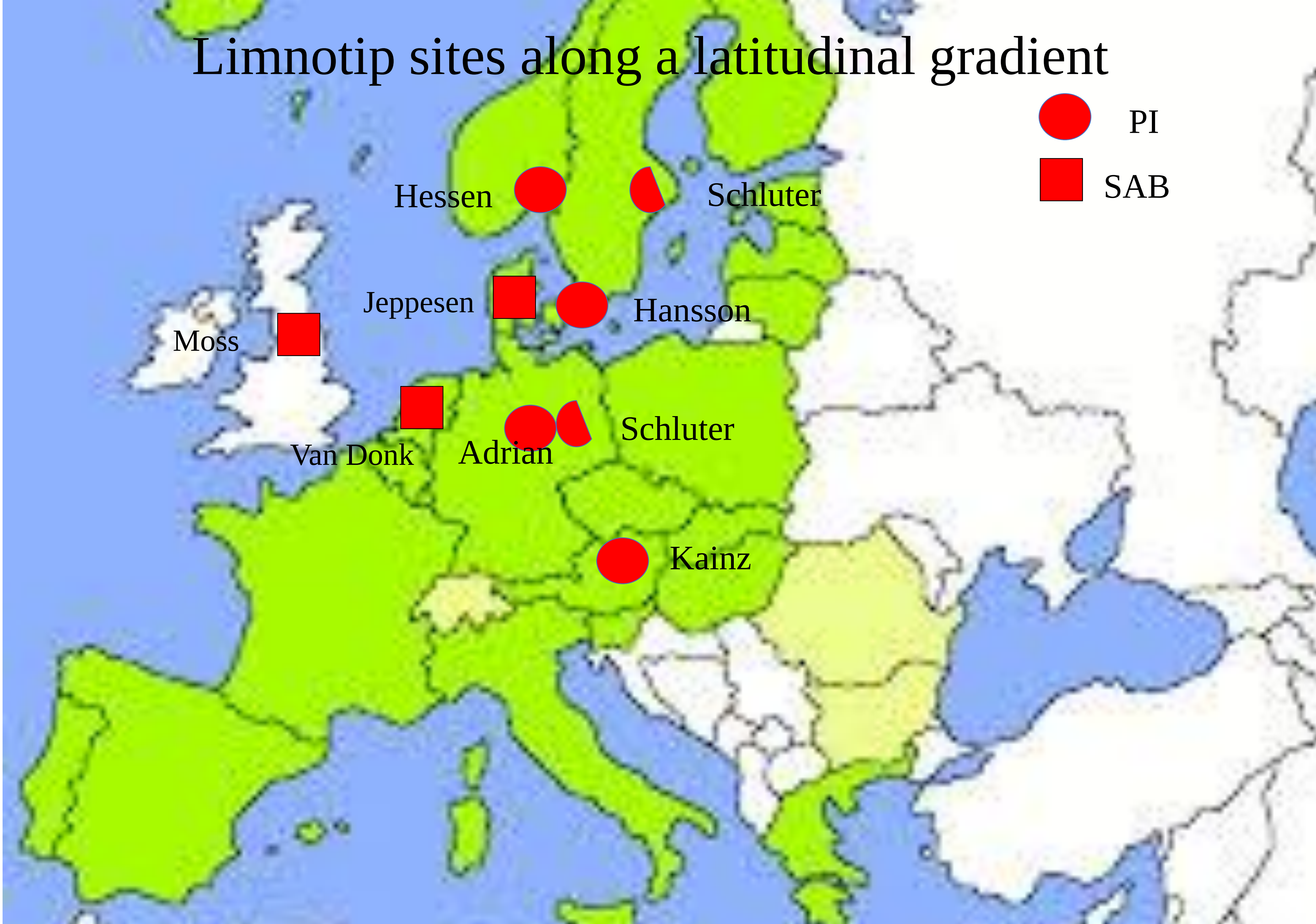
The BiodivERsA network

Towards integrated European biodiversity research strategy and programmes

