Brownification of surface waters

– causes, mechanisms and potential countermeasures.

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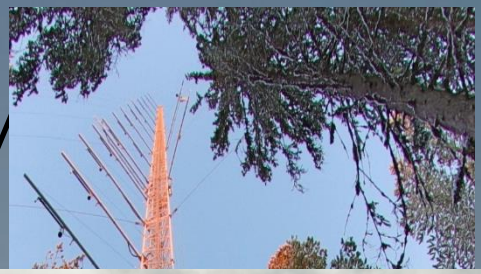
Swedish Univeristy of Agricultural Sciences

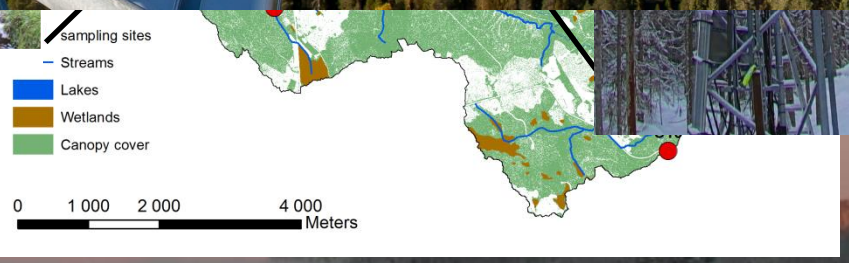

Krycklan
Area for research since 1923
Image © 2005 EarthSat
©2005 Google
Pointer 64°03'54.67" N 19°55'26.71" E
Streaming 100%
Eye alt 3428.19 mi

Krycklan

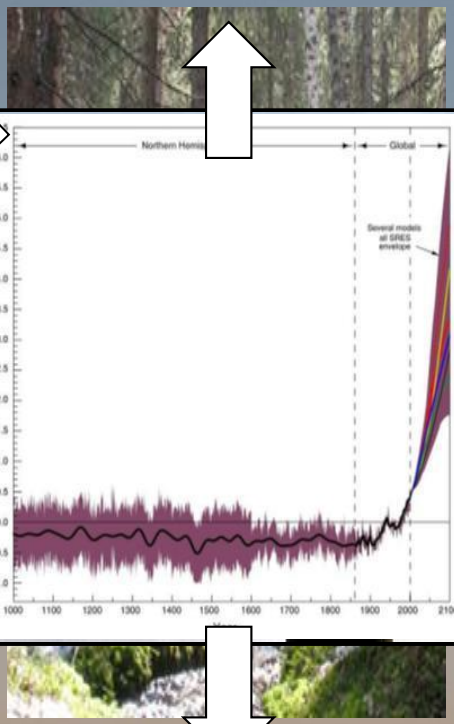


Forest stream

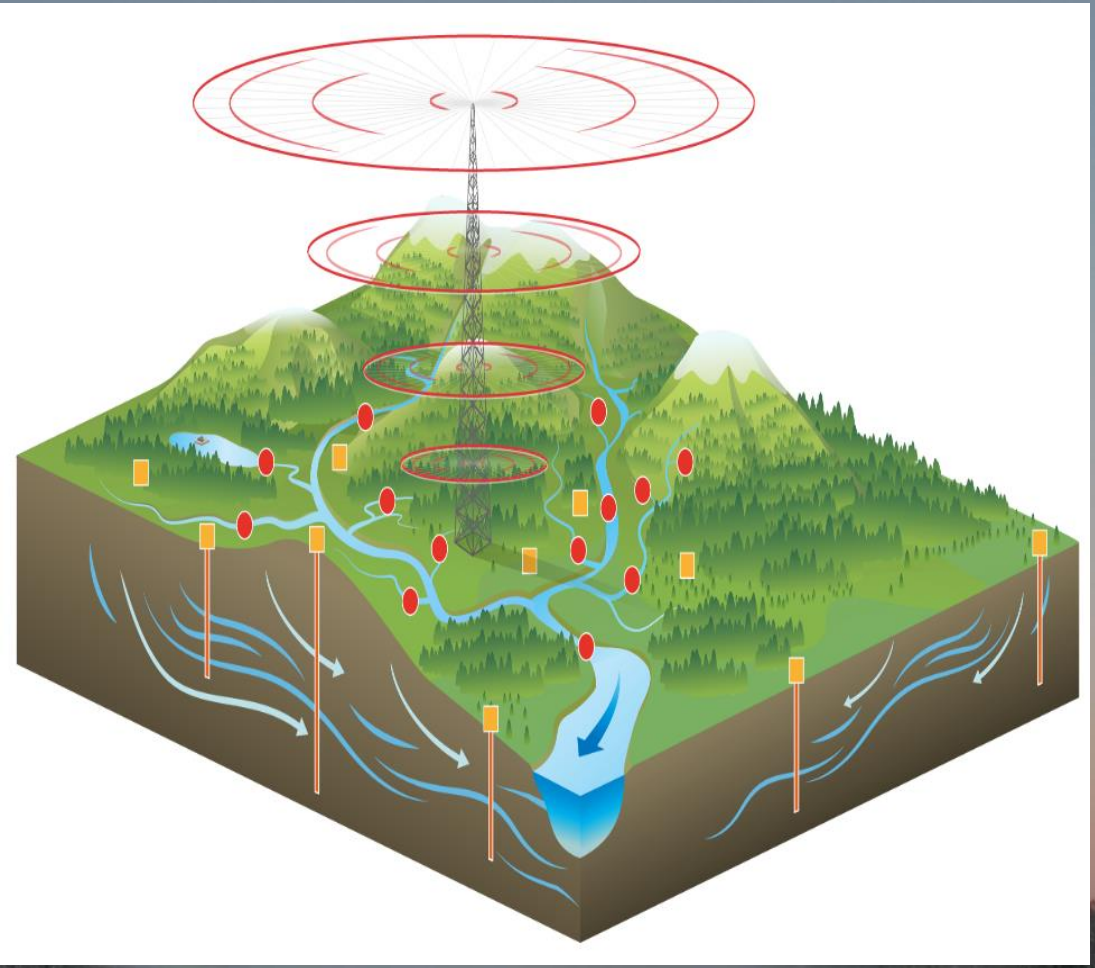
Outlet



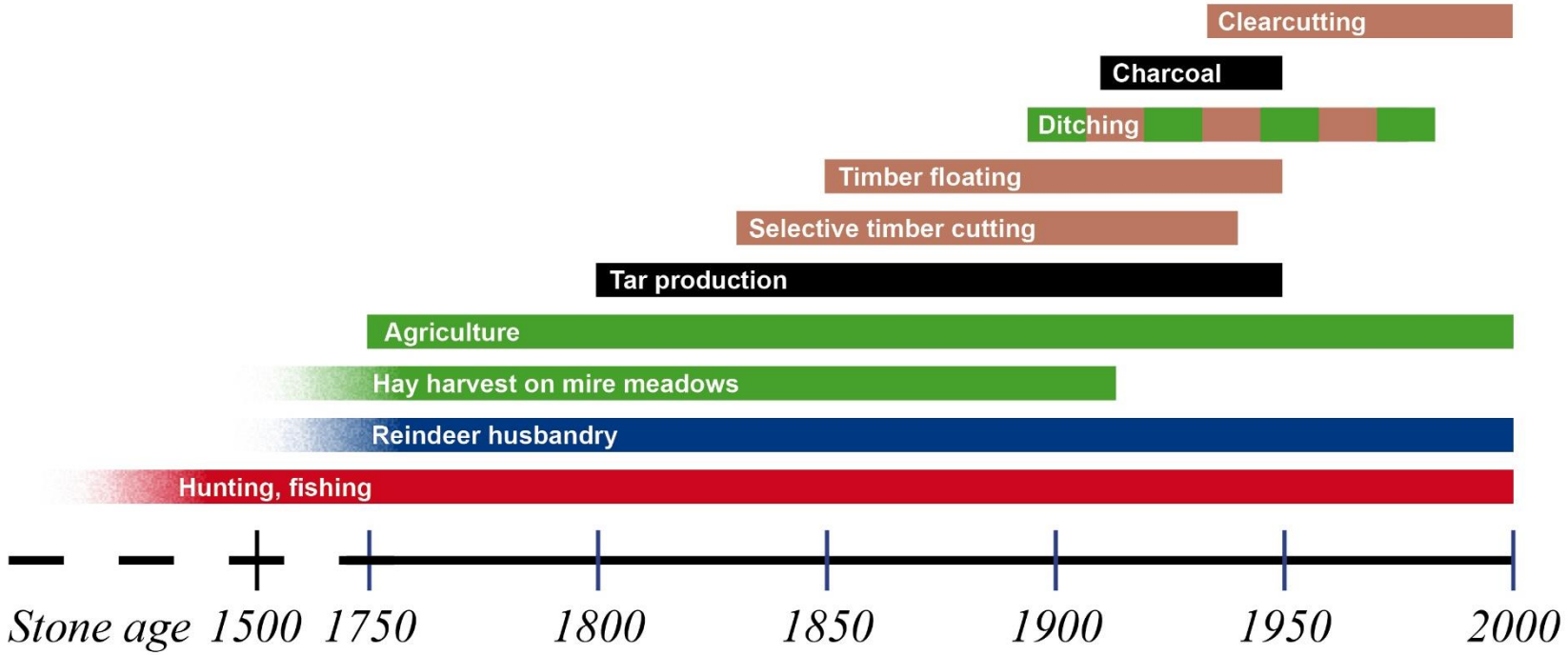
Krycklan water program



Krycklan – a 7000 ha research area for studies on atmosphere, forest, soils, water, ecology – and how they all connect

