Baltic Sea Catchment Modelling

1) General overview on CSIM

2) Modelling the input of A_T, C_T, Ca, and Corg from all rivers entering the Baltic Sea

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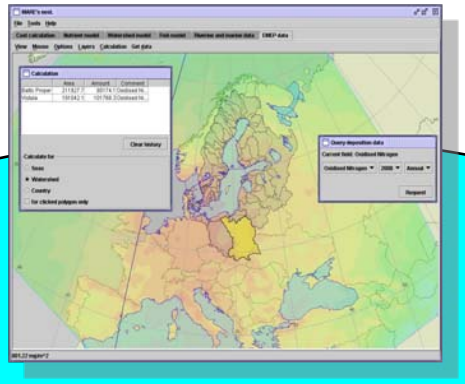
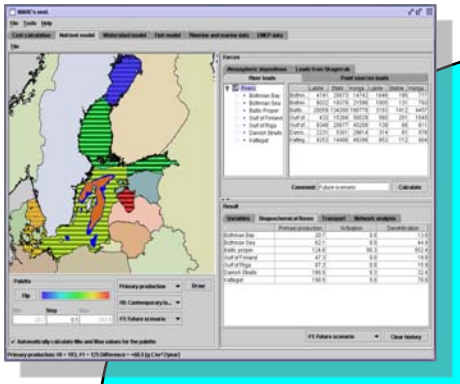
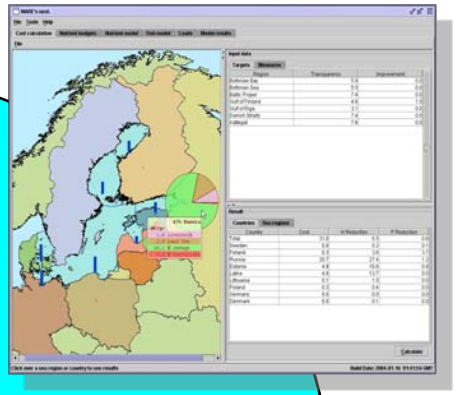
Atmospheric emissions and load



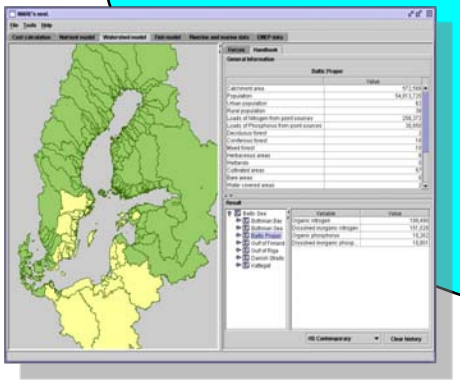
Marine modeling



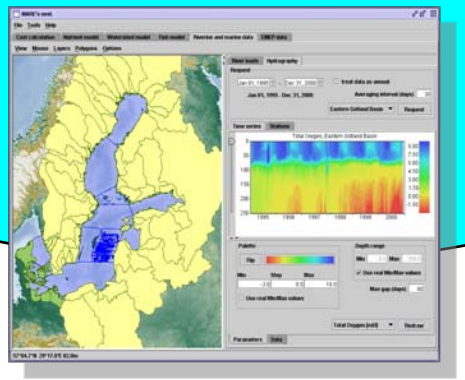
Cost minimization model



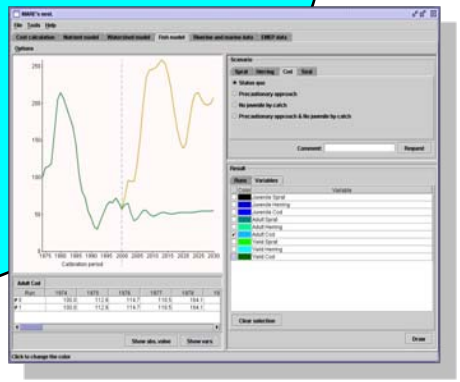
NEST can be used freely
with any computer with Internet
access from
http://www.Balticnest.org



Drainage basin modeling



Marine and runoff data



Food web model

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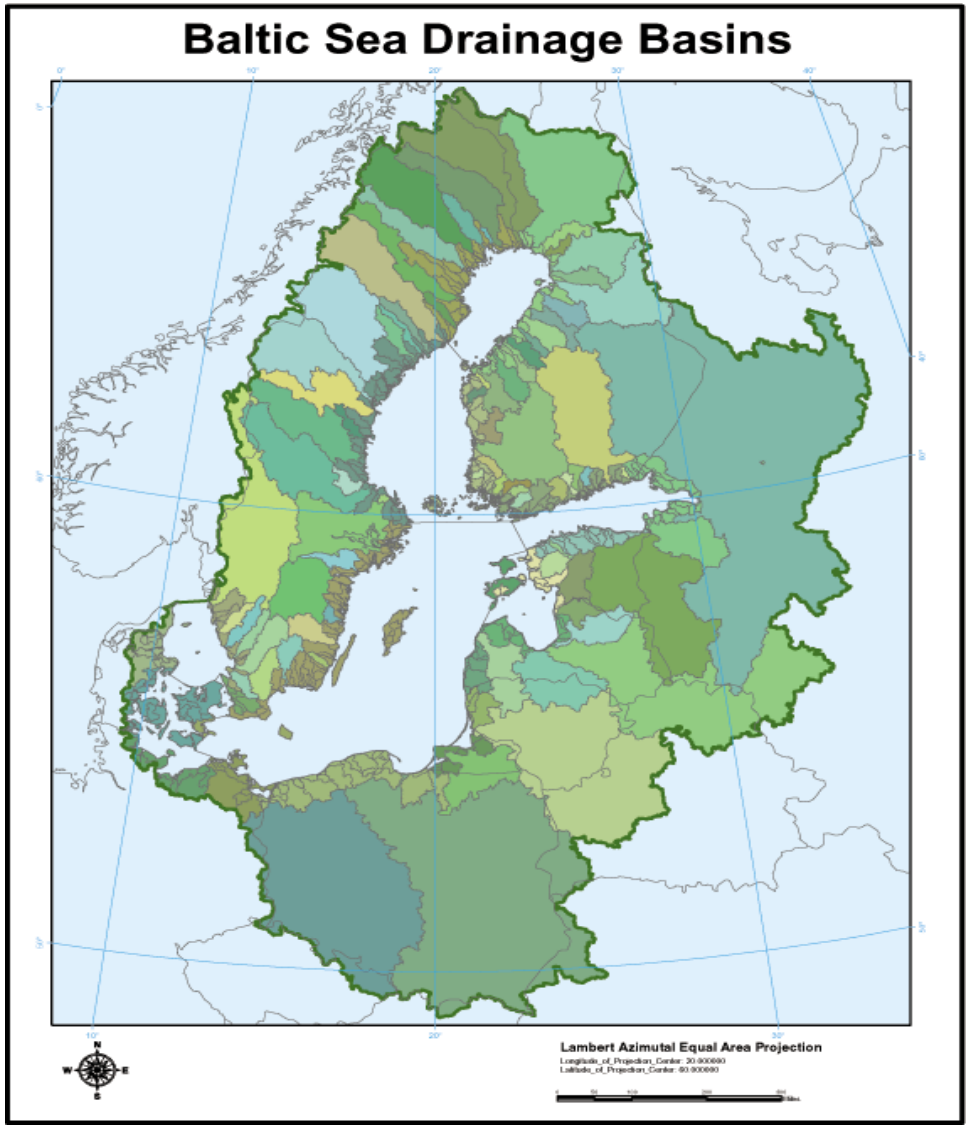
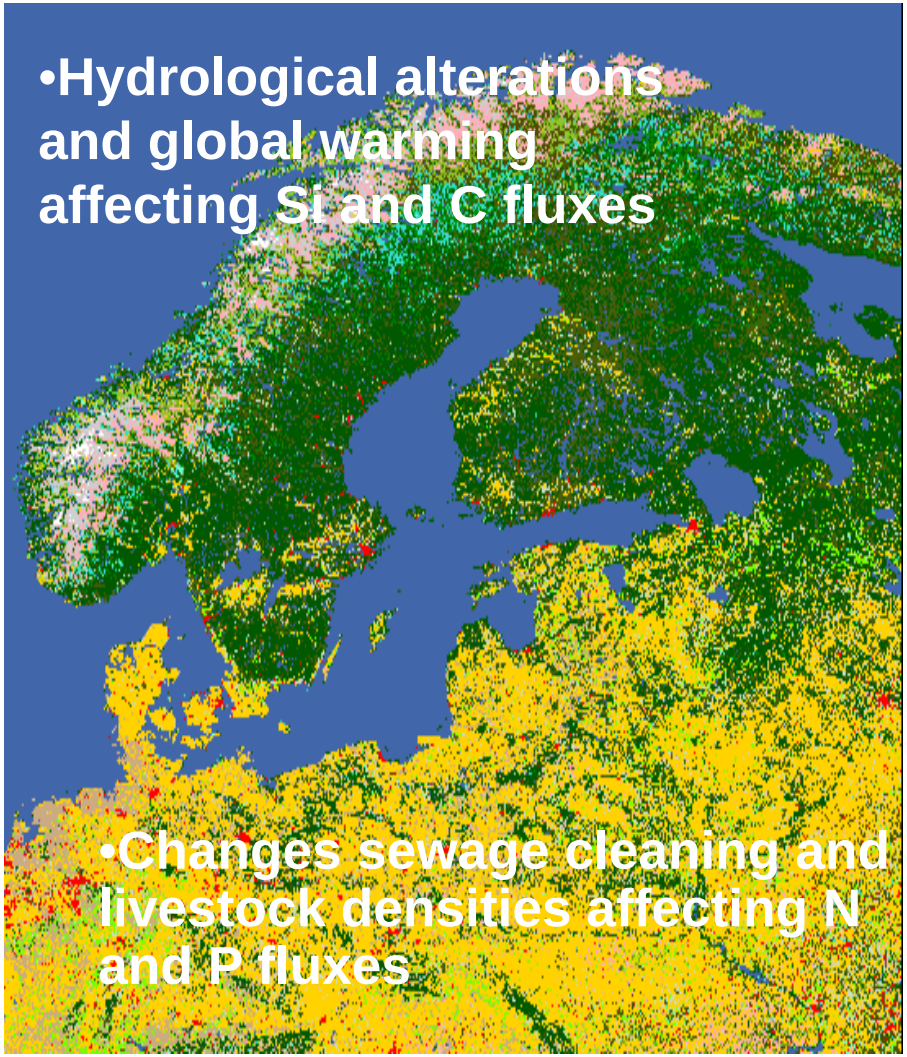


