



Long-term dynamics of biota in moorland
pools (“vennen”)

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Nature

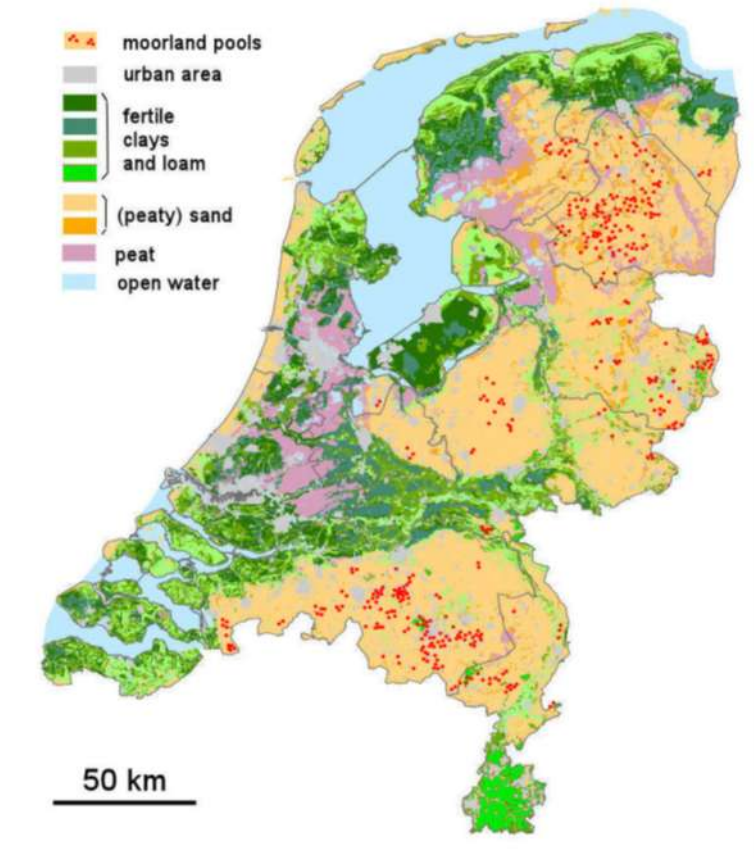
Adrienne Mertens, Grontmij

Commissioned partly by regional waterauthorities Reest
& Wieden, Vallei & Veluwe, Dommel, Province of
Drenthe and Aquon

Badplaats Hoog Buurlo, Gerritsflesch.

Moorland pools

- shallow, originally oligo- to mesotrophic, low-alkalinity lakes
- sandy soils
- fluctuating water table
- largely fed by rainwater
- very susceptible to acidification
- characteristic biocommunities




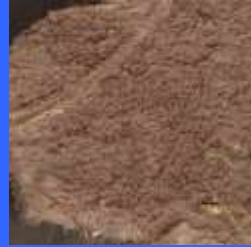


● = moorland pool



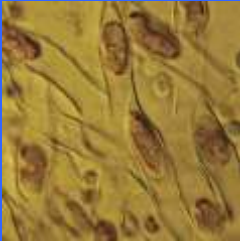

Many biota in moorland pools

few long-term studies

Macrophytes

angiosp.	mosses	charophytes	filam. algae
			

Microphytes (Algae)

desmids	diatoms	chrysoph.	cyanobact.
			

Fauna

zoöplankton



macro-invertebr.



amphibia



dragonflies



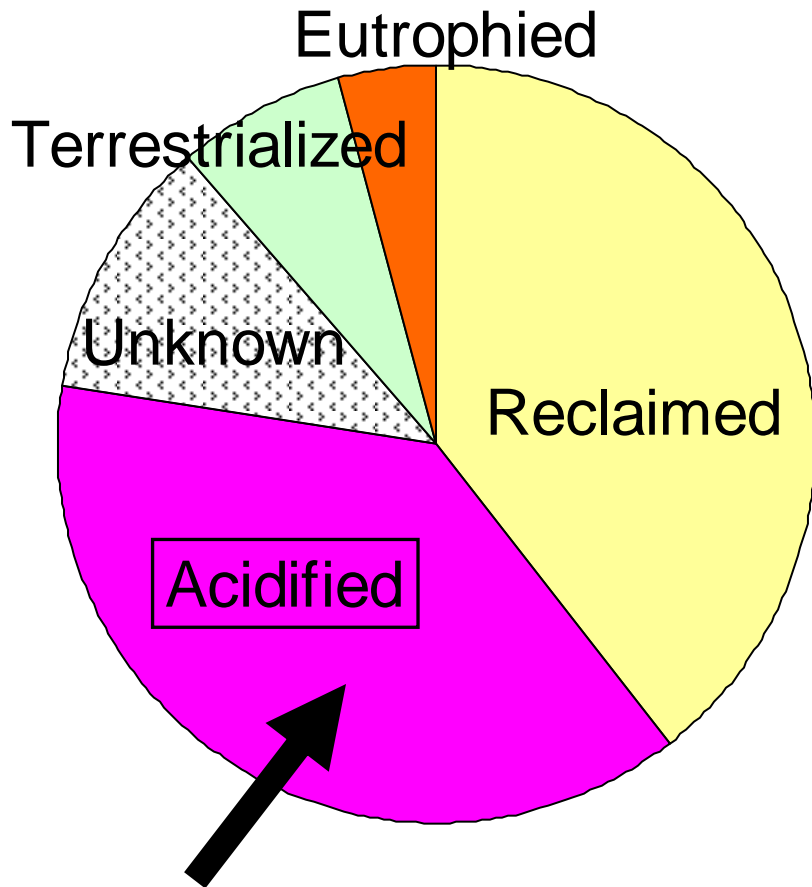
fishes



birds



Threats



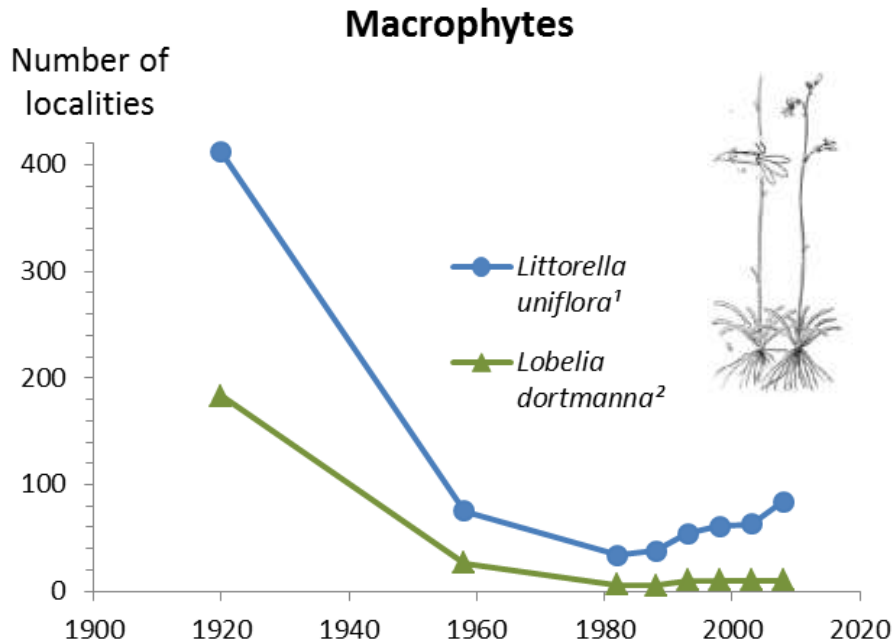
Gertie Arts 1988

“Solution”