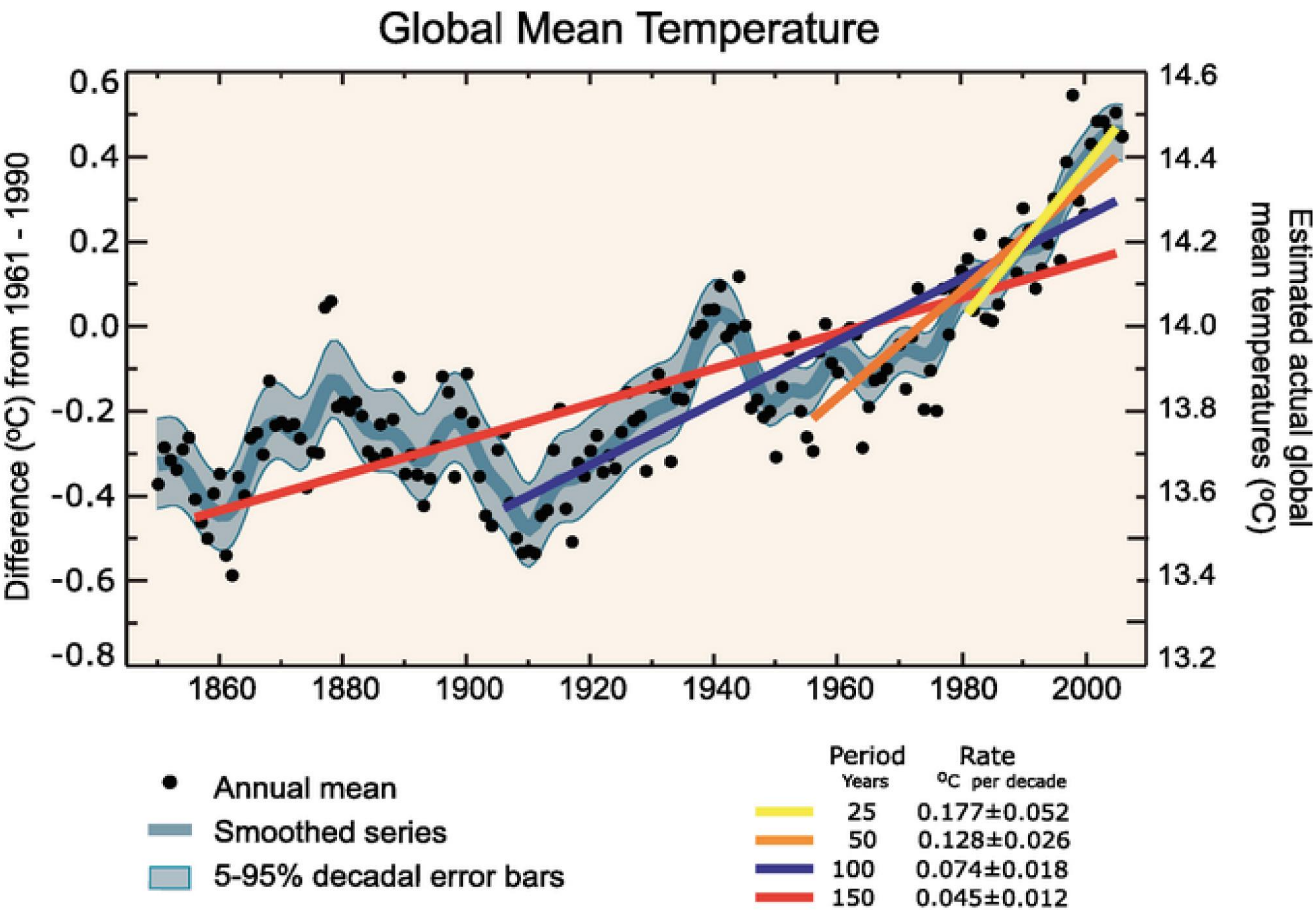
LIMNOTIP: Biodiversity dynamics and tipping points in our future freshwater ecosystems

