UiO : Department of Chemistry
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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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The main point

- We need coherent research where hydro-biogeochemical processes governing eutrophication are linked to societal response

Yuqiao water reservoir

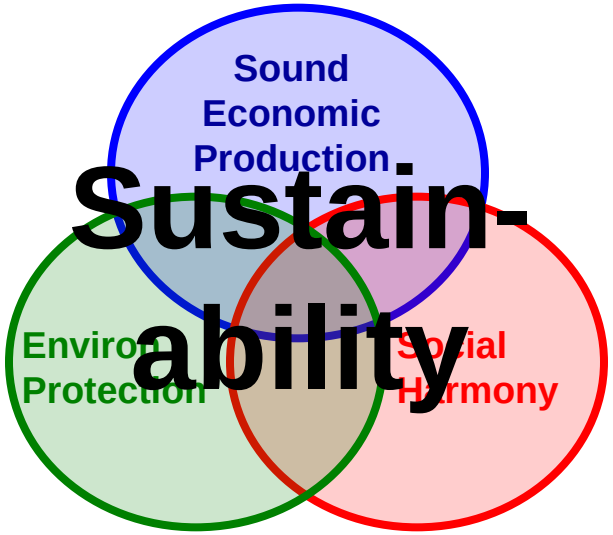
- Water source for Tianjins 6 – 10 mill. population

- Sound ecological condition requires
  - Knowledge based and system focused management
  - Knowledge based local participation and best practices
    - For scientific and sustainable development and a harmonious society

Sustainable development

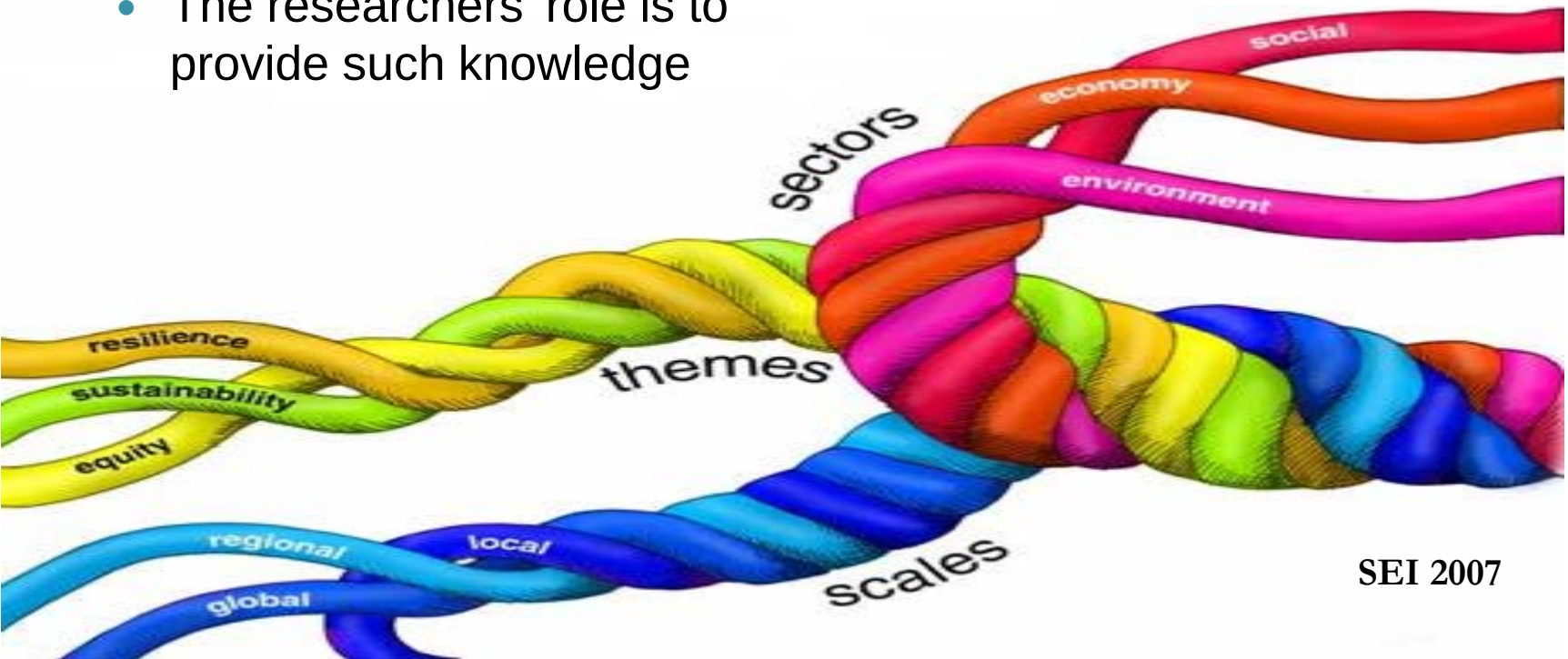
- Decision makers need
  - **knowledge** based abatement strategies on environmental challenges
  - strategies that are politically and socially feasible to **ensure** sustainable development
- We need to balance environmental protection with limitations posed by social harmony and economic production