- 87 major catchments and 21 costal strips
- Hydrological data and nutrient fluxes for 1970-2006
- Landscape types, Population Agricultural data

  Atmospheric deposition
- PLC 5 based on national inconsistent approaches



Legend

glc250m

Class_Names

- Artificial surfaces and associated areas
- Bare areas
- Cultivated and managed terrestrial areas
- Herbaceous, closed - pastures, natural grassl
- Herbaceous, open with shrubs
- Lichens and mosses
- Mosaic: crop/ tree cover
- Regularly flooded shrub and/or herbaceous
- Snow and ice
- Sparse herbaceous or sparse shrubs
- Tree cover, broadleaved, deciduous, closed
- Tree cover, broadleaved, deciduous, open
- Tree cover, mixed phrenology, closed
- Tree cover, mixed phrenology, open
- Tree cover, needleleaved, evergreen, closed
- Tree cover, needleleaved, evergreen, open
- Water

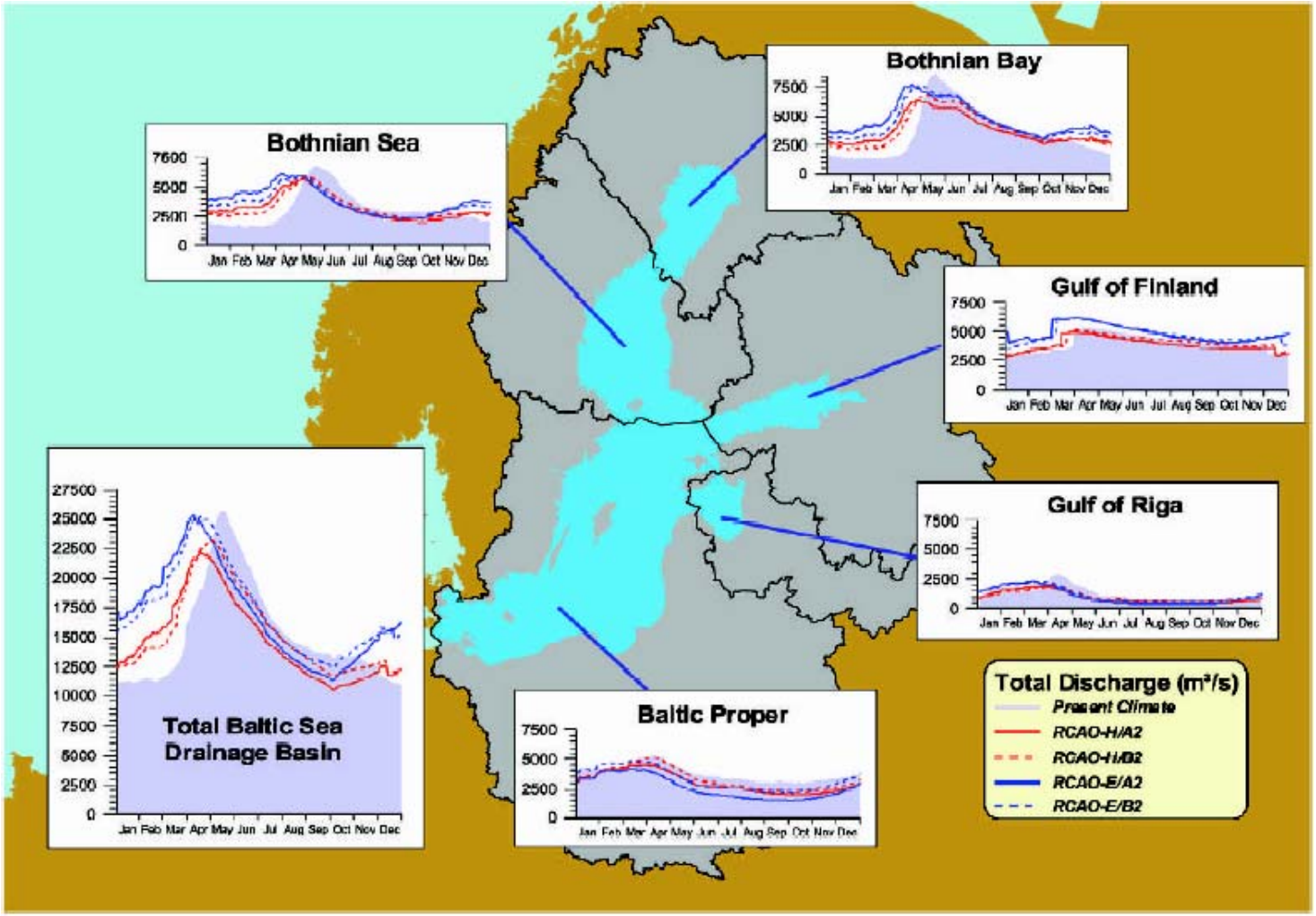
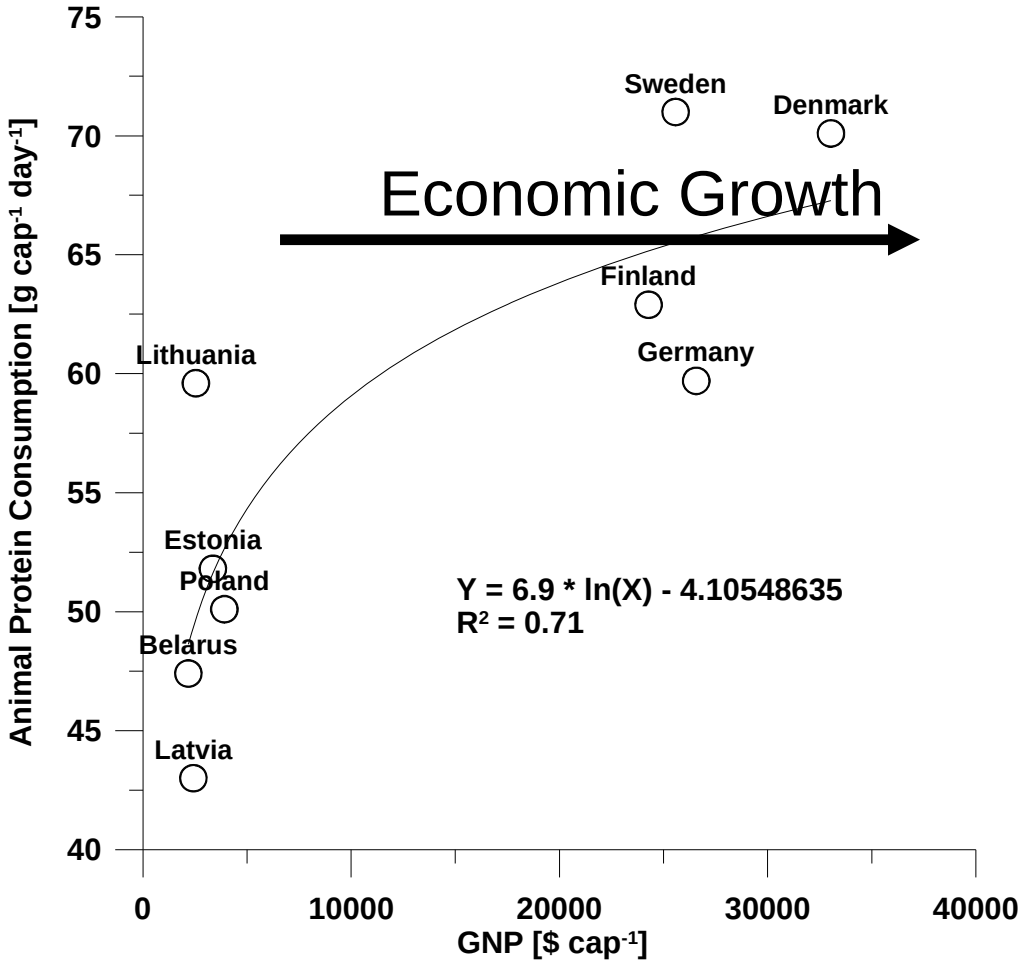


Figure 1. Modeled seasonal river discharge to the Baltic Sea from HBV-Baltic for present-day conditions (shaded) and four climate change scenarios. Shown are daily means over the 23-year modeling period. All plots are drawn to the same X and Y scales.

