Assessing the environmental effects of biomass scenarios in Sweden - from a nutrient perspective

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Outline

- **Stump extraction (nutrient concentrations in stumps)**
- **Environmental effects of biomass scenarios in Sweden (nutrient perspective) - Mass balance model**

Nutrient concentrations in stumps and coarse roots of Norway spruce, Scots pine and silver birch in Sweden, Finland and Denmark

Forest Ecology and Management

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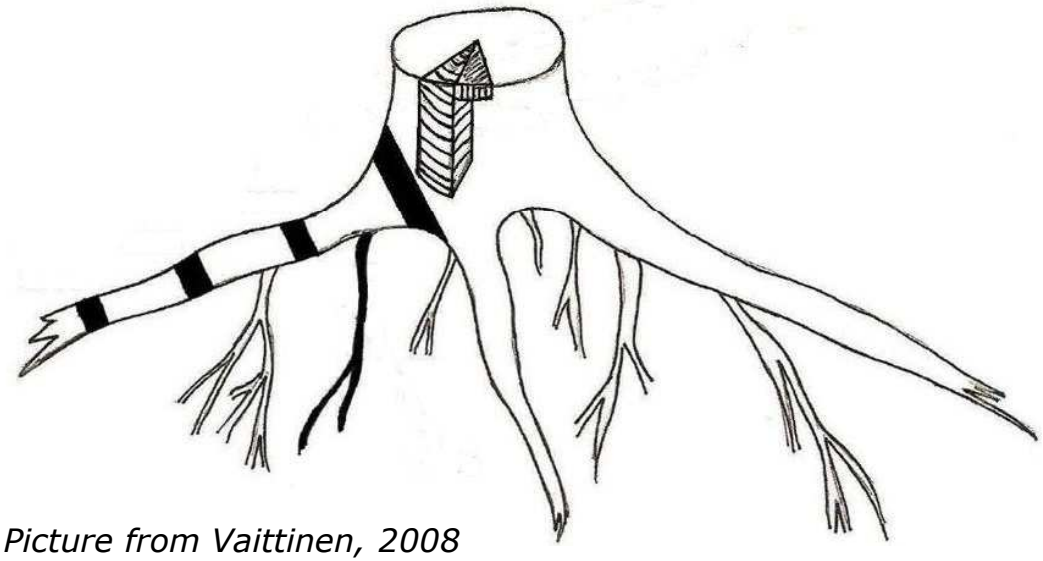
Nutrients in stumps were analysed from 8 sites in Scandianvia



Picture from Vaittinen, 2008

N	*nitrogen*
Ca	*kalcium*
K	*potassium*
Mg	*magnesium*
Na	*sodium*
P	*phosphorous*

Some conclusions from the study

- *Nutrient concentrations were generally higher in birch stumps compared with spruce and pine.*
- *A significant correlation between root fraction and nutrient concentration, with higher concentrations in smaller roots.*
- *Nutrient levels in stumps are greater compared with stems, and lower compared with foliage (however small roots are associated with high nutrient concentrations).*
- *The bark of the roots contained significantly higher nutrient levels than the wood.*
- *There is likely a geographical gradient, both in nutrient concentrations and nutrient status of the soil.*

The stump biomass constitutes about 38 % (spruce) and 33 % (other tree species) of the extracted stem volume.

→ potential to extract biomass as an additional source of renewable fuel.

Recommendations for stump removal (from a nutrient perspective)

- *From a nutrient perspective it is better to extract stumps than foliage.*
- *The extraction of small roots should be avoided.*
- *It may be unsuitable to remove stumps from certain tree species (birch).*
- *It may be unsuitable to remove small young tree stumps e.g. at thinning.*
- *The location may be important to consider, as nutrient levels in stumps, and also the nutrient status of the soil varies.*

-Extraction of biomass from forests results in:

Losses of nutrients (K, P...)