Sustainability implies positive solutions for all components



Holistic approach

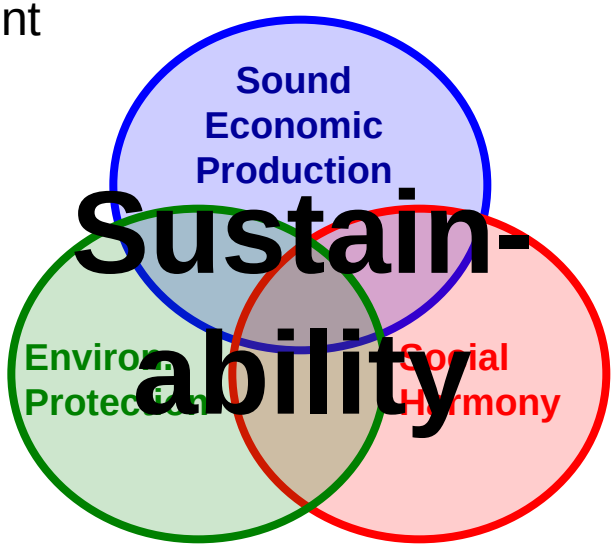
- A necessary basis for good decision-making and effective environmental policies on our increasingly complex and integrated environmental challenges
- The researchers' role is to provide such knowledge



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

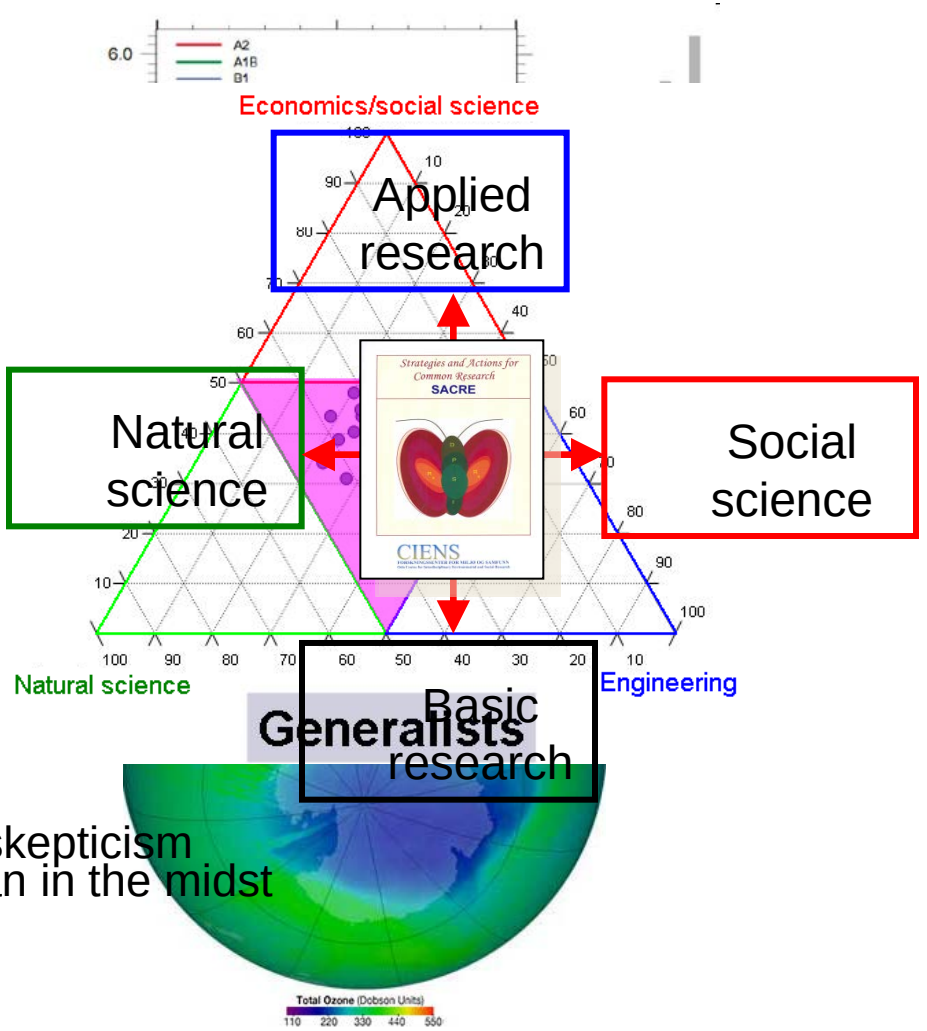
Needs for environmental protection
are balanced against limitation
posed by social harmony and
economic production

- 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

Drivers for Interdisciplinary in environmental knowledge development

- Increased societal legitimacy and improved research **relevance**
  - Environmental research must meet **societal** challenges
- Problems **discovered** by knowledge
  - Need to be solved with knowledge
- Problems **caused** by knowledge,
  - ”*can't be solved by using the same kind of thinking we used when we created them*”



- **Generates** opportunities for scientific innovation through cross-fertilisation and knowledge integration (the essence of inter-disciplinarity)
- Scientific curiosity is driven by scientific skepticism - **more prone** to be held by outsiders than in the midst of a disciplinary ‘hard core’

Building bridges

- Bridging disciplines
- Bridging approaches: modeling and observations – common research site
- Bridging spatial scales
- Bridging time scales and weather extremes
- Deterministic and probabilistic approaches