Stefan Verwey 1983 (Volkskrant)

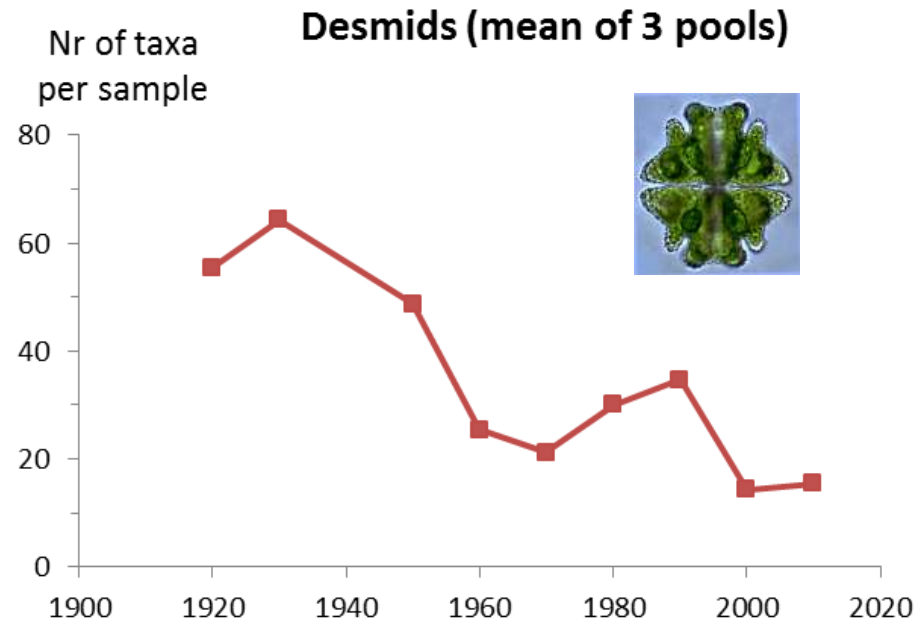
Macrophytes and desmid algae



¹Shoreweed, "Oeverkruid",

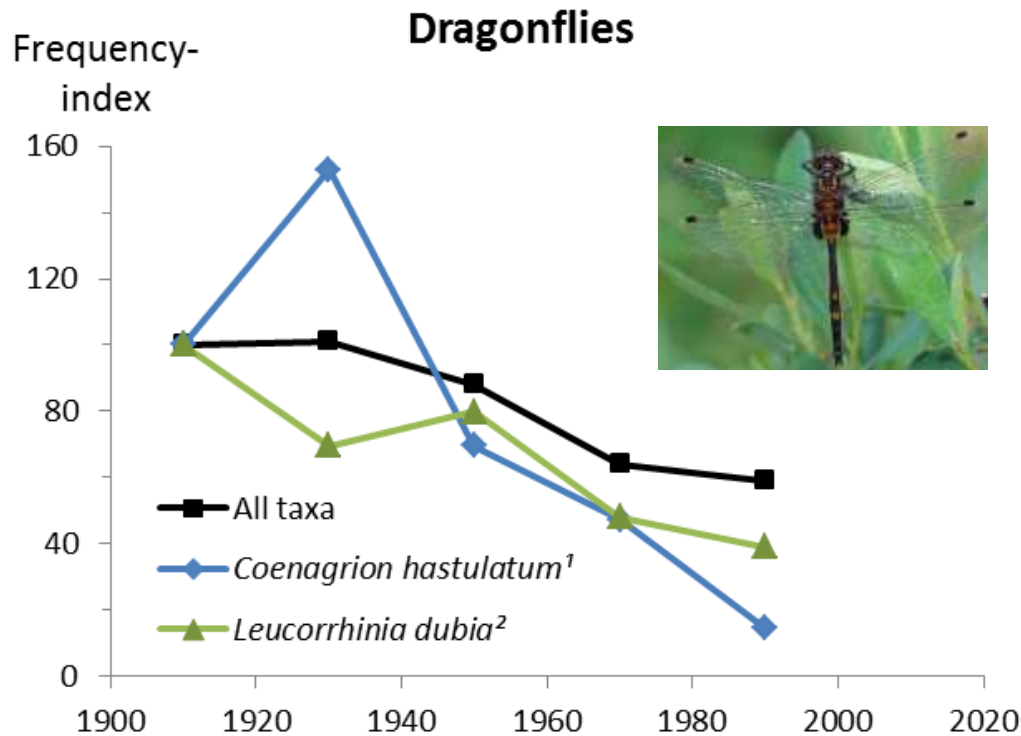
²Water Lobelia. "Waterlobelia"

(Arts 1989, Arts et al. 2002,
www.compendiumvoordeleefomgeving.nl)



(H. van Dam, A. van Tooren & J. Meesters
(unpubl.))

Other groups



¹Spearhead Bluets, "Speerwaterjuffer",

²White-faced Dragonfly, "Venwitsnuitlibel"

www.compendiumvoordeleefomgeving.nl

No continuous long-term data

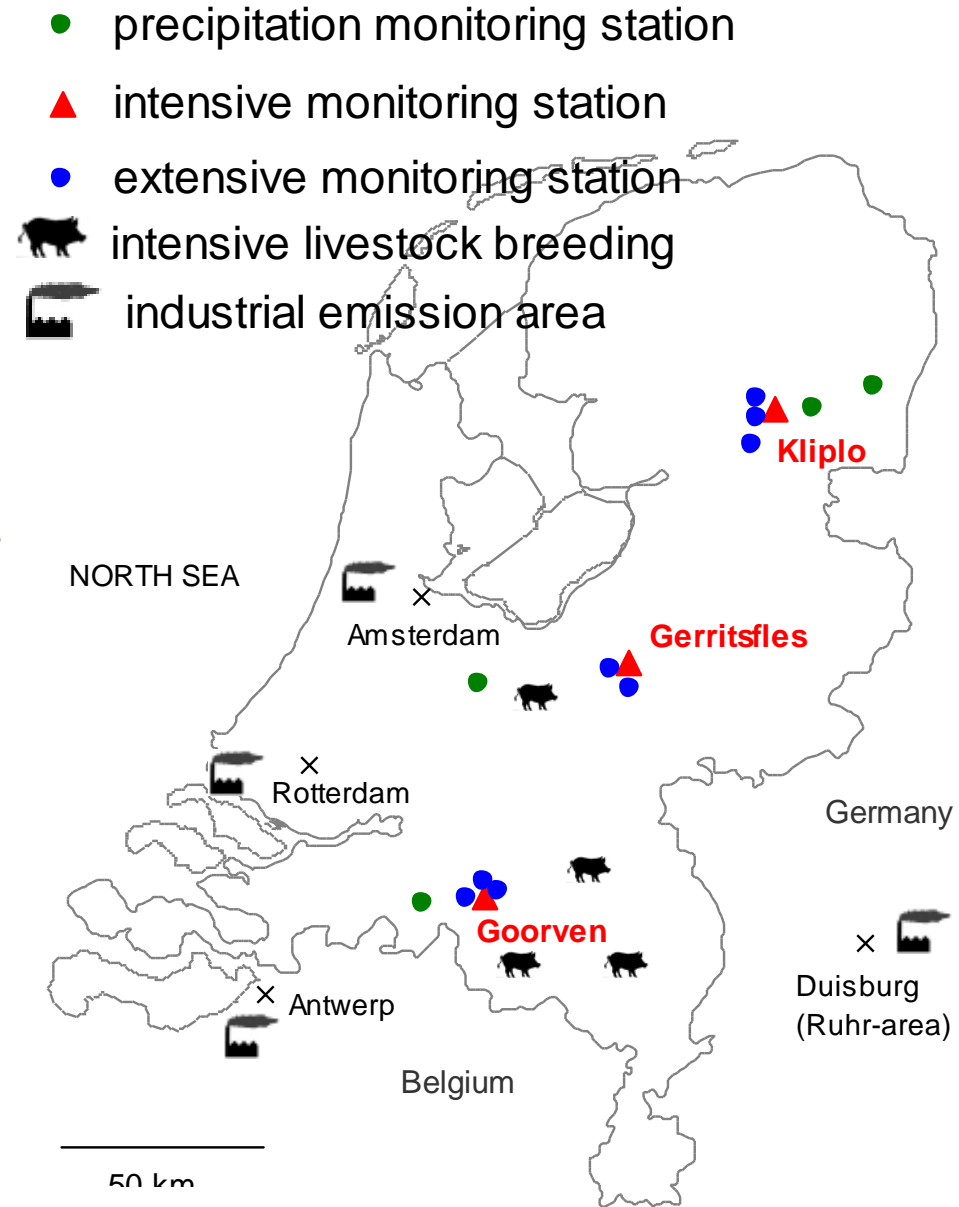
- Fishes
- Amphibia
- Chironomids
- Zooplankton
- Phytoplankton