Limno-Tip

Limnotip sites along a latitudinal gradient

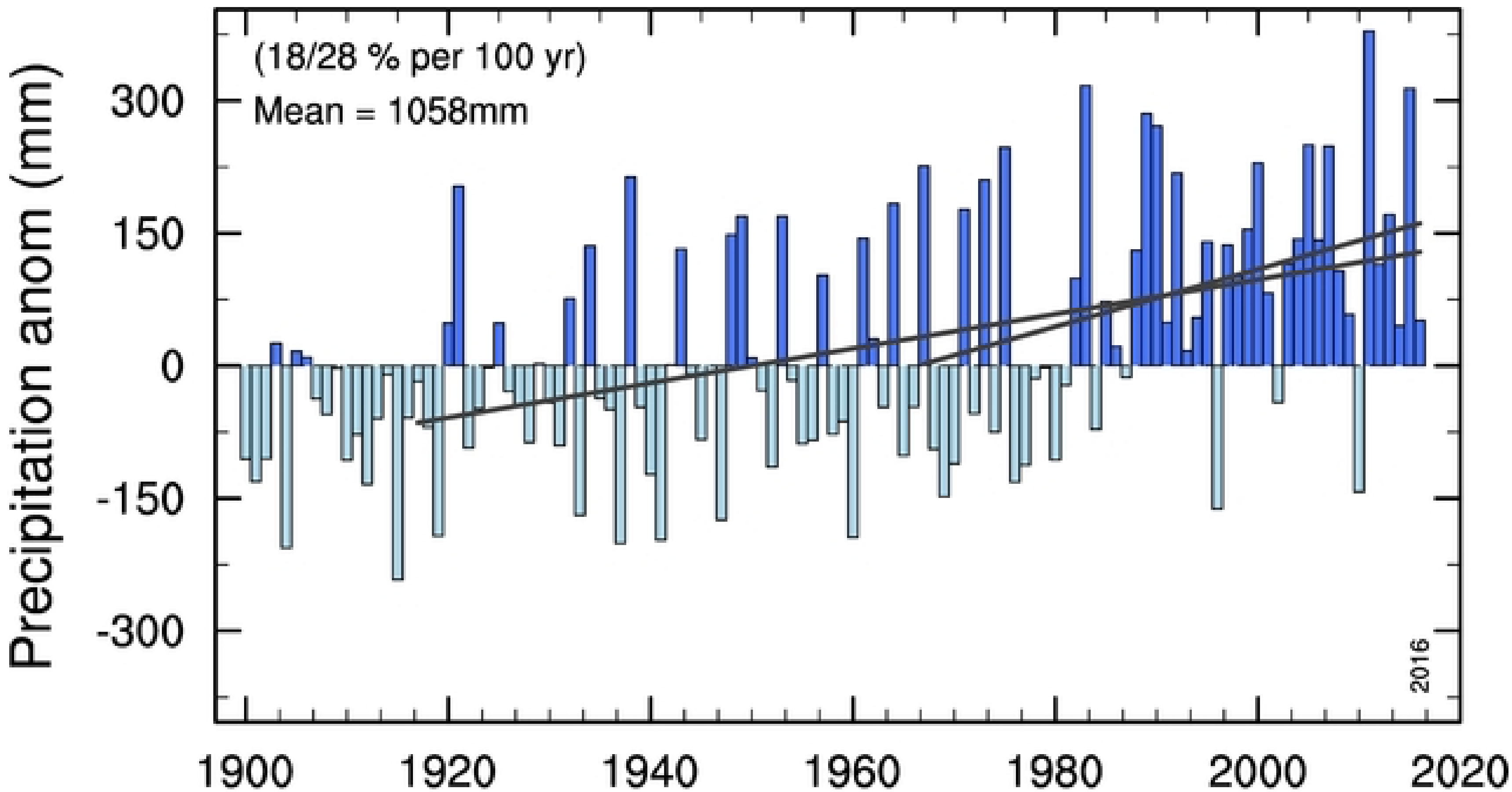


Problem affecting regime shifts: Increasing temperatures



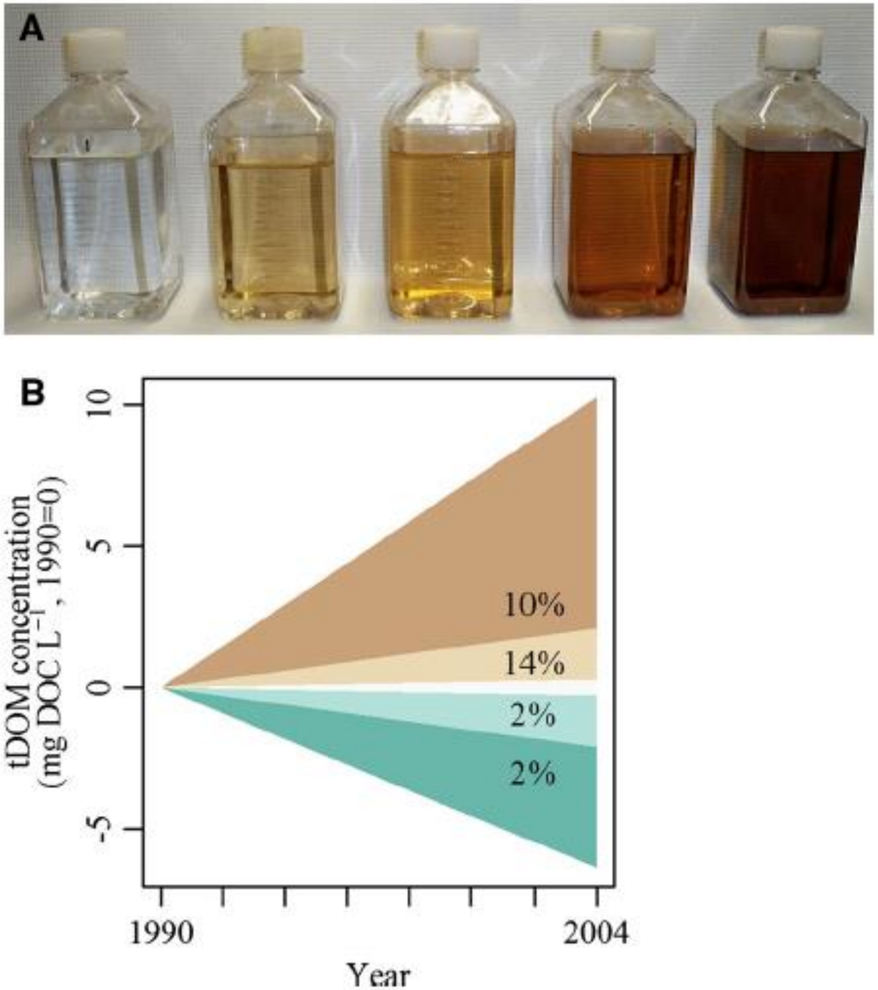
IPCC (2007)