Science to policy interaction - Integrated assessment

Monitoring

Modelling

Assessment

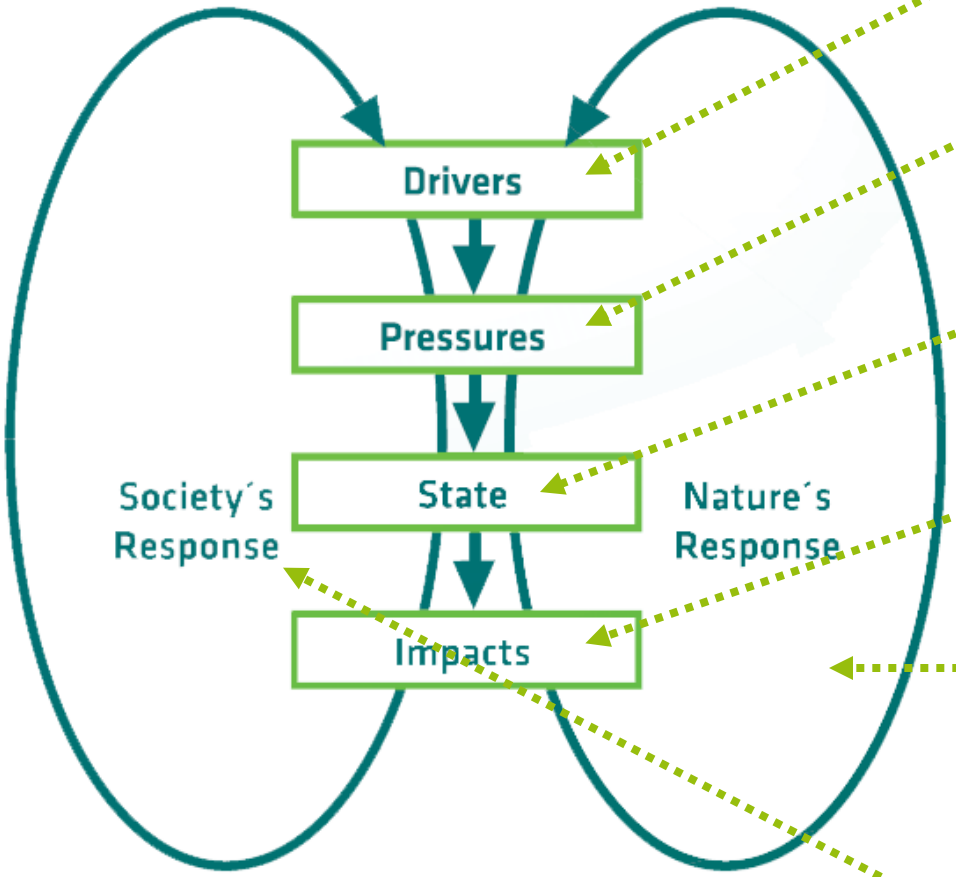
Critical Loads

- Communication with decision makers facilitated by Critical Load maps

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

Outline

DPSIR - Conceptual framework



Drivers: Population increase, climate change

Pressures: P leaching to water

State: High nutrient levels

Impacts: Eutrophication

Nature's **R**esponse: Change in eco-system services, feedback mechanisms

Society's **R**esponse: Abatement actions, adaptation, environmental technology, policy, legislations, taxes

CIENS
Oslo Centre for Interdisciplinary Environmental and Social Research

The12th. Five year plan

Scientific development

Ecological progress

Chart 10. A road-map for the 12th Five-Year Plan (2011-15)

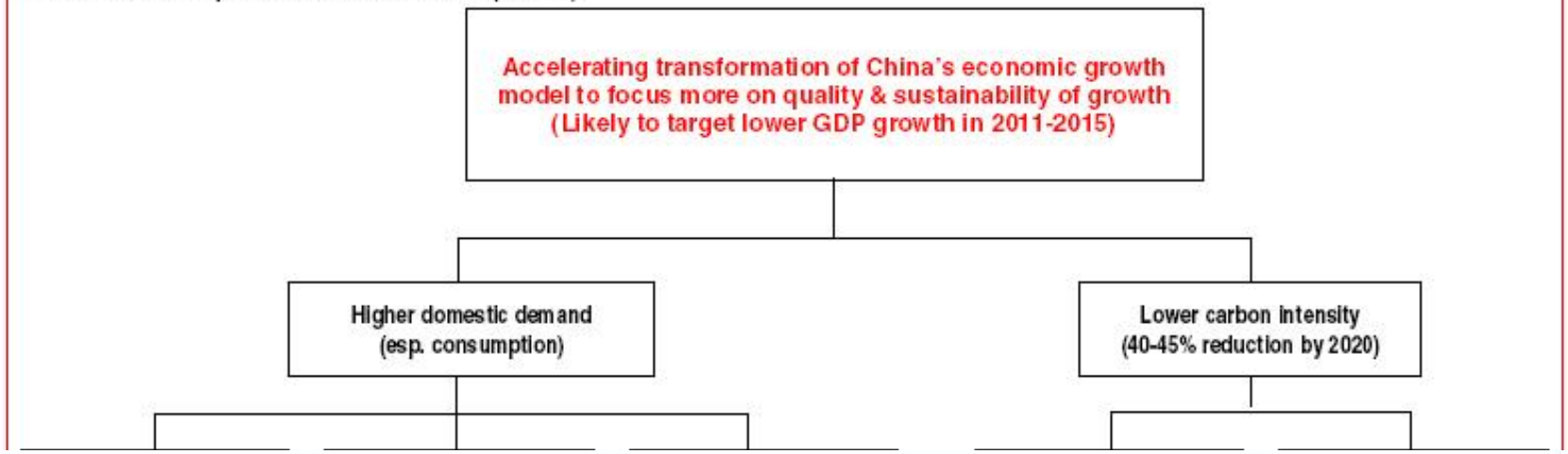


Table 35. The new Magic 7

Emerging strategic industries	Main content
Energy-saving and environmental protection	Energy efficiency, advanced environmental protection, recycling
Next generation information technology	Next-generation communications networks, Internet of things, network convergence, new flat panel display, high-performance integrated circuits and high-end software
Bio-technology	Bio-medicine, bio-agriculture, bio-manufacturing
High-end manufacturing	Aeronautics & astronautics, marine engineering equipment, high-speed rail, high-end smart equipment
New energy	Nuclear, solar, wind, biomass
New materials	Special function and high-performance composite materials
Clean-energy vehicles	Plug-in hybrid vehicles and pure electric cars

Source: State Council (http://www.gov.cn/ldhd/2010-09/08/content_1698604.htm)

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?