Reduced buffering capacity against acidification

Potentially a decreasing risk of nitrogen leaching causing eutrophication

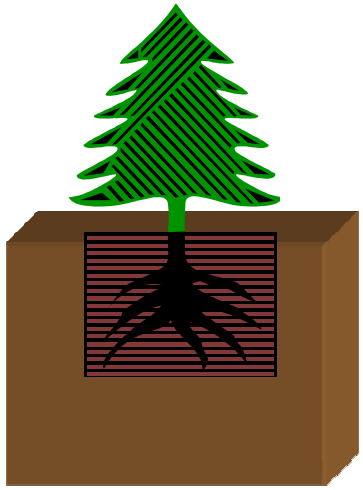
-How does biomass removal affect

1) the nutrient balance in forest soil?

2) the risk of nutrient depletion, acidification and eutrophication?

3) Is the effect different in different parts of the country?

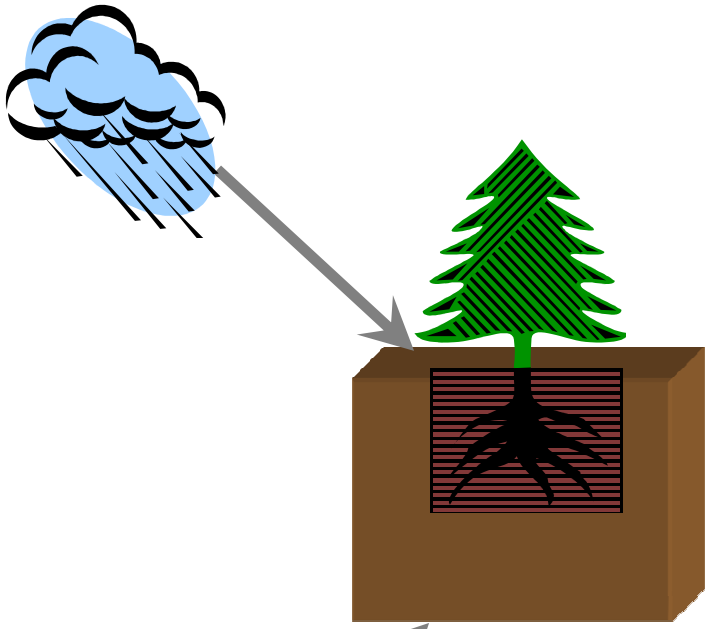
Mass balance calculation: Δ = Inflow - Outflow