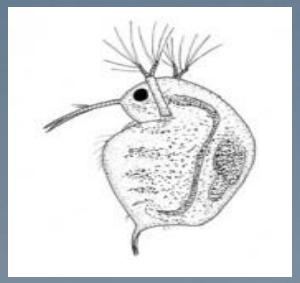


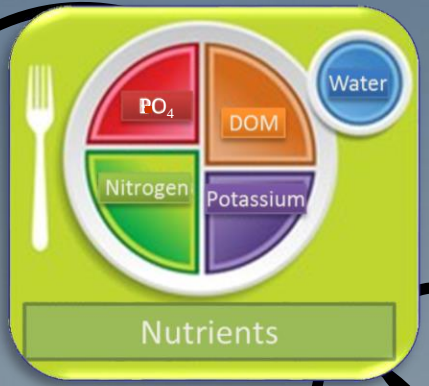
…but also human influence

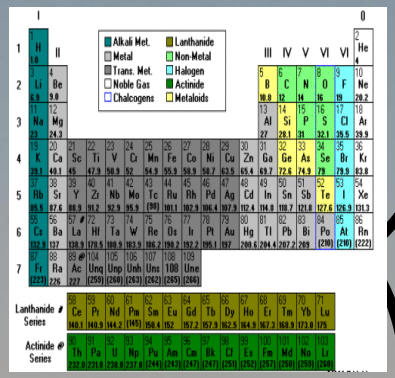


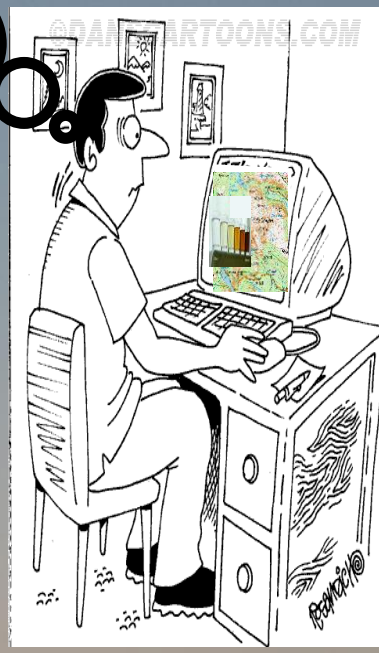
The human history of Krycklan, Nordstedt 2019

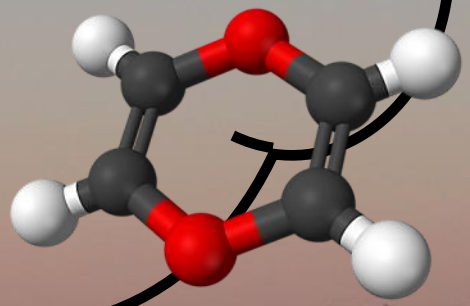

Dissolved organic carbon (DOC)



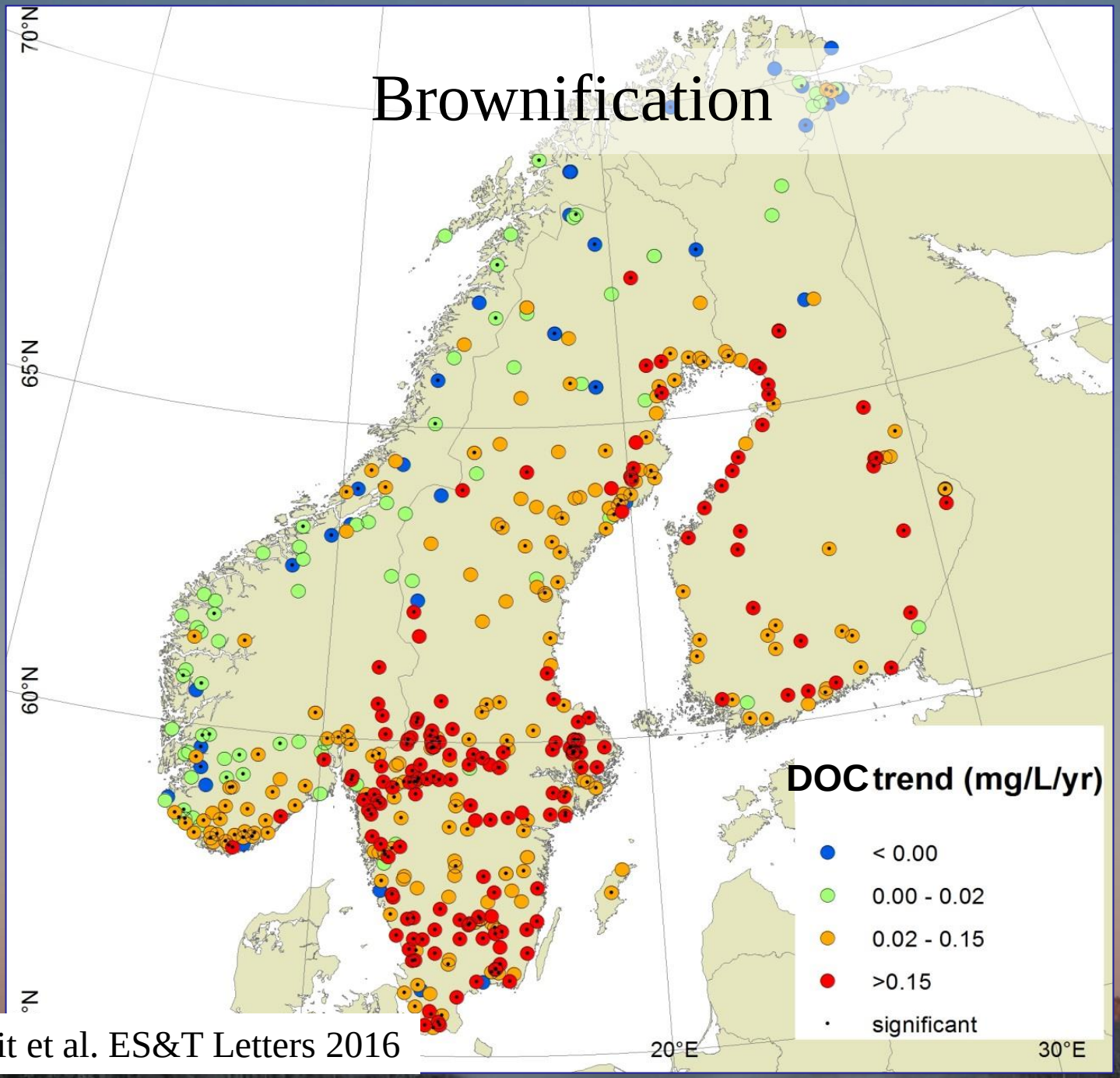

PO_4
DOM
Water
Nitrogen
Potassium
Nutrients


Alkali Met.
Metal
Trans. Met.
Noble Gas
Chalcogens
Lanthanide
Non-Metal
Halogen
Actinide
Metaloids
Lanthanide Series
Actinide Series