The research needs

- **Goal:**

  Increase our ability to **predict effects** of abatement measures and changes in the environment and the societies response to

- **Need:**

  Improve the **reliability** and **relevance** of prediction models

- **Strategy:**

  - Assess temporal and spatial variation in P-fractions
  - Assess societal thresholds and barriers towards abatement actions

  → identifying the most cost-efficient and feasible abatement actions
  by substituting empirical deduced assessments with
  conceptual induced knowledge based process understanding from nature- and social sciences.

- **Prerequisite:**

  Need to **link:**

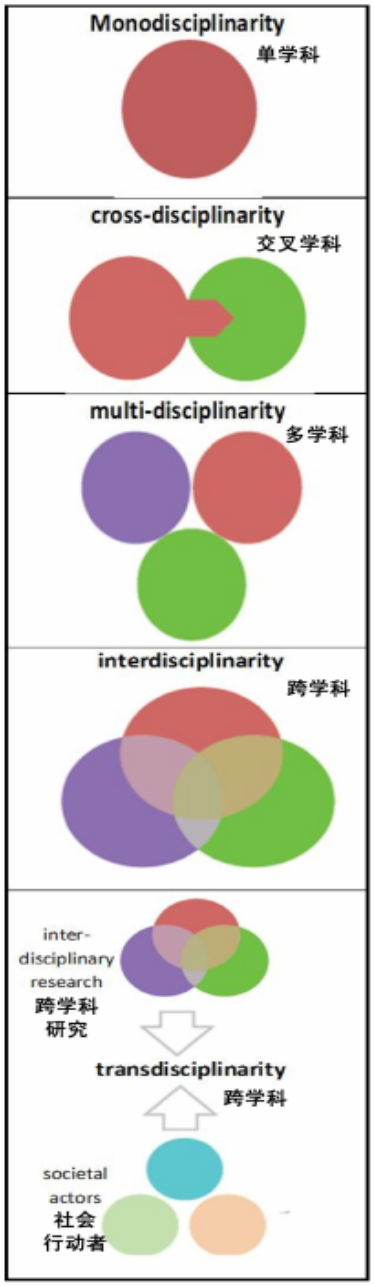
  - geochemical and physio-hydrological processes in the **catchment** with the **in-lake** biochemical processes controlling the level of nutrients (P, N, C) and its effect on water quality

  - **nature-** and **societal** sciences

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 – Analytical methods

- P-fractionation will enhance our ability to identify :
  - source of Phosphorous
  - processes governing fluxes
  - fate of the Phosphorous
    - effect of bioactive P-fractions and thereby algal growth

