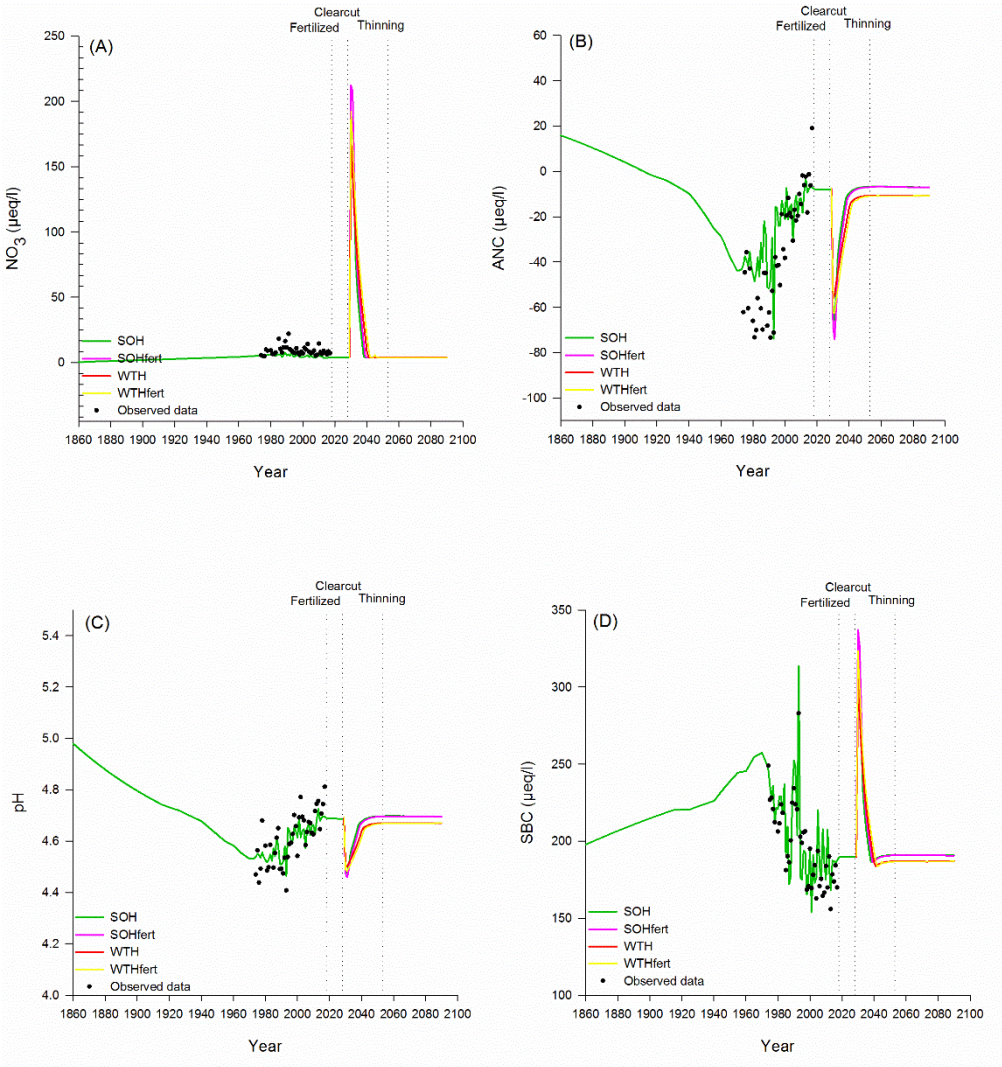


Extreme case with 100% clear cut of the forest!

Results

Water (1860-2100):