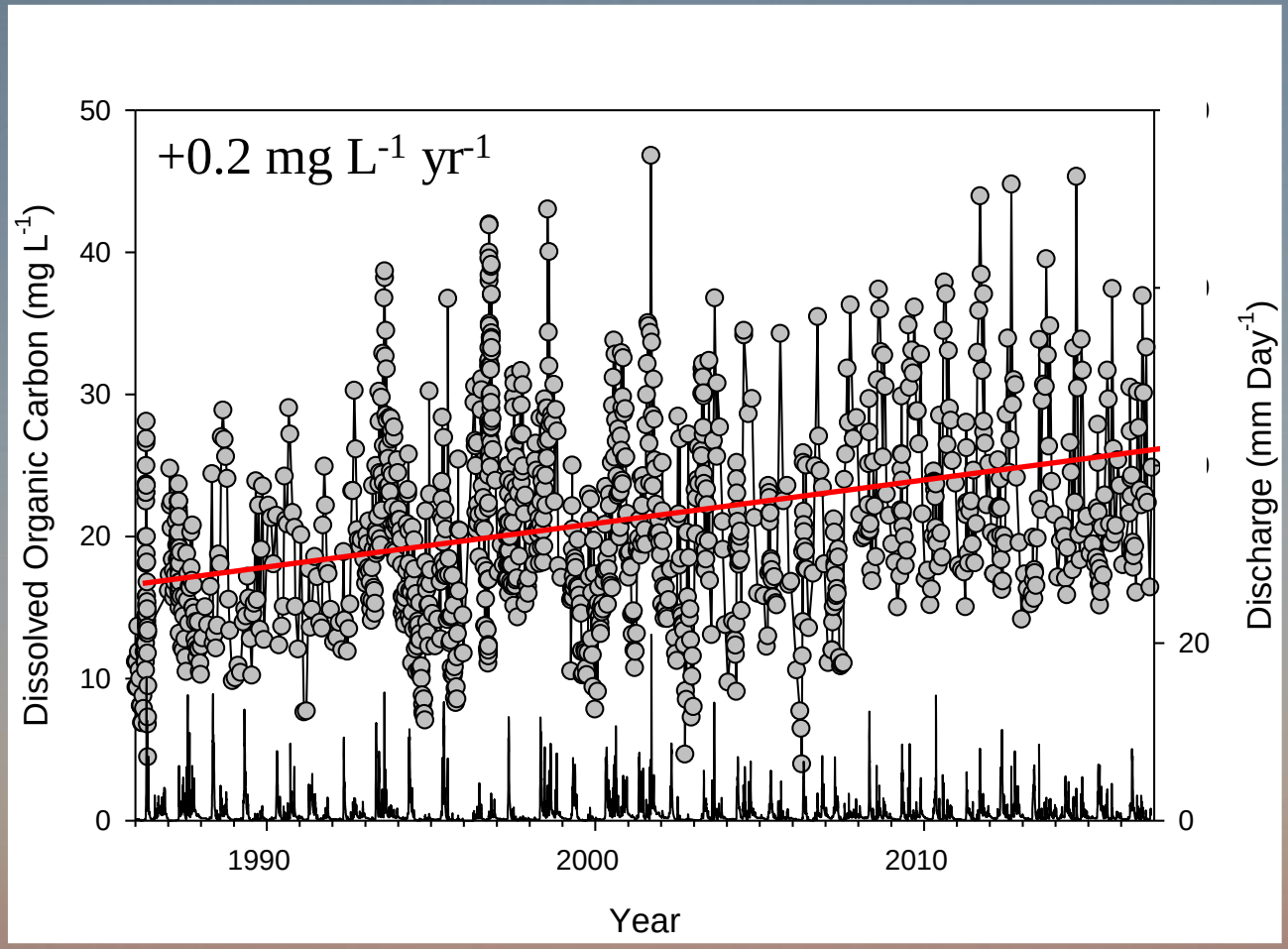


Brownification



deWit et al. ES&T Letters 2016

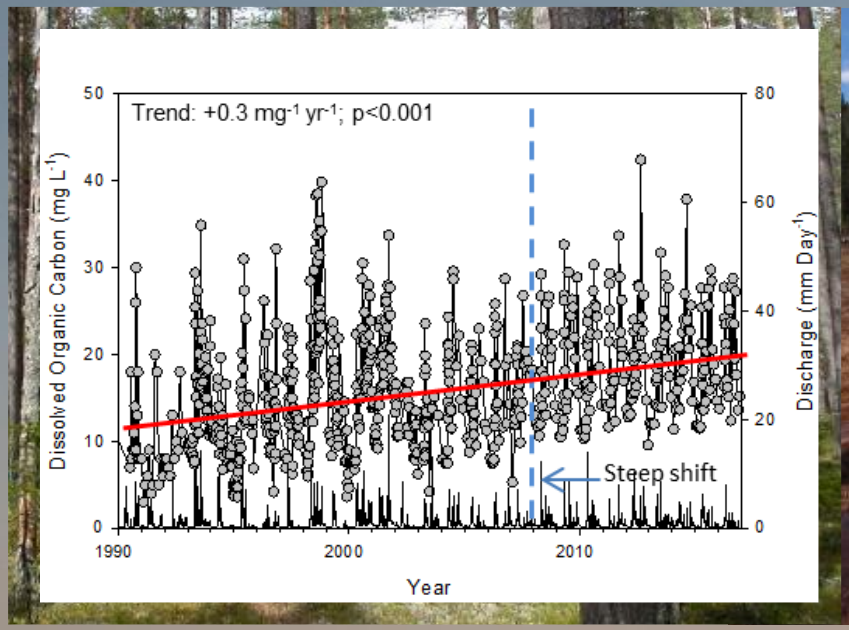
DOC in one of the Krycklan stream



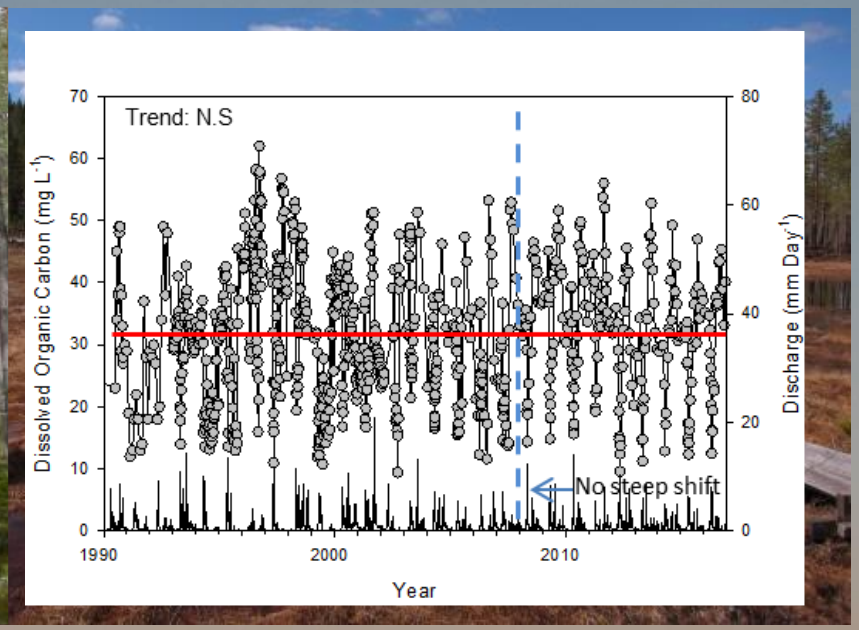
Fork et al. 2020 Water Resources Research