Continuous long-term data

- Diatoms
- Chemistry

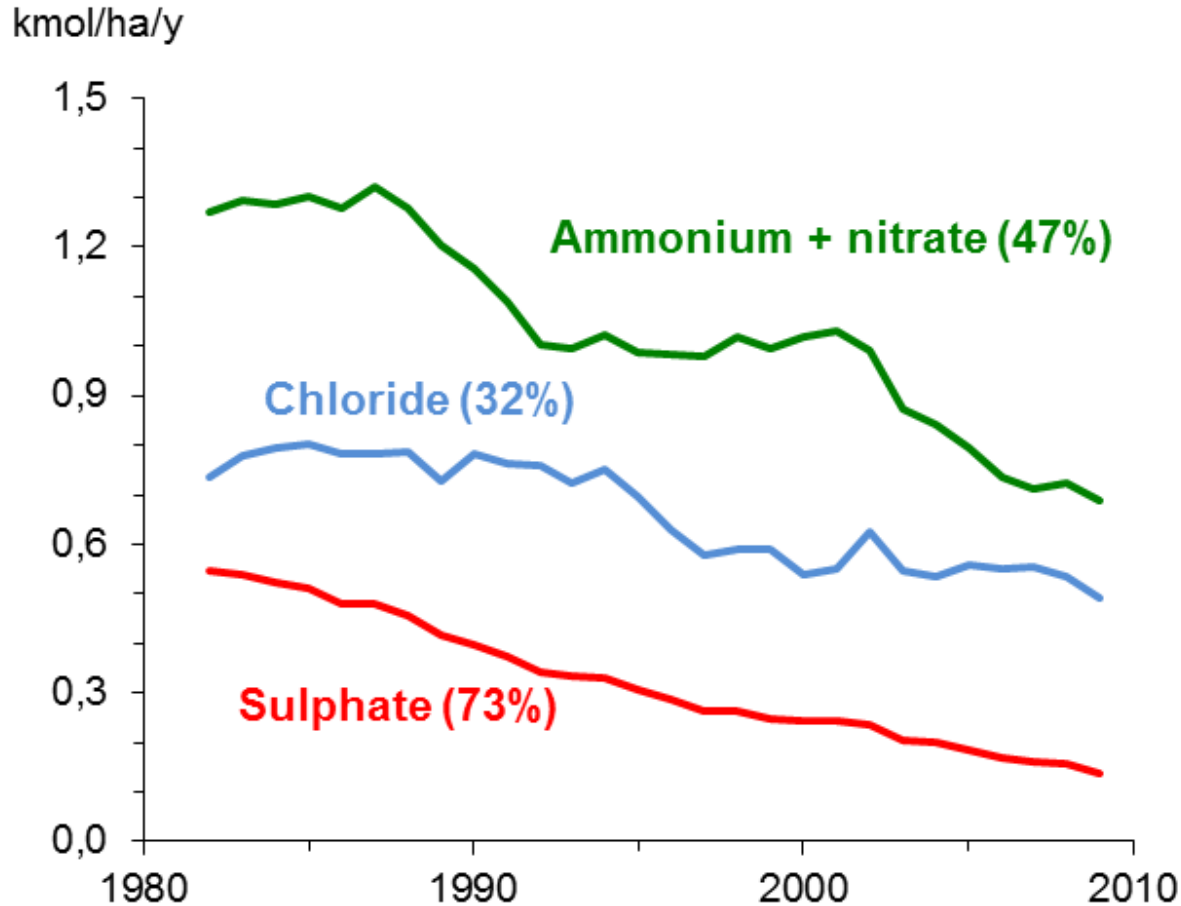
Monitoring recovery from acidification

- Since 1978 4 samples each year for diatoms and chemistry in 3 pools () and each 4 years 1 sample in 8 extra pools ().
- Reference samples from ca 1920.
- Land-use nearby now often pine forest: about 1920 much more heathland and sand dunes.



Decreased atmospheric deposition

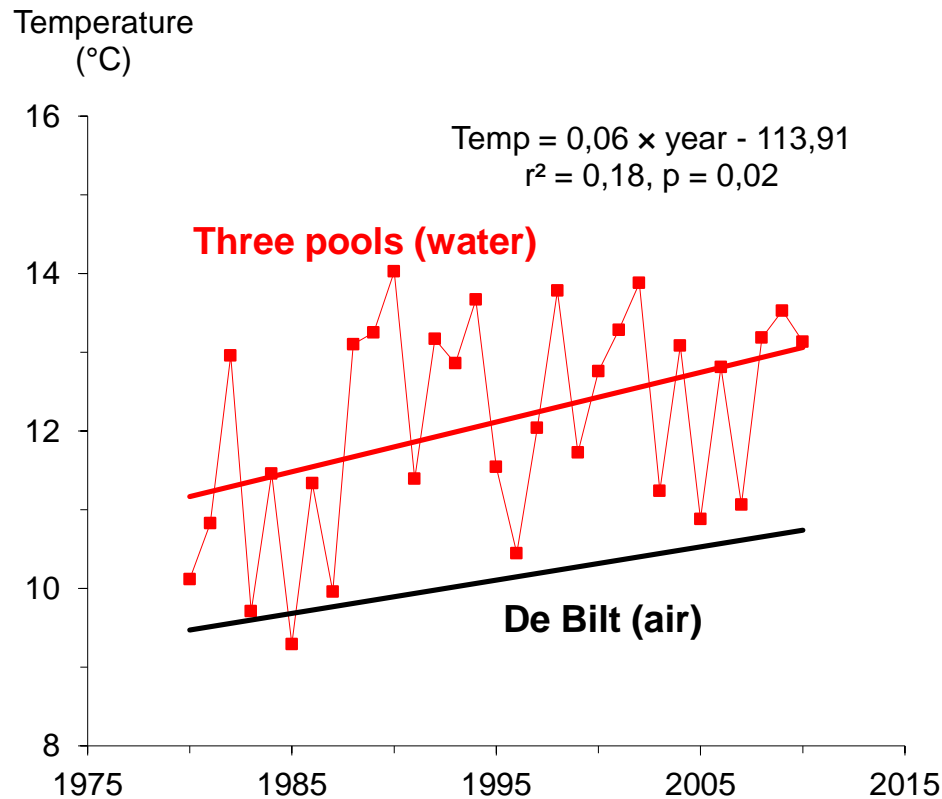
5-year moving averages stations Gilze, De Bit, Witteveen/Valthermond



