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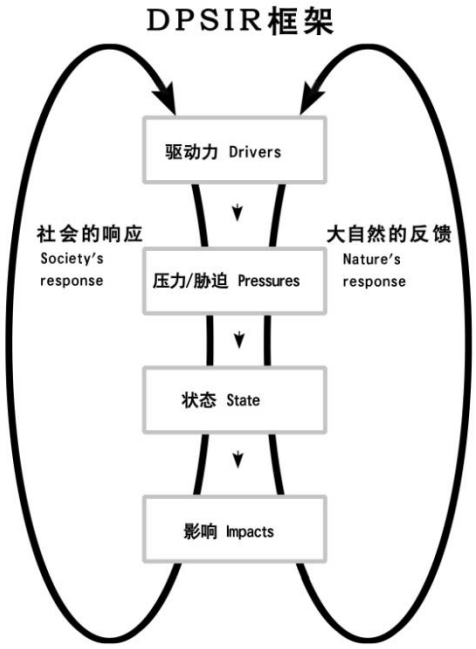
University of Oslo

Environmental chemistry group

- Interdisciplinary Approach to Environmental Research

Prof. Rolf D. Vogt
Dept. of Chemistry,
University of Oslo



Understand the links

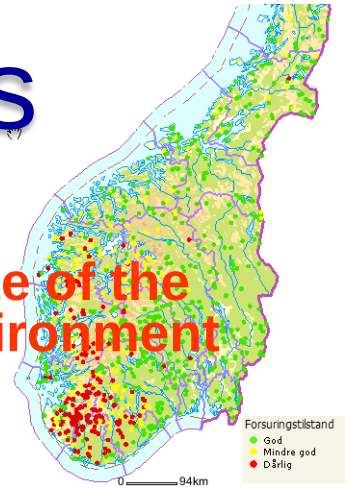
Drivers

Pressures

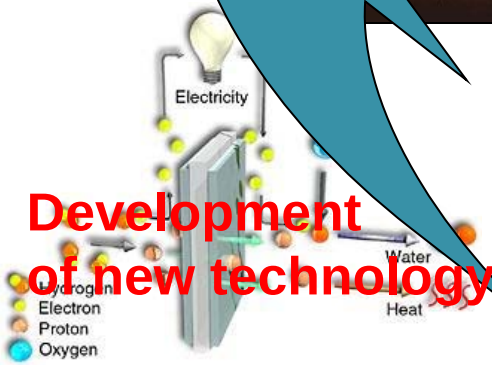
Dispersion

Long range transport

Transformation



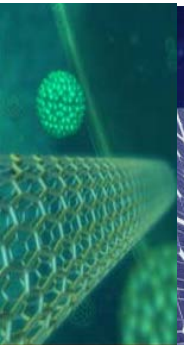
State of the environment



Development of new technology

Responces

Effects & Interactions

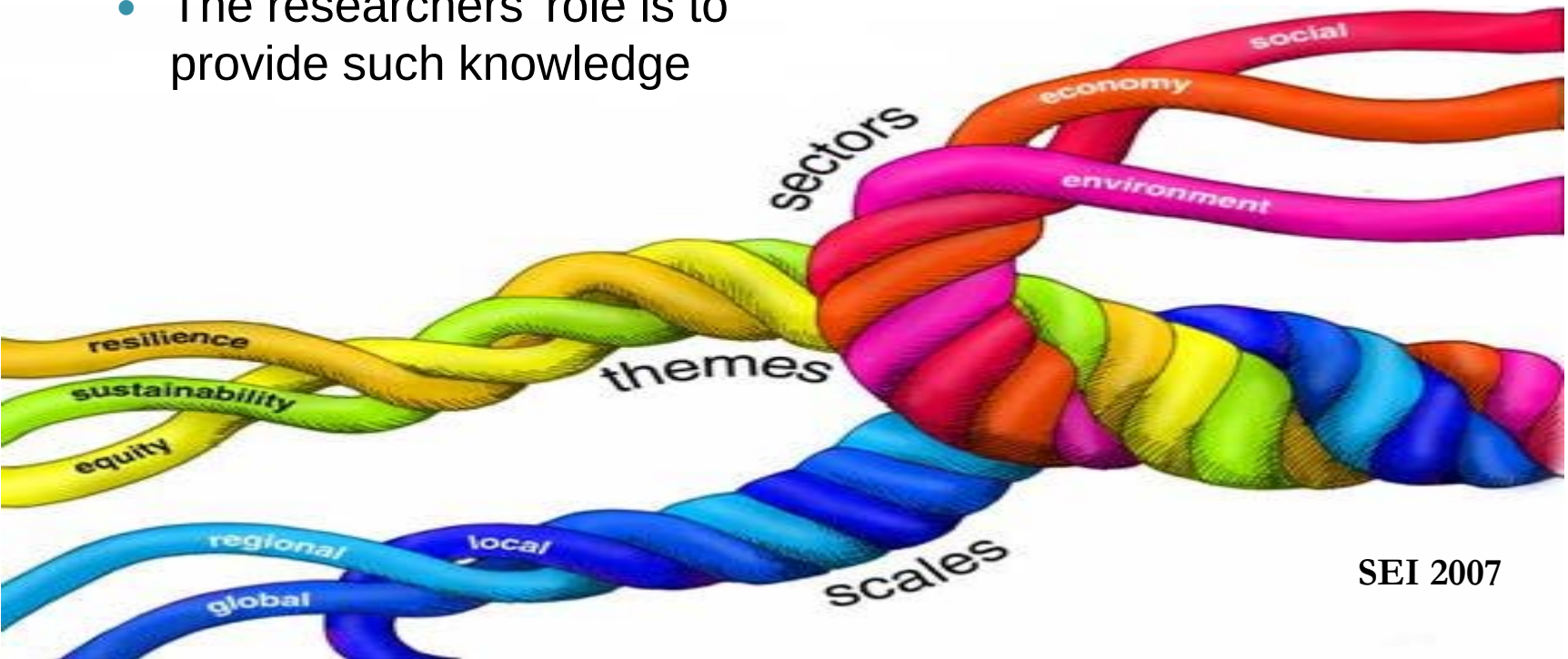


Abatement measures

Legislation

Holistic approach

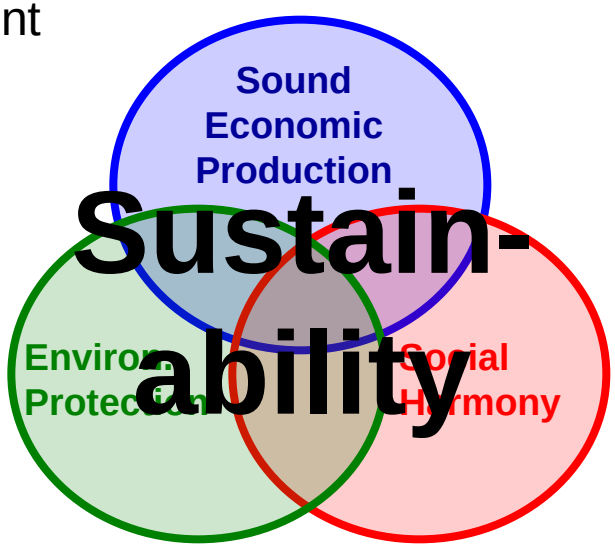
- A necessary basis for good decision-making and effective environmental policies on our increasingly complex and integrated environmental challenges
- The researchers' role is to provide such knowledge



SEI 2007

Sustainable development

- Enable decision makers
  to establish **knowledge** based abatement strategies
  on environmental challenges
  thereby **ensuring** a sustainable development



Sustainability implies
positive solutions for all components

Needs for environmental protection
are balanced against limitation
posed by social harmony and
economic production

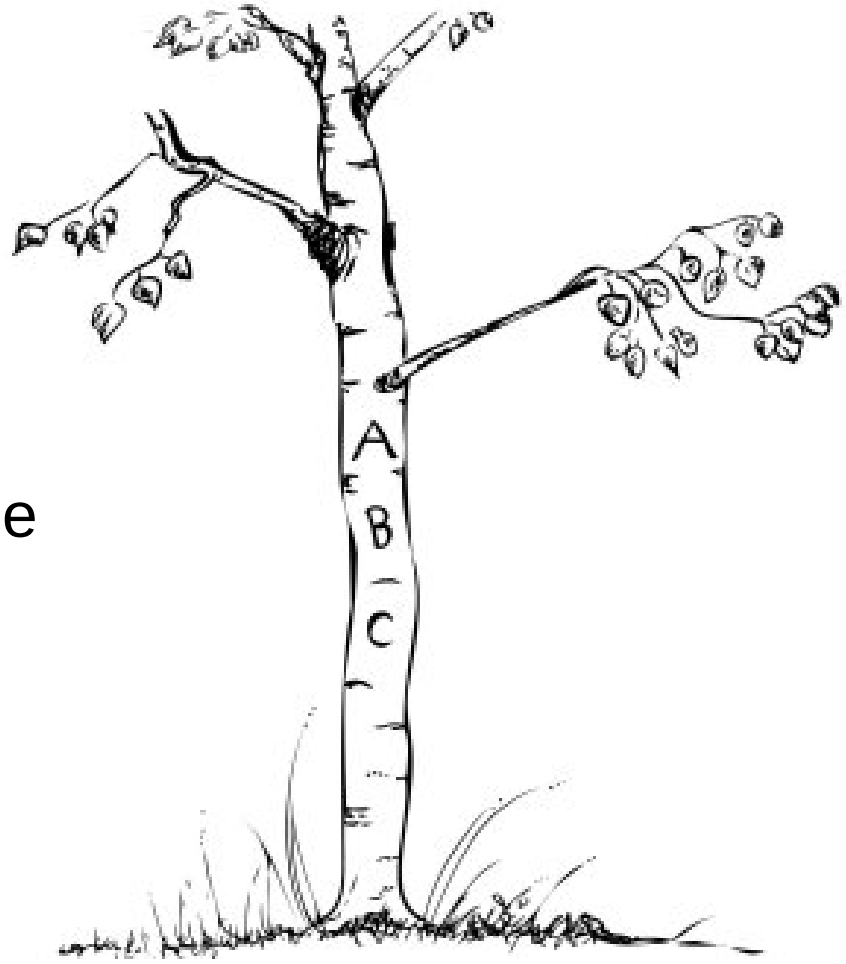
- To obtain this knowledge, **integrated assessment studies**
  of the ways pollution and inadequate resource management
  affect the environment and humans are required.

Call for Trans-disciplinary environmental knowledge assessment

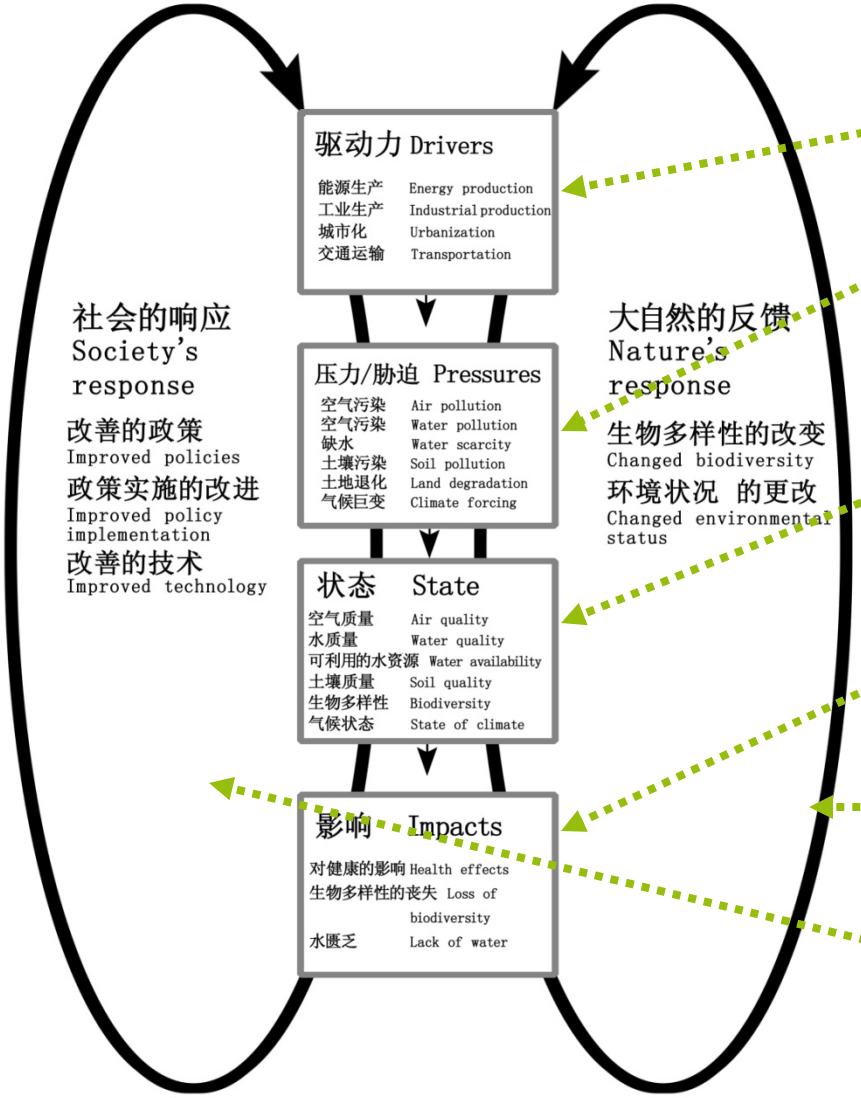
Key factor: Environmental literacy

Transdiciplinarity allows for **mutual learning**

- **Facilitating the necessary environmental literacy**
- Generating robust knowledge as a **basis** for changes in practices and societal transitions



DPSIR框架理论模型



Drivers: Population growth, consumption, energy, travel

Pressures: Side effects of drivers (Emissions to air and water)

State: Resources, Pollution, Chemical & Biological state of Water, Air, Soil

Impacts: Climate change, eutrophication, vegetation damage

Nature's Response: Changed biodiversity, change in eco-system services, feedback mechanisms

Society's Response: Adjustments, environmental protection, adaptation, environmental technology, policy, legislations, taxes

Science to policy interaction - Integrated assessment

Monitoring

Modelling

Assessment

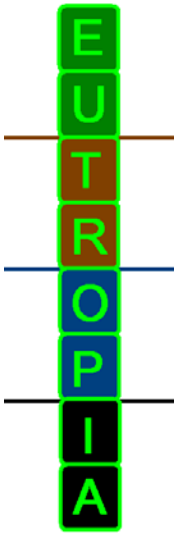
Critical Loads

- Communication with decision makers facilitated by Critical Load maps

  "The deposition below which significant harmful effects do not occur according to present knowledge"