Mean annual precipitation, example Norway

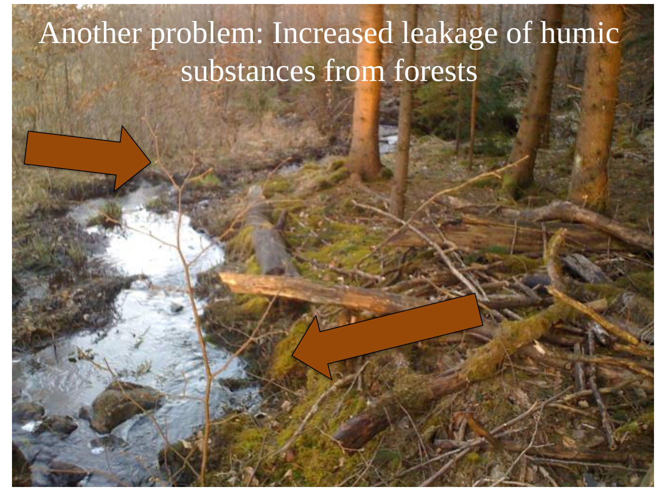


http://folk.uib.no/ngfhd/Climate/climate-prec.html

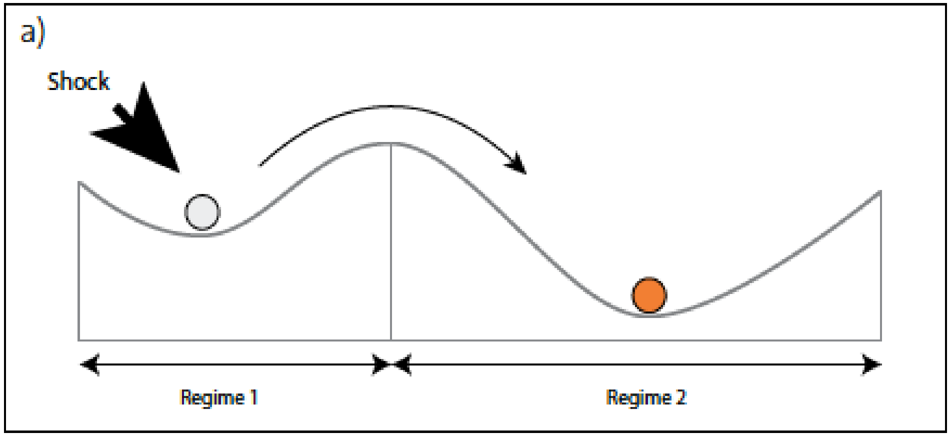
More rain → more carbon → 'brownification' of waters

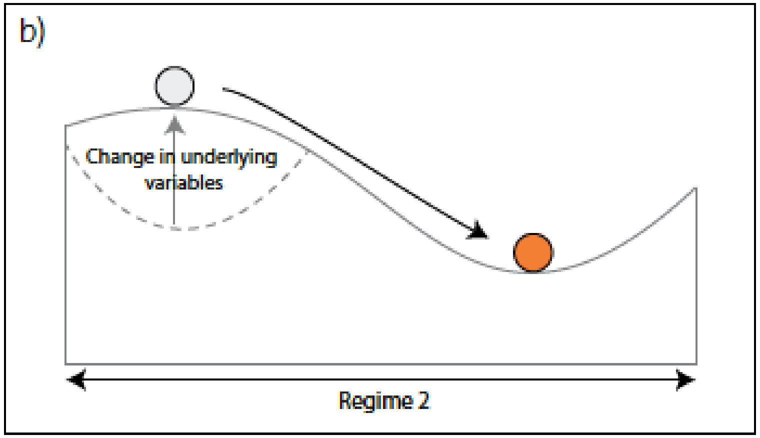


Solomon et al. (2015) Ecosystems 18



‘Regime shifts’





Biggs et al. (2009): Regime shifts. In: Sourcebook in Theoretical Ecology.

’Tipping point’

refers to the phenomenon that freshwater ecosystems sometimes tip over from a **clearwater state** dominated by submerged plants and ample biodiversity, to a state characterized by **algal blooms**, **turbid water** with **low provision of biodiversity and ecosystem services**.

http://www.biodiversa.org/1192

Objectives of LimnoTip:

1) Identification of patterns and structure of European freshwaters and land use
   - IGB Berlin

2) Mechanistic understanding of biodiversity changes by performing standardized **large-scale experiments** of future scenarios.
   - Lund University, WasserCluster Lunz