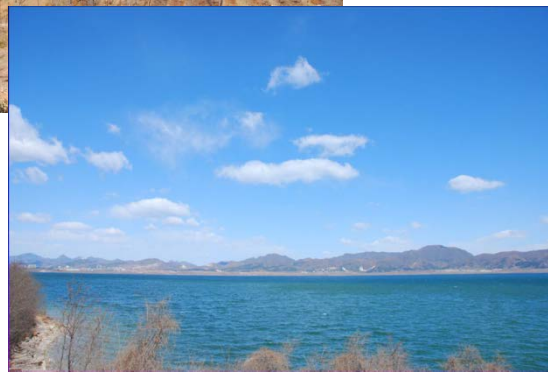
Hypothesis - Processes

- 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

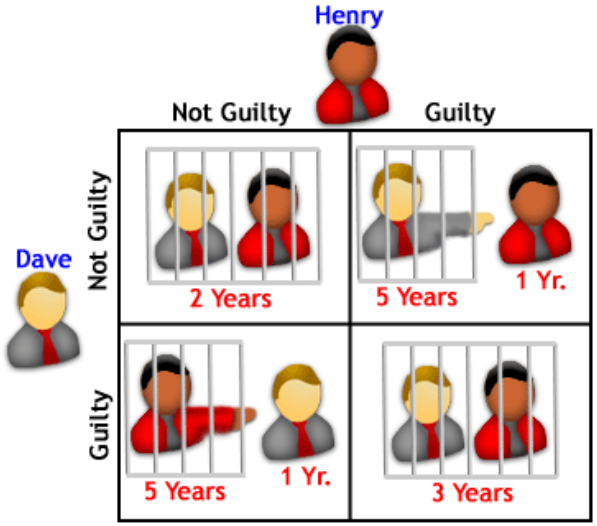
Hypothesis - Models

- 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

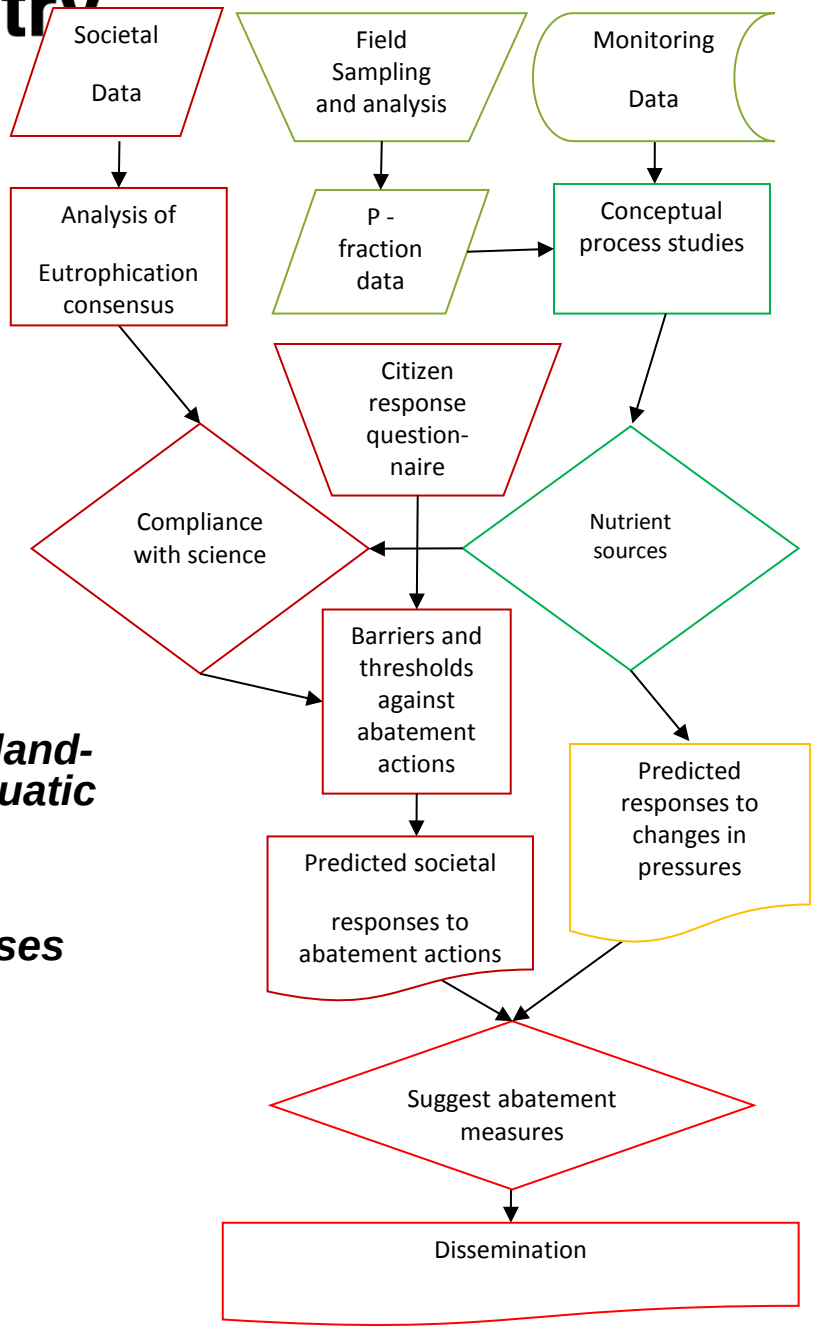
WP1 ***Field sampling and chemical analysis***

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

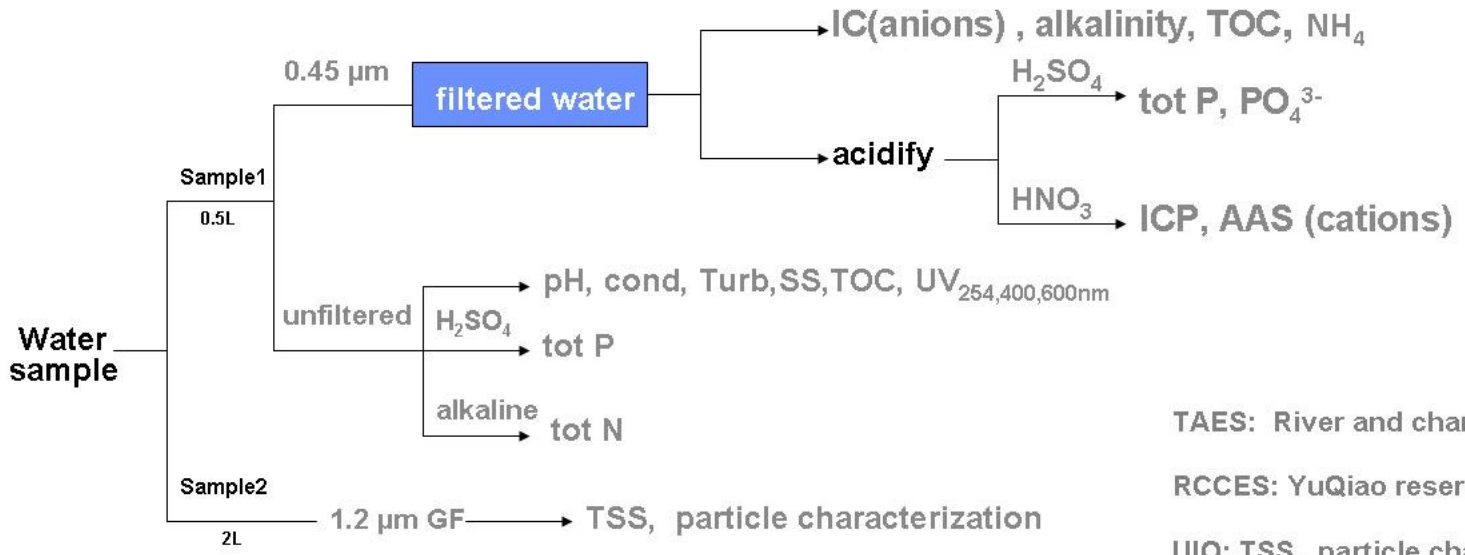
WP3 ***Modelling of catchment and lake processes***