Δ

Inflow

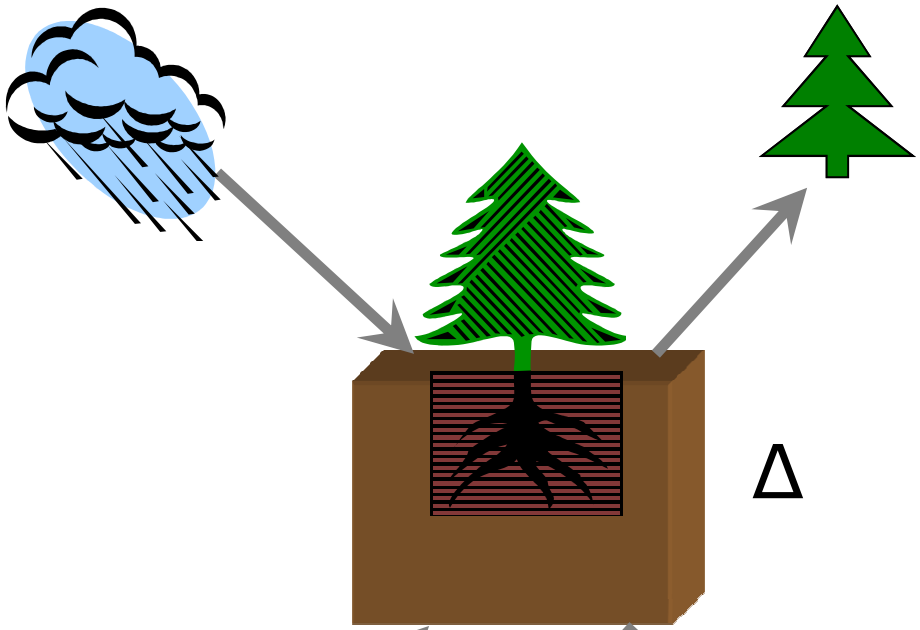
Deposition



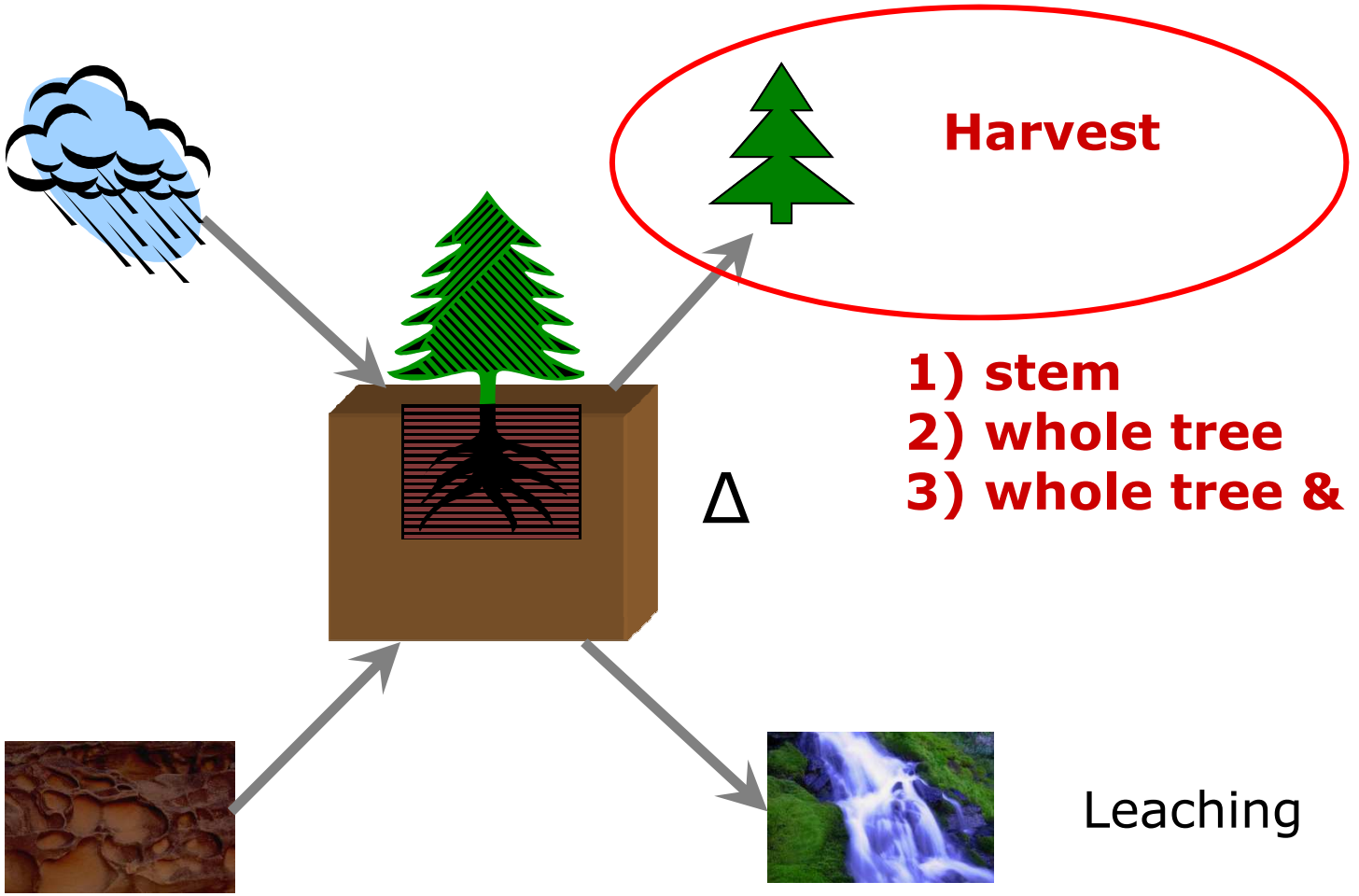
Δ

Weathering /
N-fixation

Massbalance calculation: Δ = Inflow - Outflow

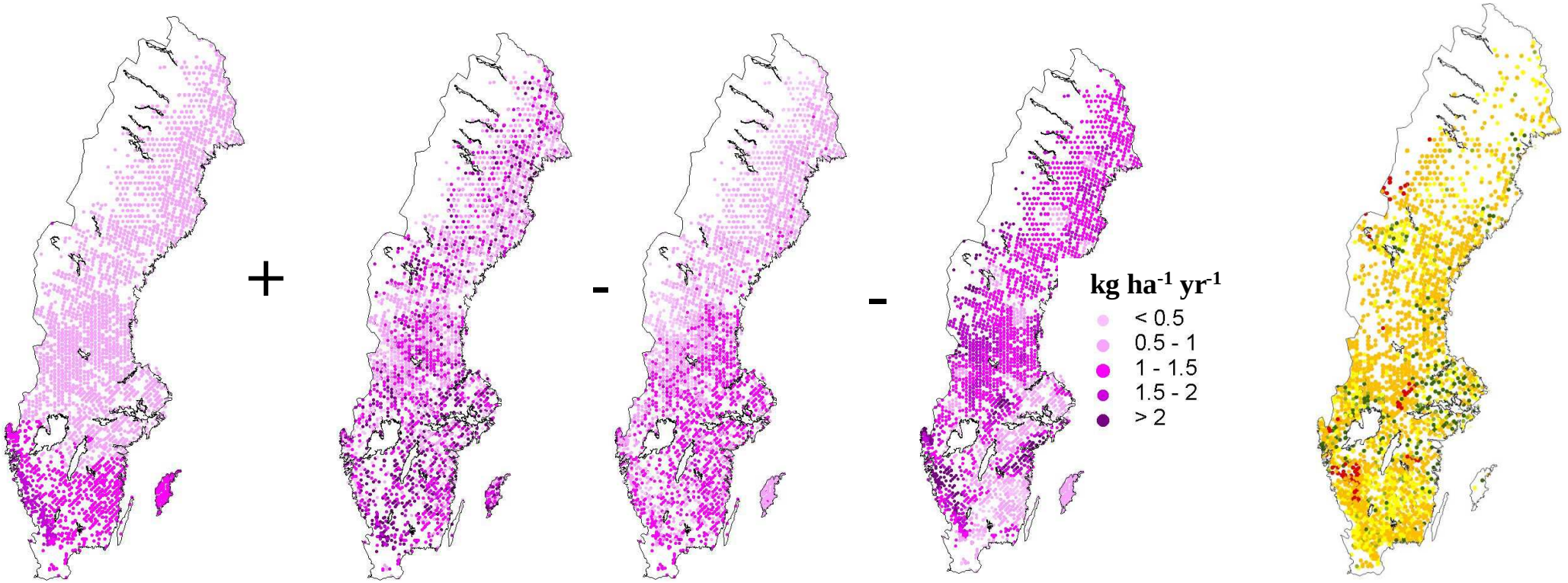