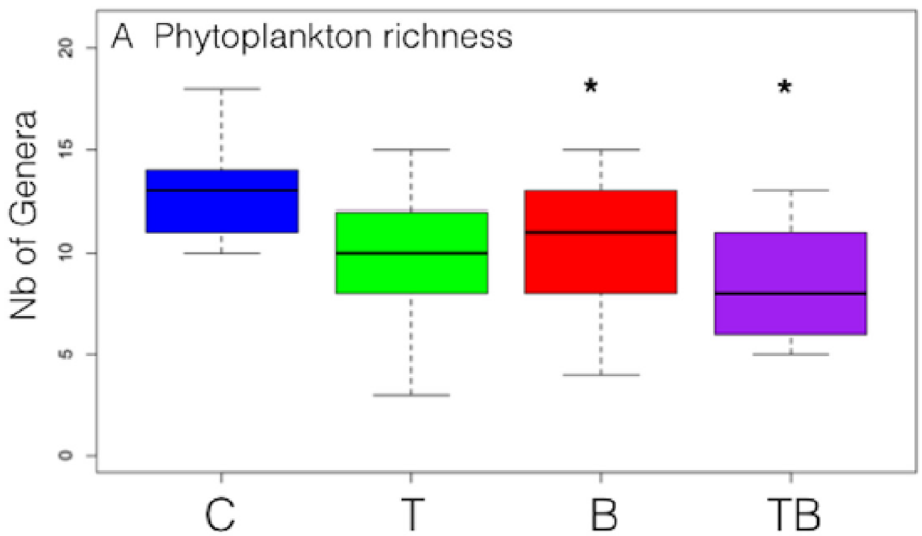
3) Apply **social-ecological integration** to the results and thereby provide a framework for future actions.
   - Stockholm Resilience Centre

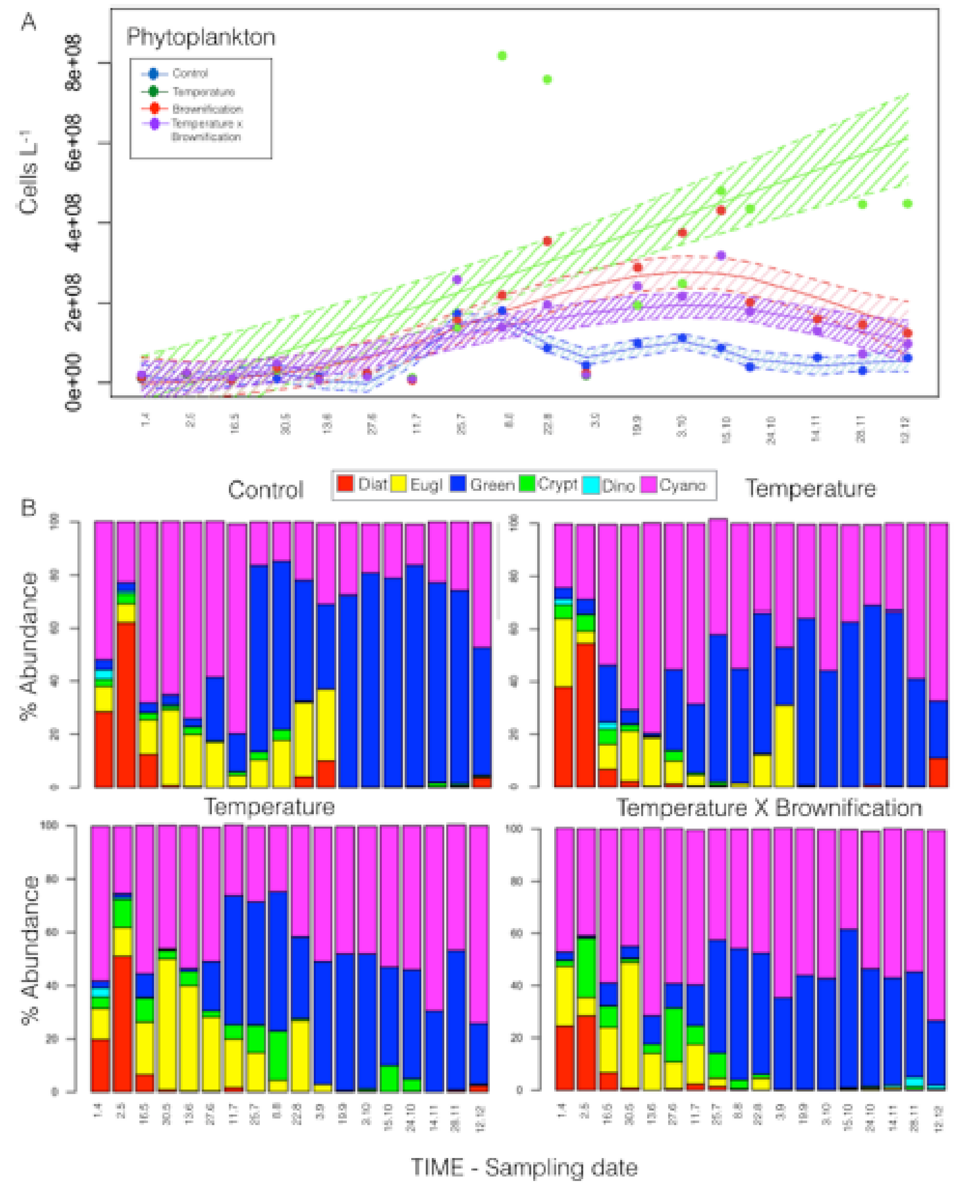
4) Reversing from tipping points through **restoration**.
   - Lund University