The boreal landscape mosaic

Forest ~75%



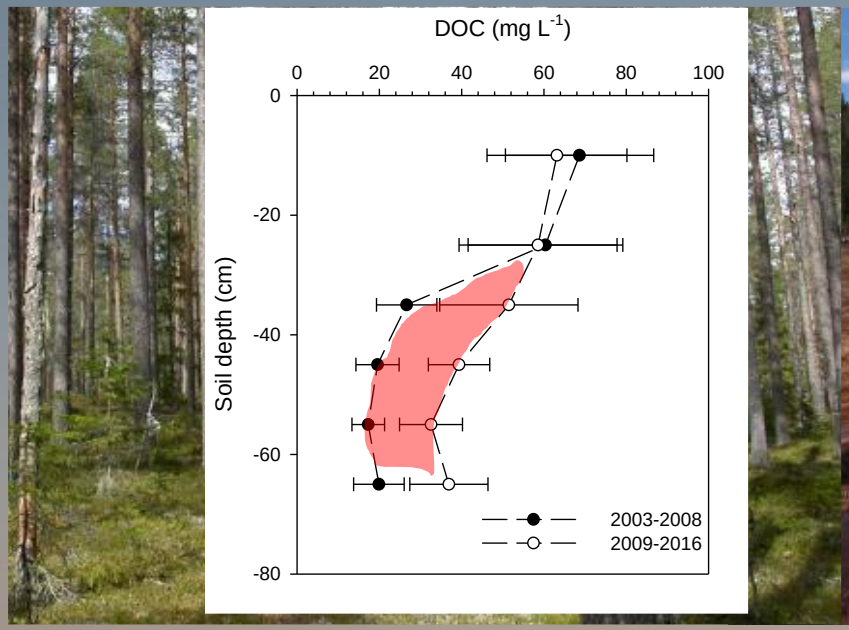
Wetlands ~25%

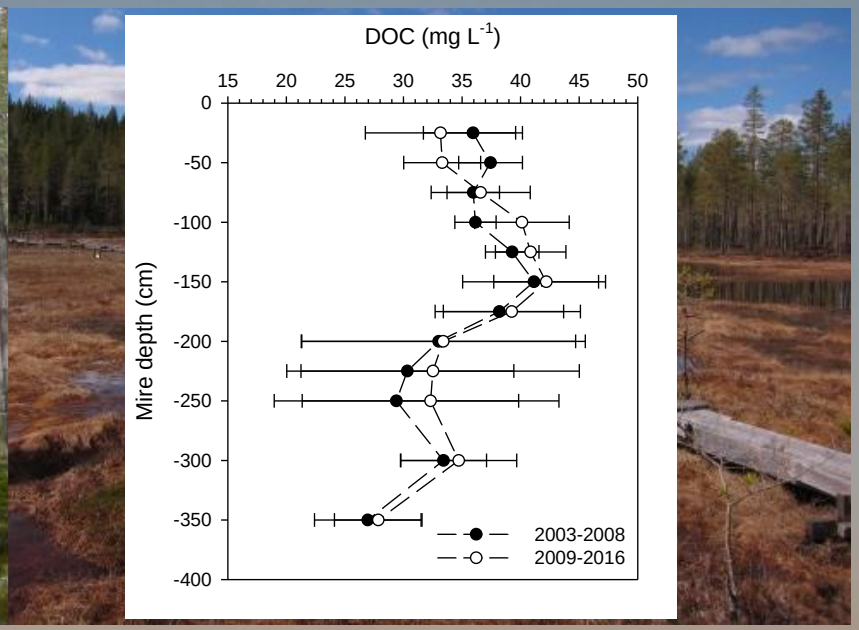


The boreal landscape mosaic

Forest ~75%

Wetlands ~25%





Scale

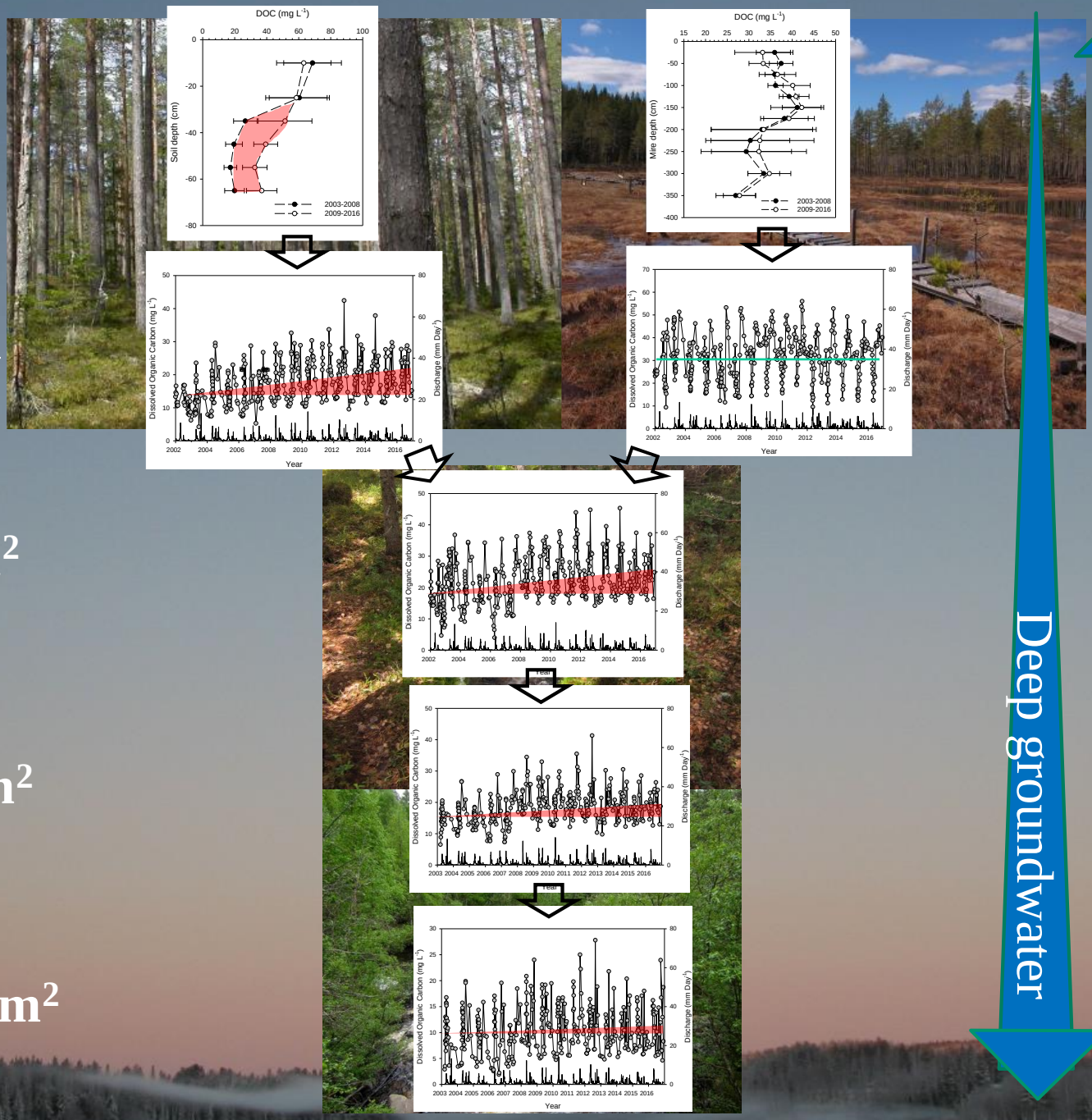
~1 m²

~10 ha

~1 km²

~10 km²

~100 km²



Deep groundwater

Local soil contribution

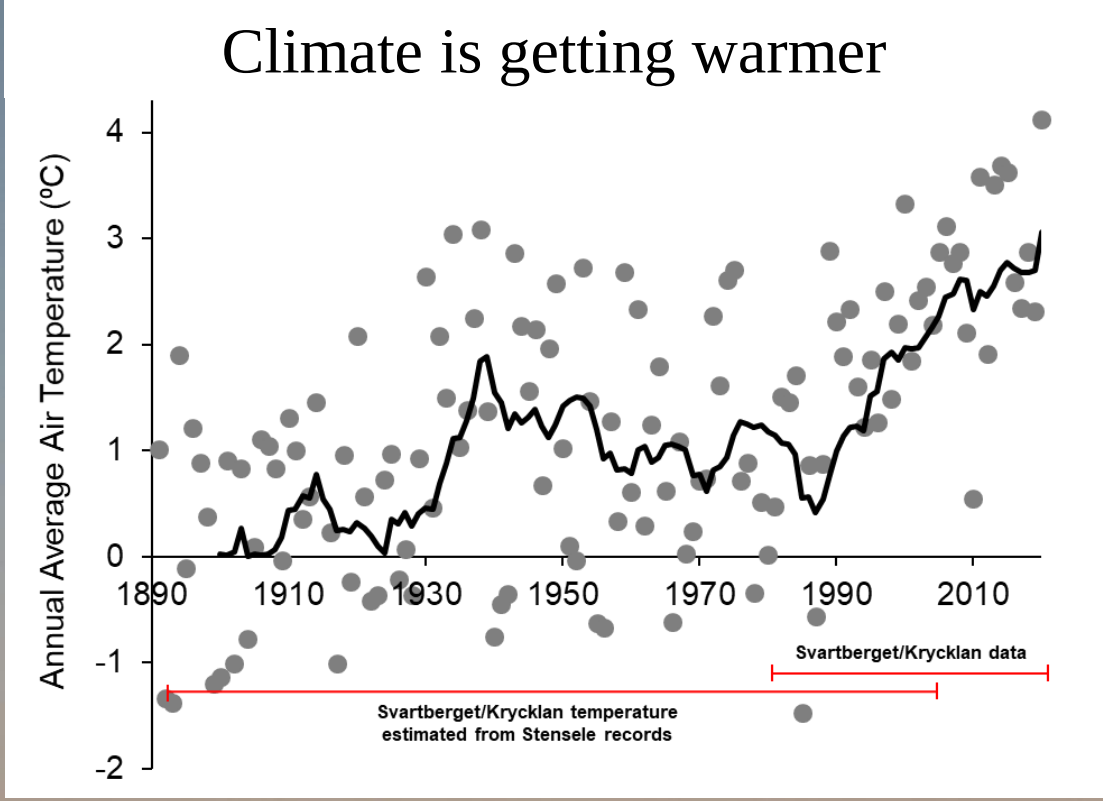
The soil carbon conundrum

Forest SOM 5-10 kg m^{-2}

Wetland SOM ~100 kg m^{-2}

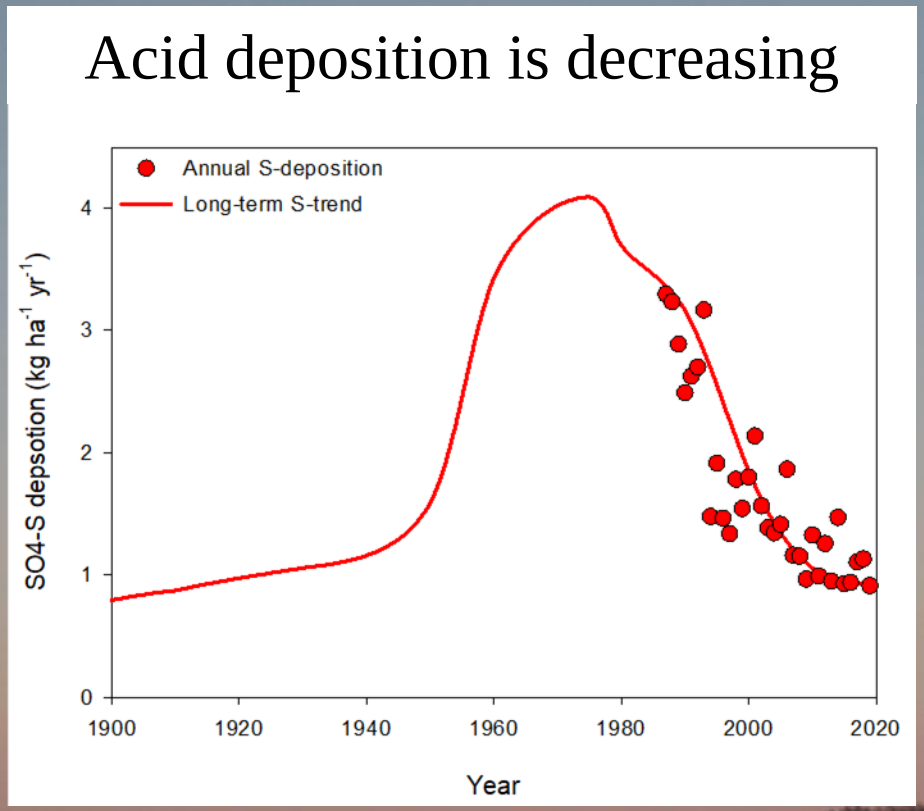
But why does it increase so rapid?