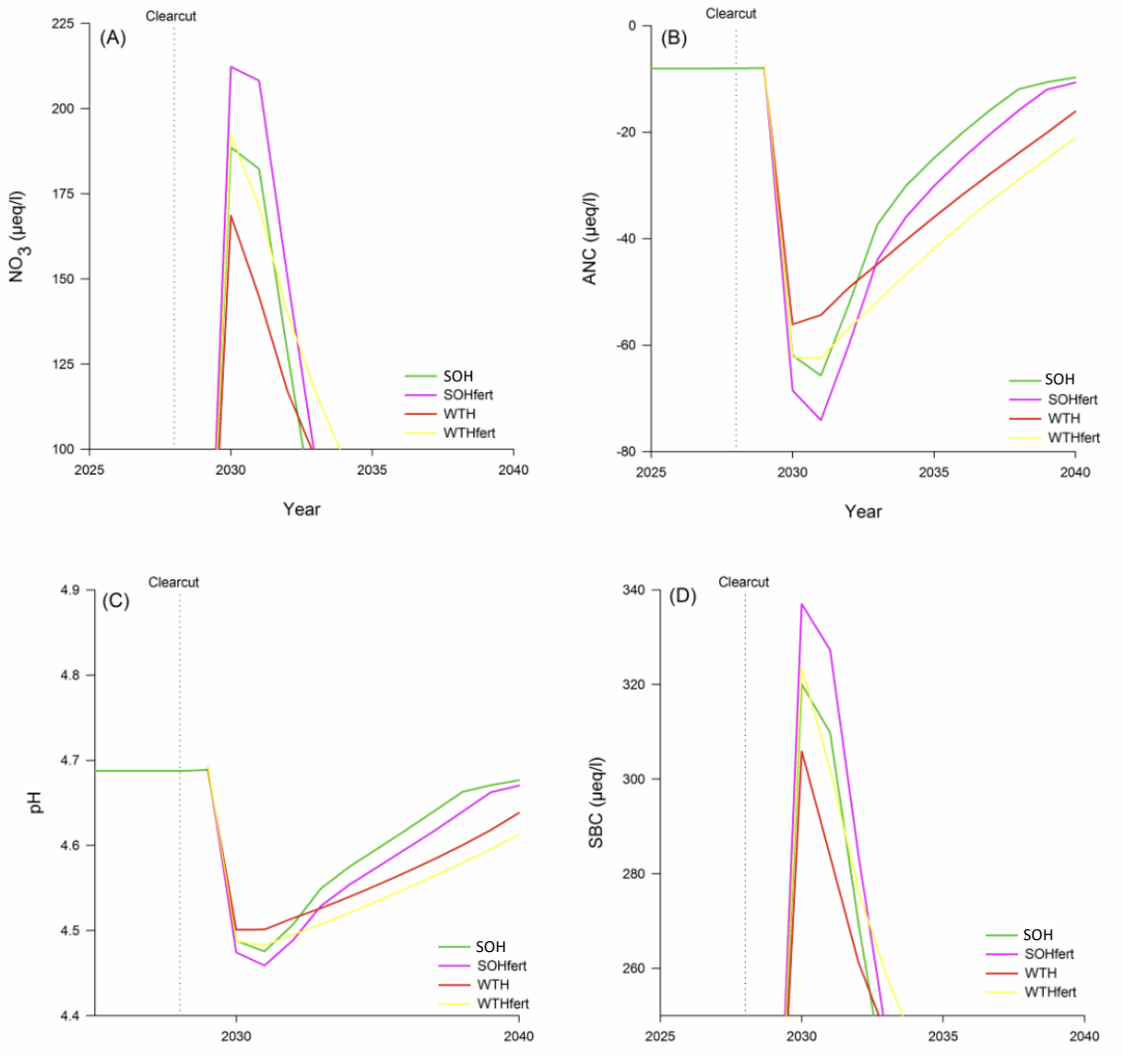
- Hindcast
- Calibration period
- Scenario period



Results

Water:

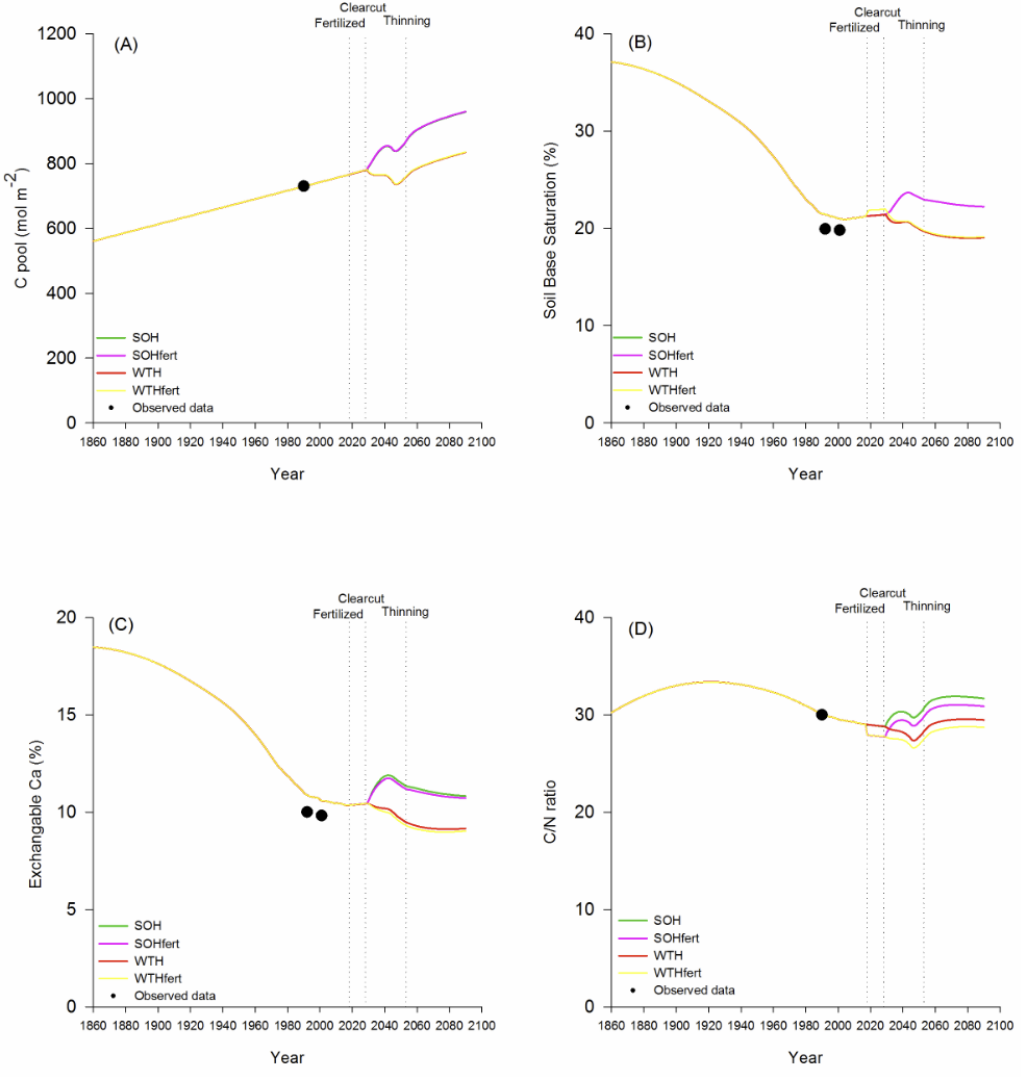
- After cutting the forest in 2028



Results

Soils:

- After cutting the forest in 2028



Results

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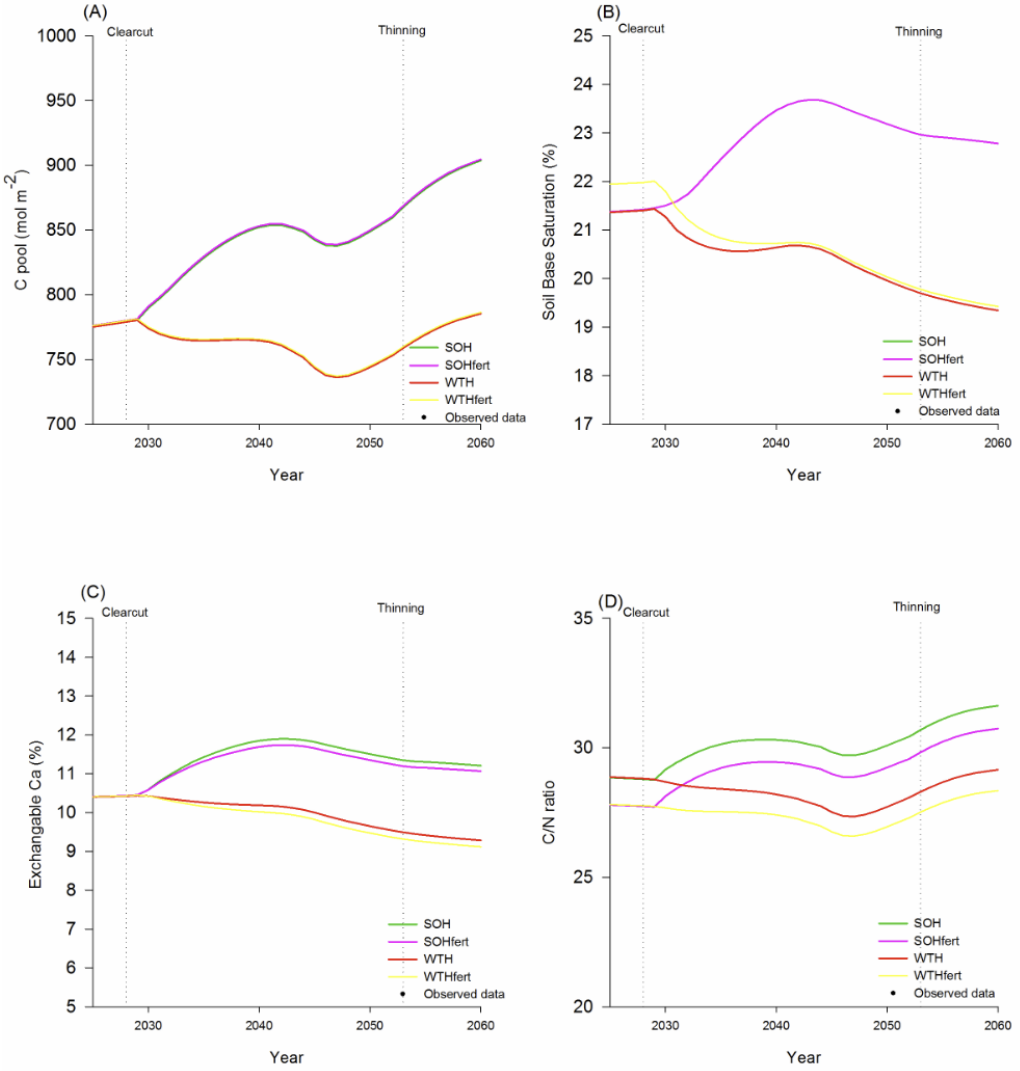
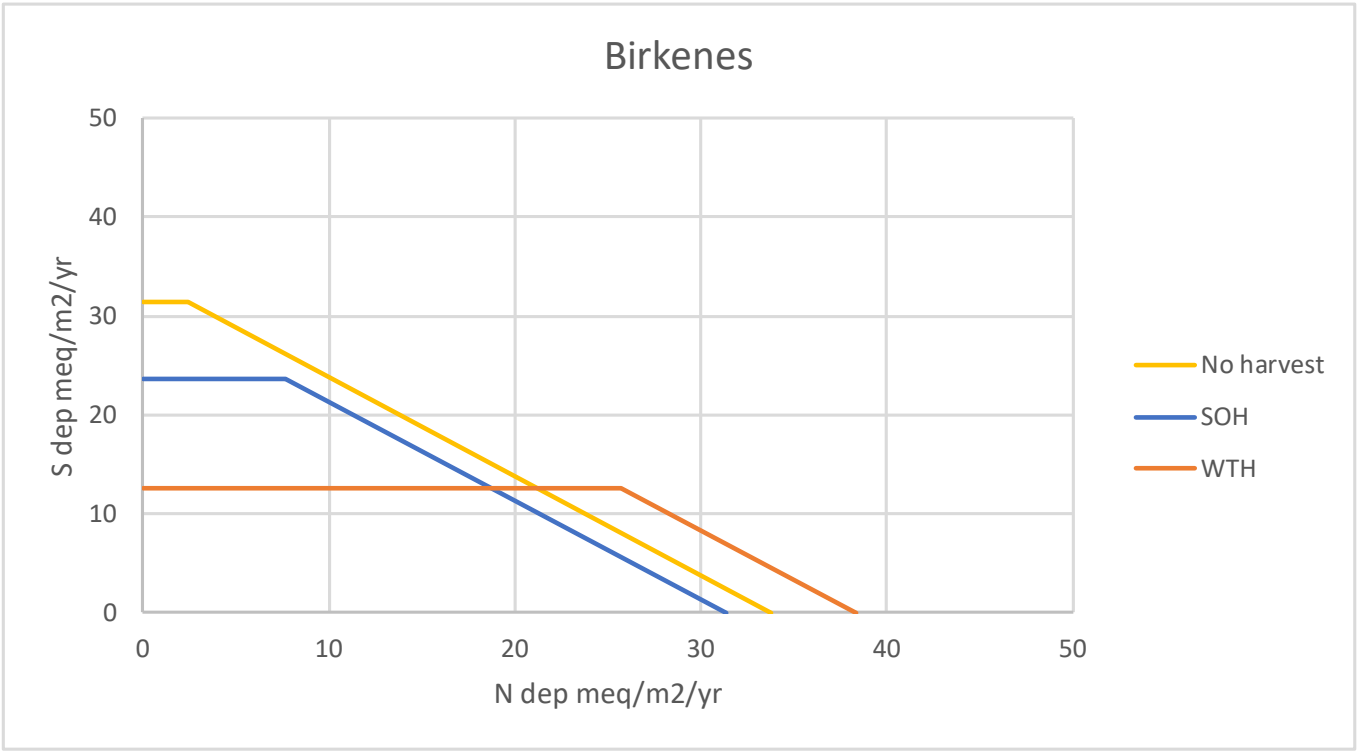