Tidbits and experiances from our interdiciplinary research

- Acid rain
  - IMPACTS
- Eutropication
  - Eutropia
  - SinoTropia
- SINCIERE



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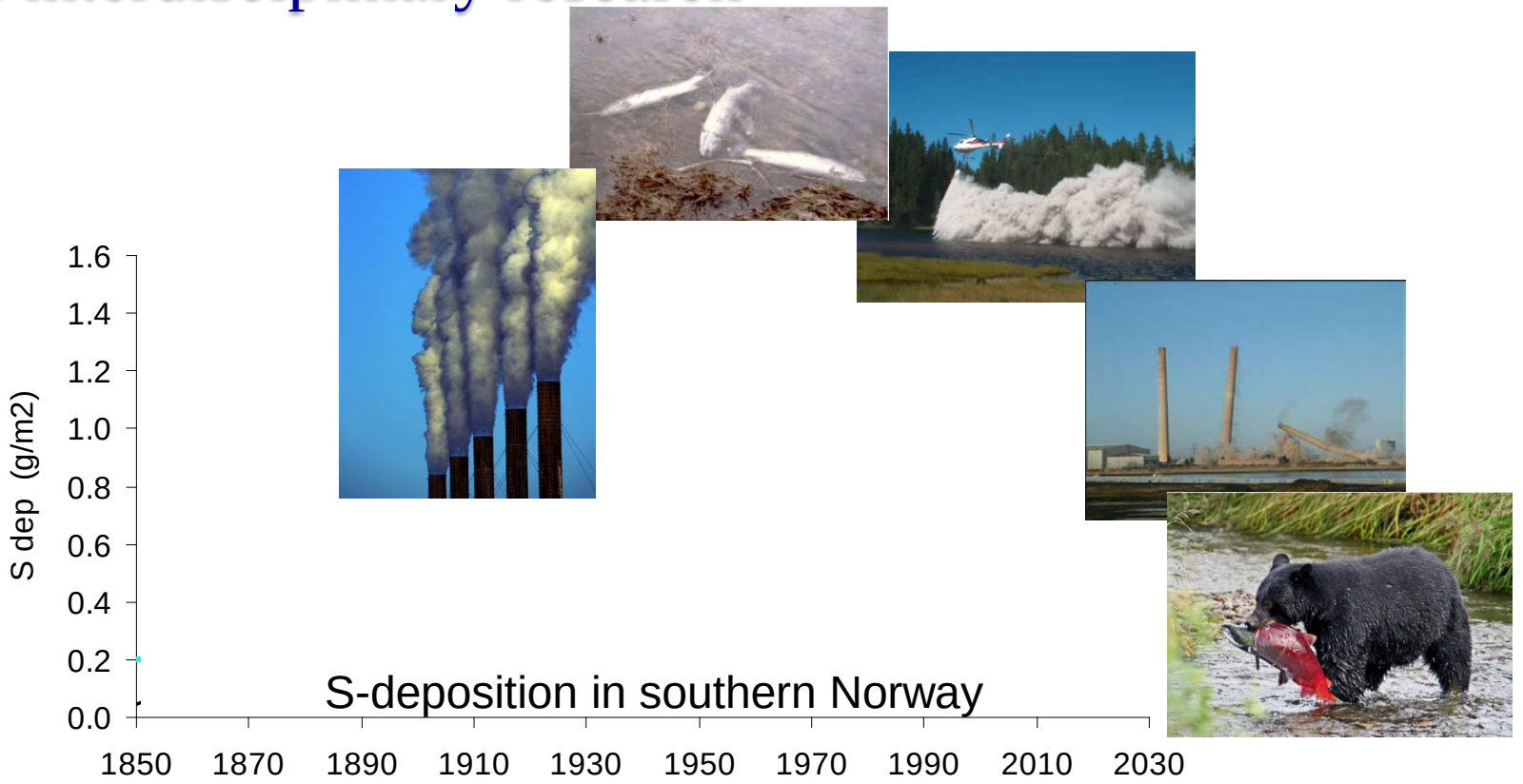
IMPACTS

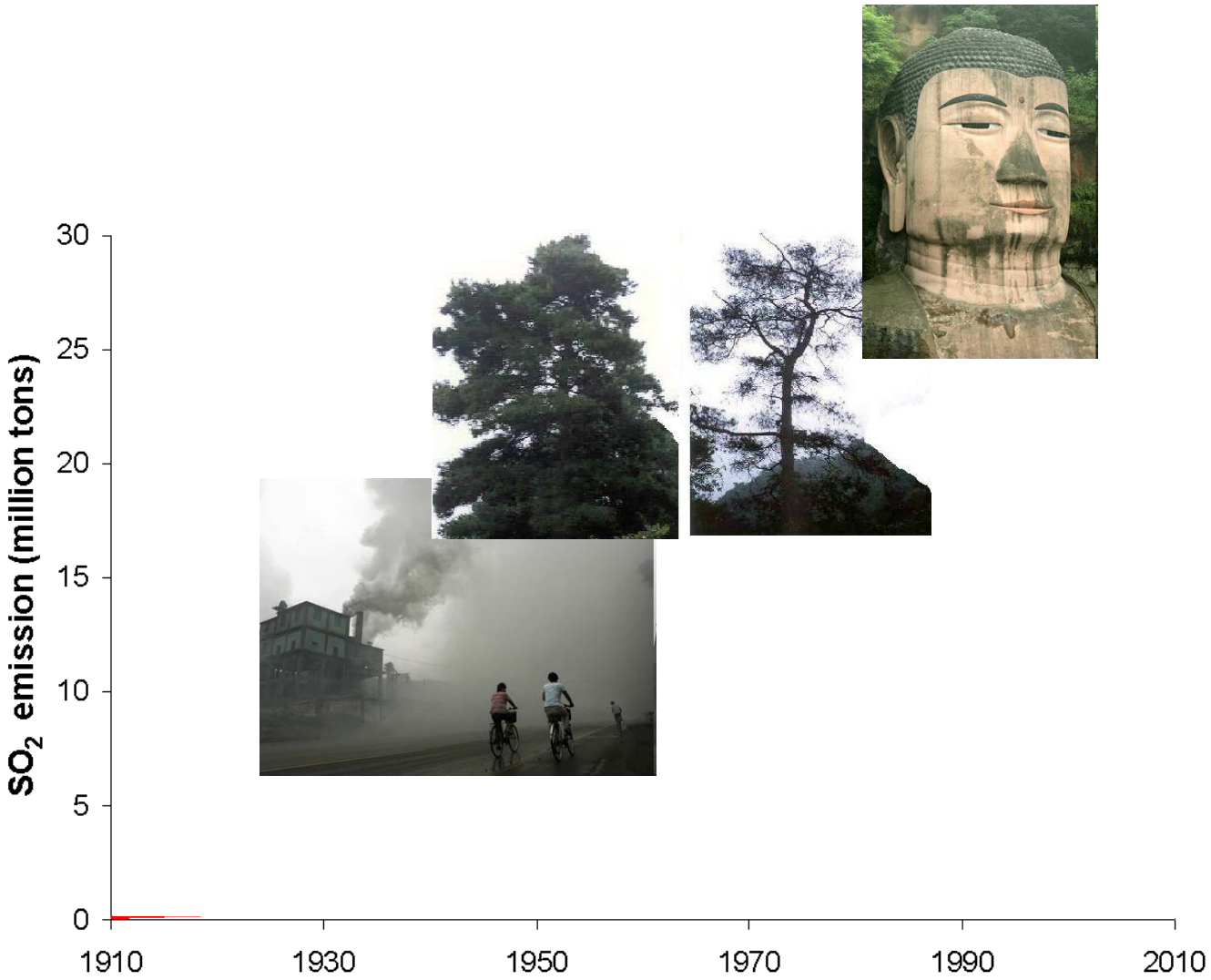
Integrated
Monitoring（监测）
Program on
Acidification of
Chinese
Terrestrial（陆生）
Systems

Acid rain – An European success story of interdisciplinary research



- Emission reduction **protocols** were developed as more **knowledge** was acquired from integrated **monitoring** programs
  - finalizing in the Gothenburg multi pollutant – multi effect protocol

What about China?



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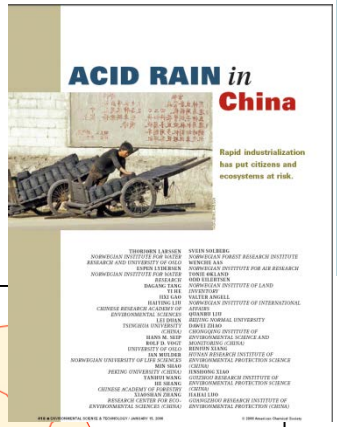
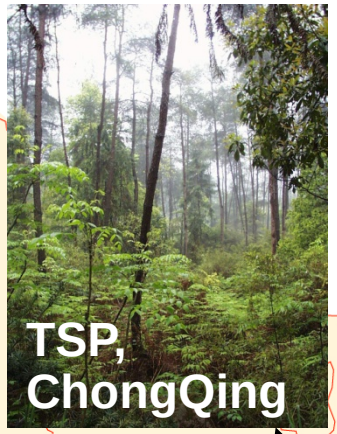
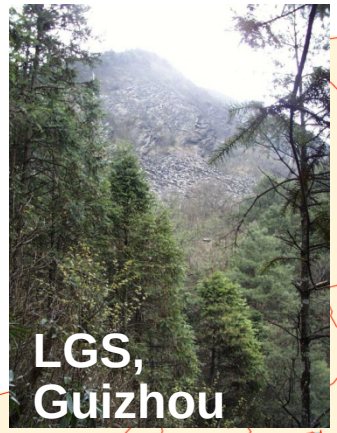
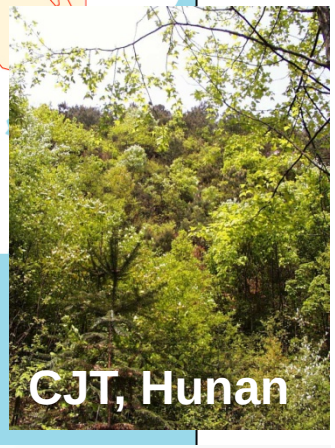
The IMPACT project: Integrated Acid rain research at 5 sensitive sites



IMPACTS







TSP
LCG
LGS
CJT
LXH

Precipitation pH isolines
- pH < 5.6
- pH < 5.0
- pH < 4.5
- pH < 4.0

Area of acid rain control zone

Location of the IMPACTS monitoring sites

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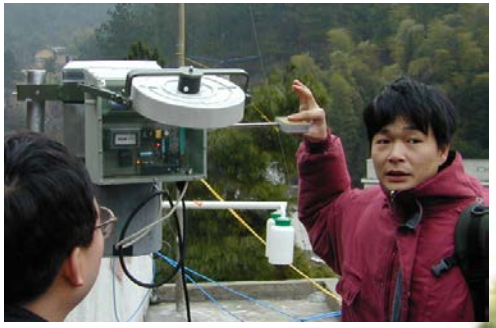
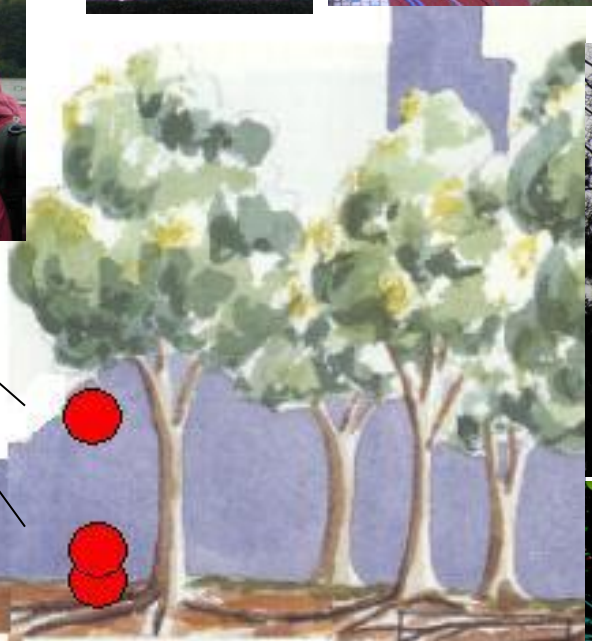
Multidiciplinary
Integrated research

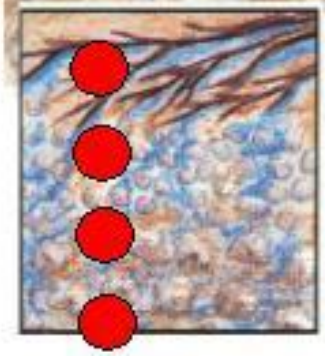
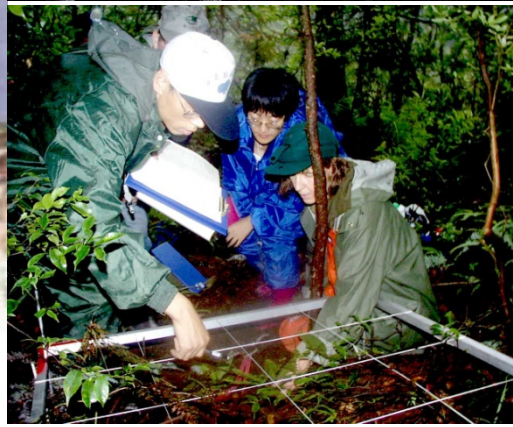
IMPACTS