Graham 2004

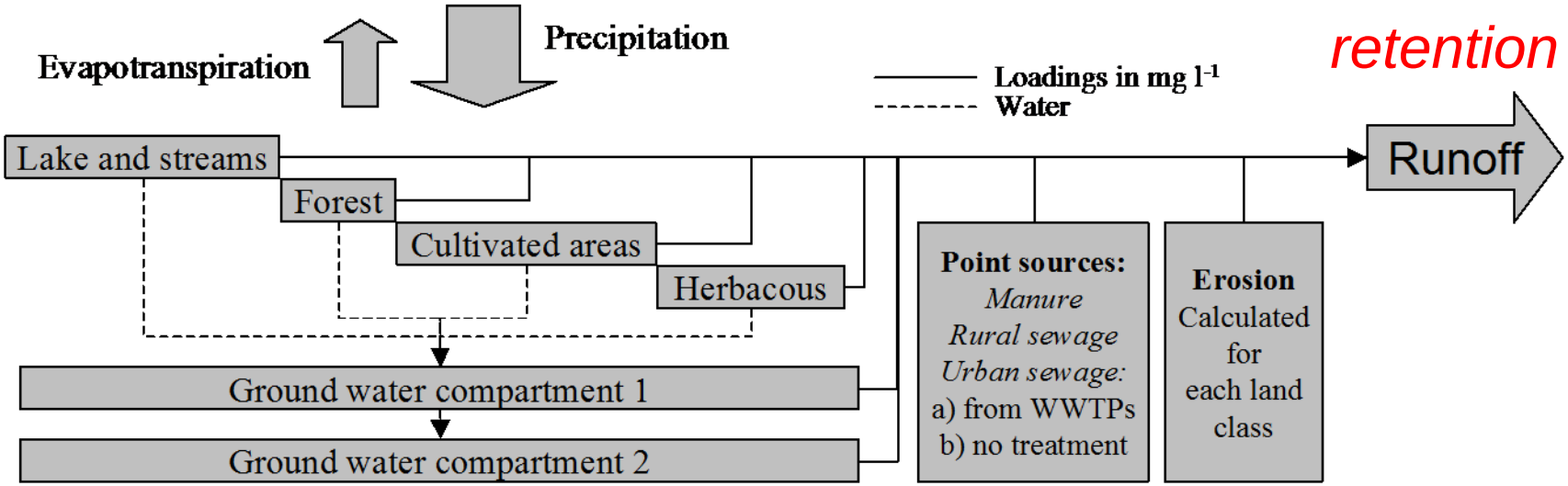
Changes in lifestyles translates into N emissions



CSIM

(Catchment Simulation)

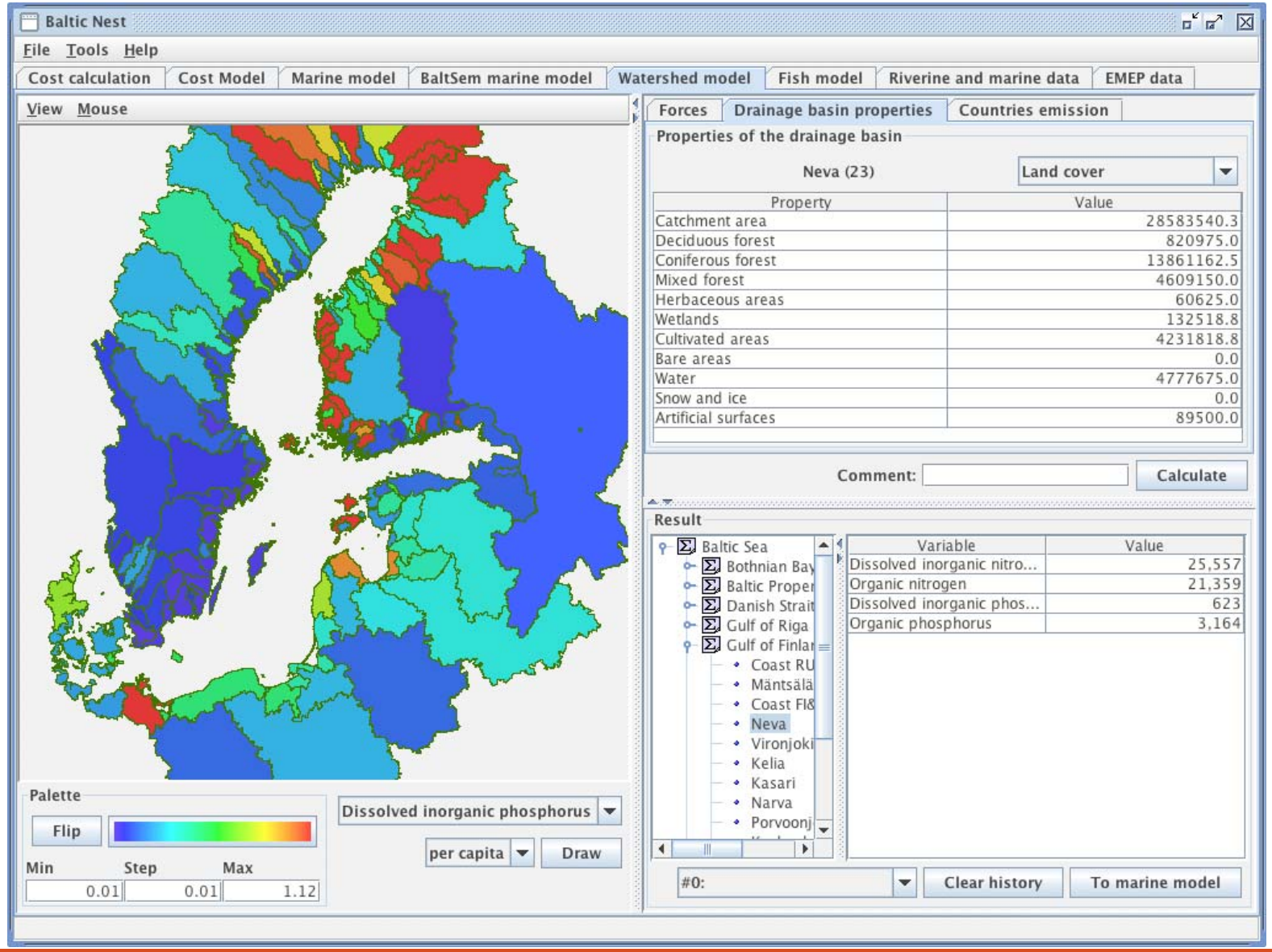
Future: dynamic Riverine retention



Now: fixed type concentrations

Future: Type concentrations =f(land use)

Mörth et al. 2007



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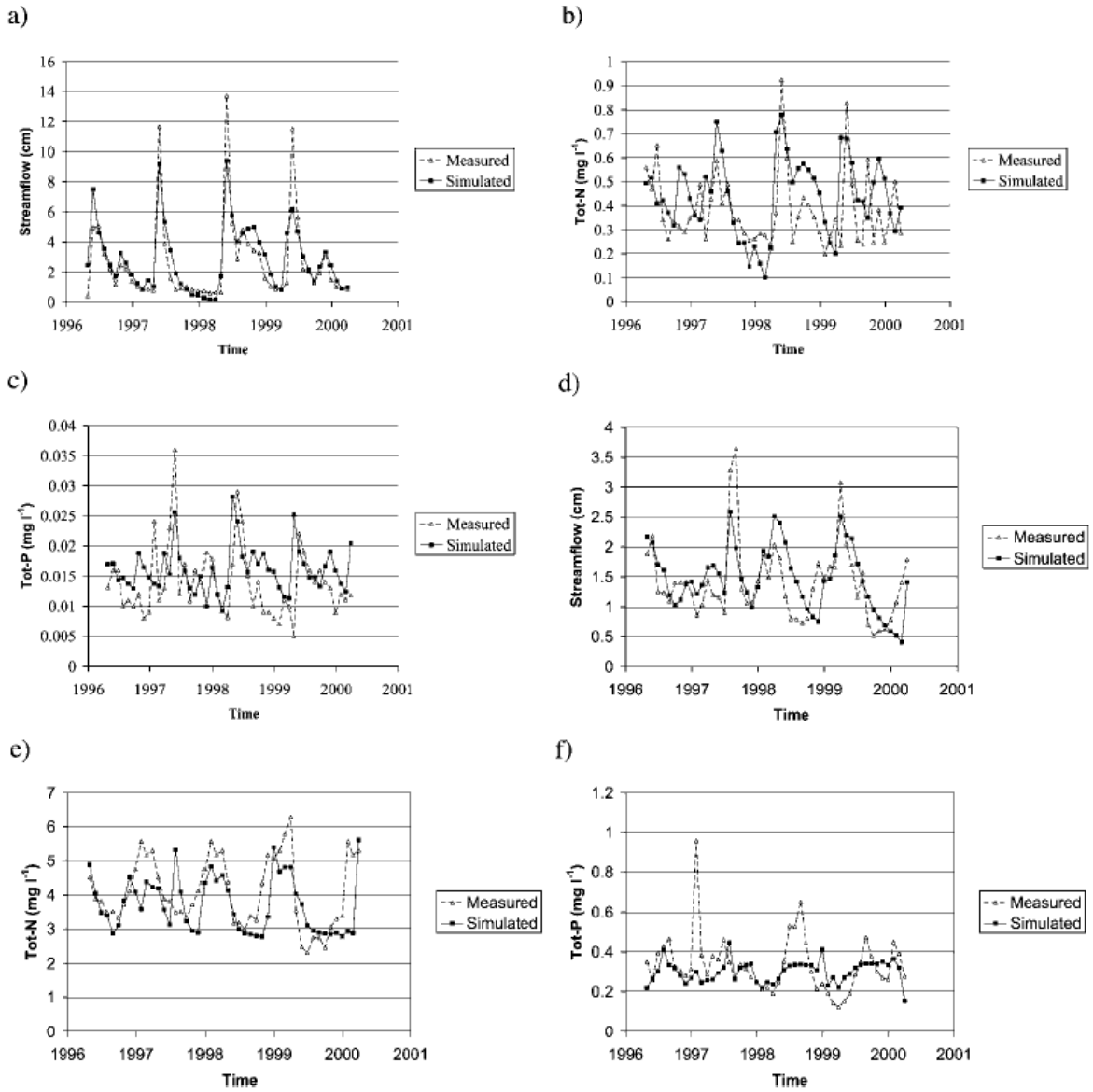
Seasonal simulations of an eutrophied (Oder) and unperturbed system (Råne)

Mörth et al. 2007



2 Deliverables:

Scenario analysis on climate change (N, P) (after 2 years)

Scenario analysis on changes in land cover, land use (N, P) (after 2 years)

Watershed budgets of C

- Polar amplification of global warming
- 450 Pg C stored
- ~ 70 annual anthropogenic emissions
- Boreal/subarctic Baltic unperturbed rivers as model systems