5) In order to further integrate the program, and provide European added value, we will launch a **post-doc training program**.
   - Lund University

Seston on GF/C filters from mesocosms
C – control
T – temperature treatment (+3° C to ambient temp)
br – brownification treatment (3X more color rel to ambient)
Txbr – interaction brownification and temp treatment

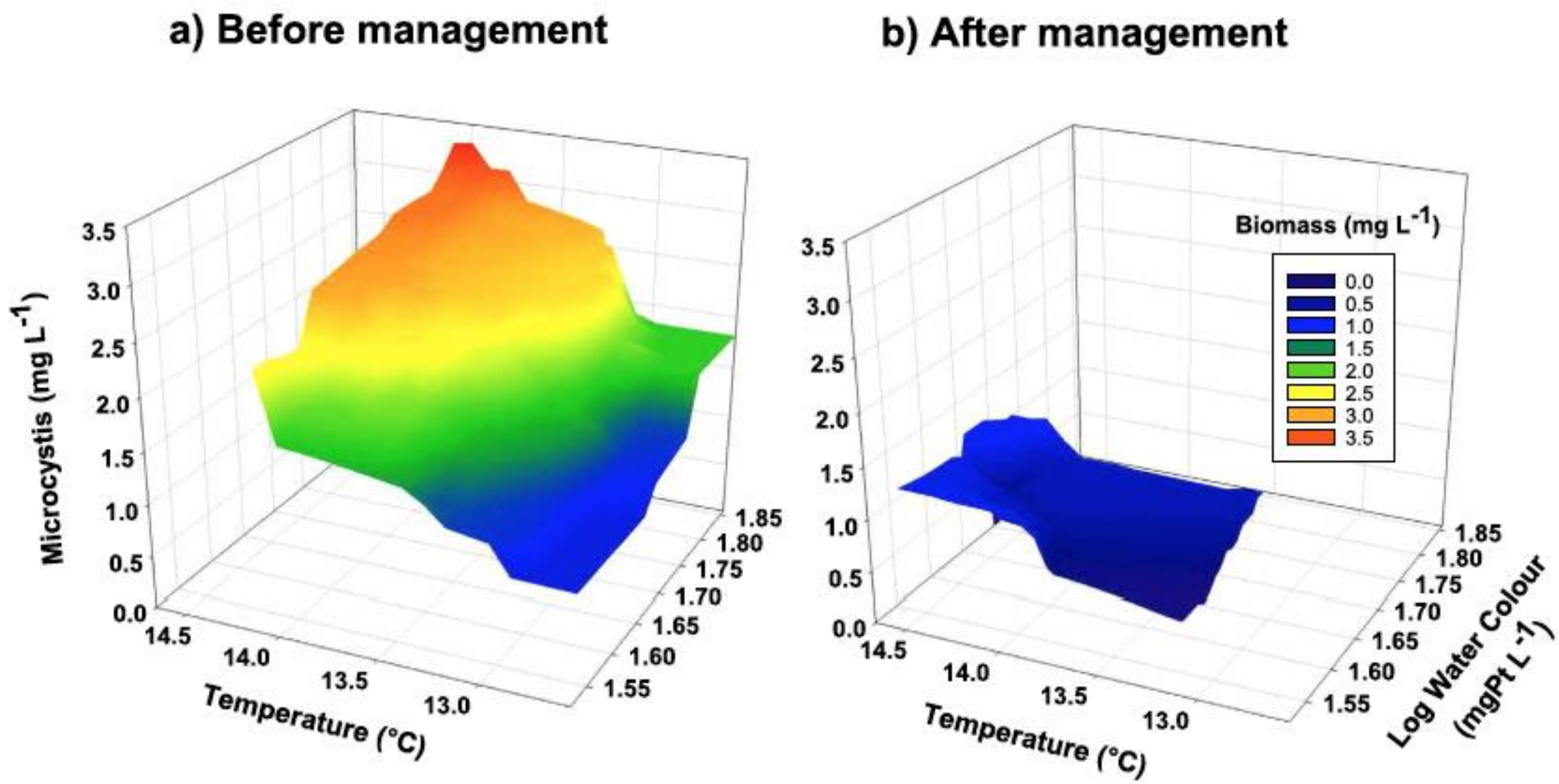
Effects of climatic warming and brownification on phytoplankton, experiments Lunz