A landscape in transition



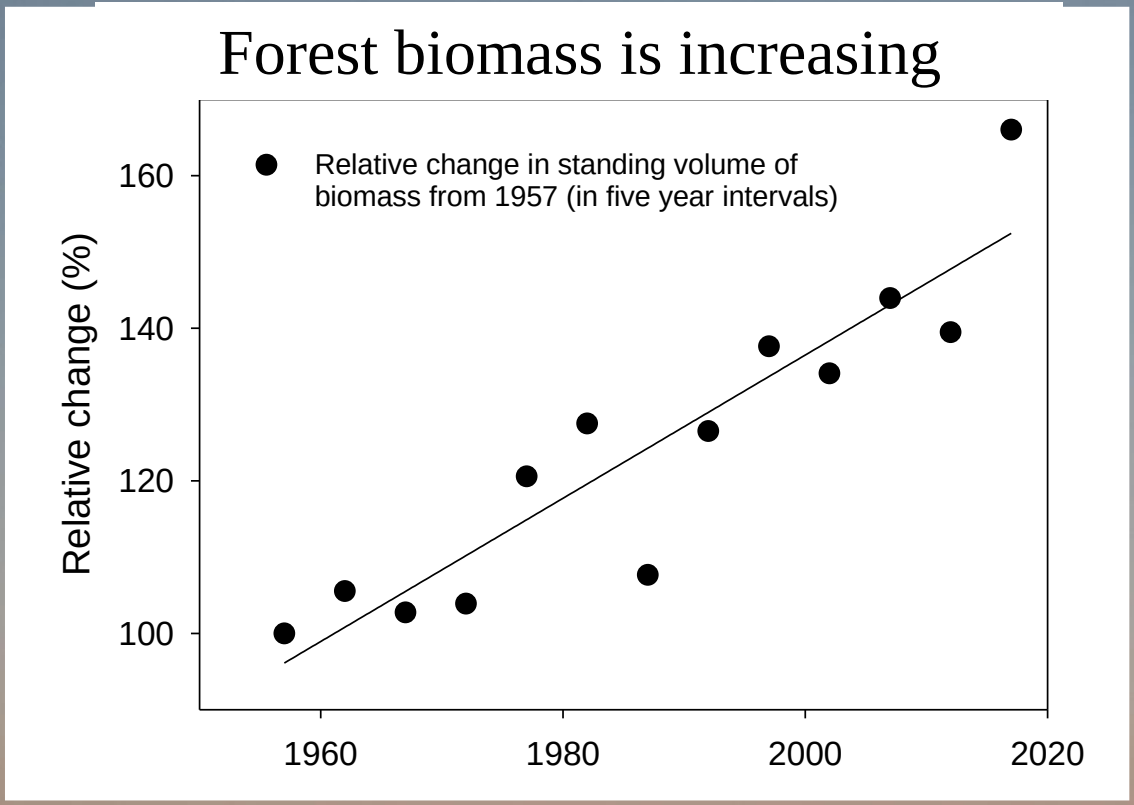
Laudon et al. 2021 Hydrological Processes

A landscape in transition



Laudon et al. 2021. Environmental Research Letters

A landscape in transition



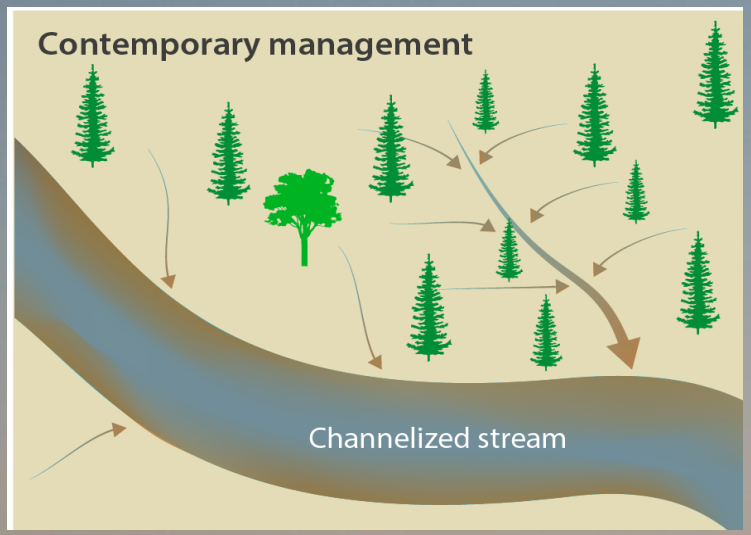
Riksskogstaxeringens data, 2020

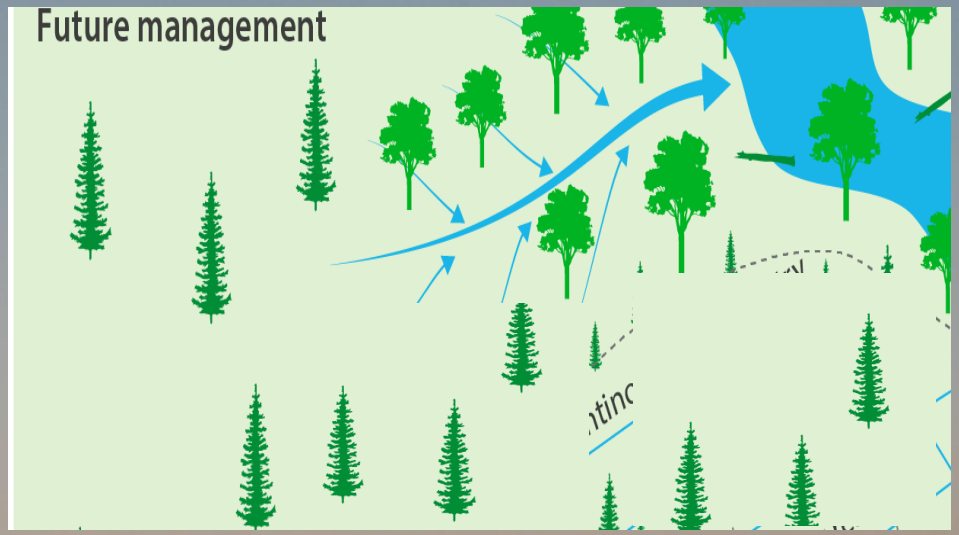
Actually we dont know what the main cause is

.. But there aresome potenttial countermeasures!

Potential countermeasures #1

Change from conifers to decidious species in riparian buffer zones and in groundwater discharge areas