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

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



Laboratory sample analysis



TAES: River and channel, lysimeter

RCCES: YuQiao reservoir

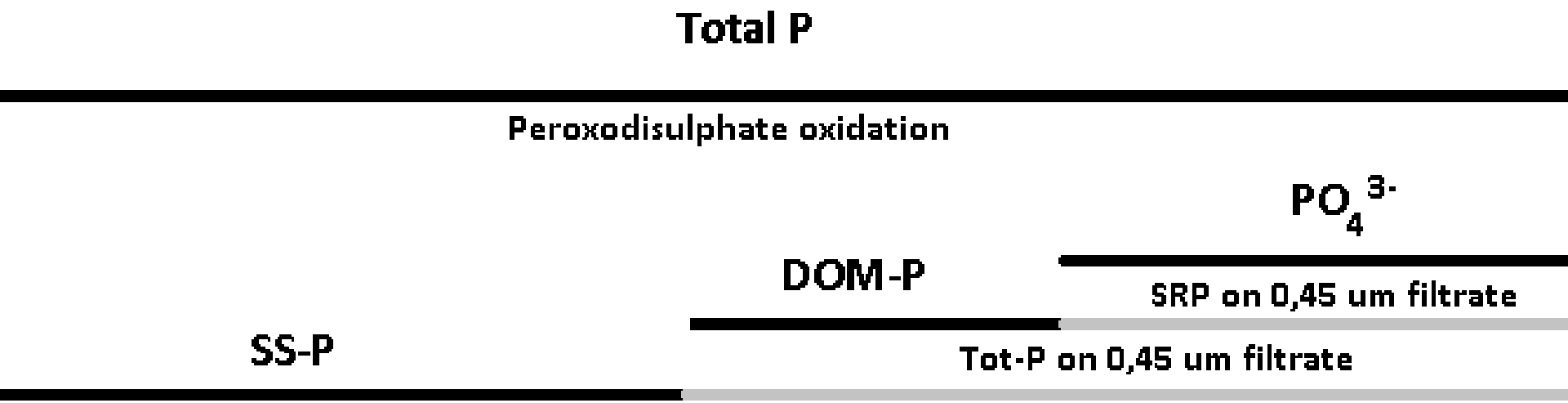
UIO: TSS, particle characterization

TAES: pH, water content, bulk density, CEC, base saturation, organic content

RCCES: PSD

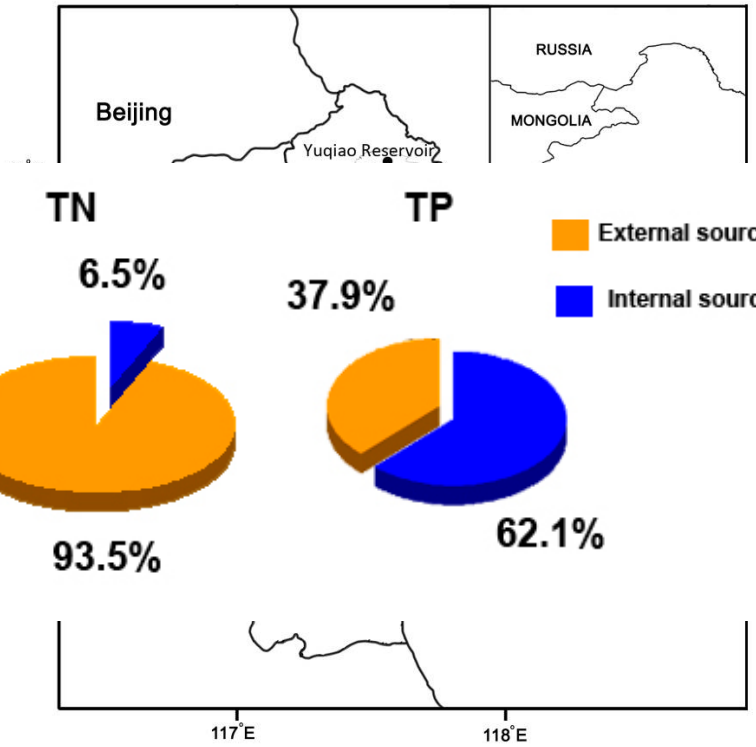