Massbalance calculation: Δ = Inflow - Outflow

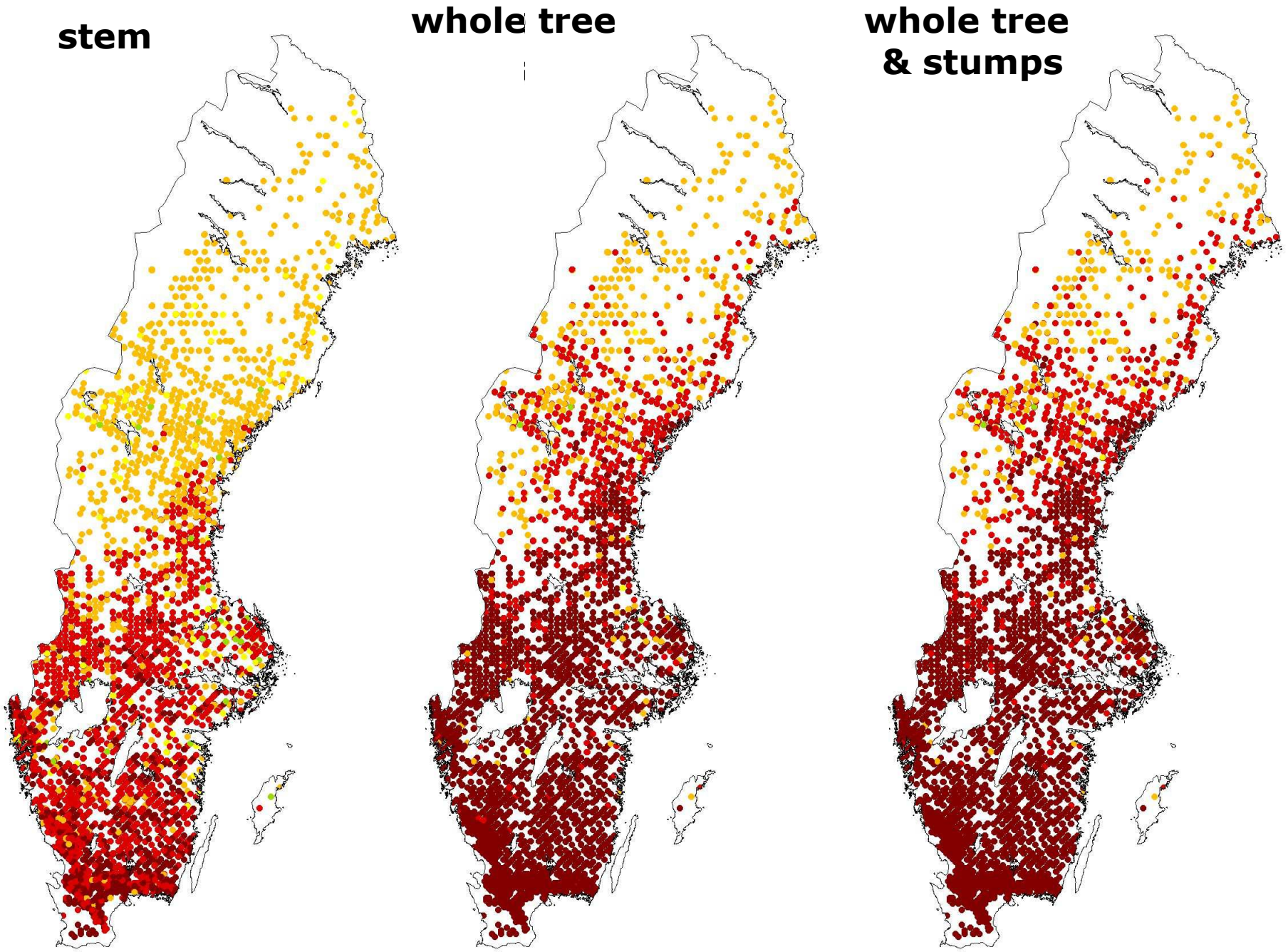


Mass balance calculation: Δ = Inflow - Outflow

\+ K Deposition + K-weathering - Harvest - Leaching = K budget



Spruce


stem
whole tree
whole tree & stumps
P budget
kg ha-1 yr-1
< -0.4
-0.4 - -0.2
-0.2 - 0
0 - 0.2
> 0.2

Nutrient budget (kg ha^{-1} yr^{-1})

(median values from all spruce sites)