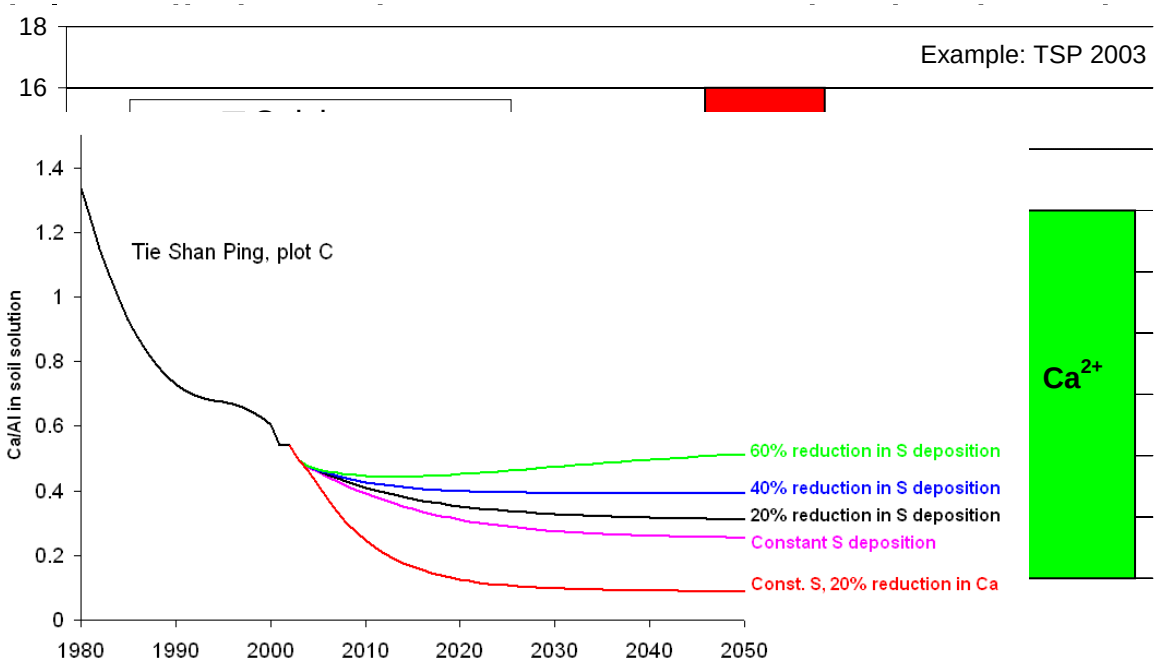



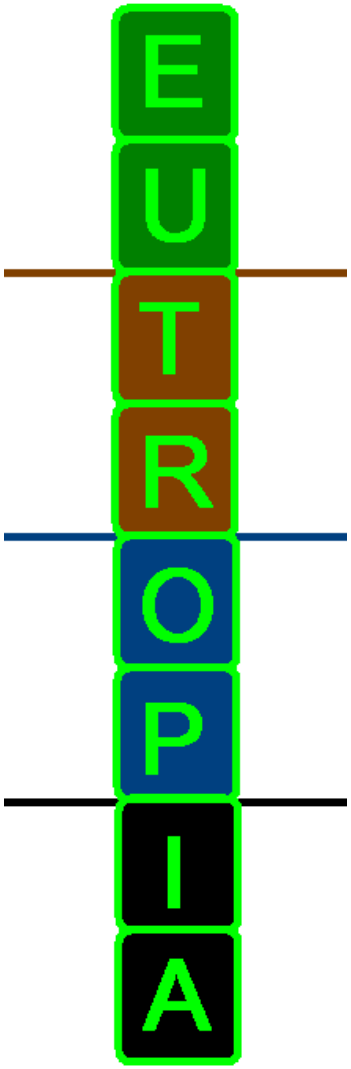
Need for cooperation

- Environmental research is readily **criticized** because we do not control all factors that affect our data
- Small research projects with **limited funds** failed to produce all the necessary data:
  - Climatic conditions
  - Vegetation, soil, bedrock, water chemistry
  - Land use, practice and history
  - ...
- .. Interpretation of conditional parameters
  - Little information comes out of studying **my** sample taken in **my** stream and prepared in **my** way, analyzed on **my** analytical instrument using **my** method

A few major findings from IMPACTS

- Substantial reactive Nitrogen emission and deposition
  - NOx contributes considerably to acidification
  - NH_3 increases the pH of precipitation though acidify the soil- and surface water
    - pH alone is not an indicator for acid rain
- Mo[illegible]osition ne[illegible]





Processes governing leaching of Phosphorus fractions to surface waters and effects of changing environment

RCN, Miljø2015 -Tvers
2009 – 2013

CIENS
Forskningssenter for miljø og samfunn
Oslo Centre for Interdisciplinary Environmental and Social Research

UNIVERSITY OF OSLO

NIVA
Norwegian Institute for Water Research

NINA

NIBR
Norsk institutt for by- og regionforskning

Bioforsk

Morsa

T. Andersen, A. Engebretsen R. Vogt et al.

O. Røyseth et al.

D. Barton

G. Orderud

E. Romstad

M. Beckman et al.

H. Gunnarsdottir

The problem

- **Eutrophication** is the **main** cause for poor water quality in agricultural districts

Miljostatus.no

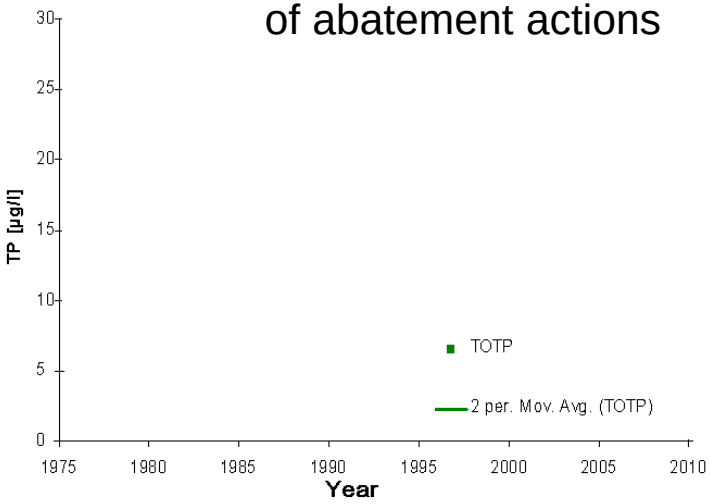
The main problem: Phosphate

- Phosphate (PO_4^{3-}) is rather immobile
  - Algae growth in freshwaters is usually limited by access to phosphate (PO_4^{3-})

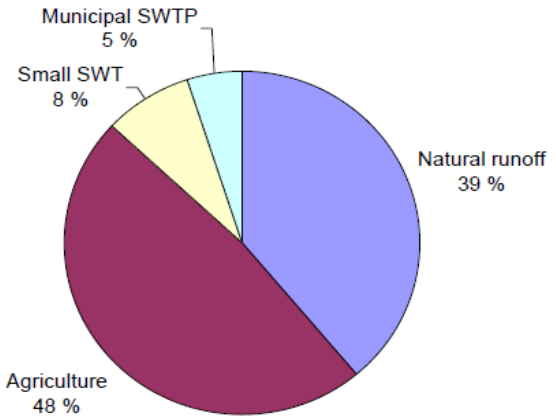
The problem continues

- 125 Million € is used on abatement measures in the case study watershed
  - No apparent improvement
  - Without the implemented measures the situation would likely been worse
  - The processes that govern the P fluxes are influenced by several **environmental pressures**

No clear effects
of abatement actions



Phosphate **sources**

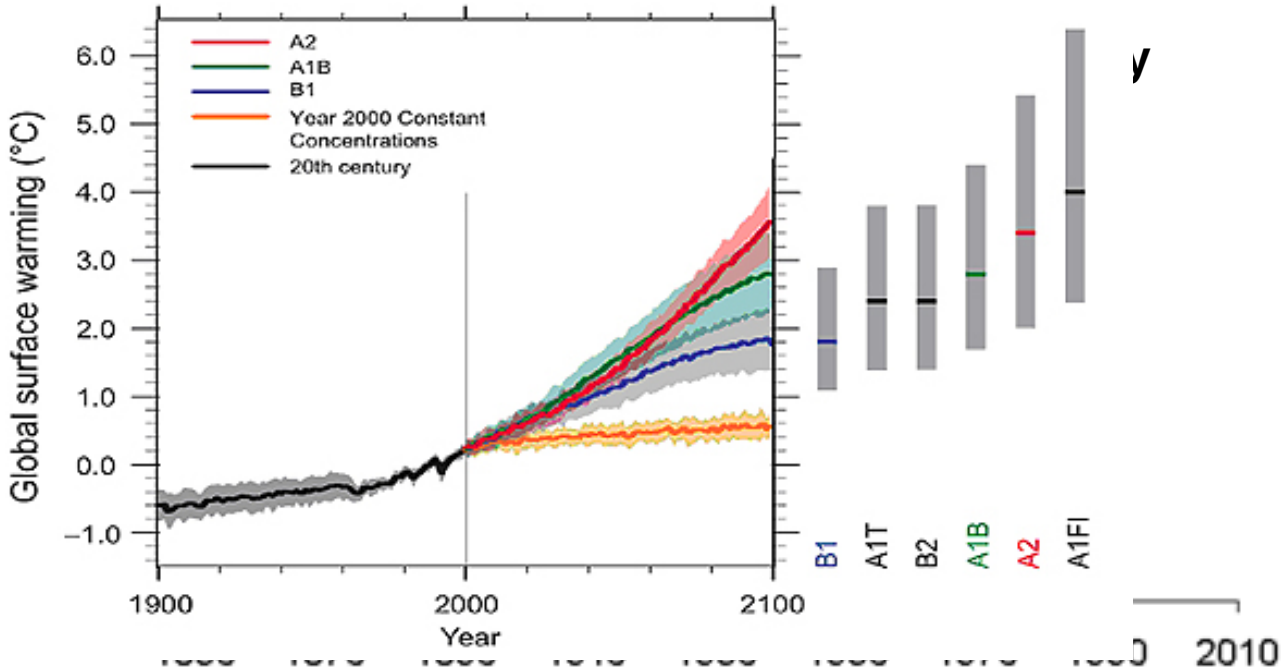


Blankenberg et al. 2008.

- 48% of the P input to the lake originates from **agricultural areas**
- 39% is **natural background** flux of P
  - Mainly in the form of dissolved natural organic matter (**DNOM-P**)
- P is mainly transported in the rivers adsorbed to **silt and clay particles (Particulate P)**

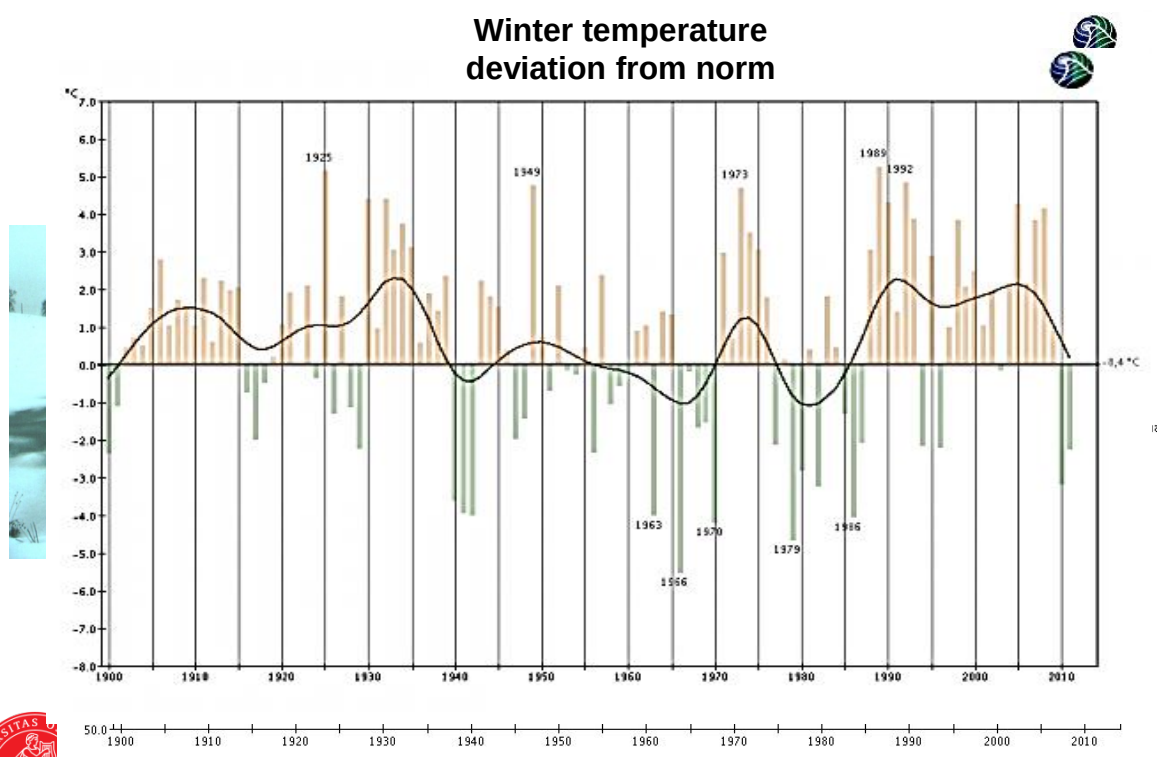
The **cause** for lack of effect of abatement actions is a changing environment

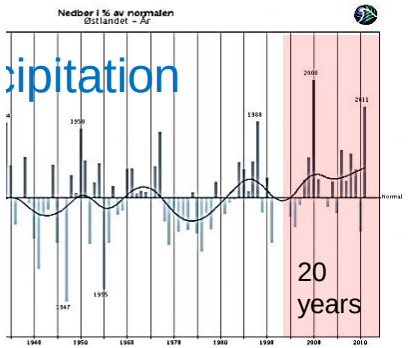
- The effect of abatement actions are disguised by the effect of changes in:
  - Climate
  - Decline in acid rain

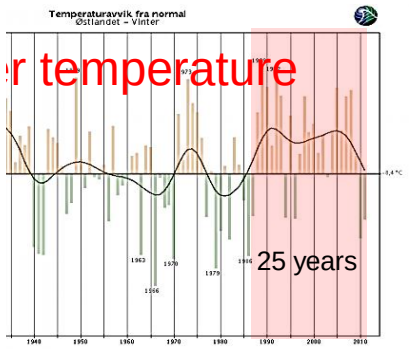


Changes in **climate** during the last 20+ years

- The amount of precipitation and the frequency of **heavy precipitation events** have increased and been above the norm during the past 20 years
  - Generates more surface runoff and flooded soils
- Average winter temperature has been **2ºC** over the norm during the last 25 years
  - Leads to more frequent **thaw** periods on barren and frozen soils