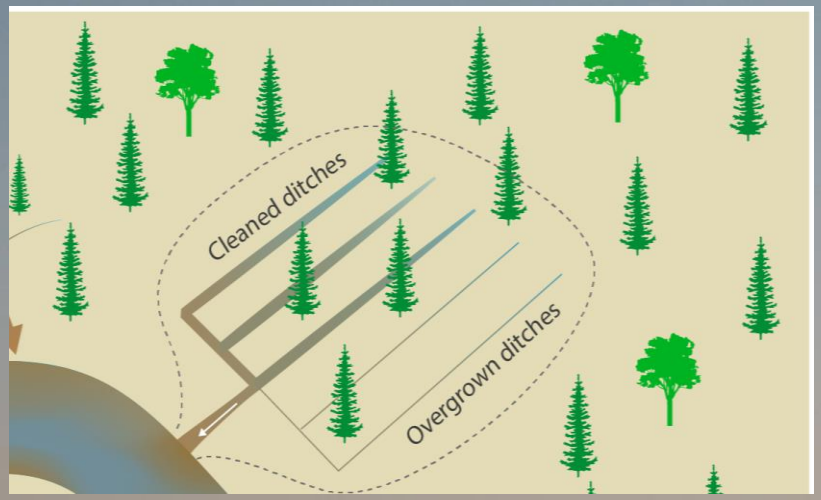


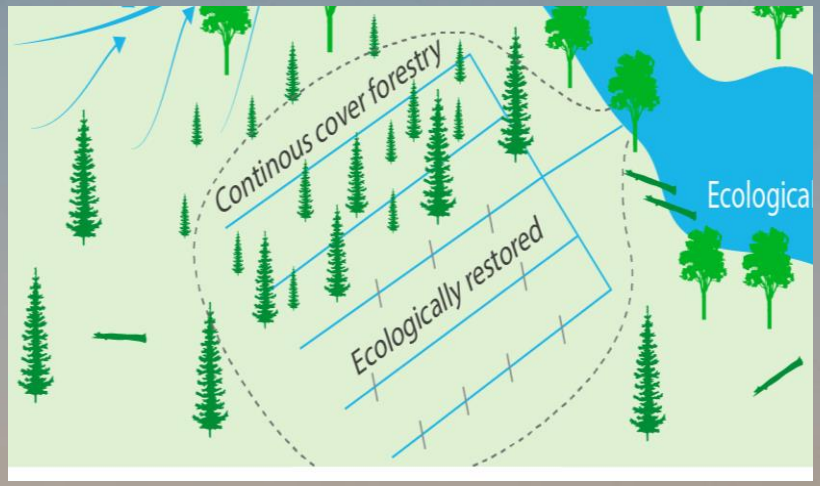


Kritzberg et al (2020) AMBIO

Potential countermeasures #2

Restore peatlands

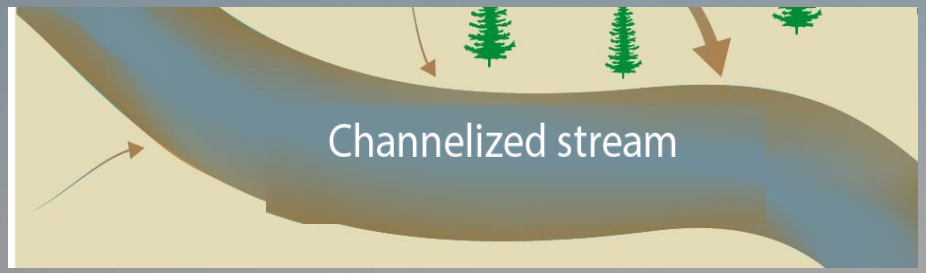




Kritzberg et al (2020) AMBIO

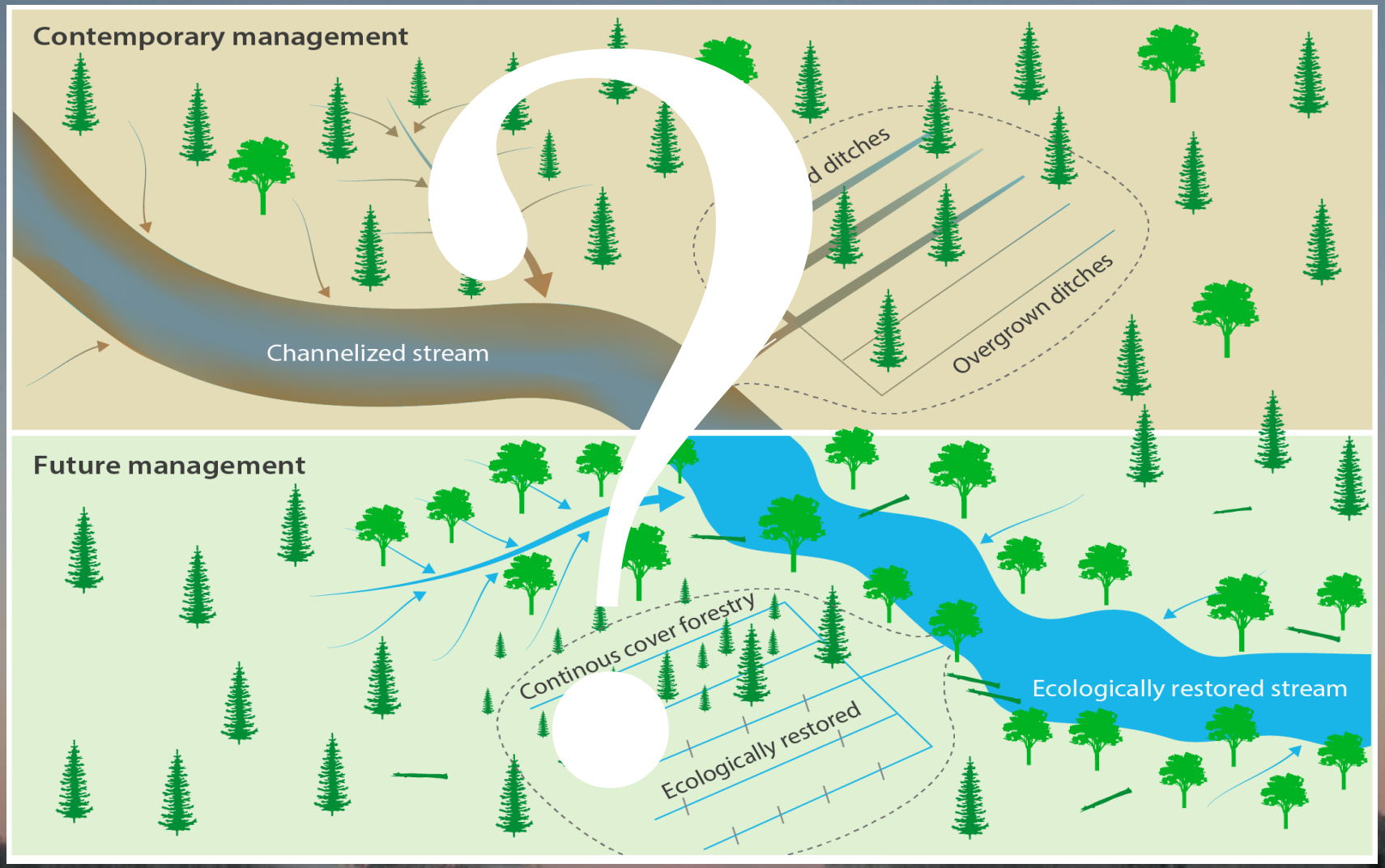
Potential countermeasures #3

Restore streams and rivers to increase water residence time



Kritzberg et al (2020) AMBIO

Potential countermeasures



Take home

- The increase in DOC can depend on several mechanims , but we can only affect a few of these.
- In conifer dominated forests, focus should be placed on areas with high hydrological connectivity.