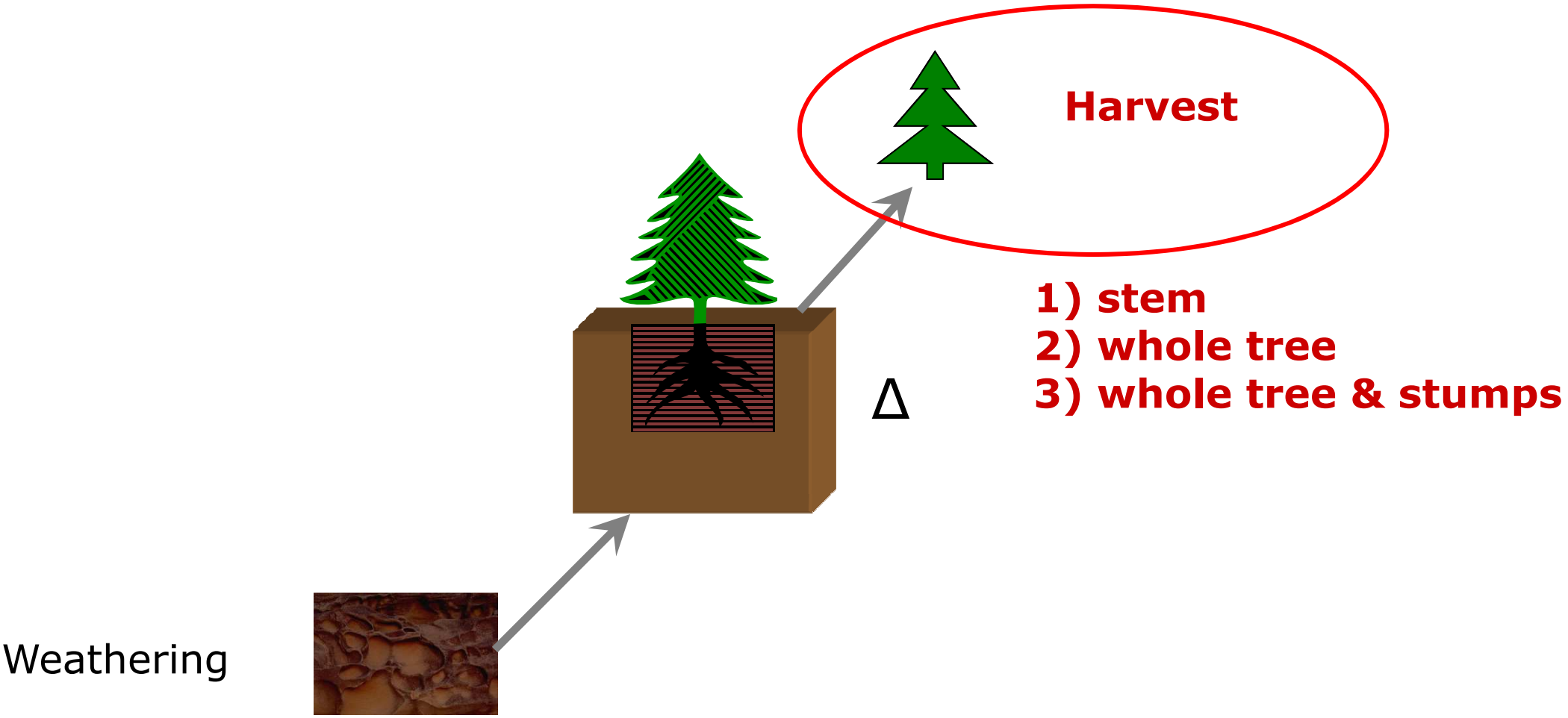
Spruce	stem	whole tree	whole tree & stumps
N	3.7	0.6	0.0
P	-0.3	-0.6	-0.7
K	-0.6	-1.5	-2.0
Ca	-4.3	-6.5	-7.4
Mg	-1.4	-1.6	-1.7

Acidification

- *European emissions of acidifying pollutants have decreased*
- *Forestry harvesting has an acidifying effect (removal of basecat ions)*
- *Hence forestry's contribution to acidification has increased*