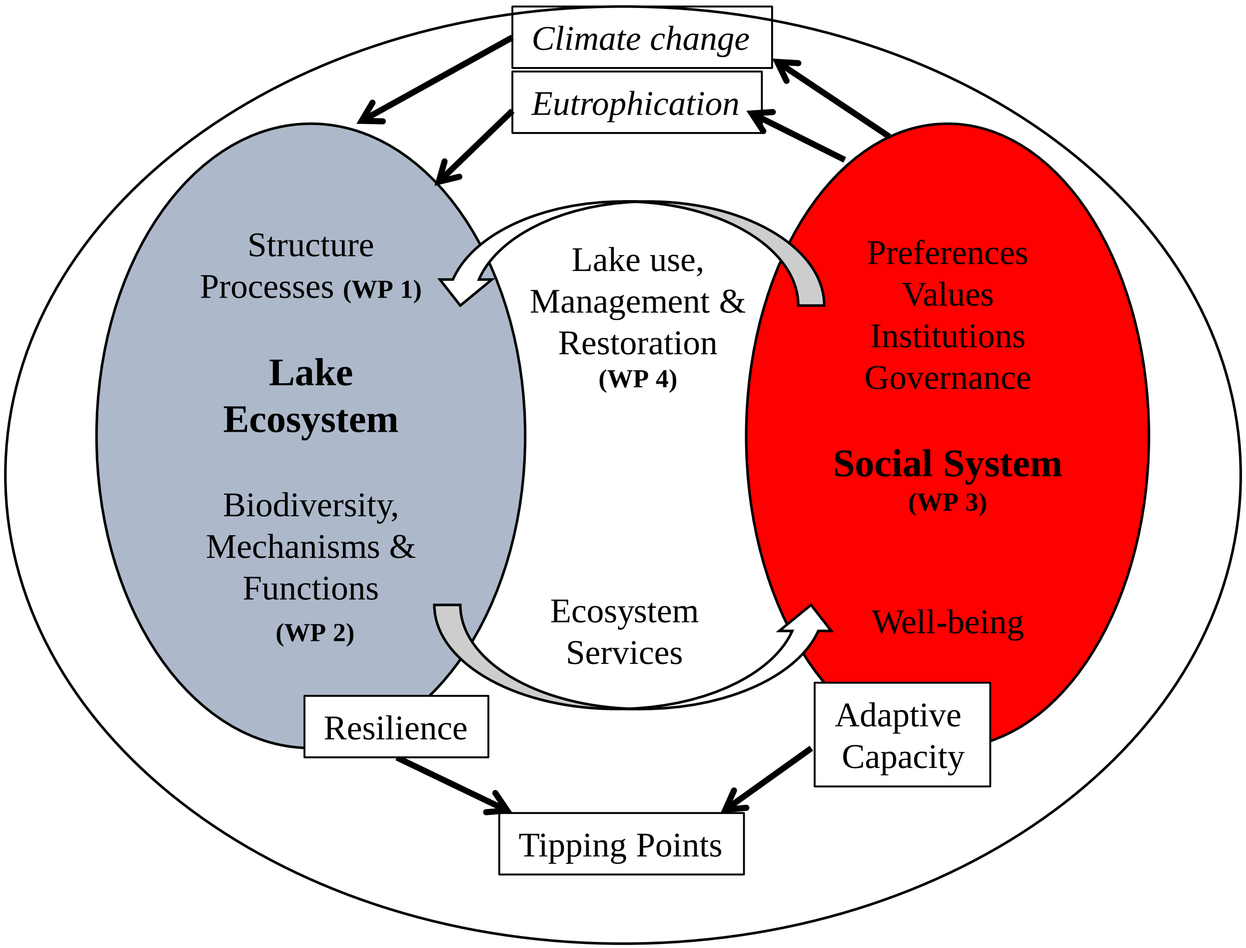
Rasconi, S., A. Gall, K. Winter, and M. J. Kainz. 2015. Increasing water temperature triggers dominance of freshwater picoplankton. Plos One:10.1371/journal.pone.0140449.

Effects of climatic warming and brownification on *Microcystis* in Lake Ringsjön, Sweden



Urrutia-Cordero, P., M. K. Ekvall, and L. A. Hansson. 2016. Local food web management increases resilience and buffers against global change effects on freshwaters. Scientific Reports **6**.

Social-ecological integration (WP 3)



Social-ecological integration (WP 3)

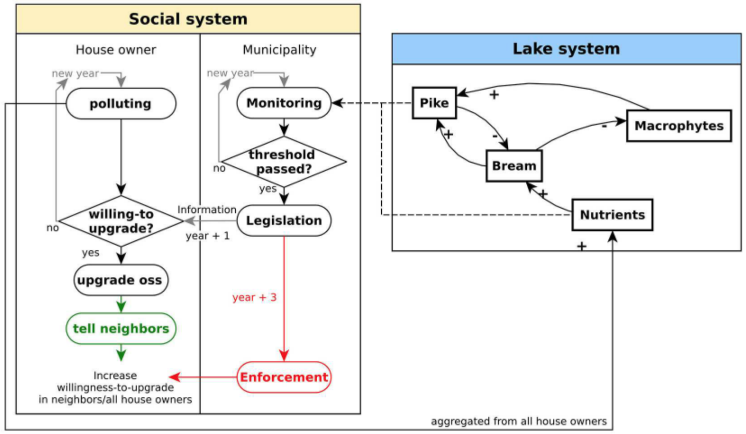


FIGURE 2 | Conceptual graph of our hybrid model with the social system represented by a flow chart and the lake system by a causal-loop diagram. The subsystems are connected via the monitoring of the municipality and the nutrient release from private house owners with insufficient onsite-sewage systems (OSS). The colored processes for the social actors show optional, additional responses that are explored and compared in our model analysis.