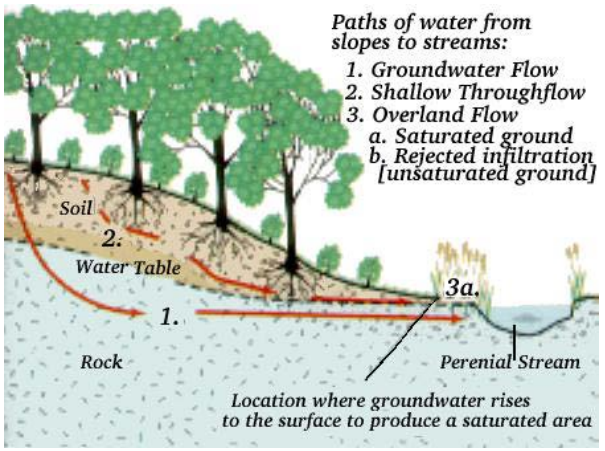




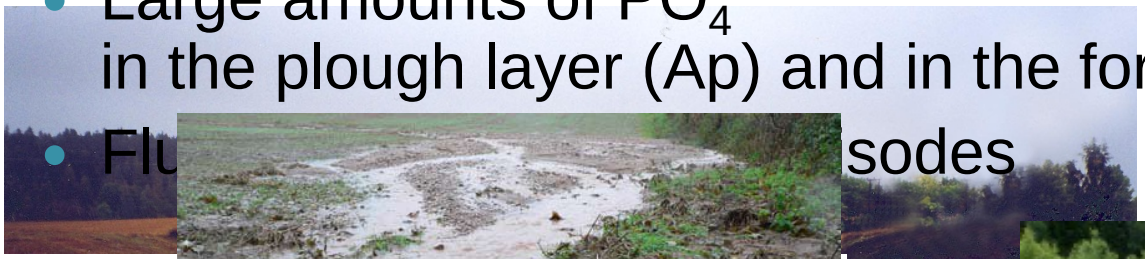


Met.no

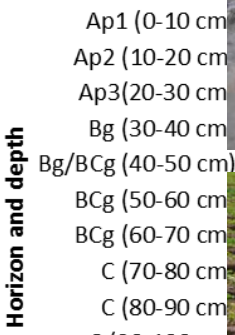
Increased surface runoff



- Increased erosion
- Large amounts of PO_4 in the plough layer (Ap) and in the forest floor (O)
- Flu… sodes



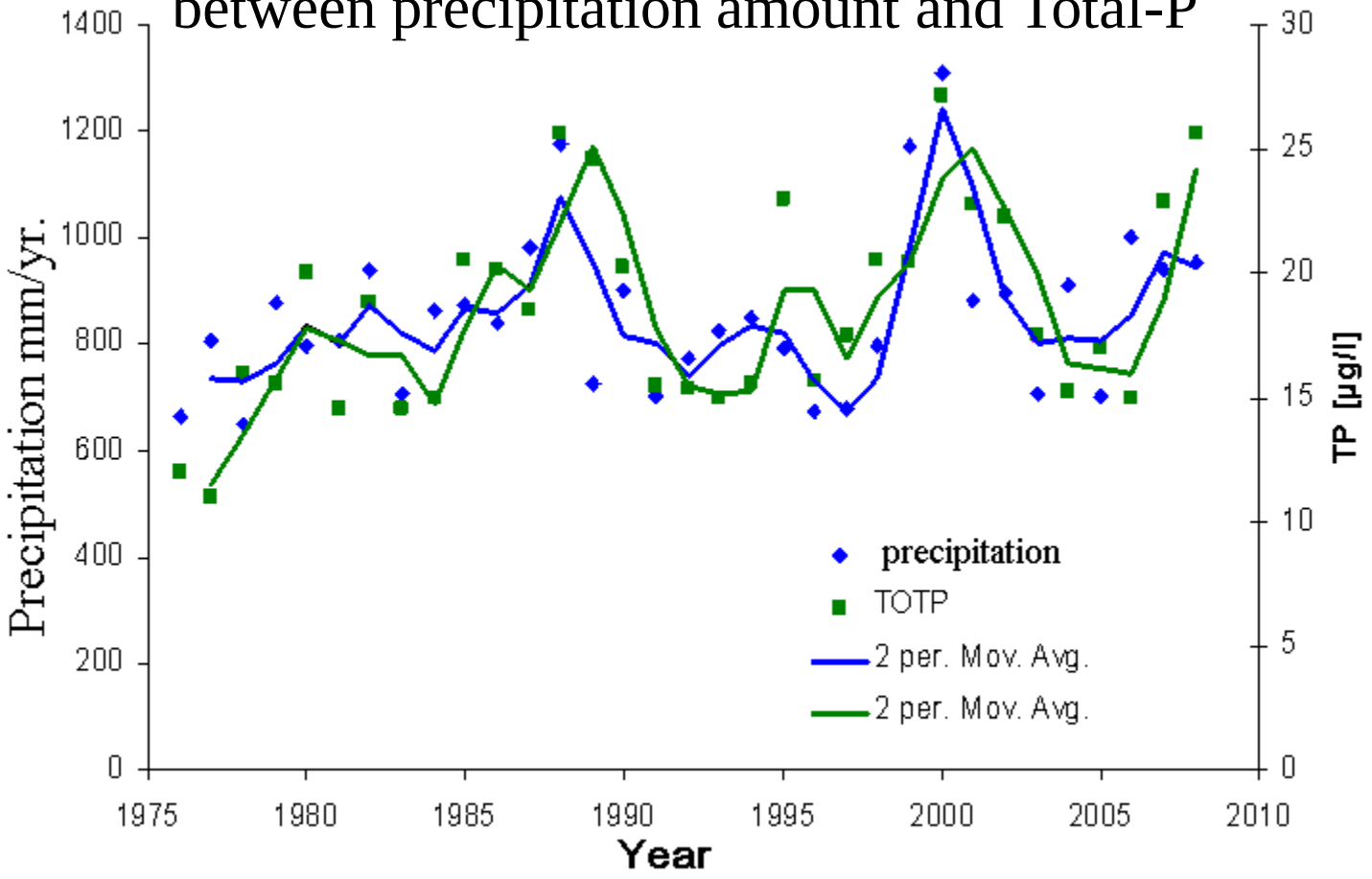
Agriculture



Desta, 2013

Effect of precipitation on P in Vansjø

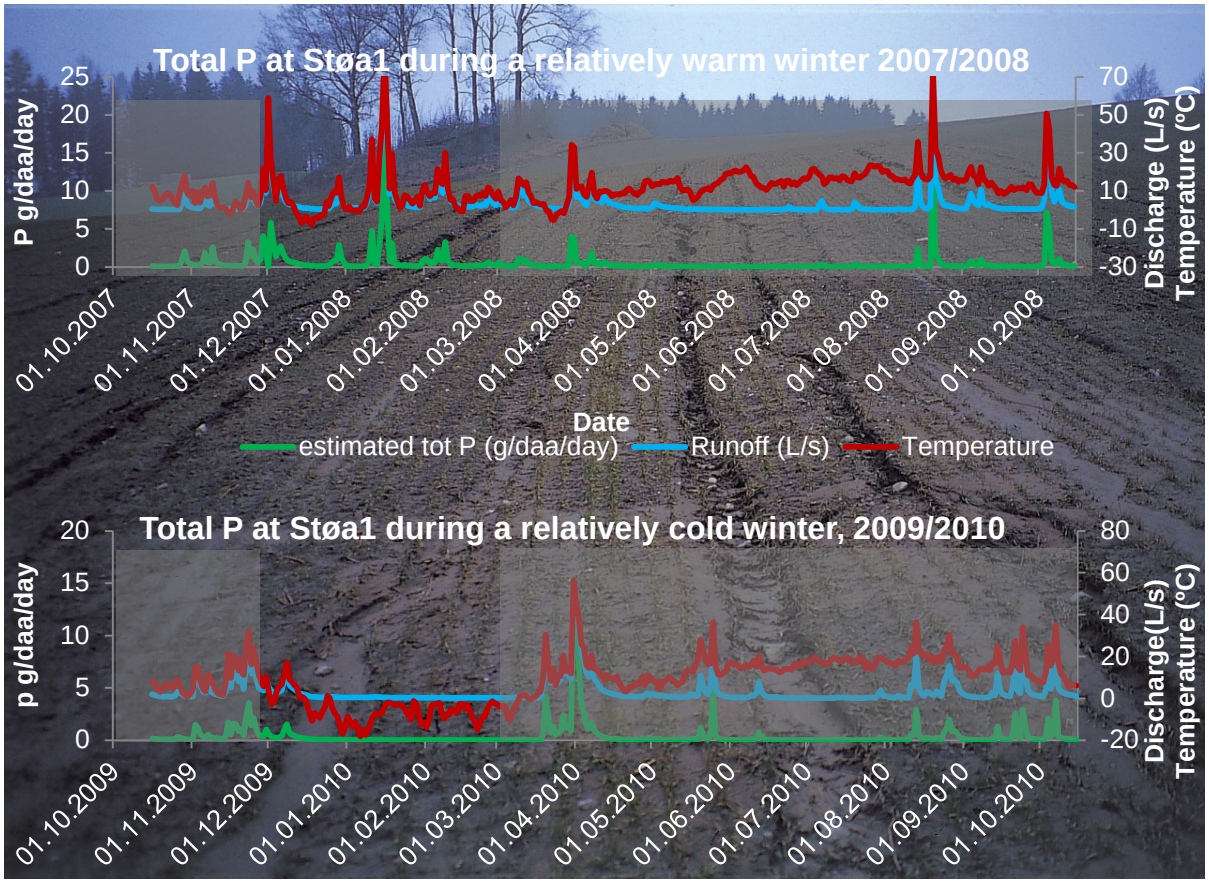
Good inter annual co-variation
between precipitation amount and Total-P



T. Rohlack, NIVA

Milder winters

- More frequent runoff periods during winter
  - Increased surface runoff and erosion due to soil frost and fall tillage

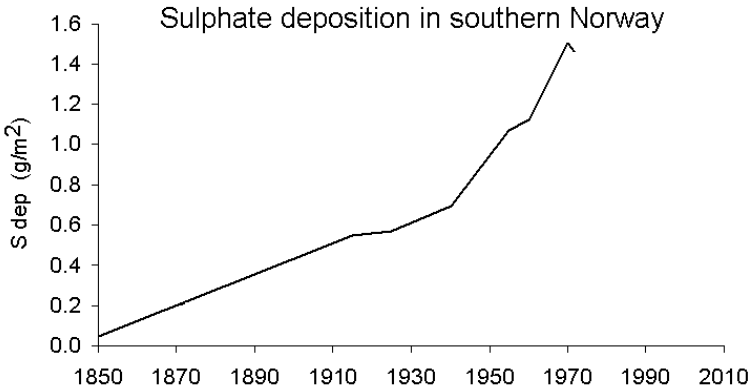


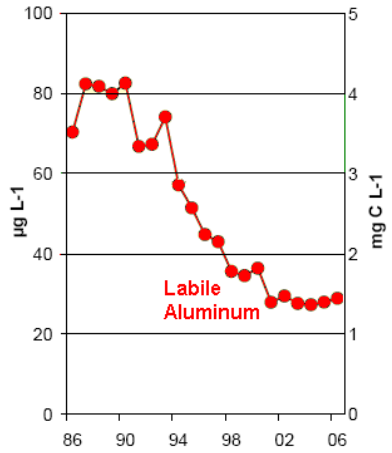
  - Large flux of bioavailable PO_4 due to no assimilation

Parekh, 2012

Reduced S deposition over the last 25+ years

- SO_4^{2-}, which in acid lakes in southern Norway constitutes the **dominant** anion charges, has **decreased by about 80%**
  - →This has led to a 66% decrease in labile **Al** leaching
  - →and an doubling in leaching of **DNOM**



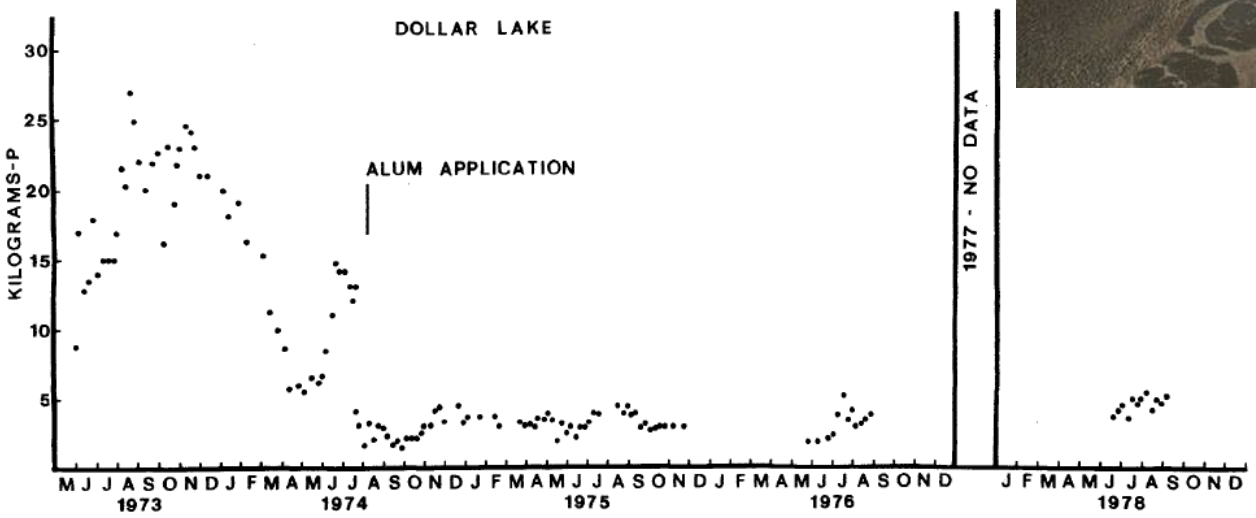


Skjelkvåle et al., 2007

Al^{3+} is used to remove PO_4

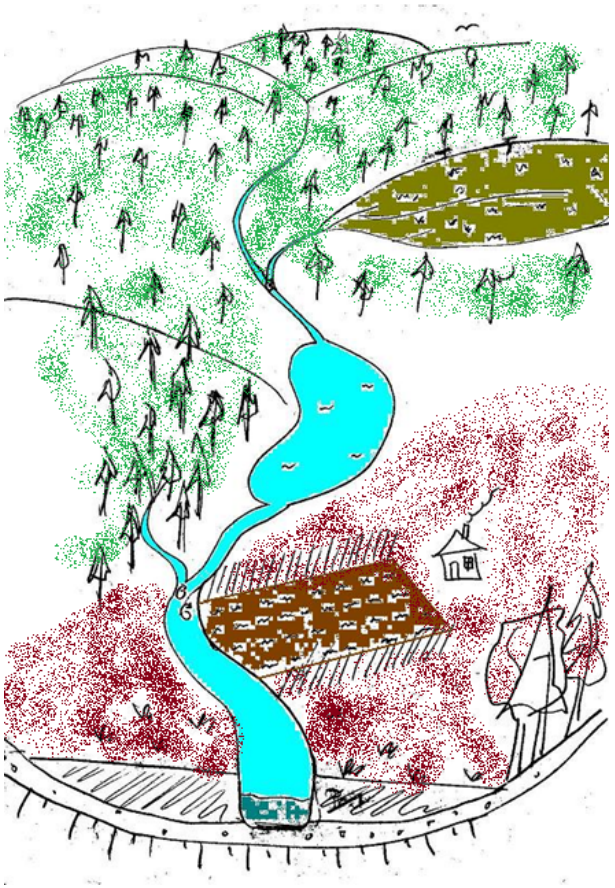
$$1.4Al^{3+} + PO_4{}^{3-} + 1.2OH^- \rightarrow Al_{1.4}PO_4(OH)_{1.2}(s)$$