UIO: Other indexes

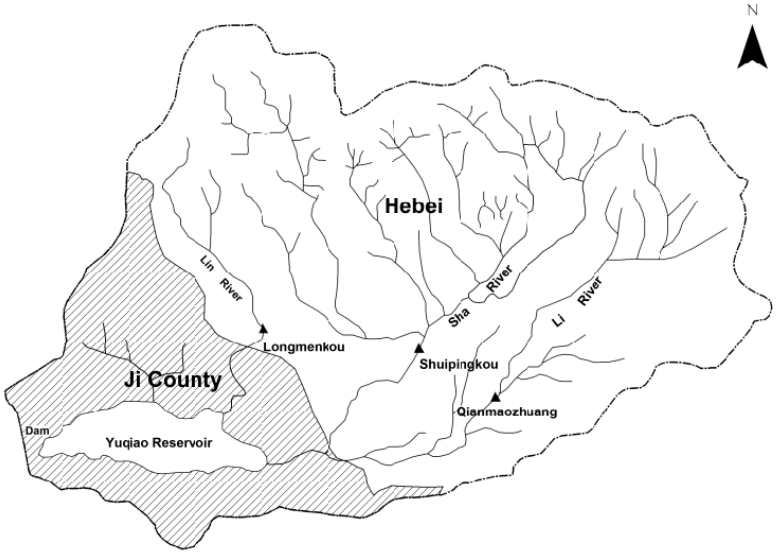
P fractionation



Yuqiao reservoir

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



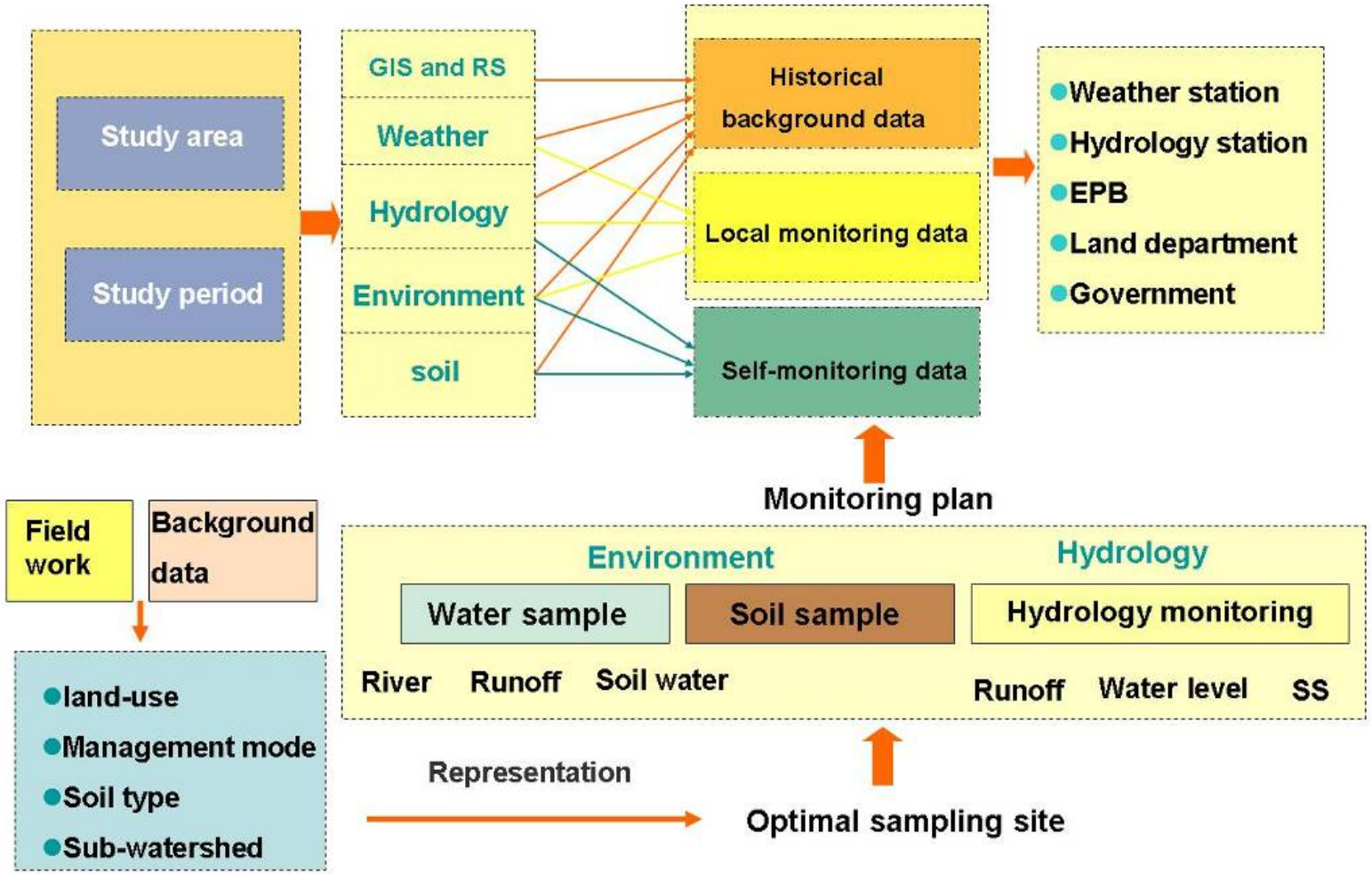


Progress so far…

- Collected and synthesized background data
- Installed equipment
- Sampled and analyzed soils and water
- Inter-calibrated chemical laboratories
- Conducted a survey covering farmers and local government officials