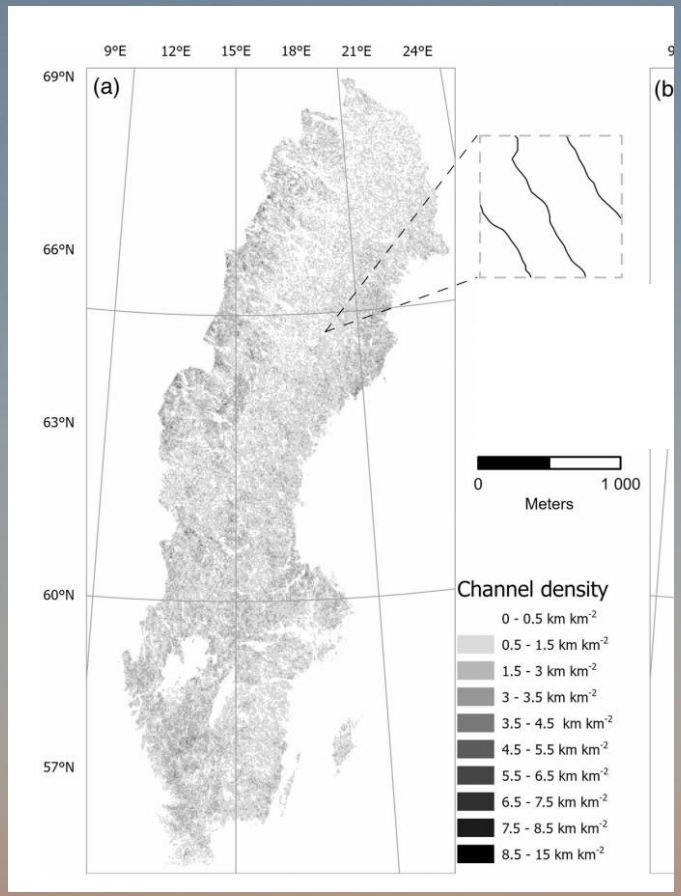
Diching – and forgotten era





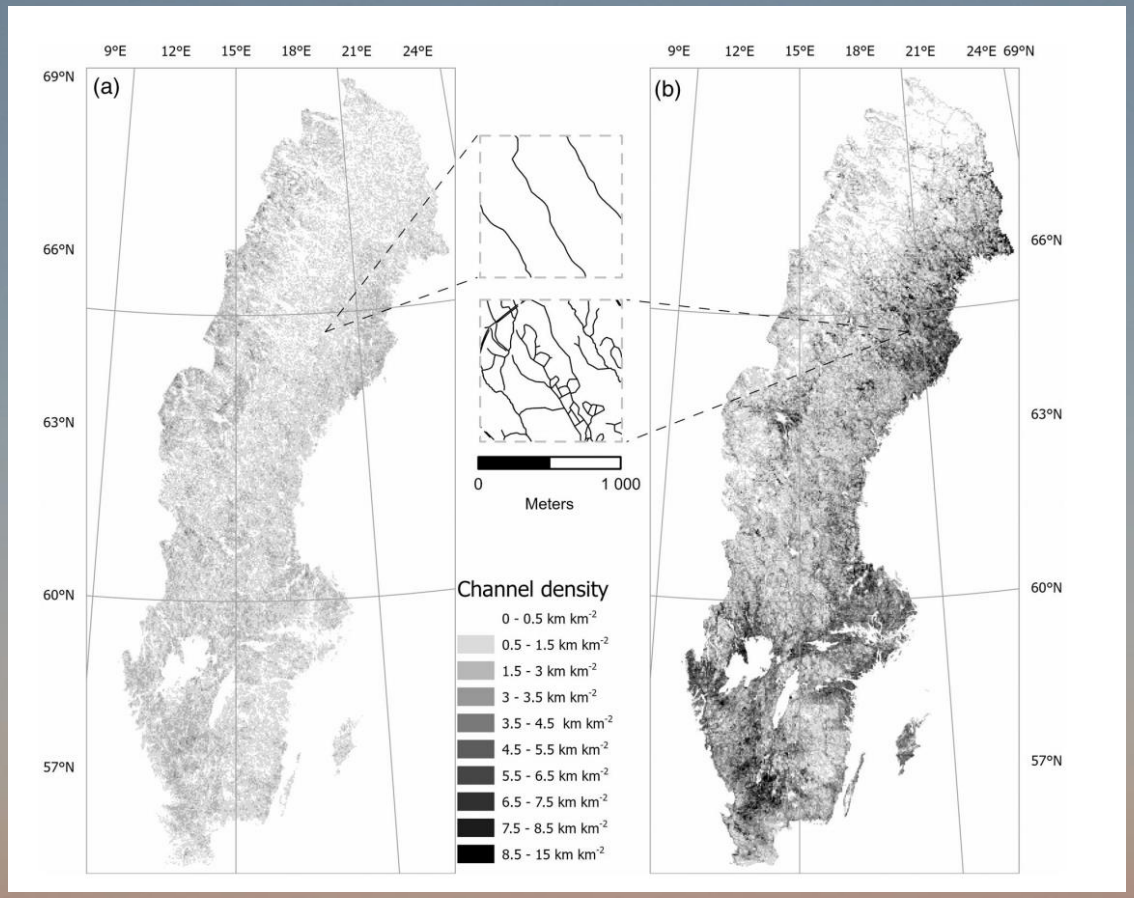

Our best maps build on 1930-technology

Drained peatlands at a cross-road



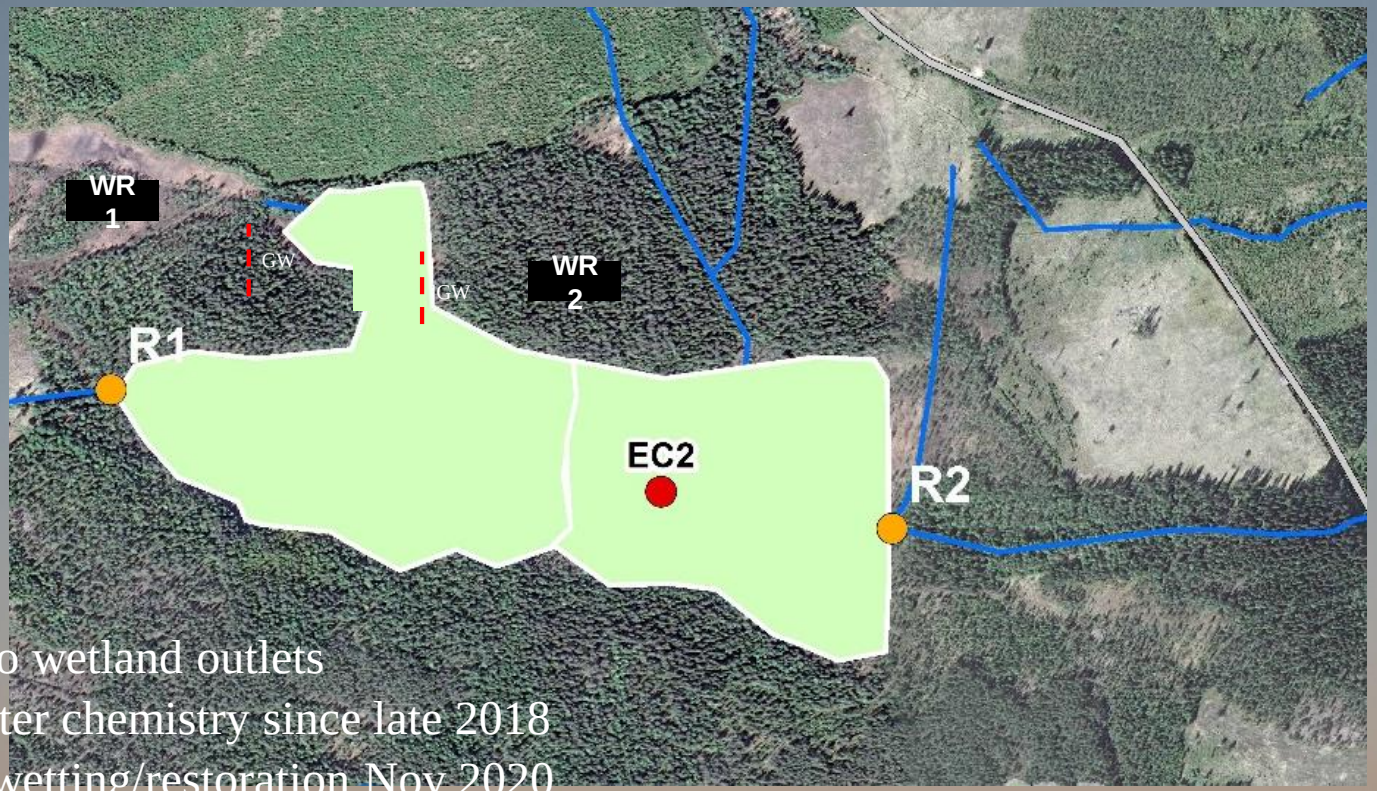
Laudon et al. 2022

Drained peatlands at a cross-road

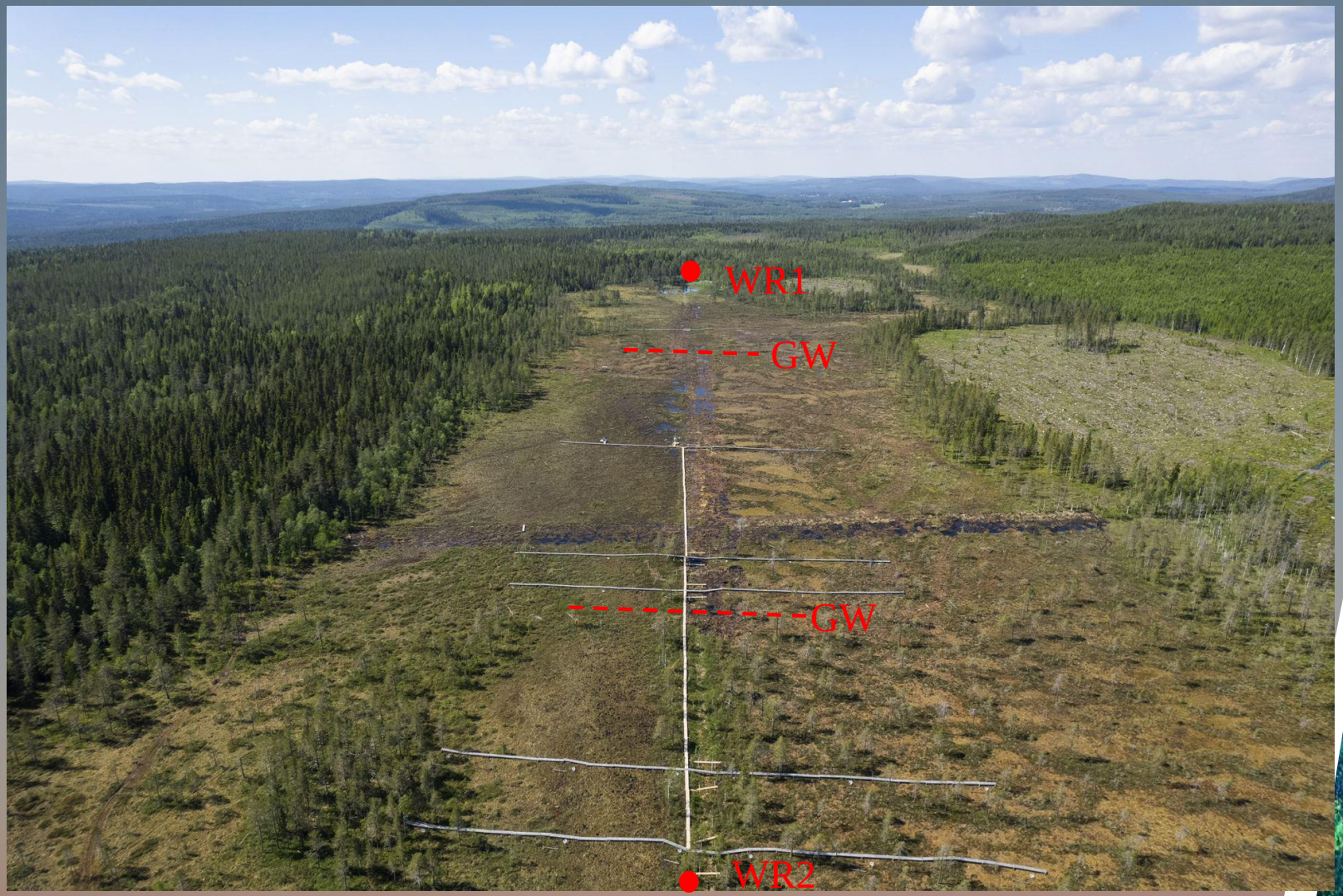


Laudon et al. 2022

A new infrastructure to test the effect of wetland restoration (and ditch-cleaning)



- Two wetland outlets
- Water chemistry since late 2018
- Rewetting/restoration Nov 2020
- 2+2 years of data pre/post rewetting
- Groundwater sampling campaigns


WR1
GW
GW
WR2

Wetland restoration

November 2020

Before restoration

After restoration

KRYCKLAN NEEDS YOU!