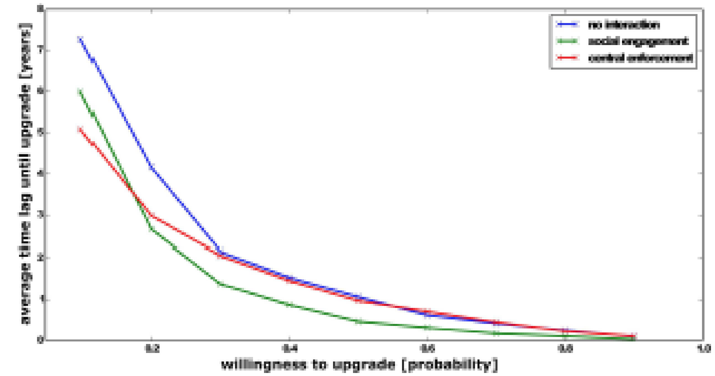


FIGURE 6 | Three scenarios showing the aggregated, average time that is necessary for private house owners to upgrade their sewage system over a range of initial values for "willingness-to-upgrade."

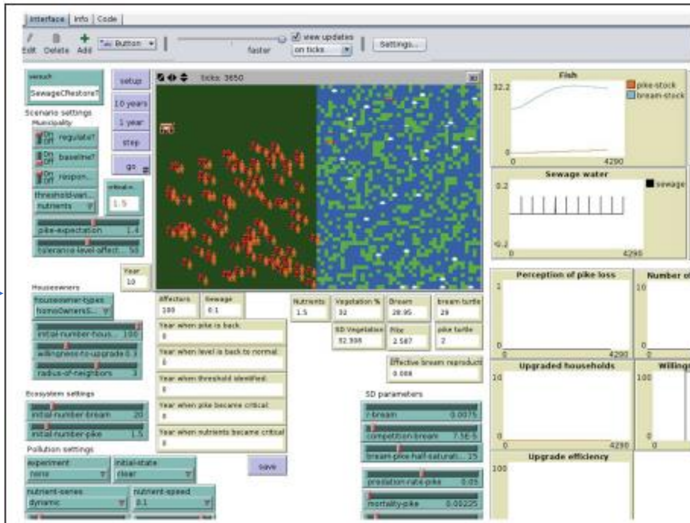


FIGURE 3 | Part of the graphical interface from our "LimnoSES" implementation in NetLogo showing in the main visualization panel house owner agents on the left side and representative agents for the fish stocks on the right side. Buttons, sliders, information boxes and diagrams are used for testing single scenarios before they were executed in a batch mode for the analyses.

Martin, R. and Schlüter, M. (2015)

>35 peer-reviewed scientific papers

Highlighted references

Gsell, A. Scharfenberger, U., Özkundakci, D., Walters, A., Hansson, L-A., Janssen, A.B.G., Nõges, P., Reid, P.C., Schindler, D.E., van Donk, E., Dakos, V., and Adrian, R (2016) Evaluating early-warning indicators of critical transitions in natural aquatic ecosystems. **Proceedings of the National Academy of Sciences** 113 (50), doi:10.1073/pnas.1608242113

Hansson, L-A, Nicolle, A., Granéli, W., Hallgren, P., Kritzberg, E., Persson, A., Björk, J., Nilsson, A., & Brönmark, C. 2013. Food chain length alters community response to global change in aquatic systems. **Nature Climate Change** 3: 228-233.

Li, Z, He, L., Zhang, H., Urrutia-Cordero, P., Ekvall, M. K., Hollander, J., Hansson, L-A. 2017. Climate warming and heat waves affect reproductive strategies and interactions between submerged macrophytes. **Global Change Biology** DOI: 10.1111/gcb.13405. (open access)

Martin, R. and Schlüter, M. 2015. Combining system dynamics and agent-based modelling to analyze social-ecological interactions – an example from modeling restoration of a shallow lake. **Frontiers in Environmental Sciences** 3:66 DOI: 10.3389/fenvs.2015.00066. (open access)

Shatwell, T. Adrian, R. and Kirillin, G. 2016. Planktonic events may cause polymictic-dimictic regime shifts in temperate lakes. **Scientific Reports** 6:24361. DOI: 10.1038/srep24361. (open access)

Urrutia-Cordero, P., Ekvall, M.K., Hansson, L-A. 2016. Local food web management increases resilience and buffers against global change effects on freshwaters. **Scientific Reports** 6: 29542 DOI:10.1038/srep29542. (open access)

(some) RDI gaps:

- Effects of heat waves on
  - lake physics (mixing),
  - carbon cycles (GHG),
  - winters (loss of ice, ...),

- Impact of climate and regional/local human impact on
  - biodiversity,
  - ecosystem services (drinking water),
  - safe provision of food from lakes and rivers (fish),

- Synergistic effects of climate and other environmental processes (eutrophication, browning) on biodiversity and overall ecosystems response.