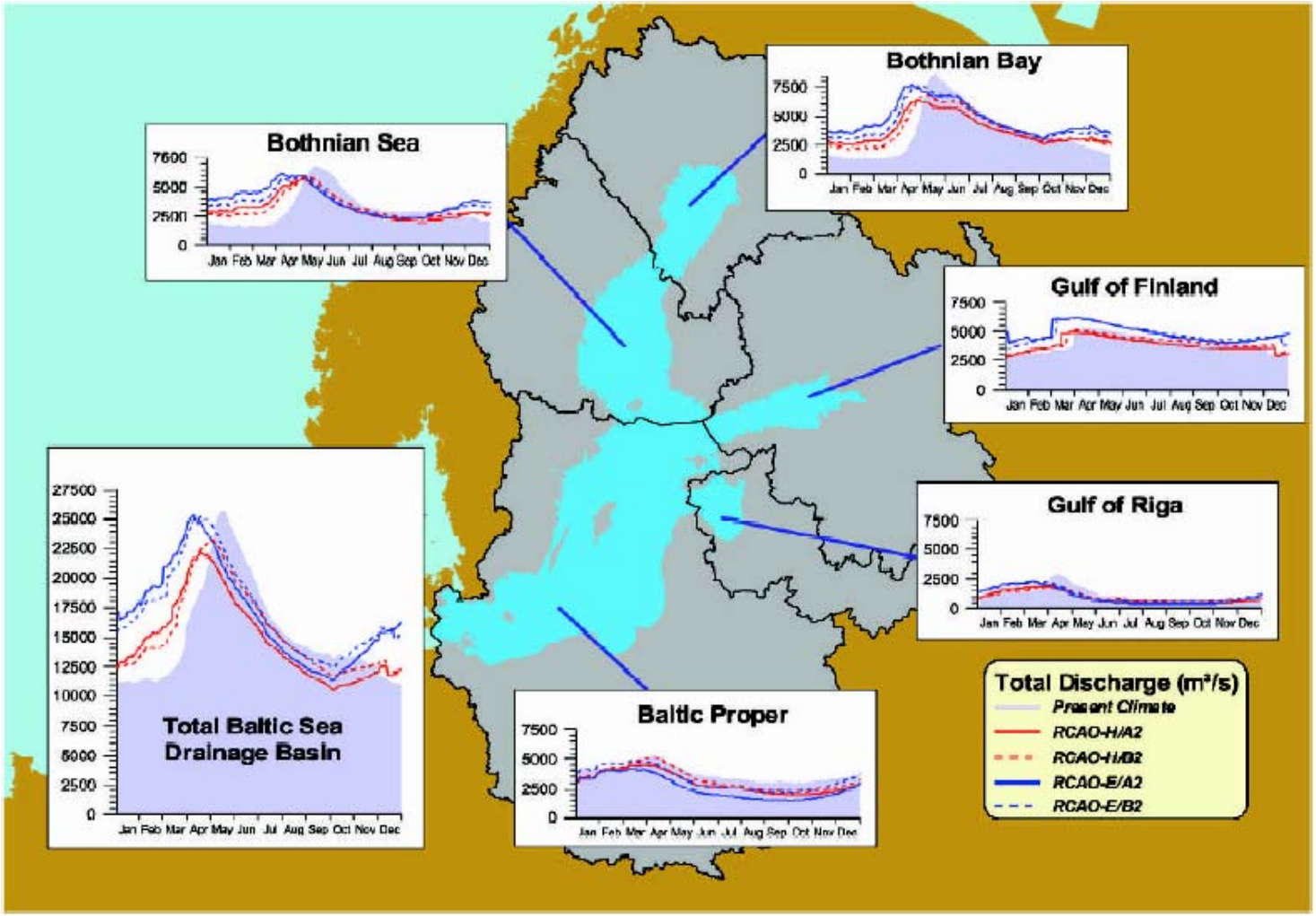
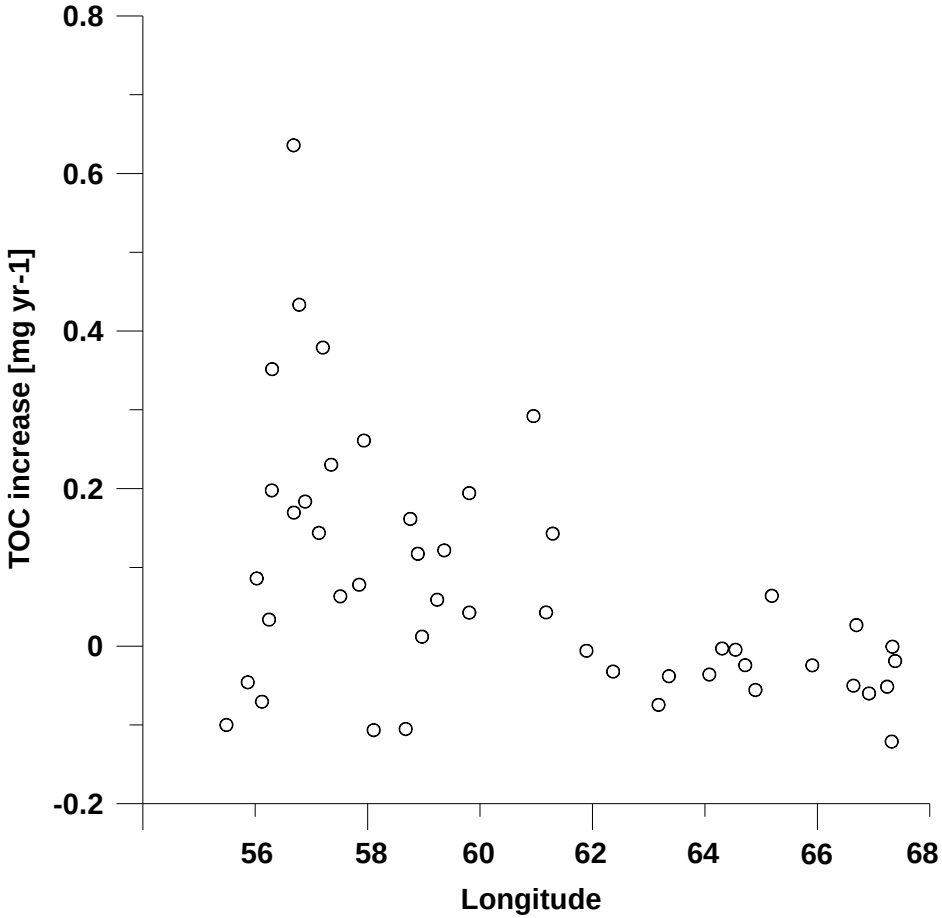


Figure 1. Modeled seasonal river discharge to the Baltic Sea from HBV-Baltic for present-day conditions (shaded) and four climate change scenarios. Shown are daily means over the 23-year modeling period. All plots are drawn to the same X and Y scales.

Graham 2004

DOC increases up to mid lattitudes in Sweden



Trend analysis
30 years
Monitoring data
With monthly
Resolution

Humborg et al., 2007
HESS

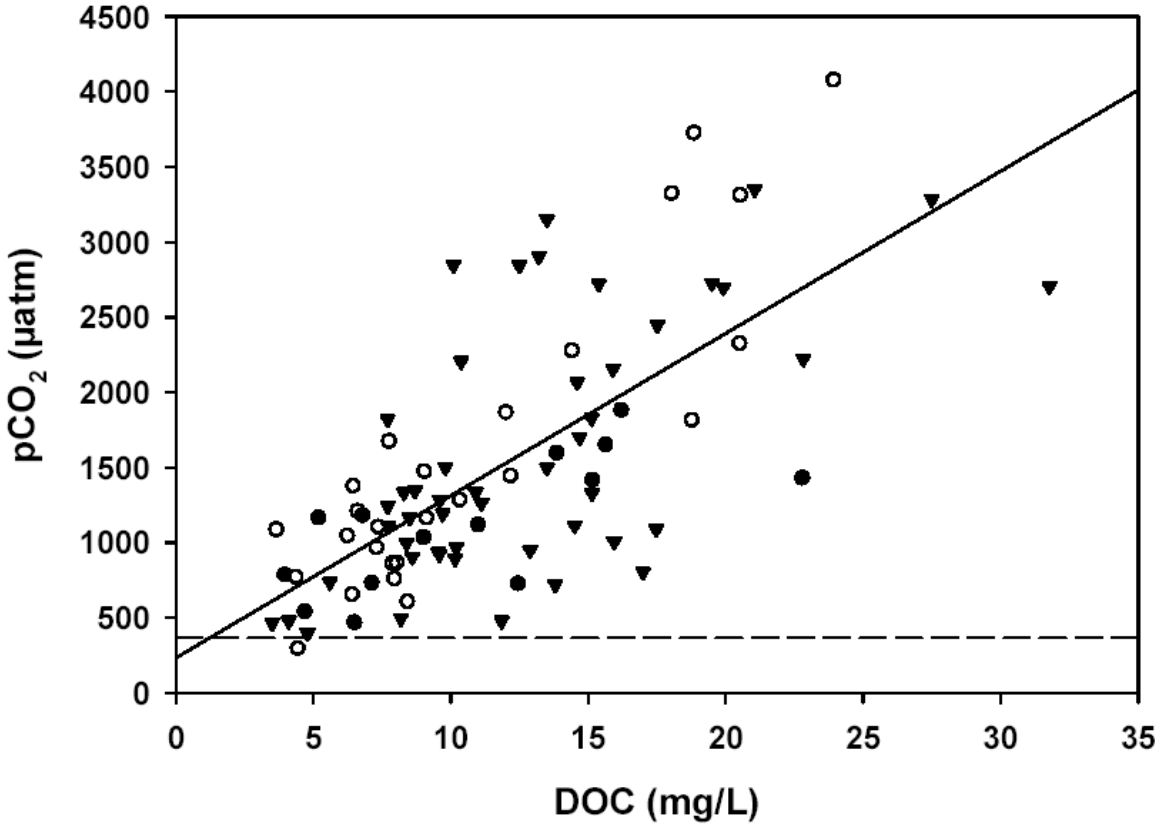
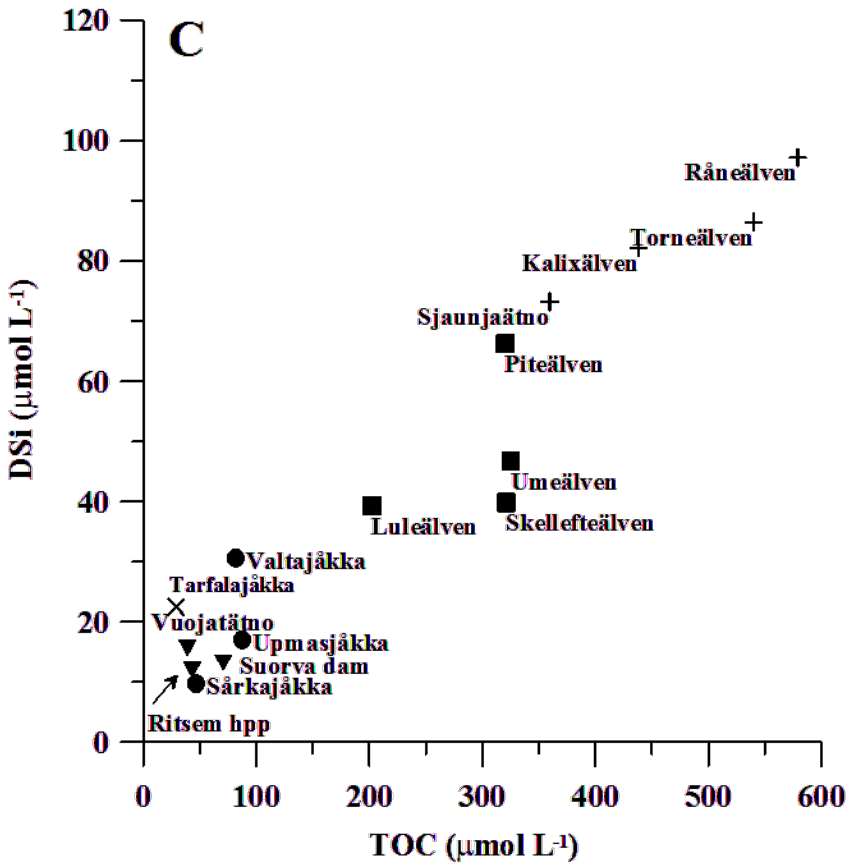