(National Institute for Public Health and Environment)

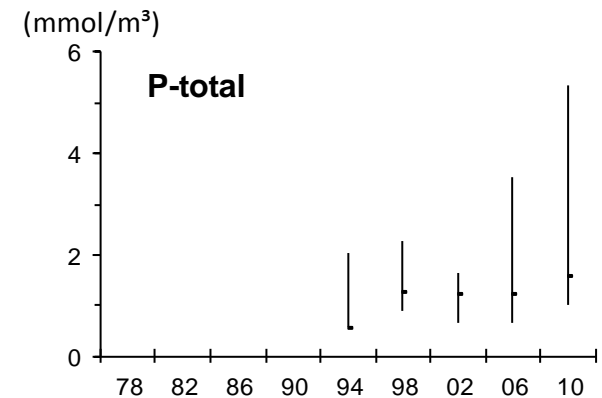
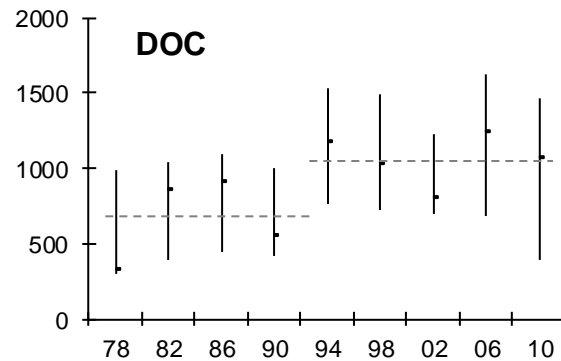
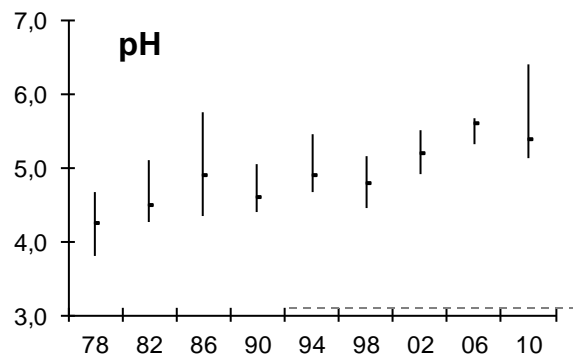
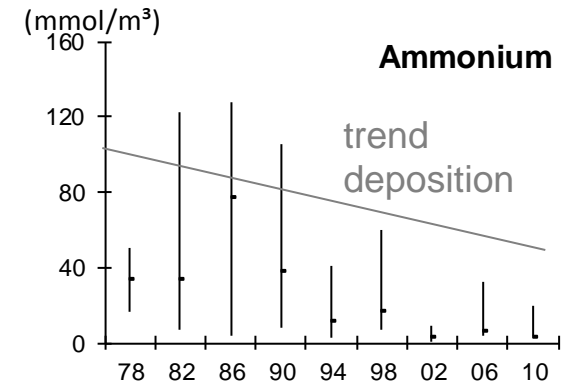
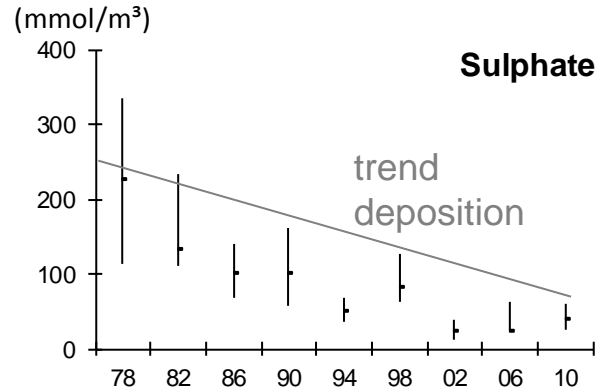
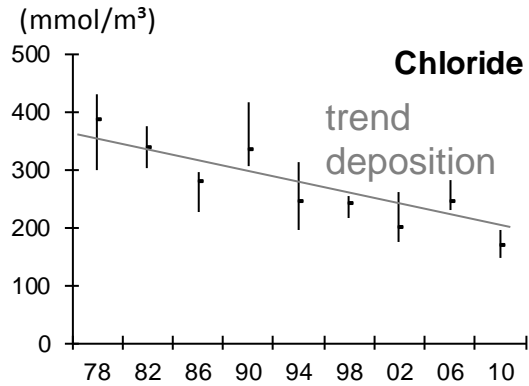
Temperature increase 2° C

Average values of 4 measurements each year (Feb. 10, May 10, Aug. 10 Nov. 10) in 3 pools.

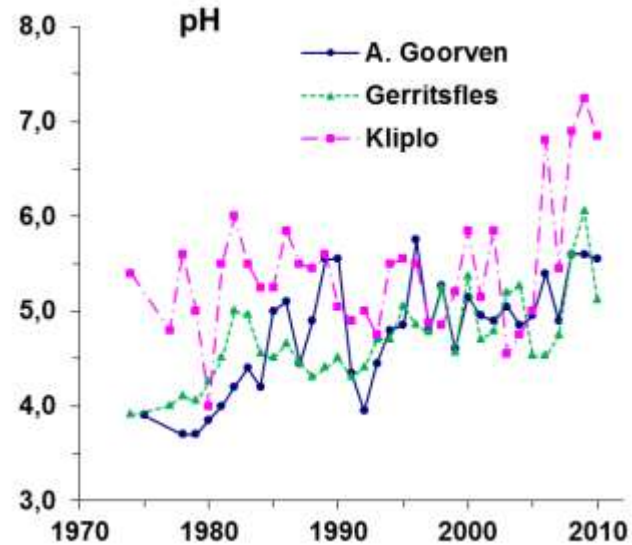
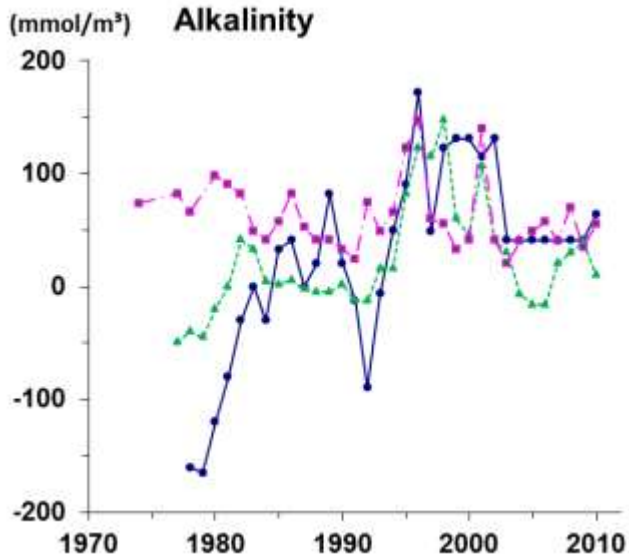
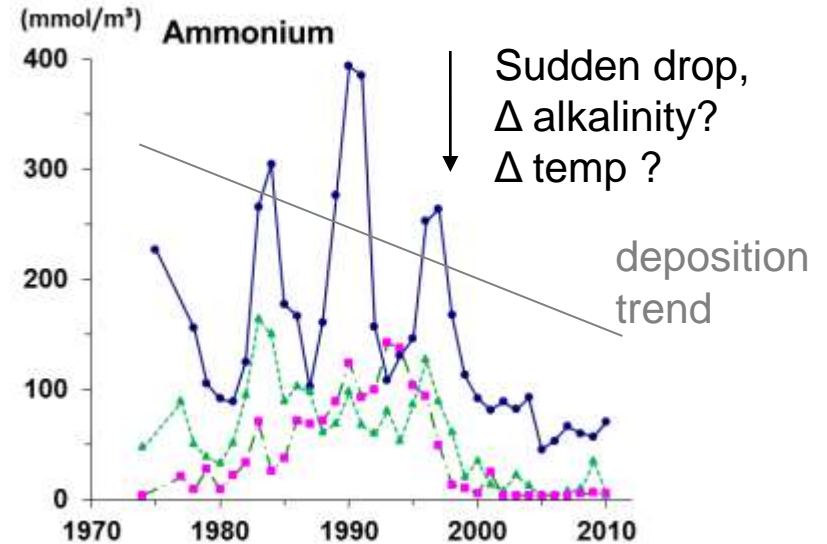
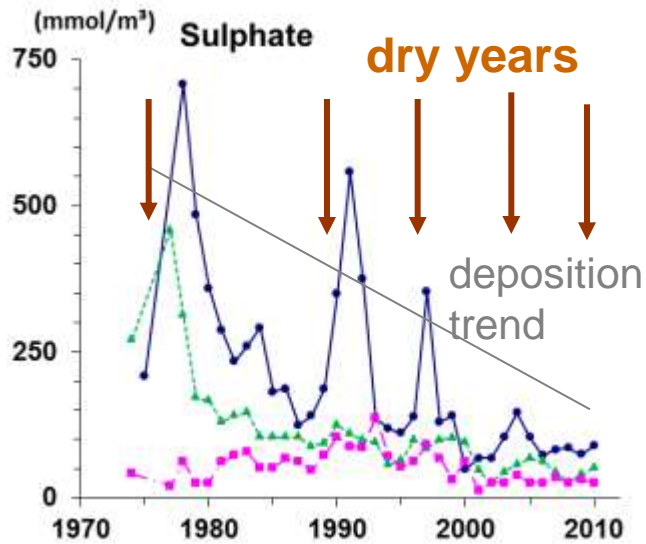