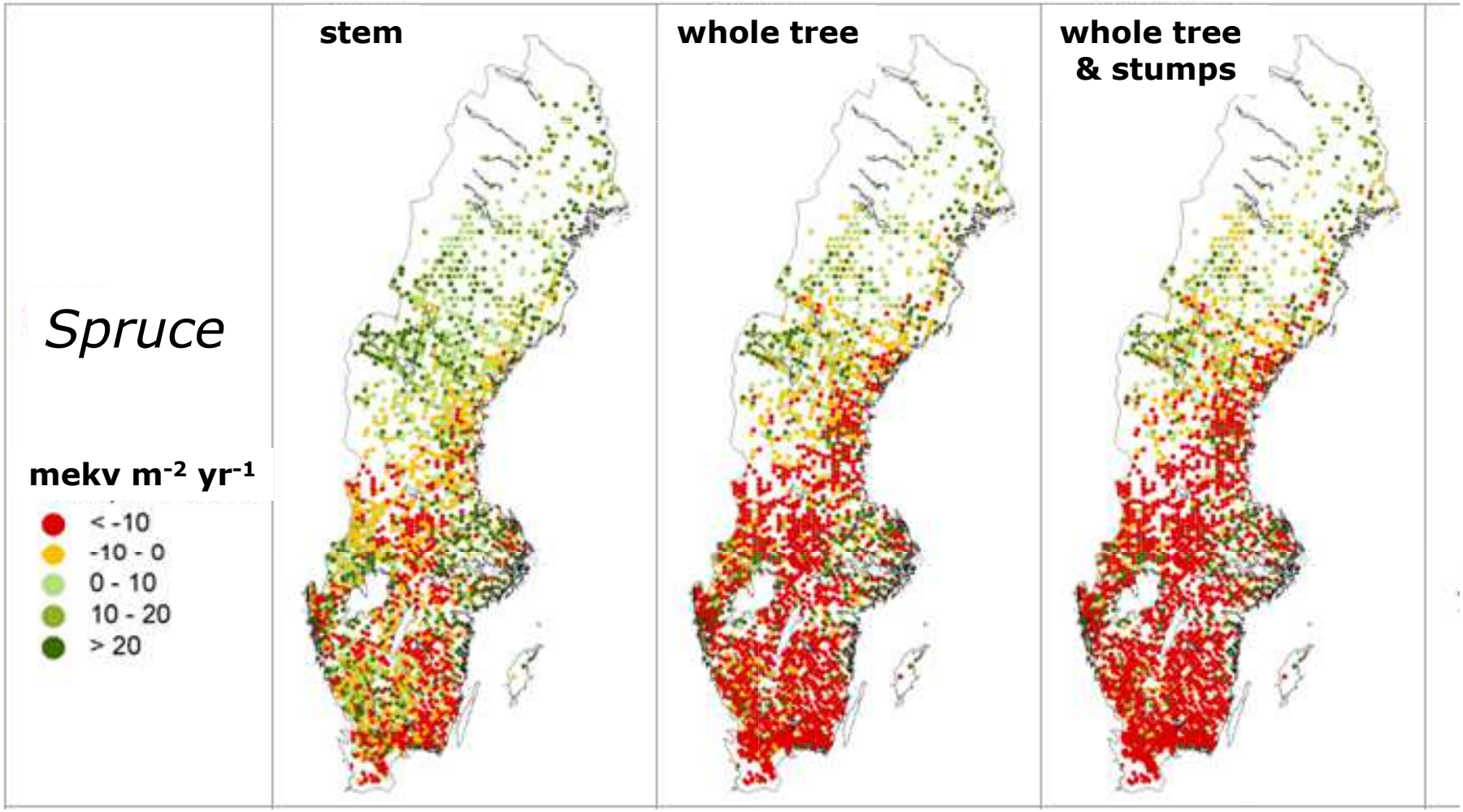
Weathering minus harvesting (base cations)

- to assess whether the removal of base cations at harvest exceeds the input from weathering.