- In sewage treatment plants
- In treatment of eutrophic lakes

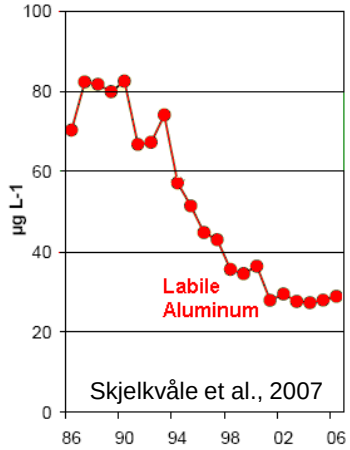


Distribution of land-use

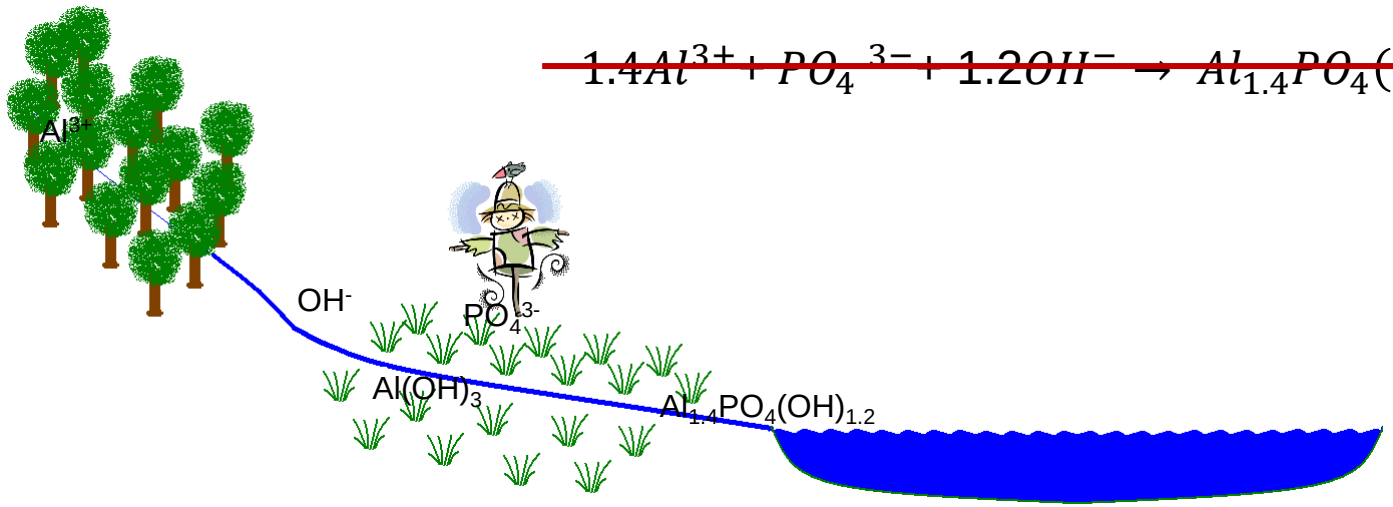
- Most watercourses drain forests areas and passes agricultural land downstream before entering the lake



Precipitation of PO_4 with Aluminium



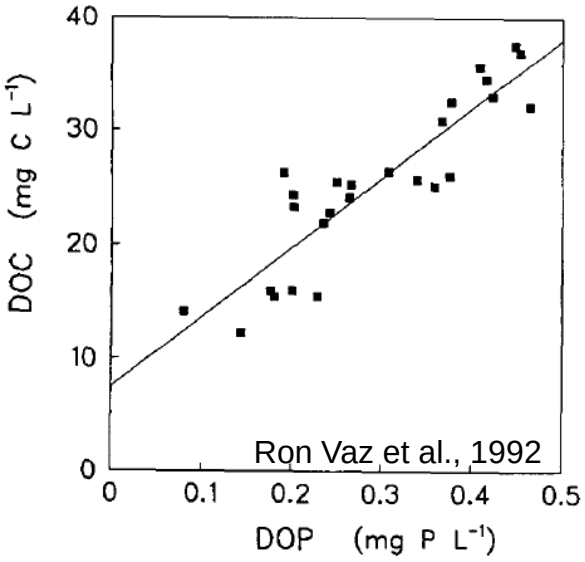
- Aluminium that was leached out of acid sensitive forests drained down into agricultural land where it mixed with PO_4 rich seepage with higher pH
- $Al(OH)_3$ precipitated and co-precipitated PO_4
- With the decline in acid rain
  we have lost an important mechanism for PO_4 removal

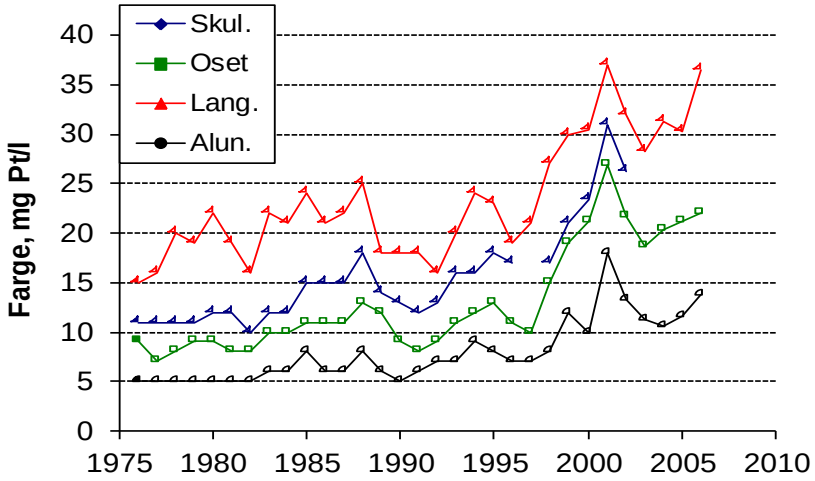


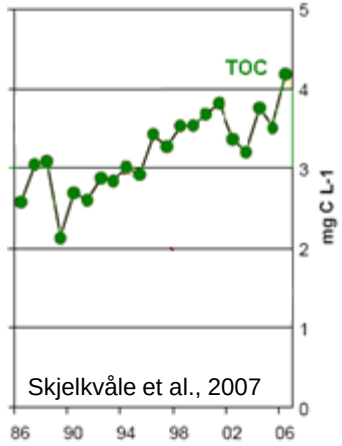
Transport of P with DNOM

- Background leaching of PO_4 accounts for 39% of the total P load
- PO_4 is in natural systems **transported** with DNOM
- There has been a doubling in the concentrations of DNOM

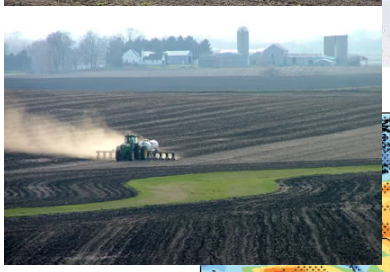
➢ **The background flux of PO_4 has thus likely doubled**

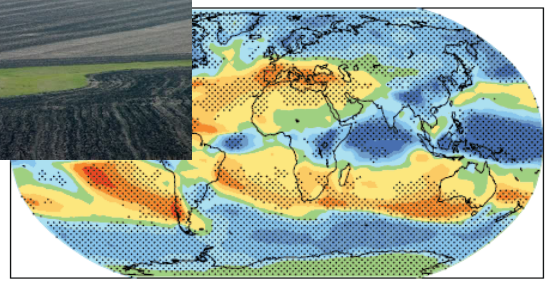


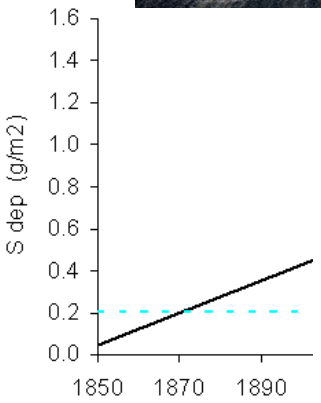


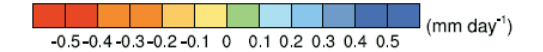


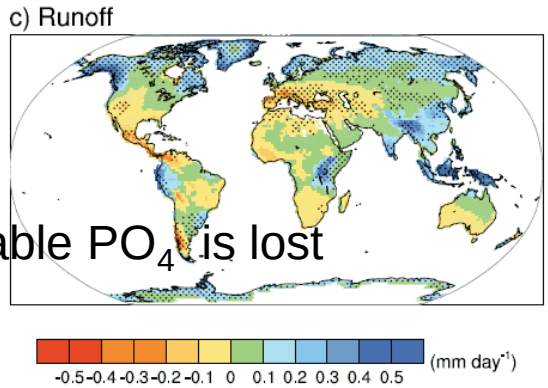
Important nature science knowledge











- More precipitation and milder winters have led to greater flux of P:
  - By increased surface runoff through only P rich surface soils
- Decline in acid rain has led to:
  - That an important precipitator (Al) of bioavailable PO_4 is lost
  - Increased background flux of DNOM-P

- **Conclusion: Without the abatement actions the conditions would today have been much worse!**

Sustainable management

- Abatement measures need to be assessed in regards to **cost-effectiveness** and an analysis of land **users'/farmers' response** to the these measures

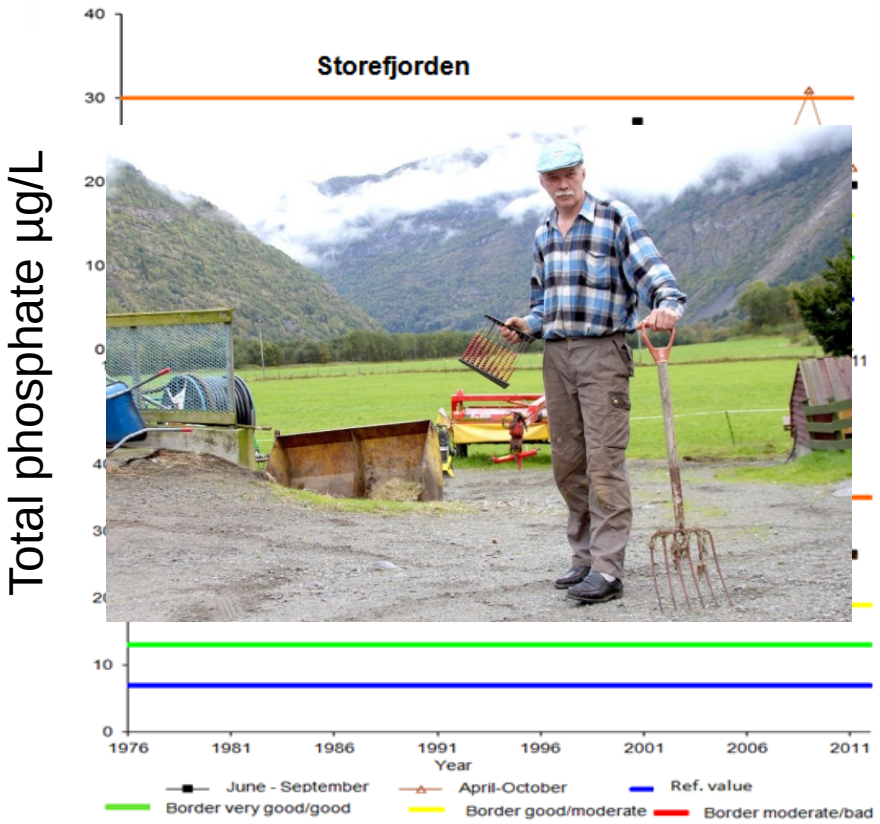
  - Especially an assessment of **probability** of implementation is lacking from previous assessments of measures

The challenge: Stakeholder commitment

- 125 Million € is spent on abatement measures in the case study watershed
- Problem still continue
  - No apparent improvement in Storefjorden
  - Limited effect in Western Vansjø

- The willingness to accept new measures is limited due to apparent small effect

No clear effect of mitigation measures



Knowledge
– the key to collective action

- The **low hanging fruits** are already picked
  - Reduced fertilizing
  - No fall tilling
  - Vegetative buffer strips
  - Wetlands
- We now need to persuade the farmers to **step-up their efforts** on sub-optimal abatement actions

This can only be achieved through increased **knowledge of why** their actions so far have not showed any affect.. – this is where nature science kicks in..

UiO : Department of Chemistry
University of Oslo

SinoTropia

Watershed Eutrophication management in China through system oriented process modelling of Pressures, Impacts and Abatement actions

- CAS/RCN Bilateral China – Norway Project
  2011 – 2014

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J. Naustdalslid

The main issue

- *60 - 70% of the surface water resources in China have too poor quality*
- *Eutrophication is the main cause for poor ecological quality*

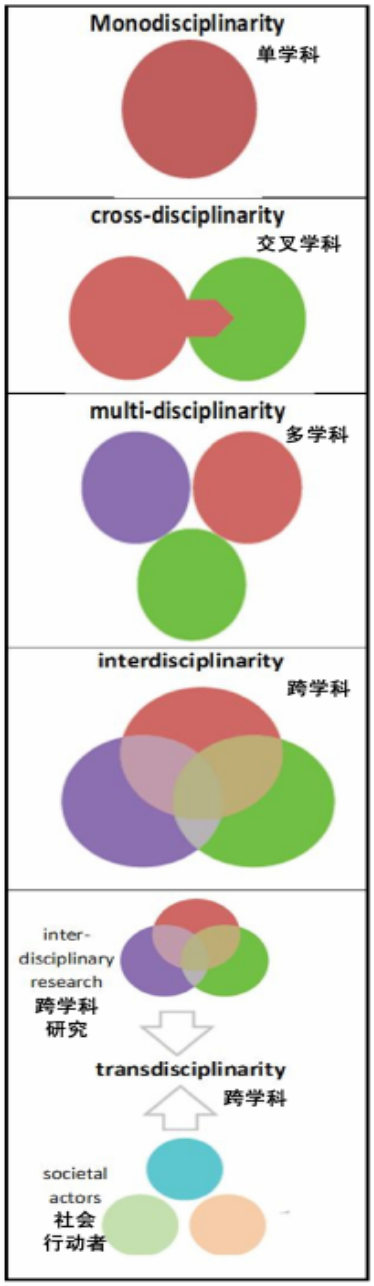
What is the solution..?