Changes in 11 pools

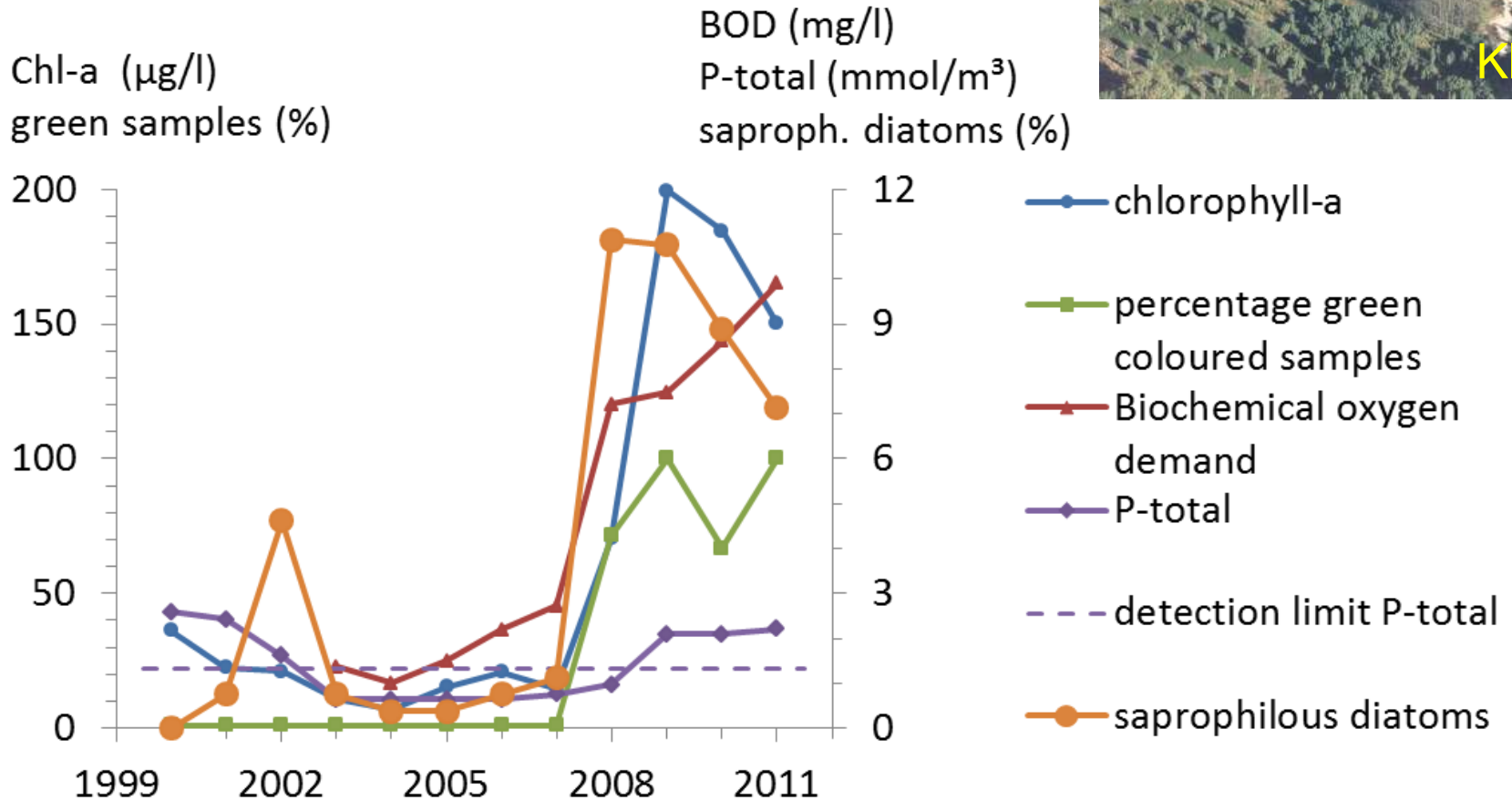
Medians and 25- and 75-percentiles



Yearly medians chemistry 3 pools



Internal eutrophication



Kliplo: diatoms mean of two samples per year,
other variables yearly means of monthly samples

What is happening?

Decomposition of organic material by intensive sulphate reduction and denitrification, enhanced by temperature increase



increase of alkalinity and pH and internal eutrophication by sulphate release from sediments