Data freely available at www.slu.se/Krycklan

VINNOVA

Skogssällskapet
VI GÖR ALLT FÖR DIN SKOG

formas

Stiftelsen Oscar och Lili Lamms Minne

Future Forests

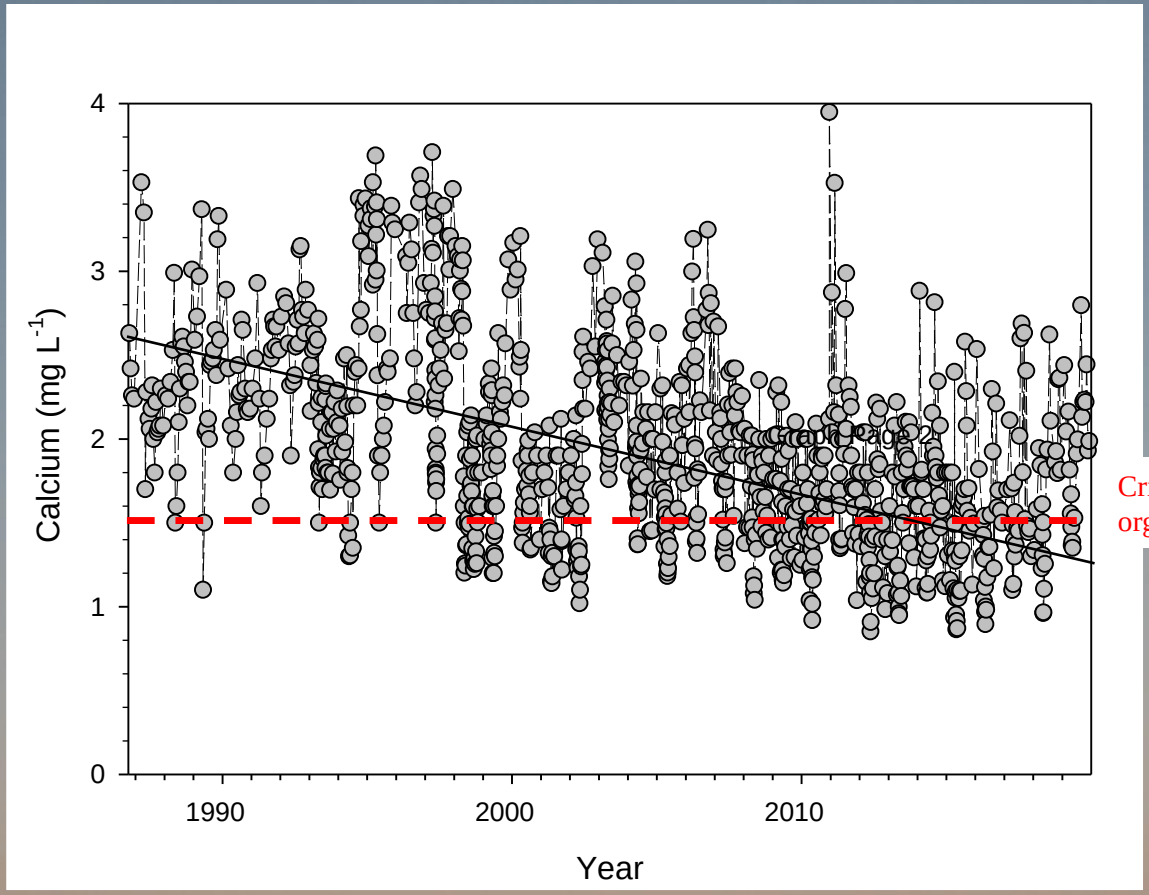
SKB

Kempestiftelserna

Vetenskapsrådet

Knut och Alice Wallenbergs Stiftelse

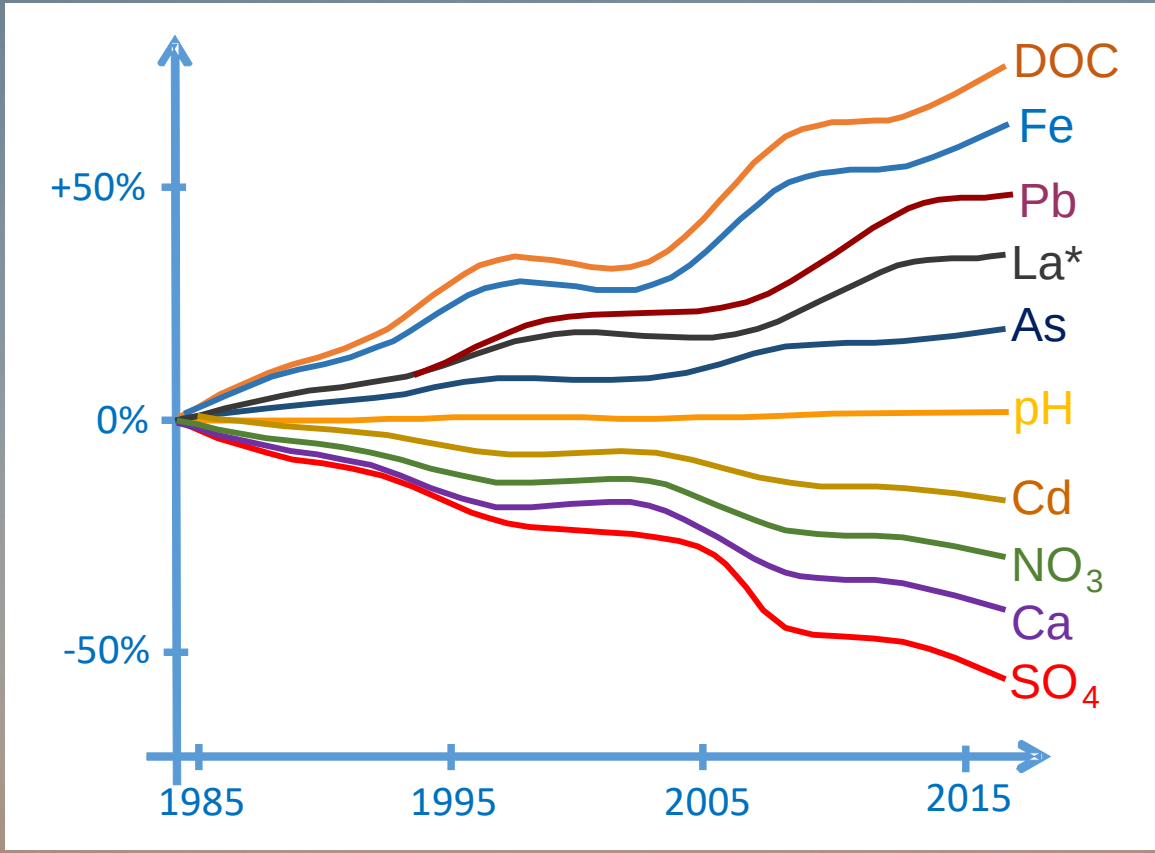
Calcium – a downward trend

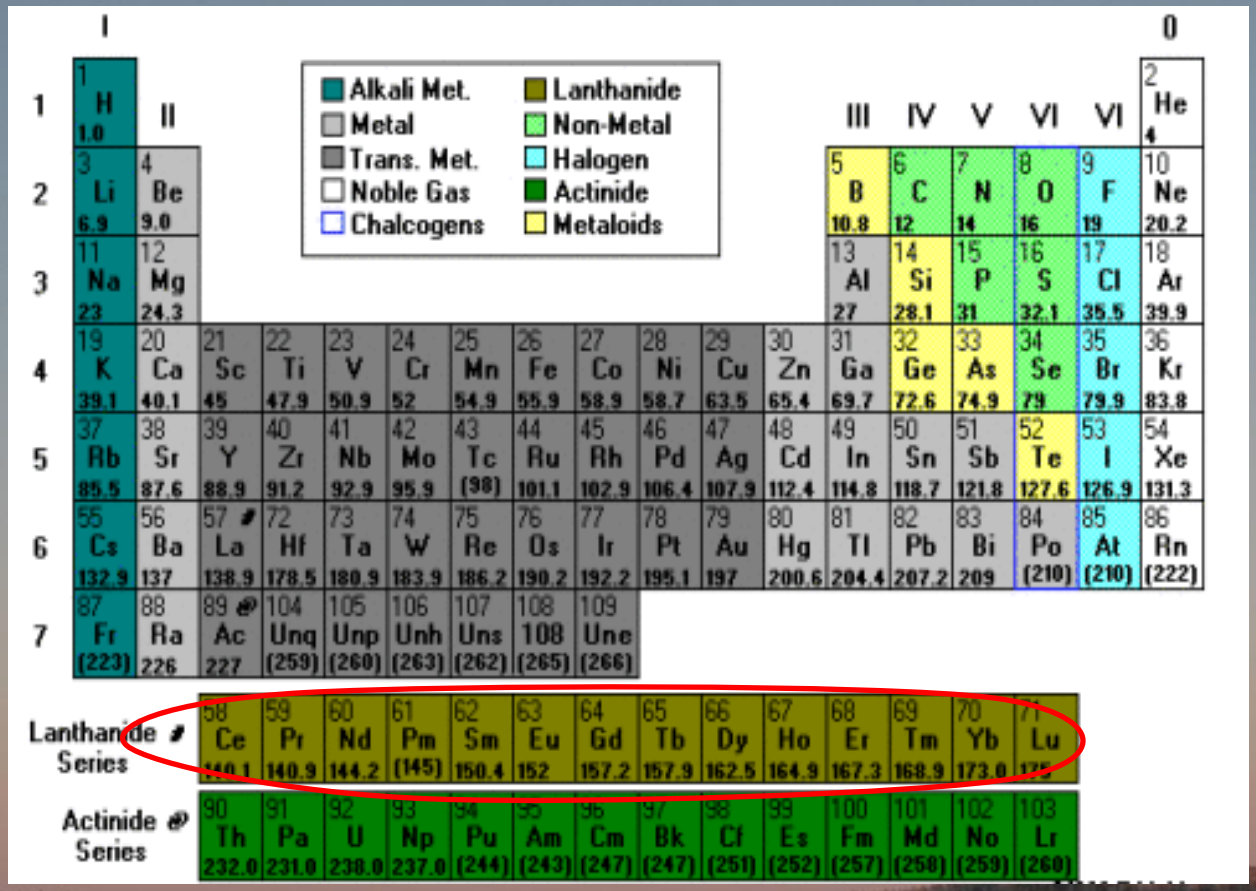


Critical level for many aquatic organisms

Laudon et al. 2021 Environmental Research Letters

Some other chemical trends




Alkali Met.
Metal
Trans. Met.
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Chalcogens
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Actinide Series