- Can we deal with eutrophication?
  - Are the abatement actions appropriate?
    - Are we targeting the right sources of nutrients and form of nutrients?
    - Are the effects of our abatement actions disguised by changes in other environmental pressures?
  - Are the abatement actions politically and/or socially feasible?
    - What barriers or thresholds in society hinder the implementation of abatement actions?
    - Is there sufficient knowledge of stakeholder interests?
    - What motivates collective action?
  - What can we do next, together?
    - We have already used the obvious abatement actions
    - What do we do next? How do we decide the best next step?

Thesis

- By adopting a **trans-disciplinary** approach to the eutrophication challenge, i.e. by integrating natural and social sciences with policy - we will improve:
  - Policy-making process
  - implementation of relevant policies

  In order to achieve water resource management that meets society's needs



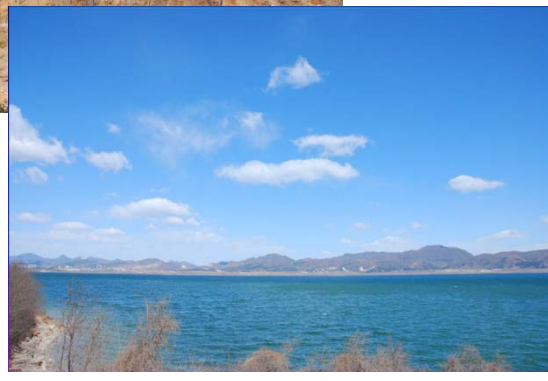
Hypothesis - Processes

- The role of **particle transport** of nutrients is likely overestimated. Most of this material is mainly buried in the sediments

- More frequent and intensive **rain episodes** enhance eutrophication due to increased erosion and leaching of nutrients

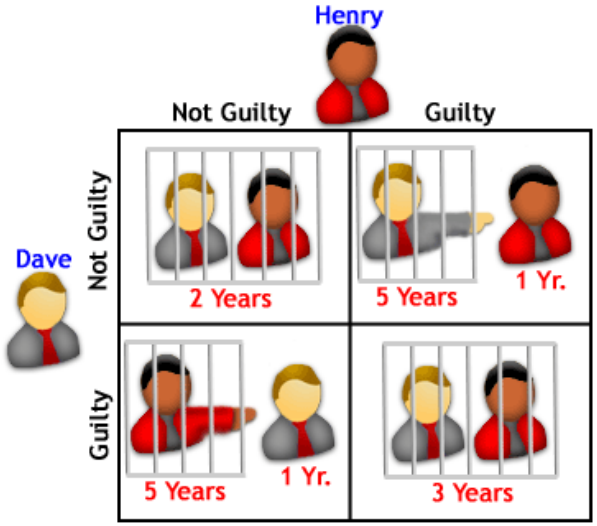
Hypothesis - Models

- Models need to be **adopted** to Chinese environments
  - The main governing processes may not be the same



Hypothesis – Societal response

- Knowledge -
  - Of stakeholder **interests** and learning processes are essential for the success of the public policies abating eutrophication
  - Constitute a necessary basis for sound environmental management through facilitating **collective** action and public policies



SinoTropia Research Strategy

- The hypotheses are tested through integrated works packages

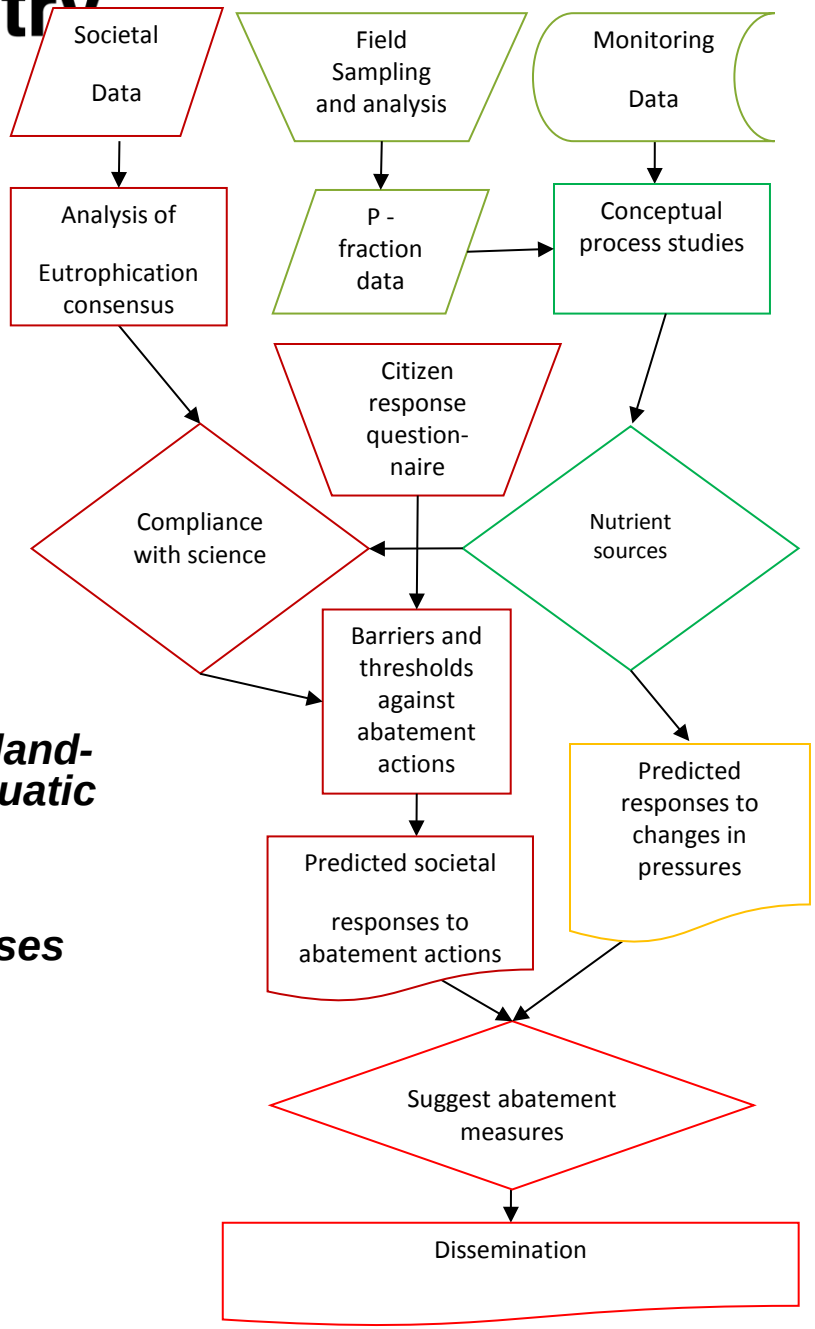
WP1 ***Field sampling and chemical analysis***

WP2 ***Catchment processes - the influence of land-use and climate on nutrient fluxes into aquatic systems.***

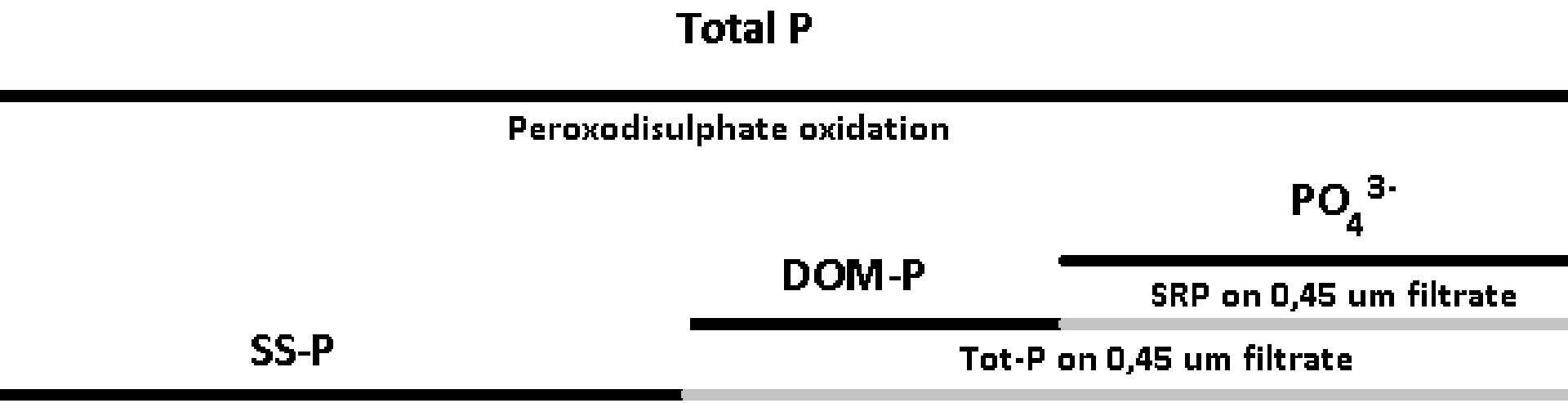
WP3 ***Modelling of catchment and lake processes***

WP4 ***Societal processes and management procedures***

WP5 ***Nutrient management plan for Yuqiao reservoir***

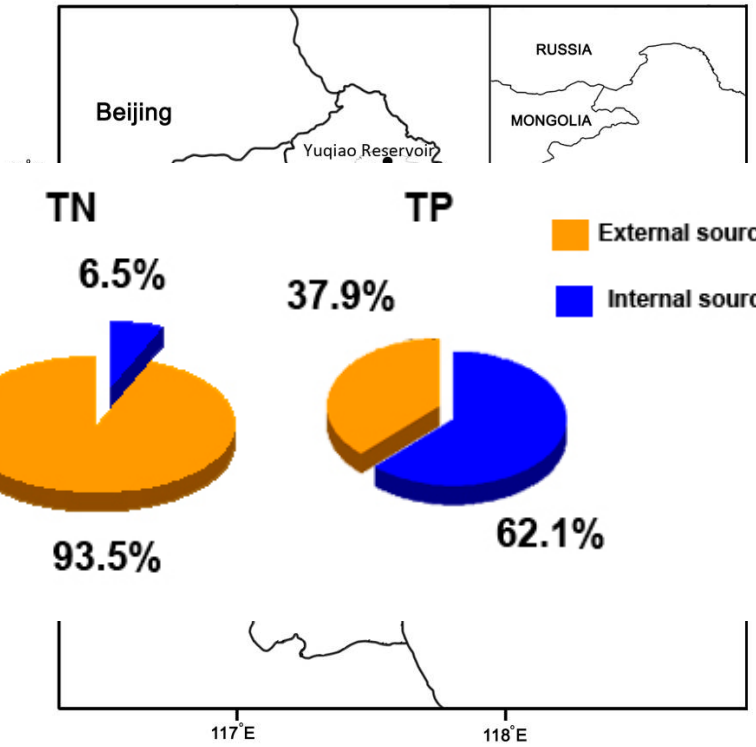


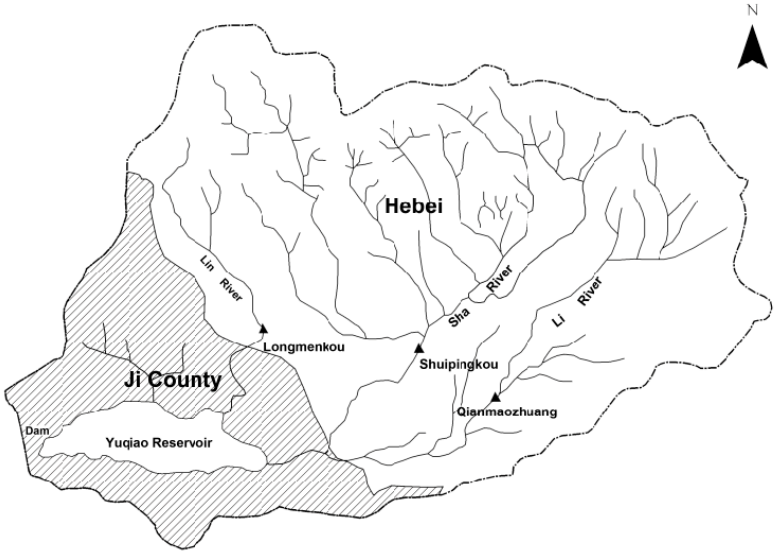
P fractionation



Yuqiao reservoir

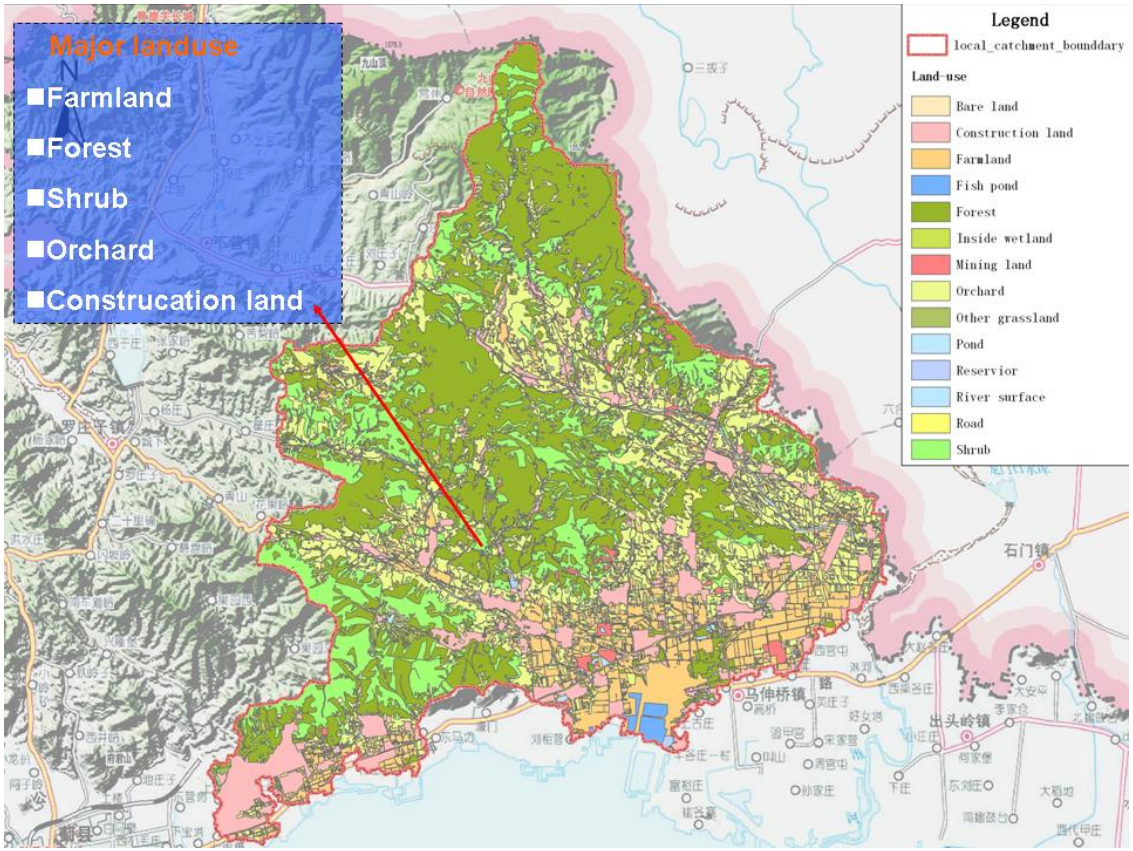
- Main water supply for 5 mill people in Tianjin
- Attracts considerable attention due to its eutrophication problems
- Receives water from the diverted Luan river watershed in Hebei
- Main P flux is from local watershed