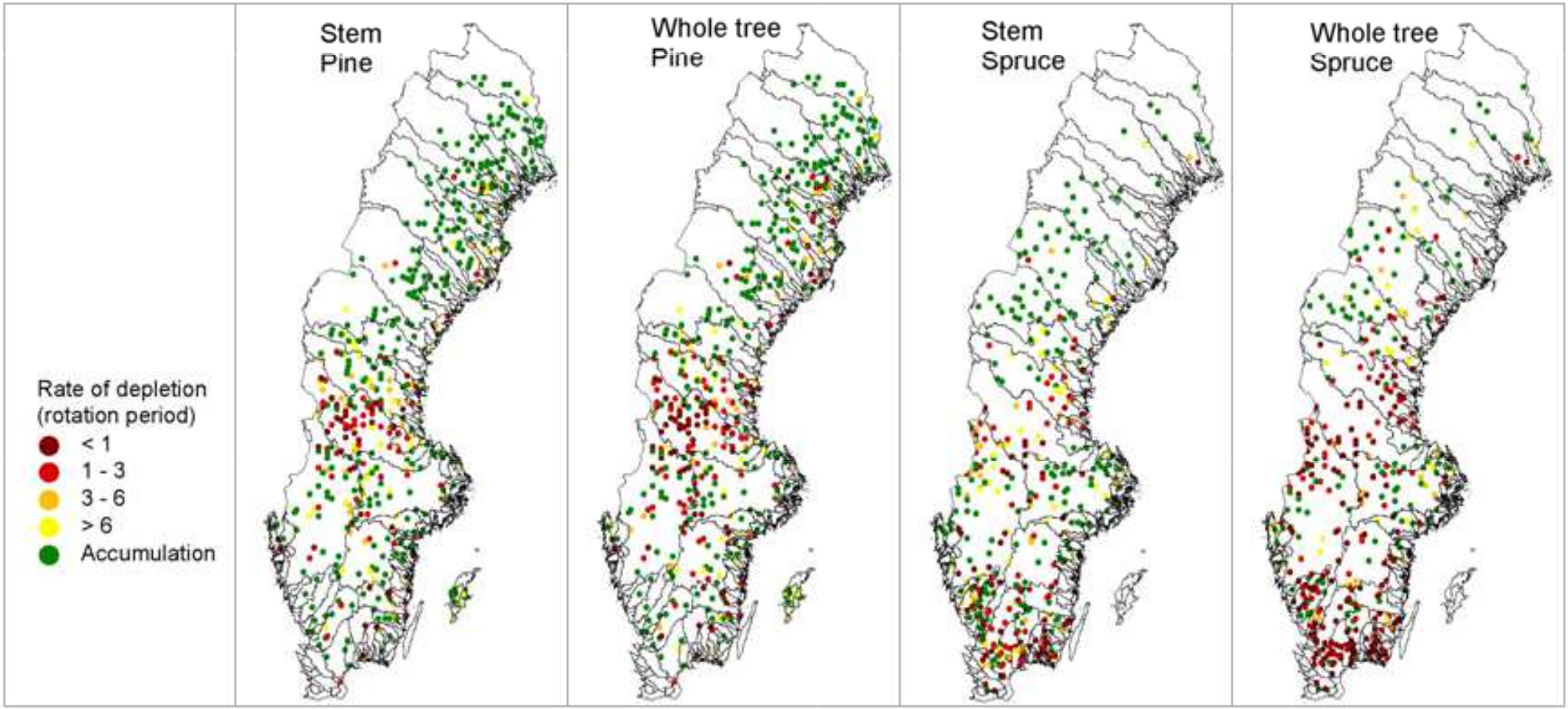
Weathering minus harvesting (base cations)

A negative value indicates that the removal at harvest exceeds the contribution from weathering.



Rate of depletion of the pool of base cations in the soil

- Comparing net losses of base cations with the soil pool of exchangable base cations – to get an indication of the rate of depletion (expressed as rotation period).



Conclusions

- Biomass removal (whole tree harvesting and extraction of stumps) affects losses of base cations, particularly for Ca and K → reduced buffering capacity against acidification.
- *Ash recycling may be necessary to compensate for losses to ensure a sustainable extraction of biomass from forestry. (Also recommended by the Swedish Forestry Agency.)*
- *There is a risk of phosphorous depletion, particularly in the south of Sweden.*
- *Increased biomass removal → smaller accumulation of N in south west Sweden (with a high N status) → may reduce the risk of N leaching (unless the extraction results in other nutrients being depleted hence reducing growth).*
- *Difference in nutrient losses between WTH and WTH+stumps is smaller compared with differences between stem & WTH, however losses at stump removal are still important (particularly in combination with WTH) as it increases a nutient loss that may already be of importance.*

Thank You

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