Implications for critical loads



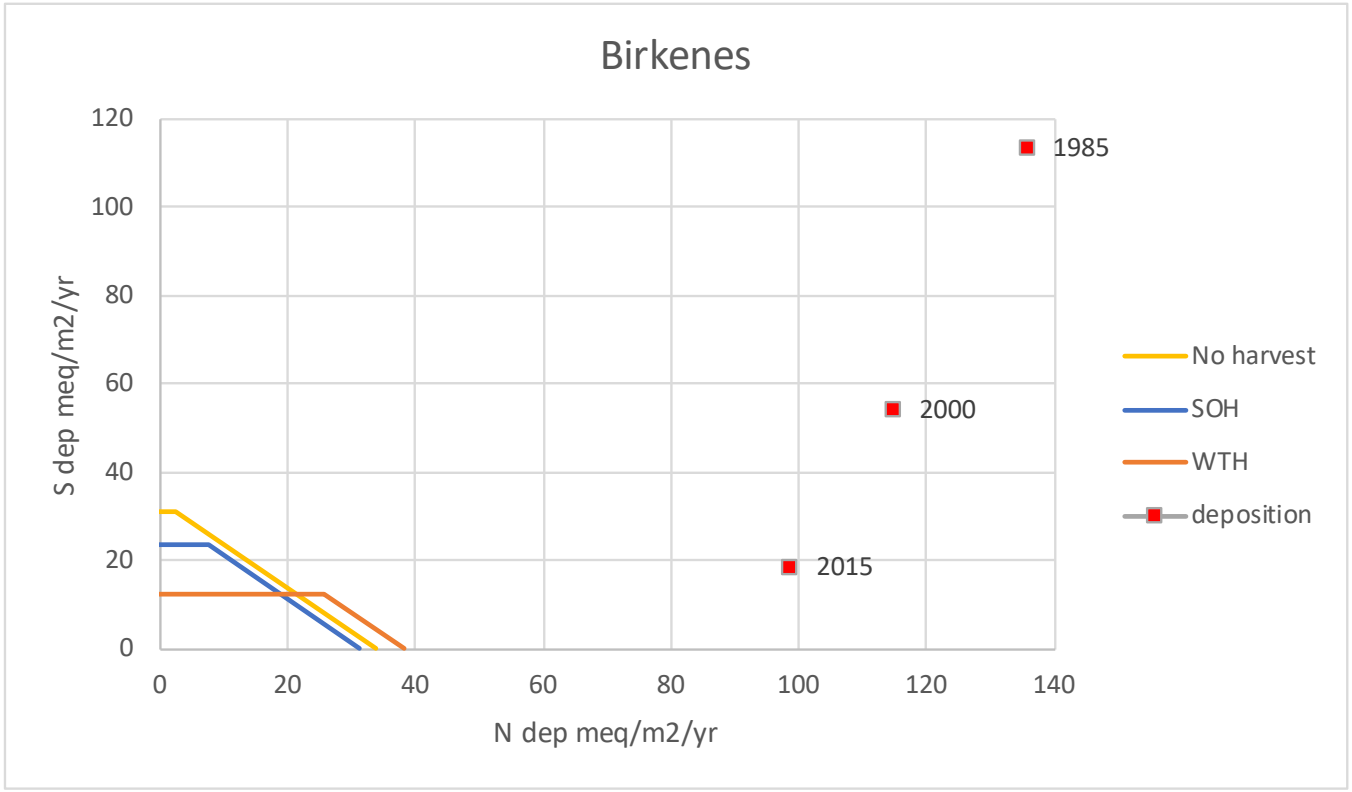
SOH and WTH:

Both removes BC -> Lowering Cl_{max} (S)

WTH:

Lowest Cl_{max}(S), highest Cl_{max} (N)

With historical and current deposition



Conclusions

- Intensified forestry can have substantial effects on surface water quality in acid sensitive areas
- Fertilisation was not followed by an immediate N pulse in surface water, but the response came after the forest was cut.
- SOH had a more immediate effect on NO3 leaching, while WTH had a long–term effect on acidification
- Both SOH and WHT reduces CLmax(S), while WTH increases CLmax(N)
- The Birkenes study represents an extreme case with 100% clear cut of a catchment.
- In reality; only a small fraction a catchment will be cut each year, and it is mandatory to establish buffer zones along streams with permanent flow.

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Photo: Lierposten