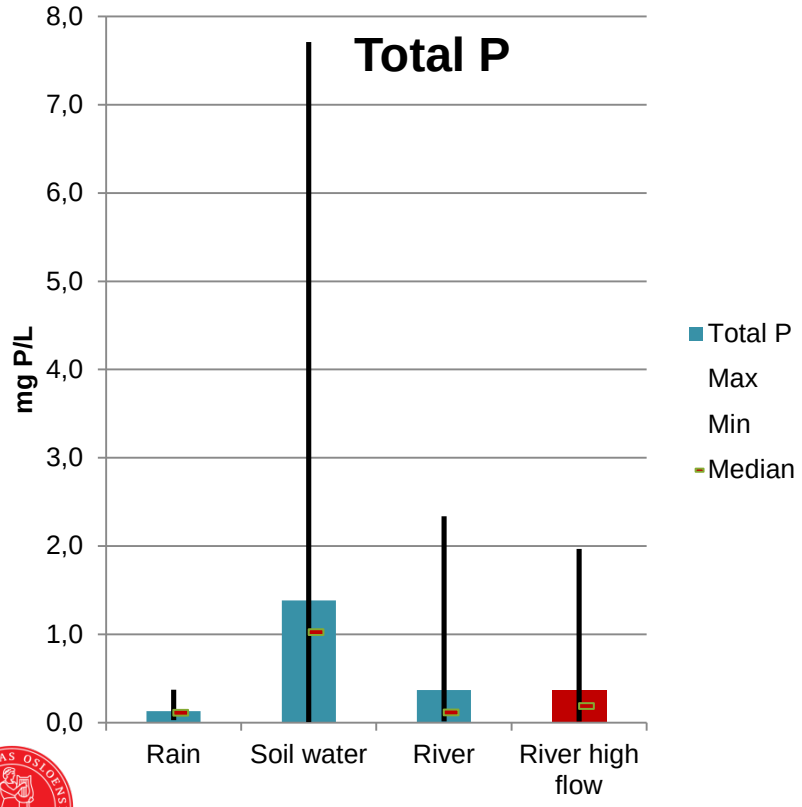
Land-use in local watershed

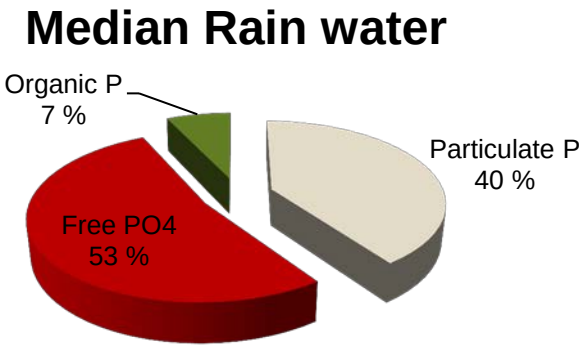
- 130 000 residens in the local catchment
- Omnipresent agriculture with abundent use of fertilizers
- Clay soils with poor water infiltration

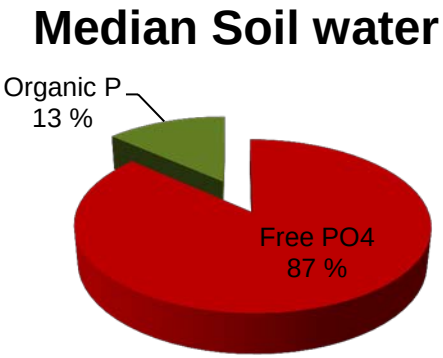


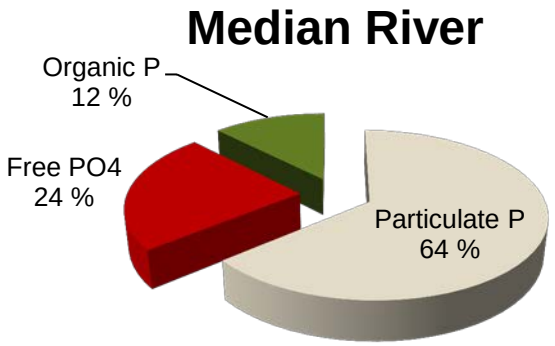
P fractions

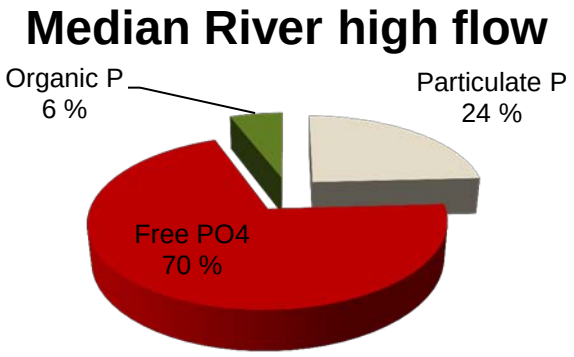
Large variation in soil water
Surpriced that P is not higher at high flow, especially the particle bound P





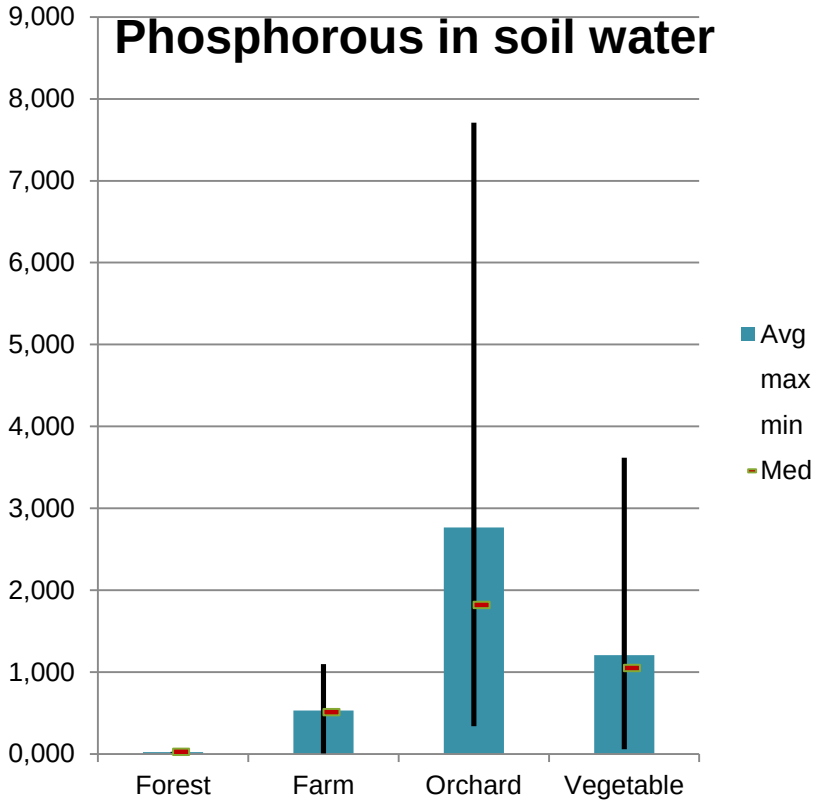




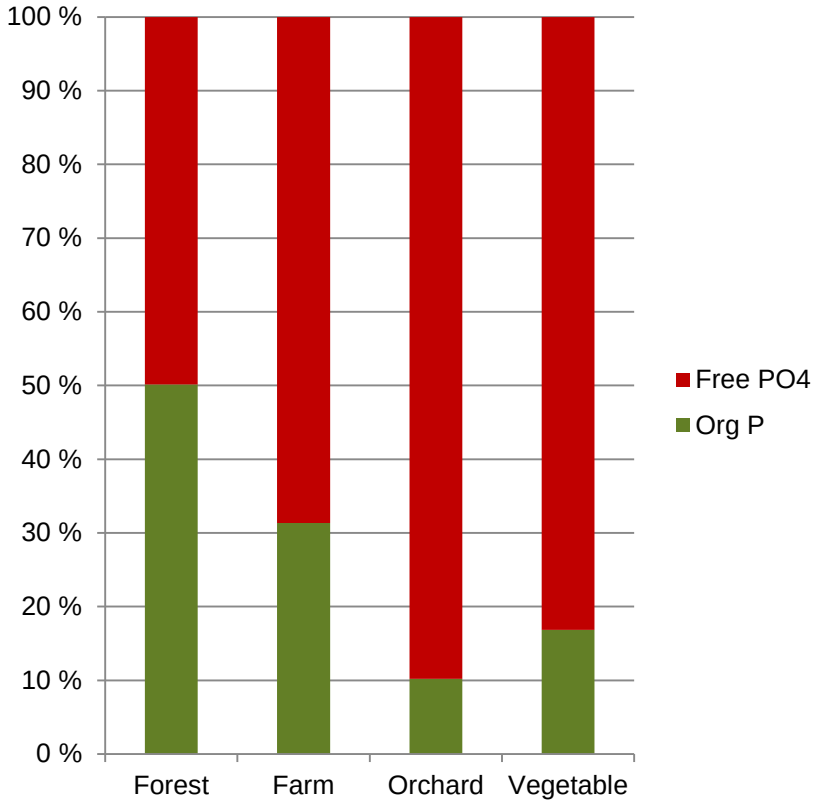


P in soil water

Surprising high values in orchards

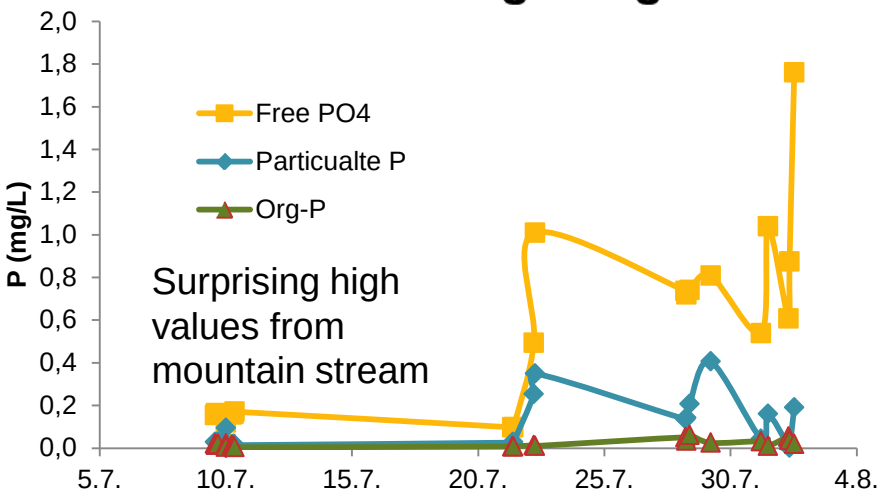


High Free P in Orchards
- Due to over fertilization?