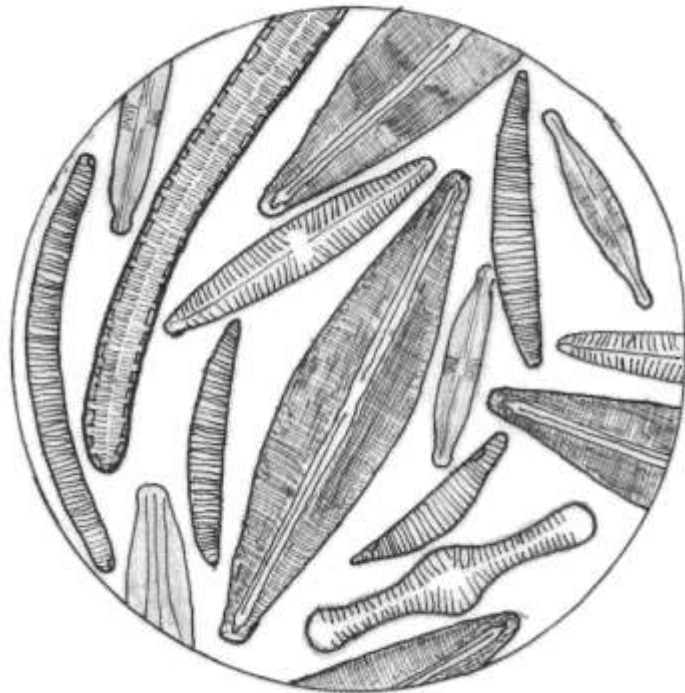
Diatom methods



Plankton tows over bottom and through macrophytes

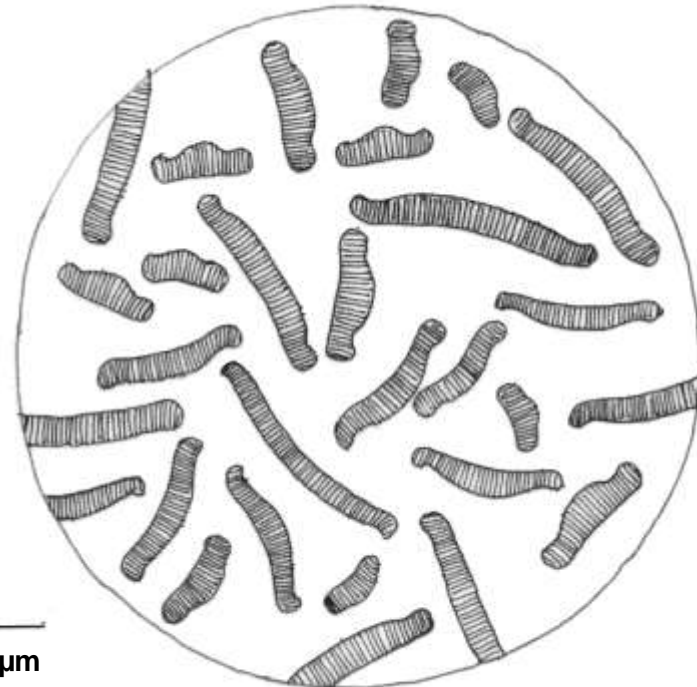
Identification of 400 specimens

Strong decrease of diversity by acidification



1920

Mixture of taxa from acid and low-alkalinity water



1978

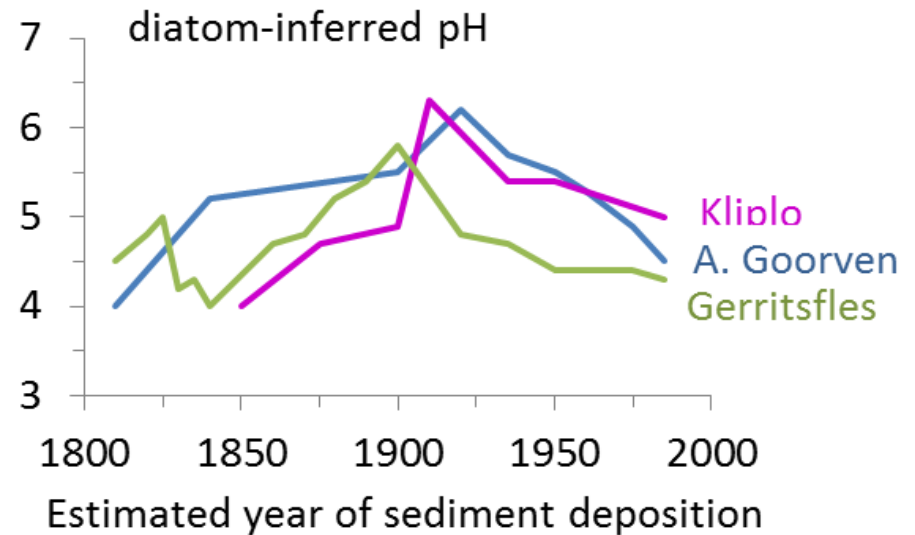
'Monoculture' of 1 acidobiontic species (*Eunotia exigua*)

10 μ m

Intermezzo: Retrospective monitoring (paleolimnology)



(Van Dam et al. 1987, 1988)



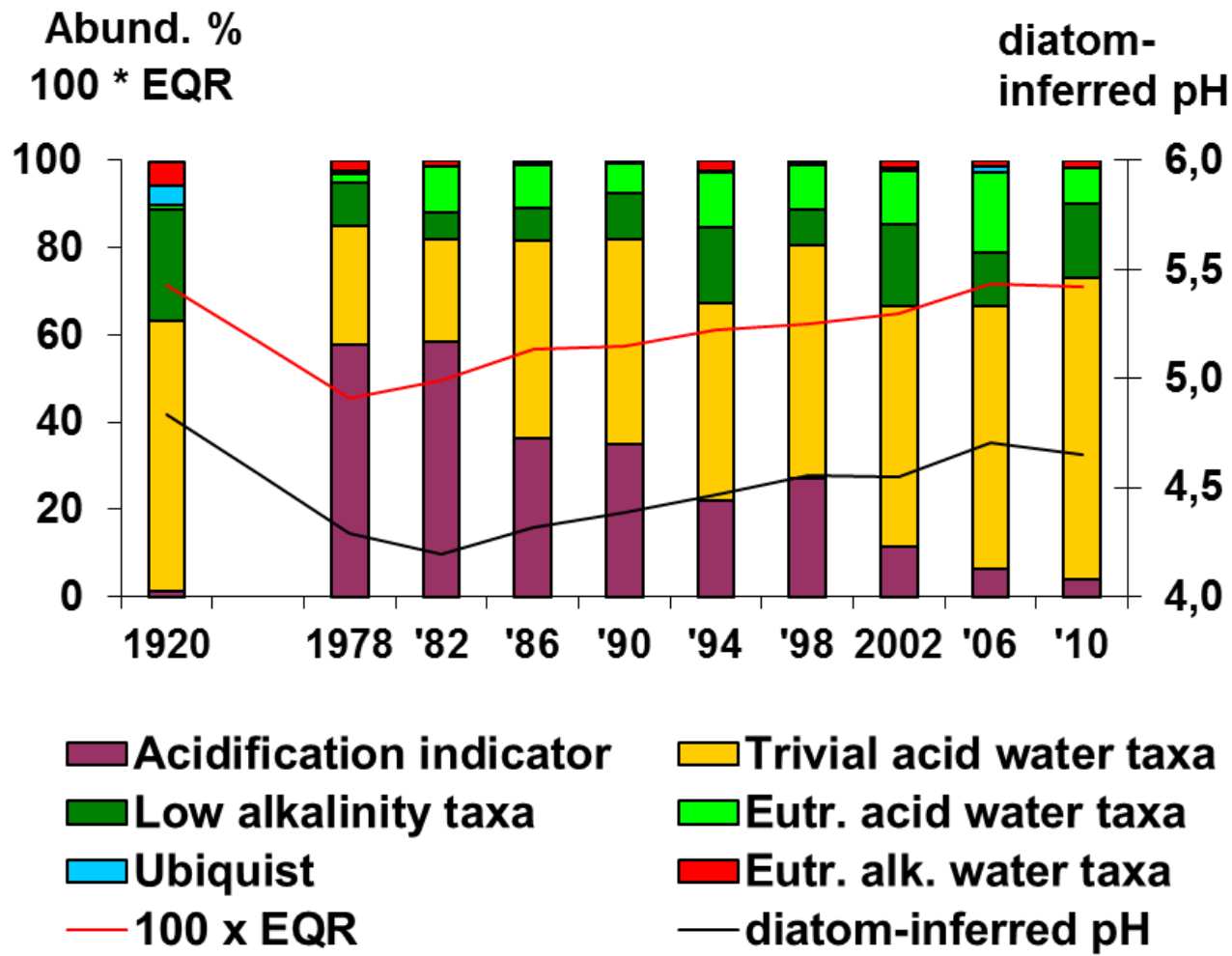
- 1800: humic acids
- 19th cent.: sheep washing, duck decoy, etc.
- 20th cent.: acidification (mineral acids)