Figure 2. The relationship between DOC concentration and pCO_2 in the surface water of 33 boreal lakes during open-water conditions (spring, summer, autumn). Filled circles: Småland (southern Sweden); open circles: Bergslagen (middle Sweden); triangles: Västerbotten (northern Sweden). Solid line: linear regression, $y=233.2+107.9*x$; $R^2=0.51$. The dashed line depicts atmospheric equilibrium.

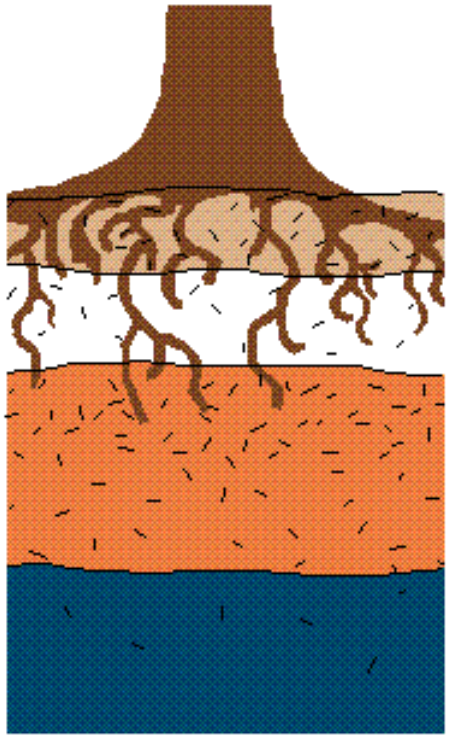
Sobek et al. 2003

High weathering rates and TOC concentrations co-occurr



Humborg et al. L&O 2004

Weathering and organic matter



	pH-values (pH_{H_2O}) Normal	Acidified soil
Humus horizon, (Mor horizon), (O)	3.5-4.5	3.0-3.8
Eluvial horizon, (A)	4.0-4.5	3.5-4.0
Illuvial horizon, (B)	5.0-5.5	4.0-4.5
Unweathered parent material, (C)	>5.5	<5.5

Source: Swedish Environmental Protection Agency report 4421

Weathering and organic matter

$$4Na_{0.5}Ca_{0.5}Al_{1.5}Si_{2.5}O_8 + 6H_2CO_3 + 11H_2O \rightarrow$$

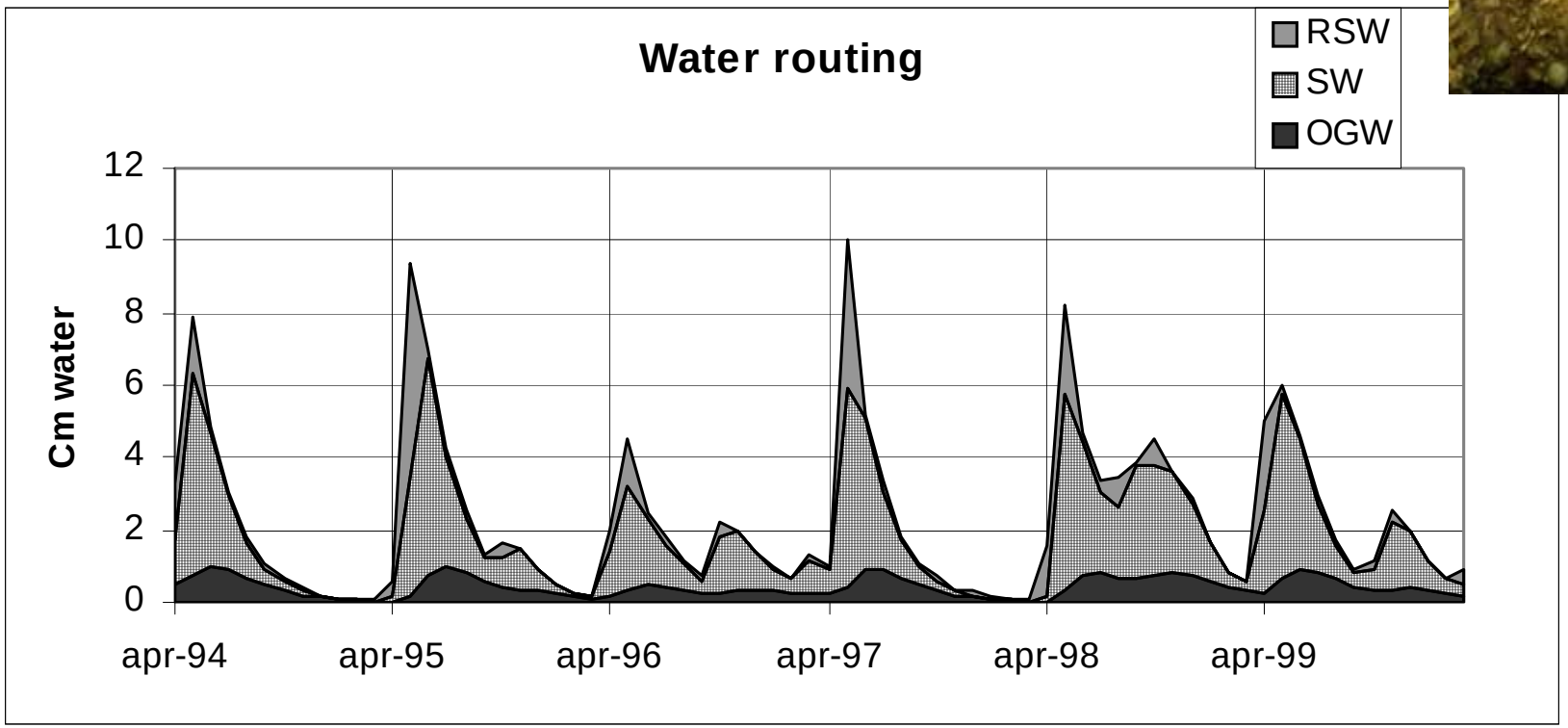
$$3Al_2Si_2O_5(OH)_4 + 2Na^+ + 2Ca^{2+} + 6HCO_3^- + 4H_4SiO_4$$

Primary mineral plus carbon acid (from soil CO_2)