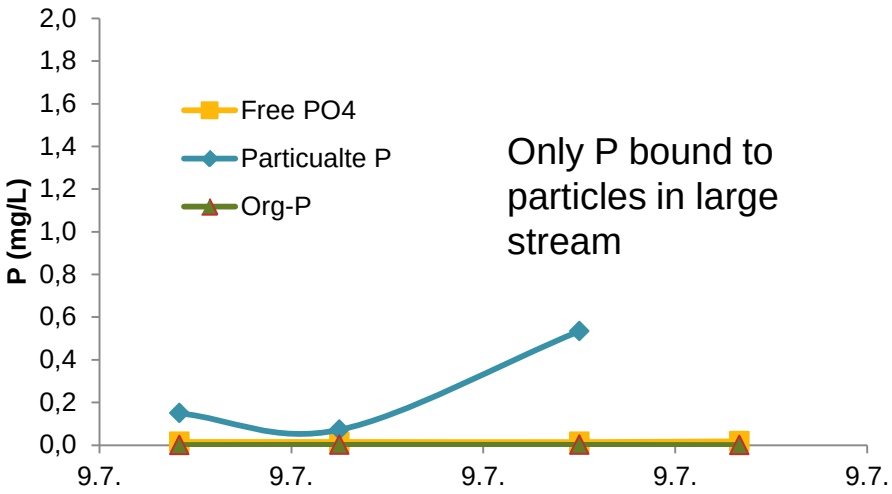


P fractions: Large differences between streams

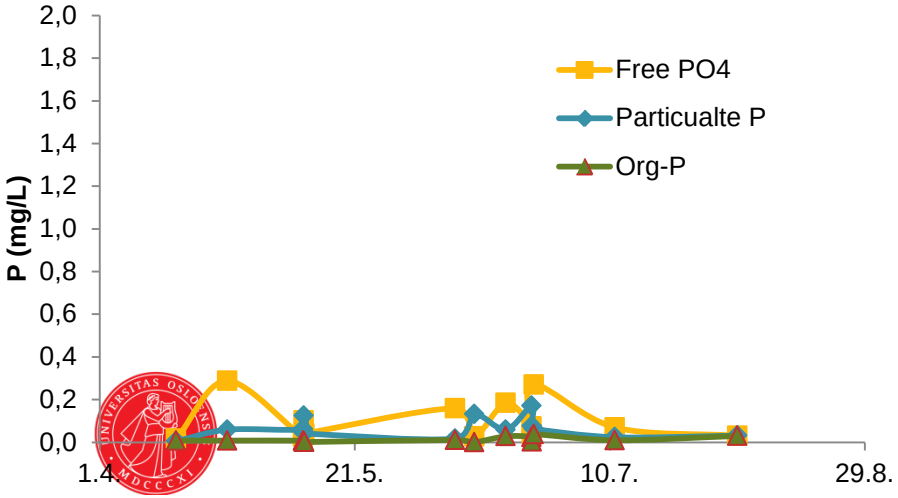
Beixinzhuang bridge



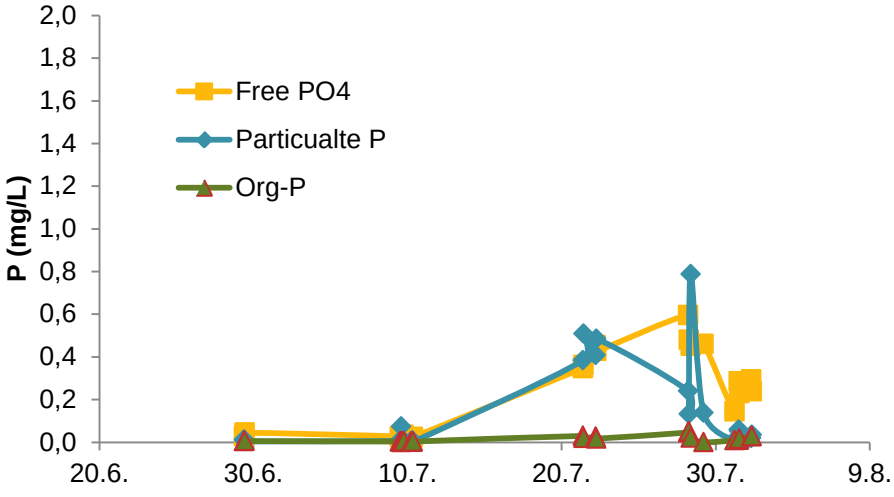
Lin river bridge



Liuxiangying river

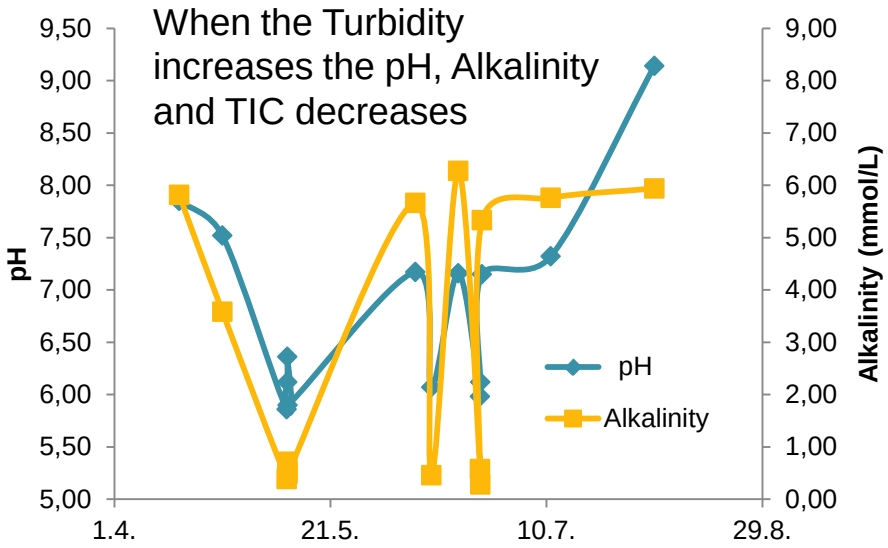


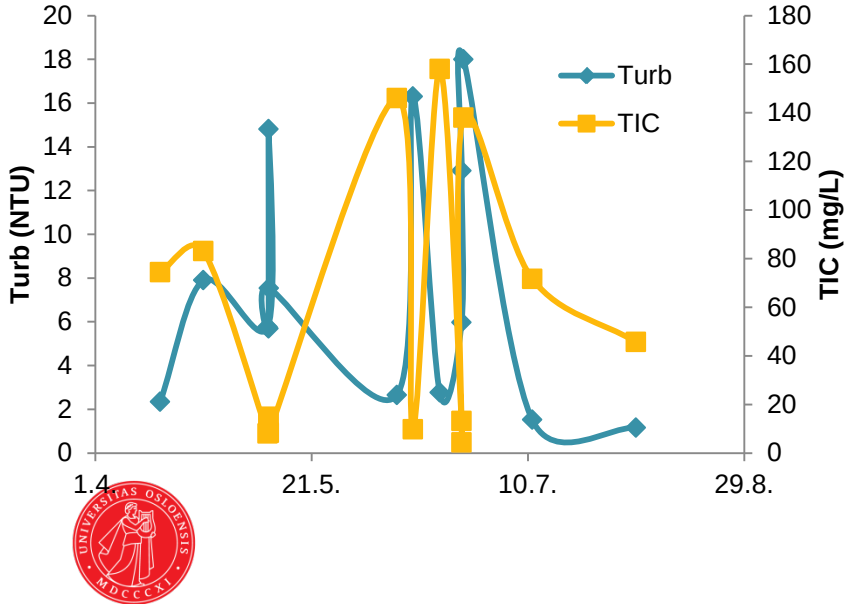
Xiaojugezhuang bridge

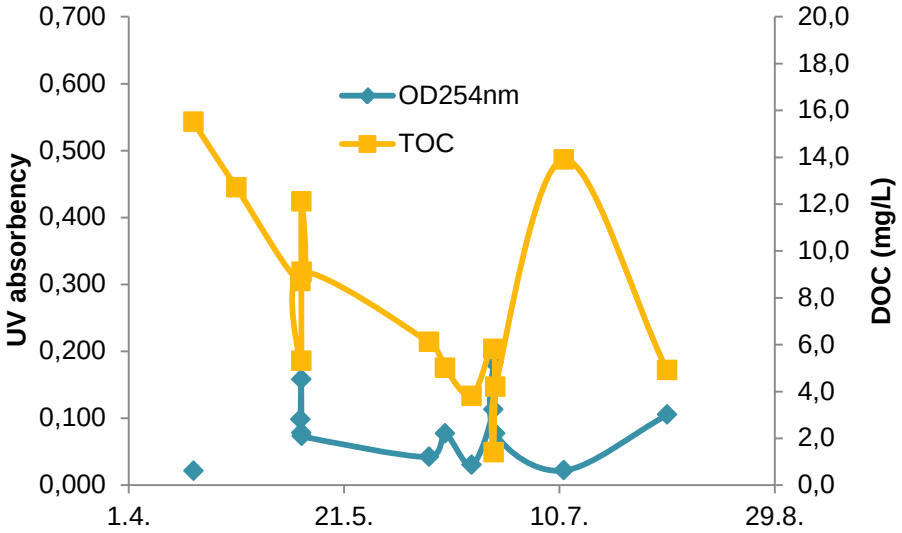


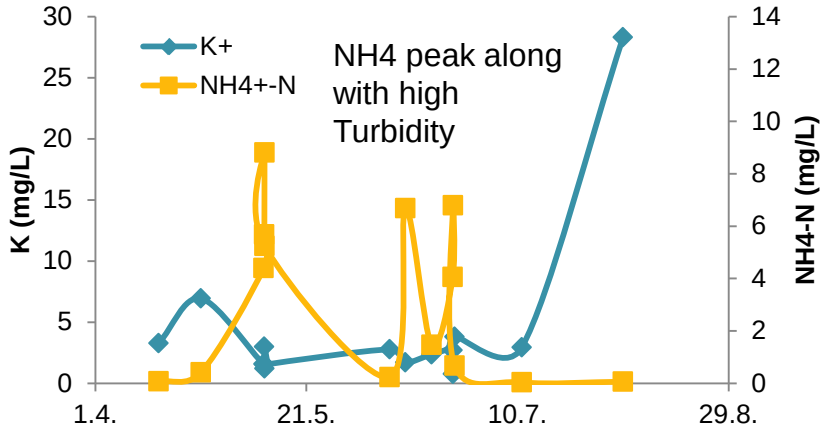
UiO

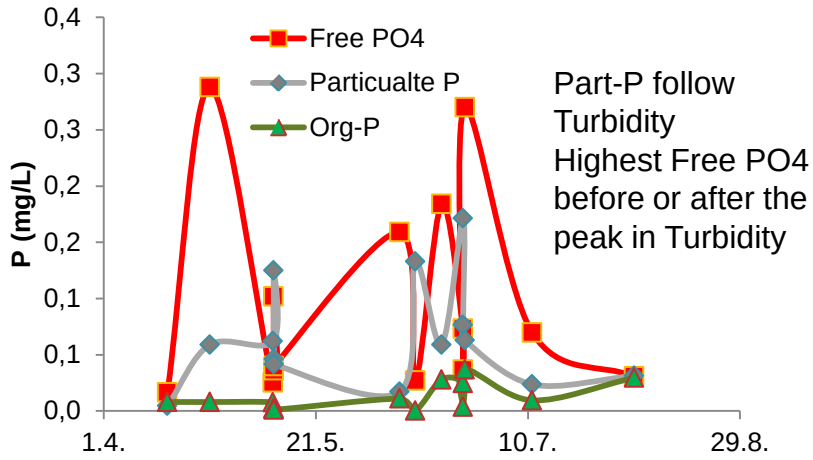
Liuxiangying river











Society: Structures and driving forces

- Nutrient sources should be put into a structural framwork and contextualised
  - Local communities in the context of structural frames
    - Map central indicators and identify driving forces
    - TAES has already done much work in this field by collecting data:
      - Summarise and identify gaps in knowledge

Society: Identifying local socio-cultural and socio-economic patterns and attitudes

- Main empirical sources:
  - Survey and in-depth interviews
    - Survey was conducted spring 2012.
    - In-depth interviews to be conducted during January/February 2013
  - Survey focussing on a wide range of topics/issues
    - Environmental awareness and motivational aspects for farming
    - Information sources and knowledge about envrionmental aspects of farming
    - Local community and Belonging

Society: policies and management

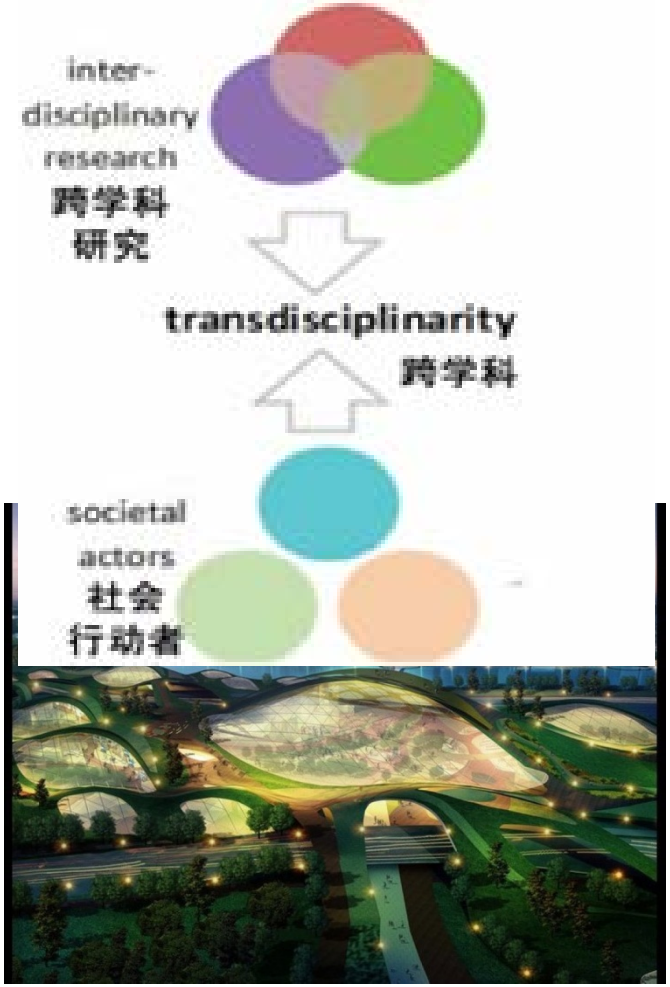
- Achieving aims of transdisciplinary research/process:
  - Input and discussions with on-going work in other work packages
  - Contact with and interaction with local leaders:
    - Policy-makers and management (on different adminstrative levels)
      - Village leaders, county officials in Ji county
      - Tianjin municipality?
      - Hebei?
    - Input for Work Package 5 – Nutrient management plan for YuQiao reservoir

Planned output

- Nutrient management plan for Yuqiao reservoir
  - including a conceptual model for pre-warning of algal blooms and pollution control for blue-green algae – pilot implementation in two villages
- Improve public awareness regarding nutrient pollution

Working together?

- Preservation of water resources through precautionary principle
  - Solving the problem up-stream rather than end-of-pipe
- Partnership in a innovative and inclusive project with a trans-disciplinary approach
- Contributing to the Tianjin goal of scientific development and social harmony



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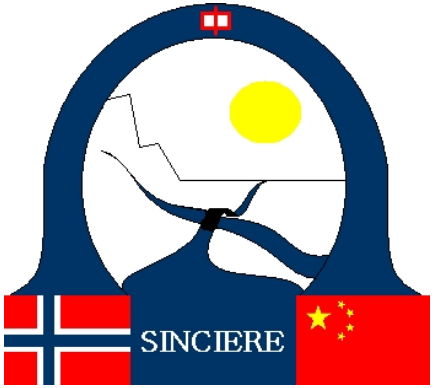

Our SINCIERE Vision:

To act as a catalyst and mediator for cooperation between China and Norway within the field of environmental research

- Facilitate interdisciplinary and policy relevant research and serve as a node for a broad network of associated institutions.

Thank you for your attention

Some experience

- **Common goal** is necessary for good cooperation
  - **Modeling** promotes the interdisciplinary collaboration by concretizing the common goal
- Important to have clear **roles and respect** for the individual's academic integrity and platform
  - Respect for differences in approach: **Inductive – deductive**
- Interdisciplinarity requires participation outside your **comfort zone**
  - Time to establish **trust**
- **Polymath** hampered by lack of **polyglot**

Some experience cont.

- Cooperation is best achieved through **physical co-location**
  - **Common research site** make it possible to generate sufficient data
  - Easier to work together "**out there**" than in office
- Interdisciplinarity enables **cross-fertilization**
- **Coupling** Nature - Social Sciences and users:
  - Leads to that we are better able to ask the right **questions** and see the relevance of our studies
  - Facilitates the **practical** work in the field through collaboration with local stakeholders
  - Enable us to indentify the **relationship** between land use / activity and environmental parameters

Thank You

谢
谢！