Ecological groups of diatoms

- acidification indicator (*Eunotia exigua*)
- trivial taxa from acid waters (e.g. *E. rhomboidea*, *Frustulia saxonica*)
- low alkalinity taxa (**targets**) (e.g. ***Navicula leptostriata*, *Brachysira procera*, *Tabellaria flocculosa***)
- ubiquist (*Achnantheidium minutissimum*)
- taxa from acid, eutrophic water (*Eunotia naegelii*, *E. nymanniana*, *Nav. mediocris*, *E. meisteri*)
- taxa from alkaline, eutrophic water and saprophilous diatoms (e.g. *Cocconeis placentula*, *Nitzschia gracilis*)

Changes of ecological groups of diatoms

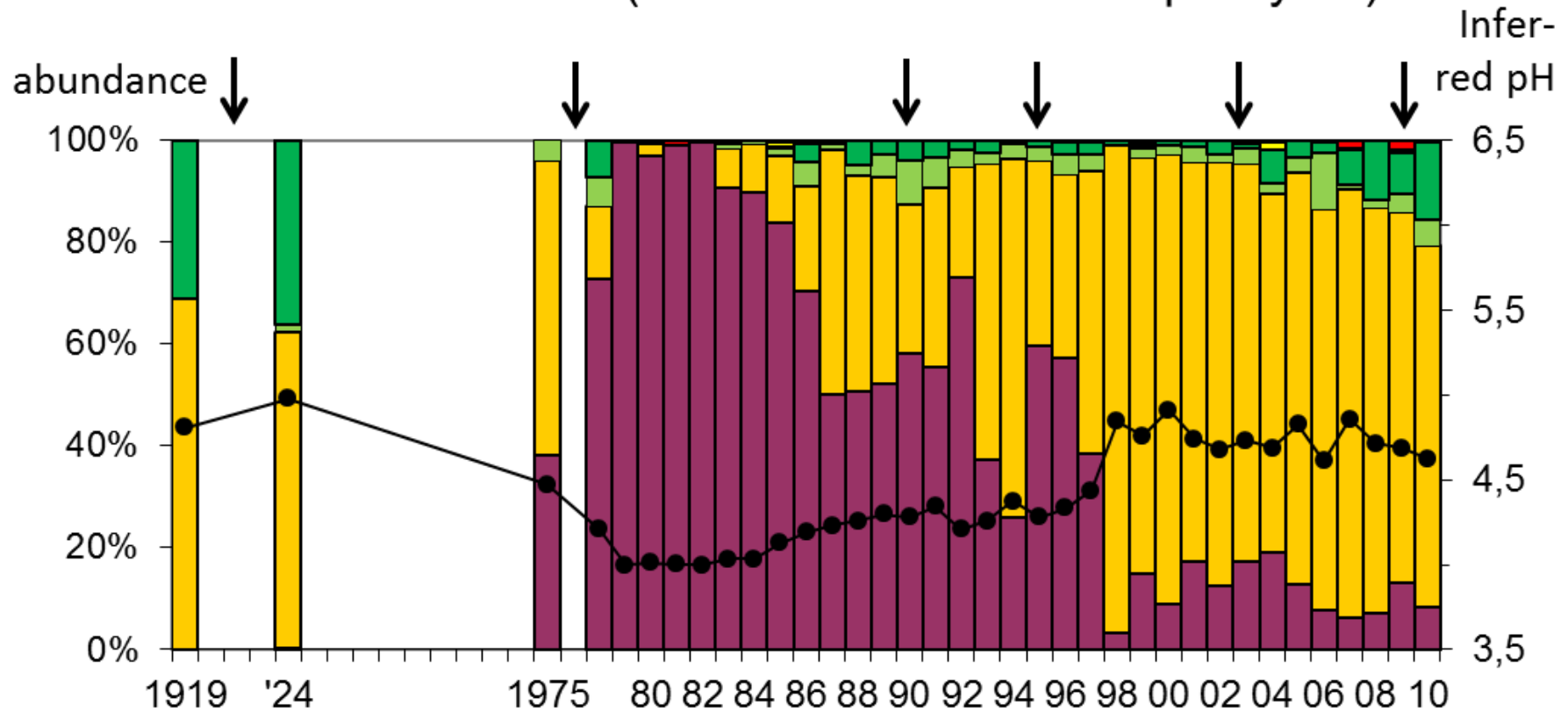
(11 isolated pools, 103 samples, 190 taxa)



EQR: Ecological Quality Ratio (Water Framework Directive)

Recovery from acidification, impact of dry years

Achterste Goorven (means of 2 diatom samples/year)



Acidif. ind.