$\rightarrow$

Secondary mineral plus DSi plus alkalinity

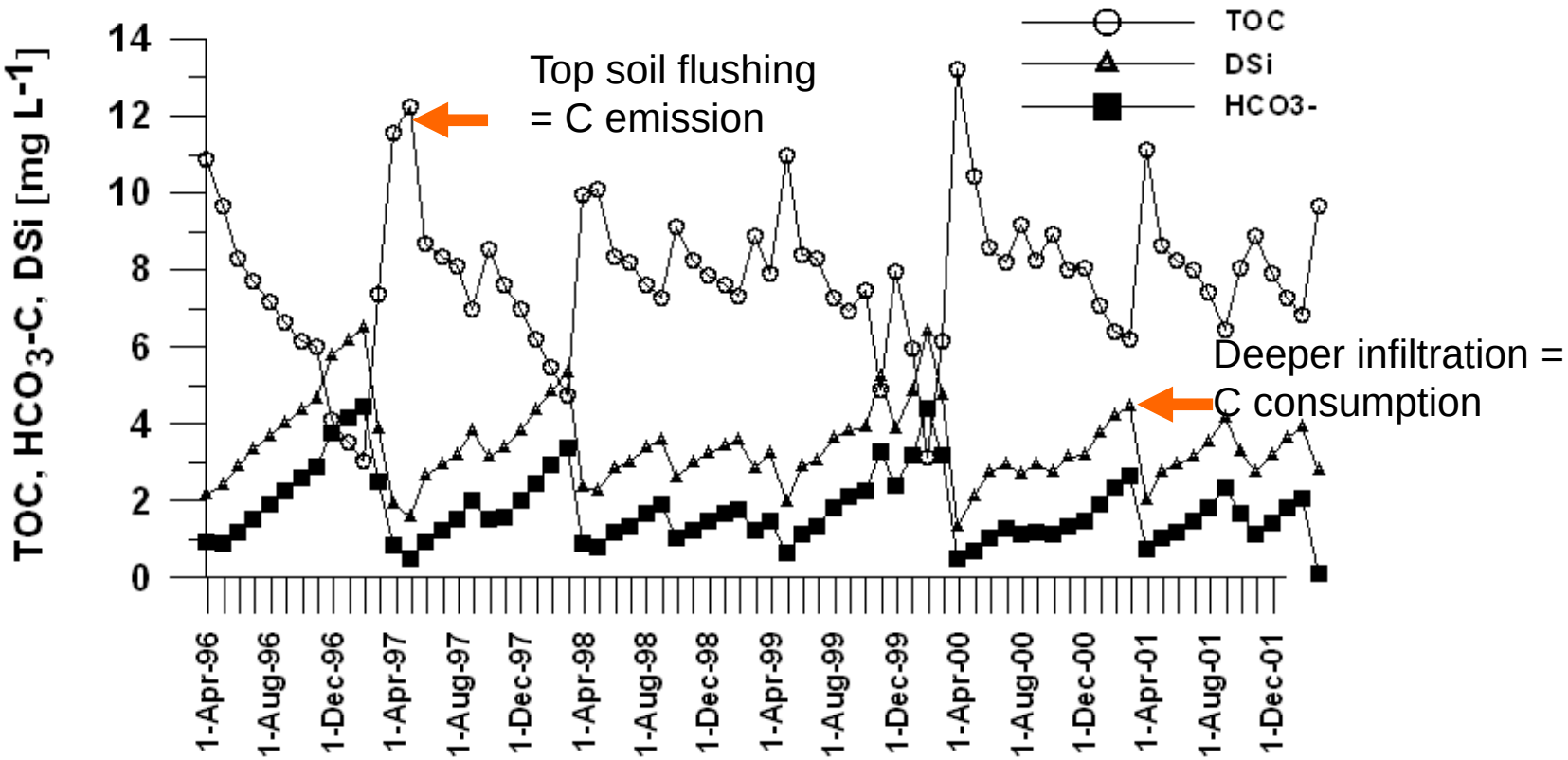
Pronounced spring flow flushing top soils



Aquatic conduit a source or a sink for atmospheric C?

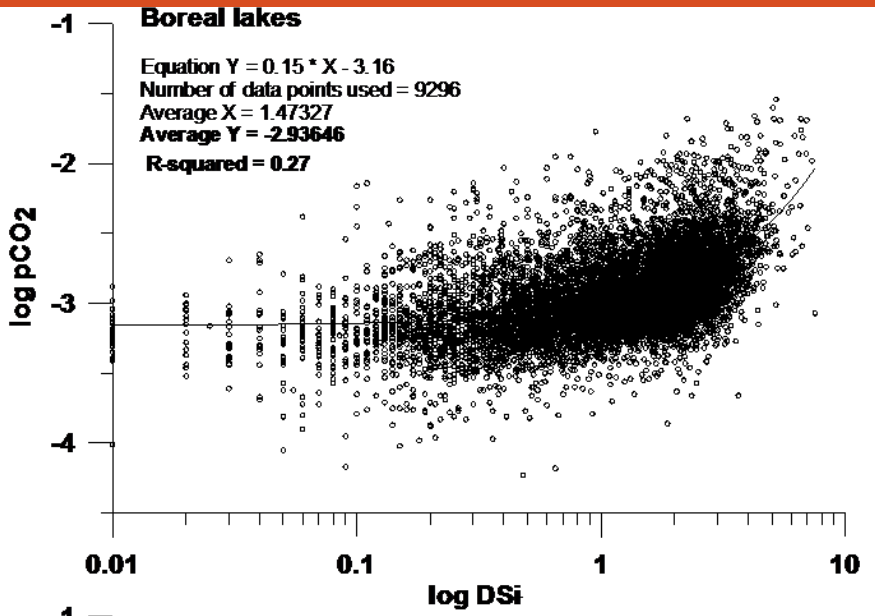
Top soil flushing -> **DOC export** (1-2 tons C via pCO_2)

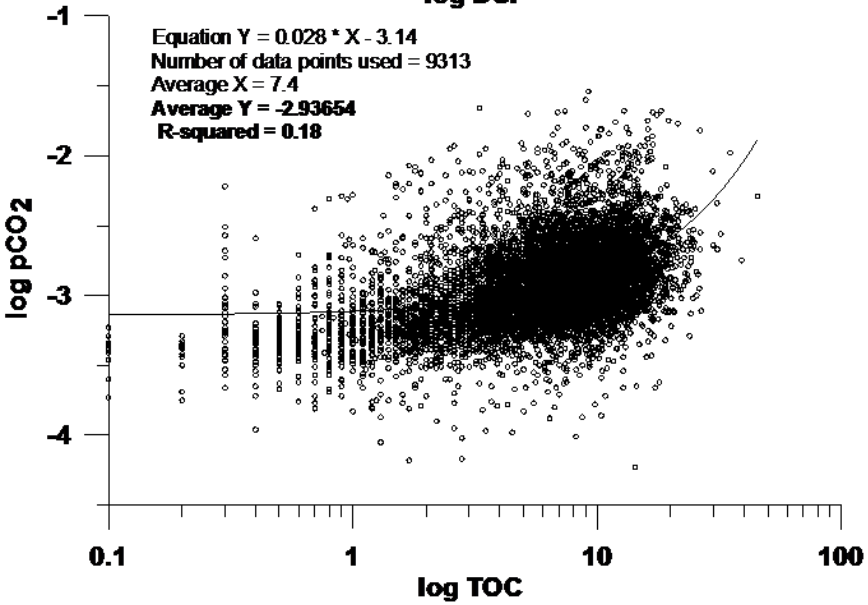
Infiltration -> **Alkalinity export** (0.6 tons C)



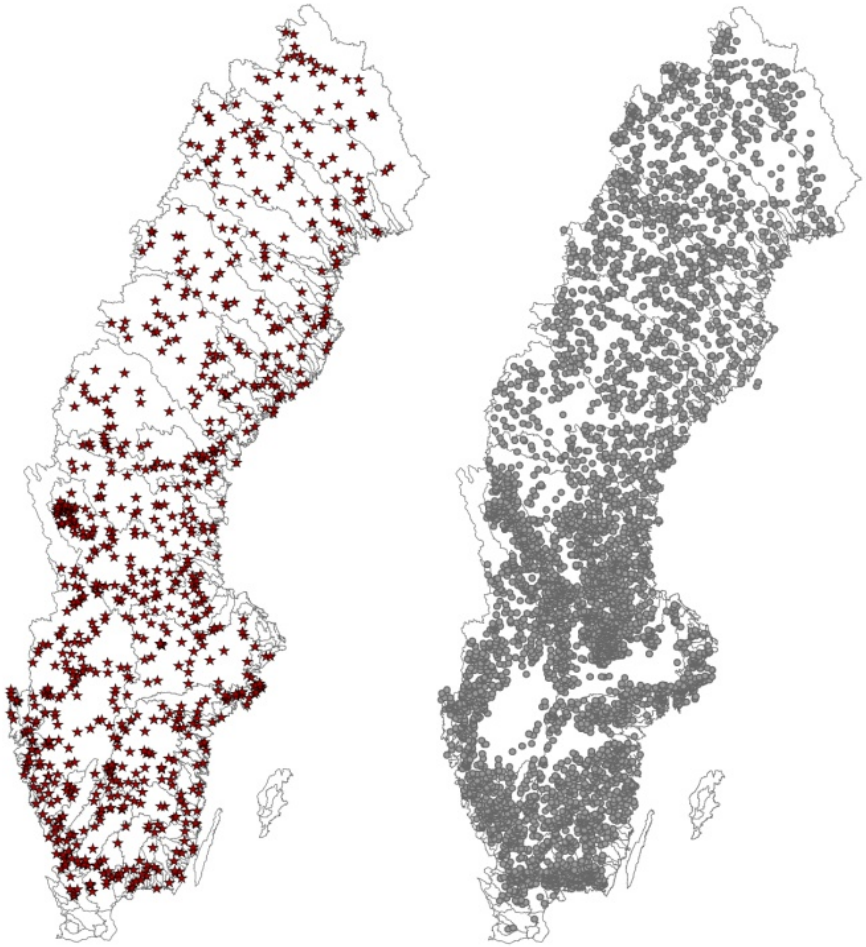
Smedberg et al. 2006, GBC

pCO_2 in lake utilization or groundwater ?

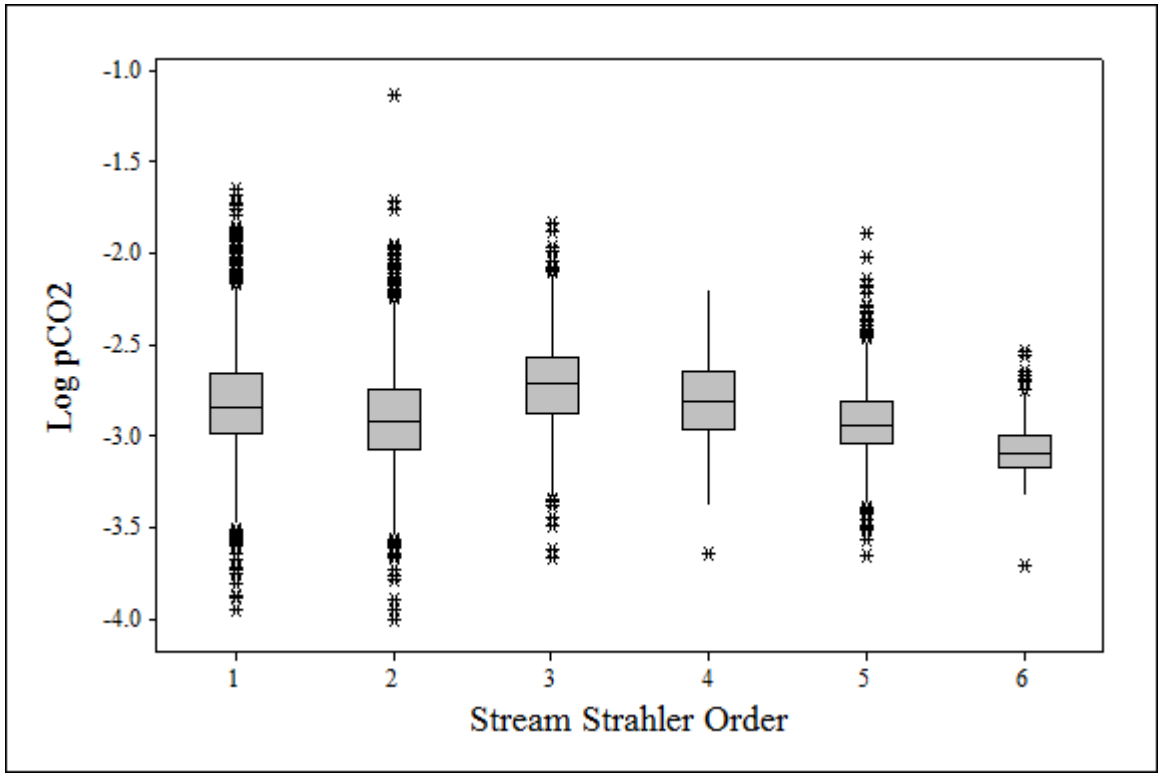




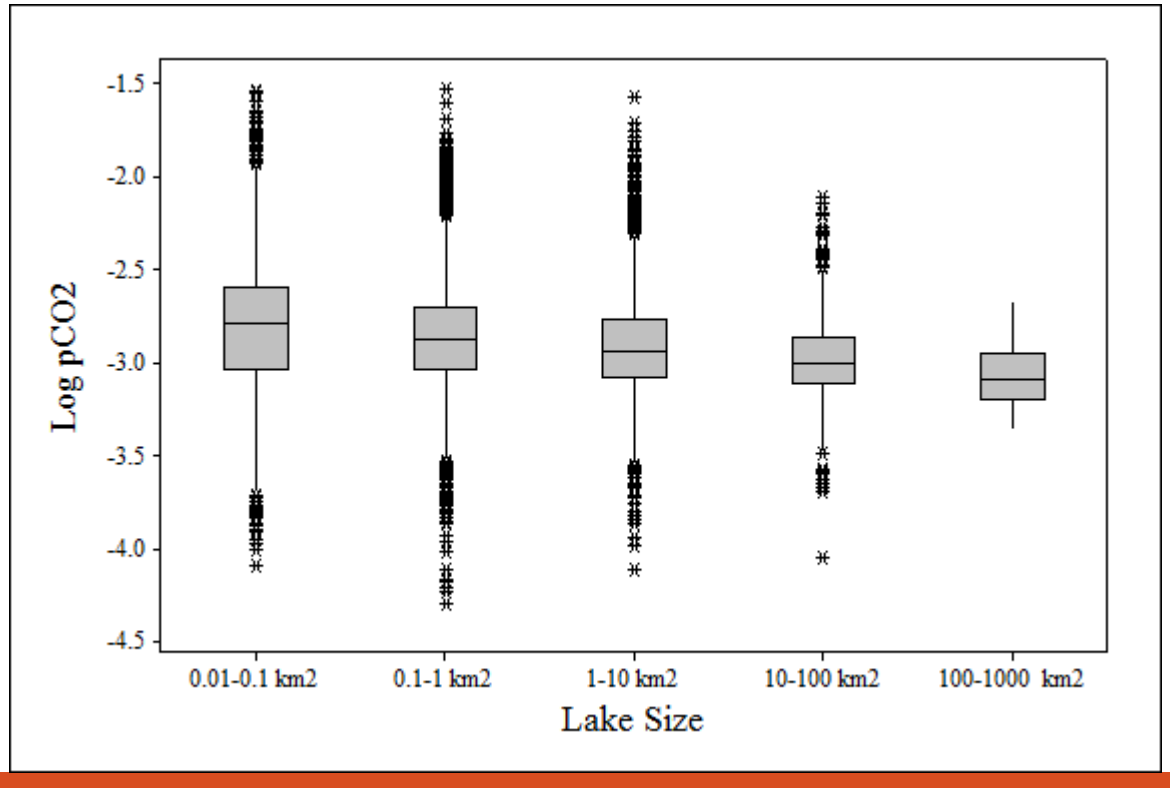
Sampling station for streams and lakes



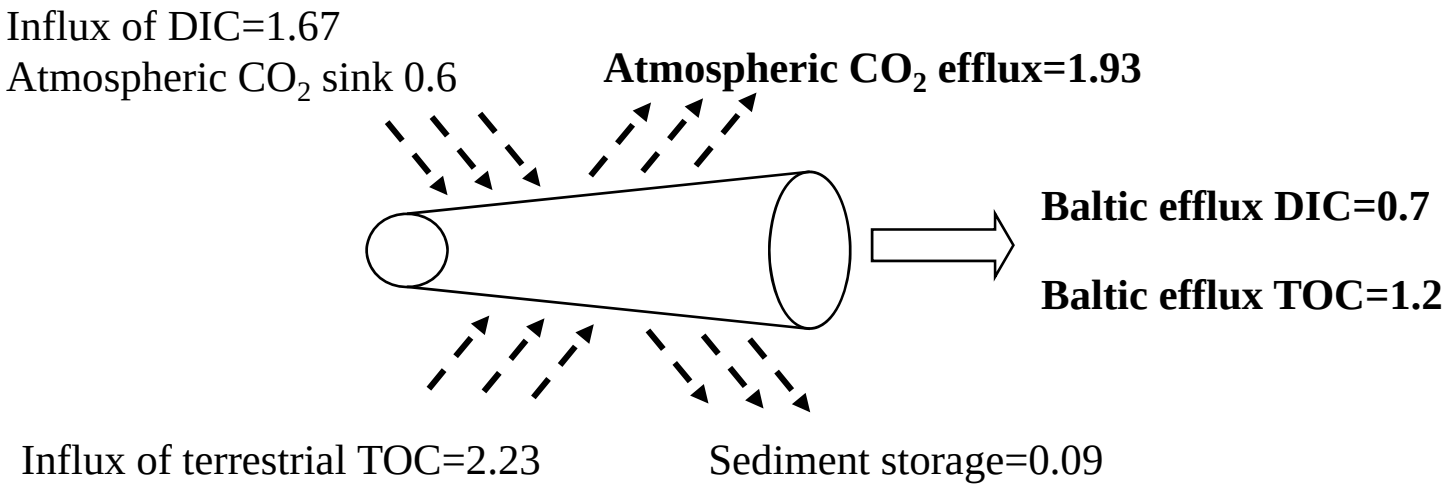
pCO2 in streams



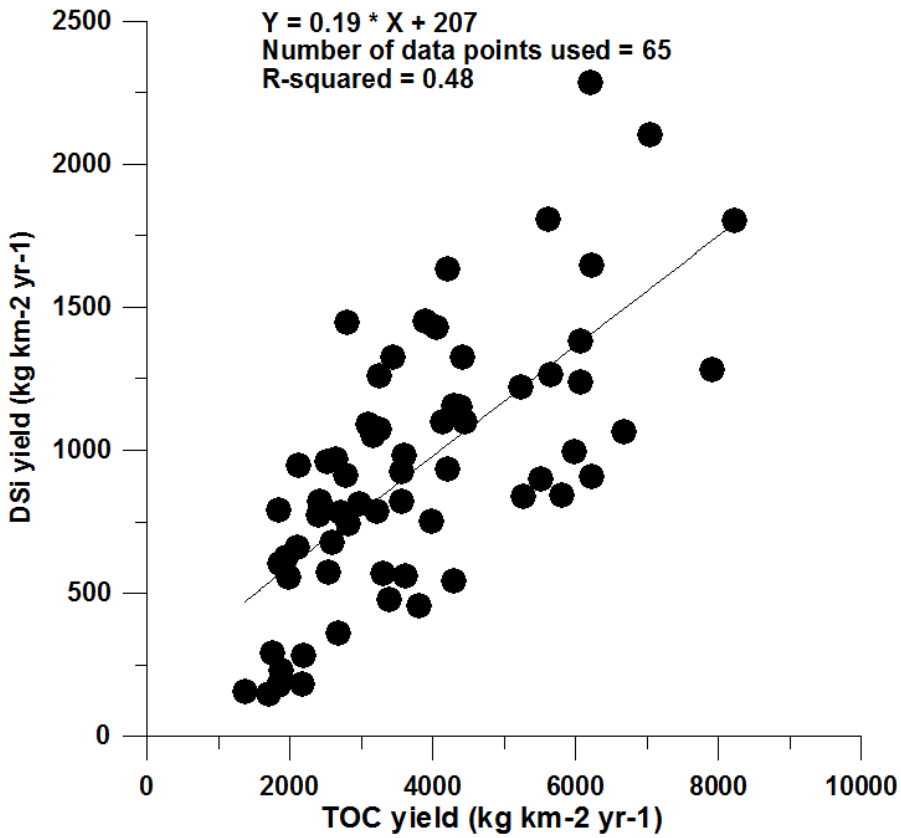
pCO2 in lakes

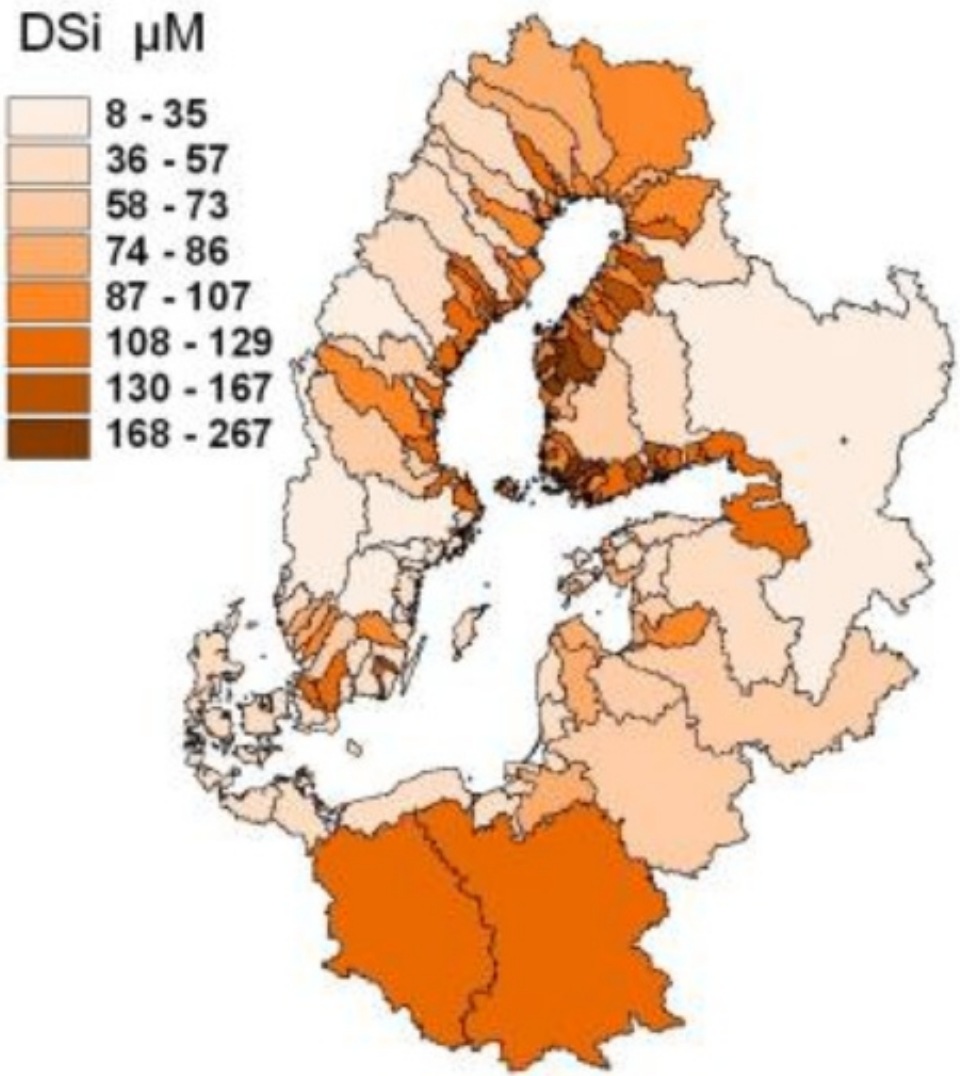


Preliminary C budget (10^6 tonnes) for aquatic conduit in Sweden: A sink or a source for atm. CO_2?

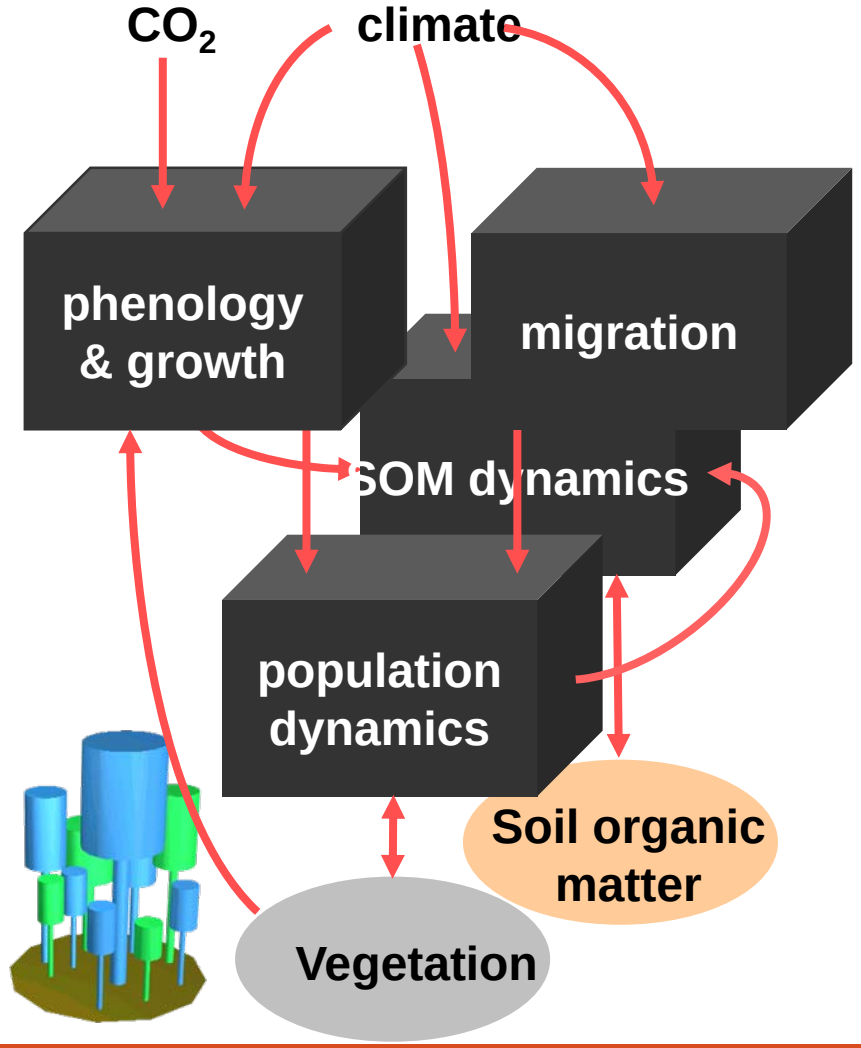


Si flux coupled to TOC flux