Low alkalinity

Inferred pH

Trivial acid

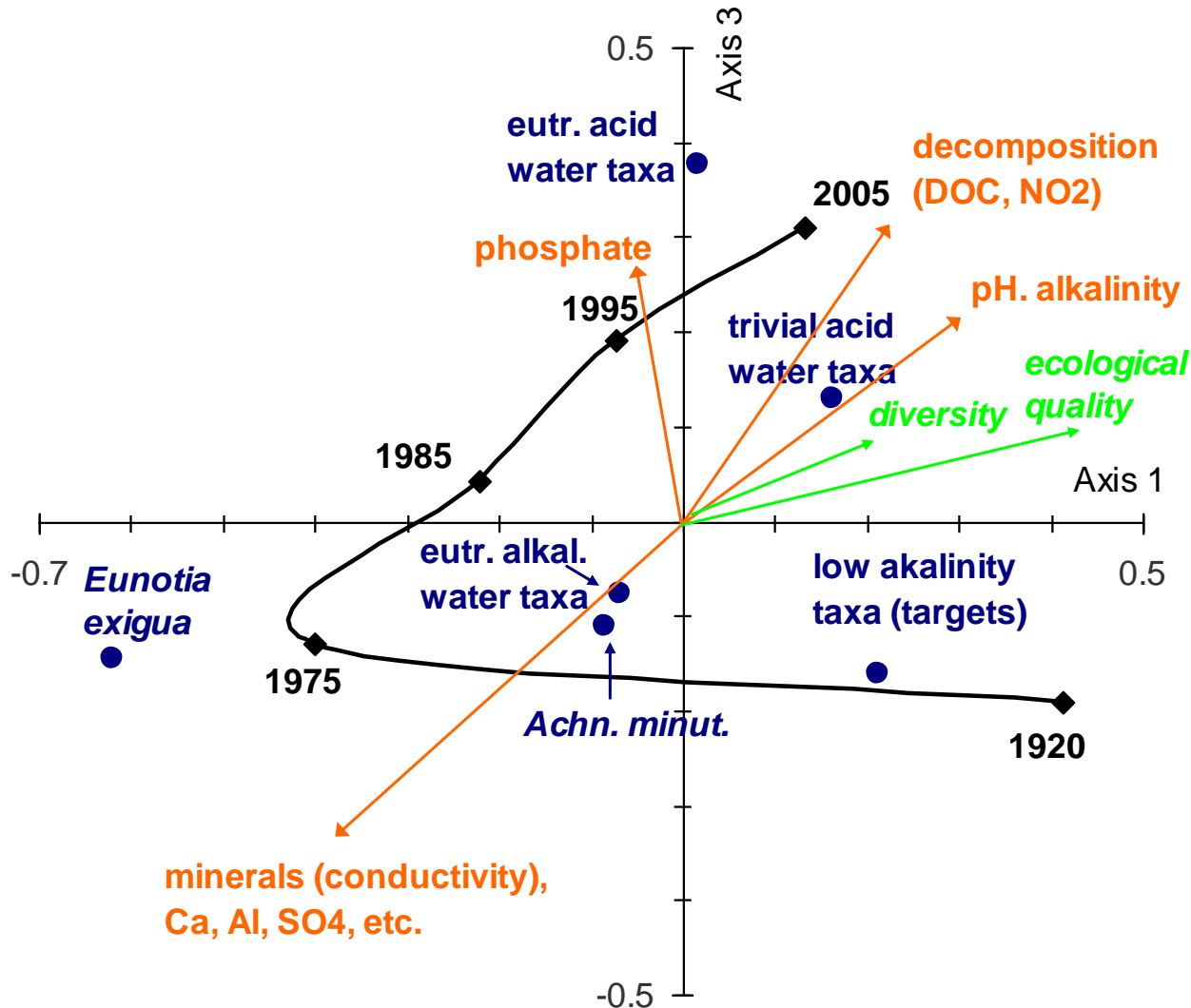
Ubiquist

↓ dry year

Acid, eutroph.

Saprophilous

Ordination of 142 diatom samples from 11 isolated moorland pools: recovery is partial



Samples clustered in 10 year periods

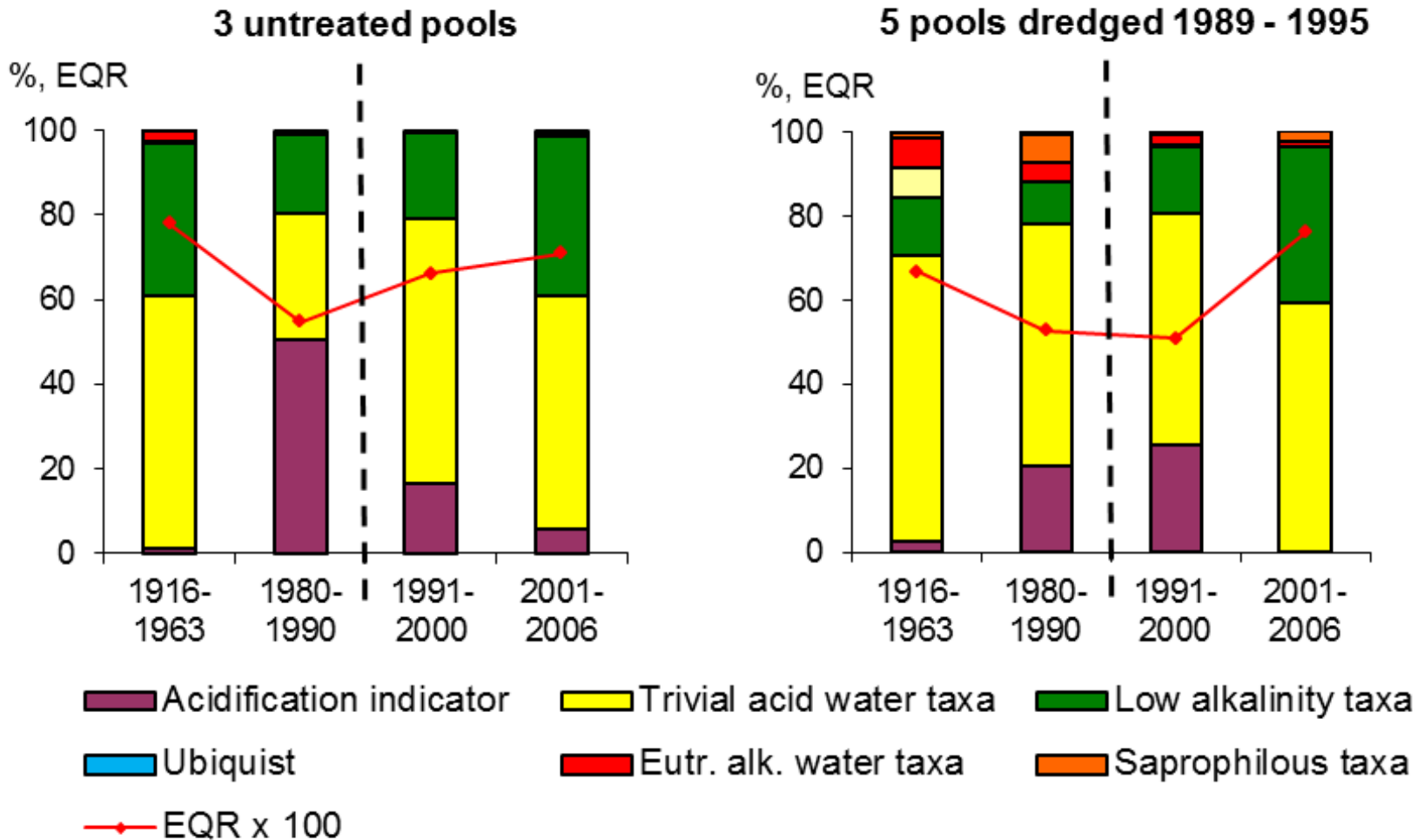
Taxa clustered in 6 groups

Correlations with environmental variables

Diversity: number of taxa and dominance

Quality:
Ecological
Quality Ratio

Reference for restored pools



E. Brouwer et al. 2009. Effectiviteit van herstelbeheer in vennen en duinplassen op de middellange termijn. Rapport Directie Kennis en Innovatie, Ministerie LNV

History and future of this network

Period	Institute	Funding	Programme	Chemistry labs	Diatom anal.	Project leader
1978 - 1994	RIN, IBN-DLO	Ministry of Agriculture and Nature, EU	UN/ECE Air Pollution Convention	Hydron	A. Mertens (RIN, IBN)	H. van Dam (RIN, IBN)
1995 - 1996	AquaSense	Ministry of the Environment	UN/ECE Air Pollution Convention	Hydron	A. Mertens (AquaSense)	H. van Dam (AquaSense)
1997 - 2006	AquaSense - Grontmij	Private foundations, AquaSense, H. van Dam, A. Mertens, Regional Water Authorities	-	Regional Water Authorities	A. Mertens (AquaSense - Grontmij)	H. van Dam (AquaSense - Grontmij)
2006 - 2012	Herman van Dam	Regional Water Authorities, Province of Drenthe, H. van Dam, A. Mertens, Grontmij	-	Regional Water Authorities	A. Mertens (Grontmij)	H. van Dam (private consultant)
> 2012	?	?	?	?	?	?

After 1996 year-to-year (no) funding, depending on the ideas of regional water managers. They are mainly interested in short-term results. It seems to be not always obvious that system knowledge is necessary to prevent unnecessary and costly measures.

A few conclusions

- Chemistry, particularly alkalinity, has much improved by decrease of sulphur and nitrogen deposition.
- Taxonomic composition of diatoms has improved after an acidification maximum around 1980, but differs essentially from the reference situation in 1920, probably due to internal eutrophication
- The network was established to monitor the recovery of acidification, but, unforeseen, climatic change appears to be an important ecological factor
- Intensive and standardized sampling is necessary to retrieve the essential processes and changes over the years
- Funding of projects like these is extremely difficult
- This information has proven to be necessary as background information for restoration projects