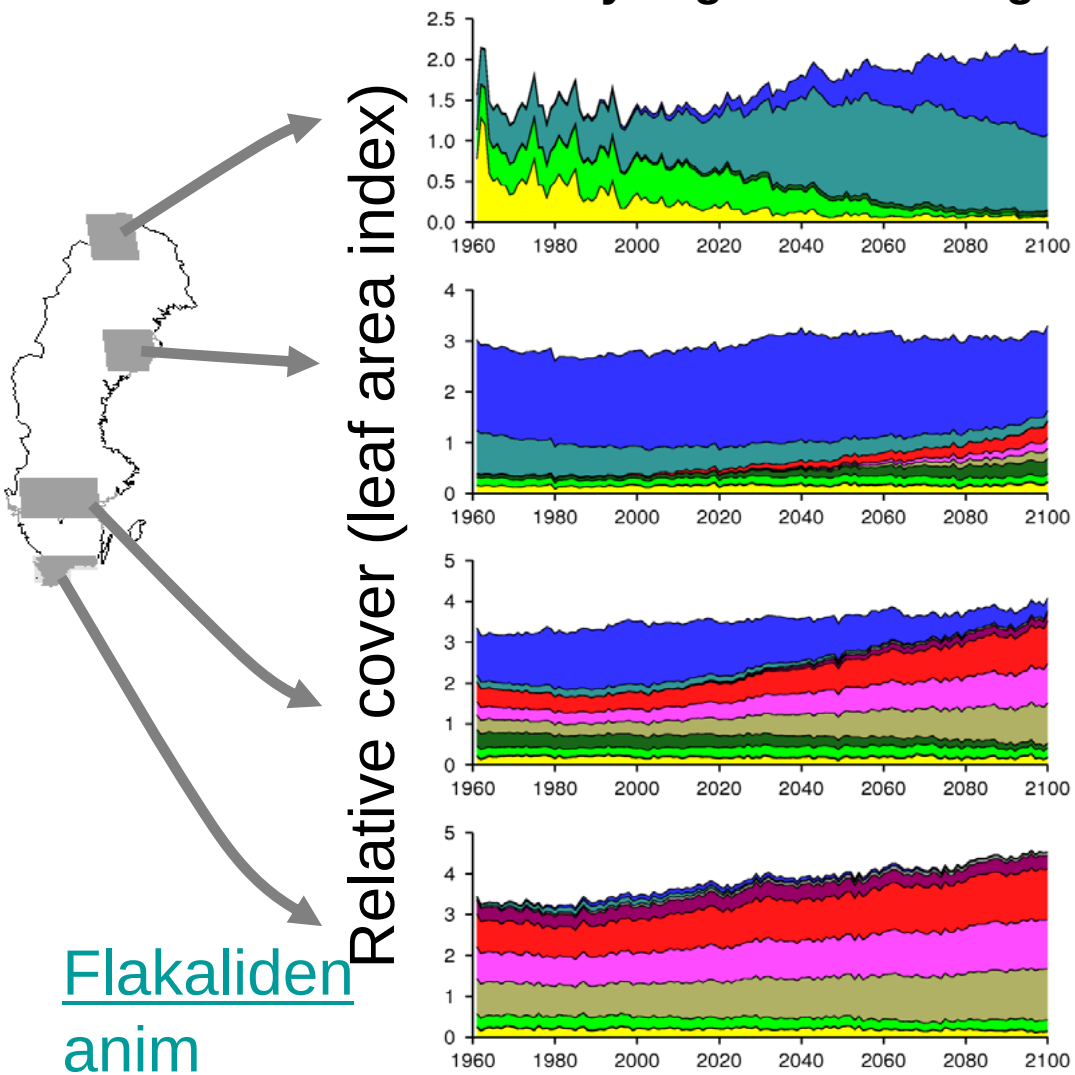


The tool: LPJ-GUESS – an individual-based process-oriented ecosystem modelling framework*

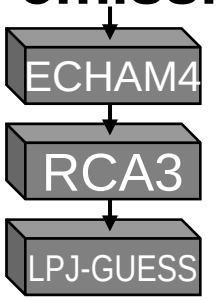


*Smith et al. 2001 *Global Ecology and Biogeography* 10: 621

Potential 21st century vegetation change in Sweden*



A2 emissions



- Norway spruce
- Scots pine
- other conifer
- beech
- elm
- ash
- oak
- alder
- birch
- other broadleaved
- herbaceous

[Flakaliden anim]

* Smith et al. 2007
SOU 2007:60