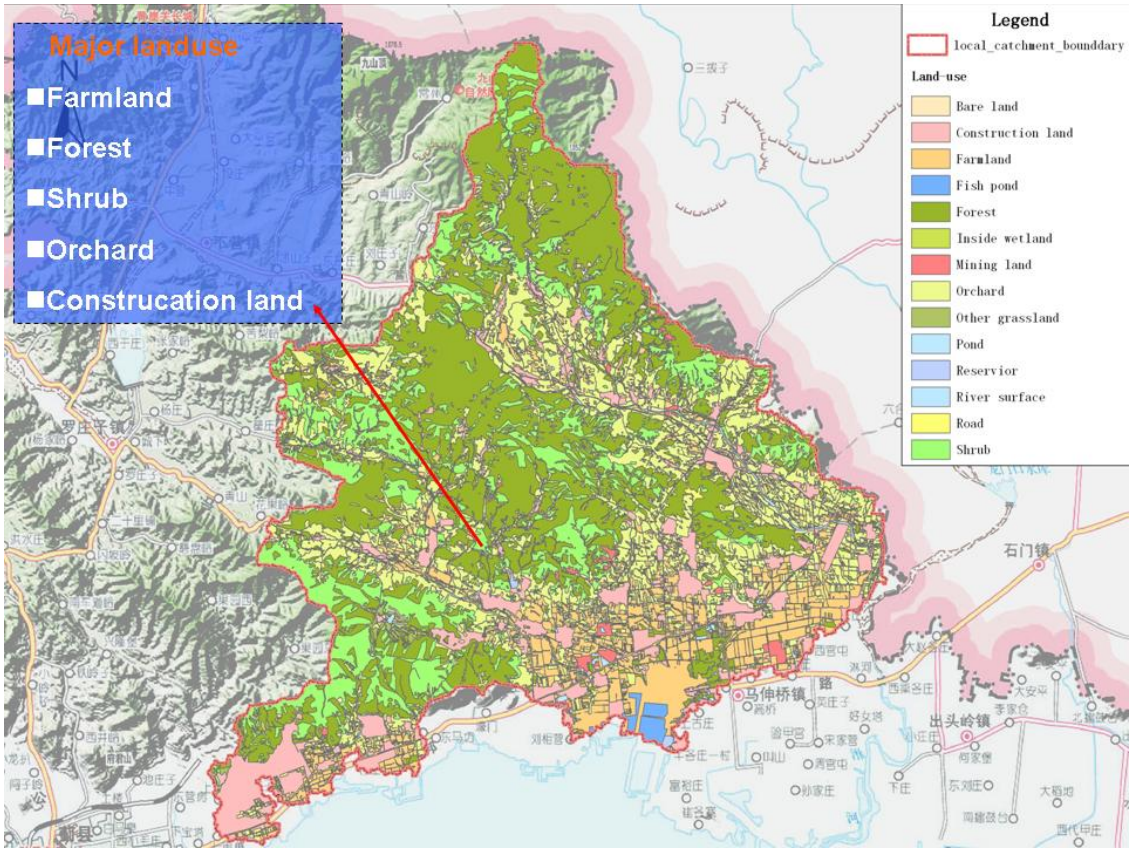
.. And much in process

Background data

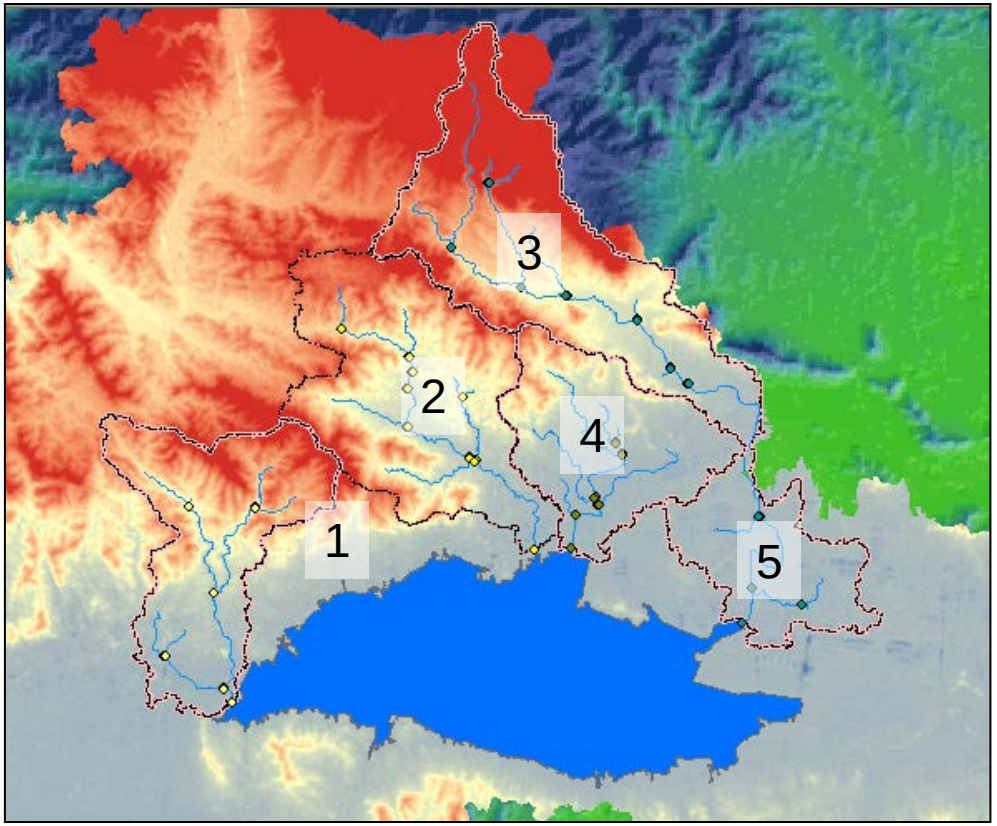


Land-use in local watershed

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



Catchments

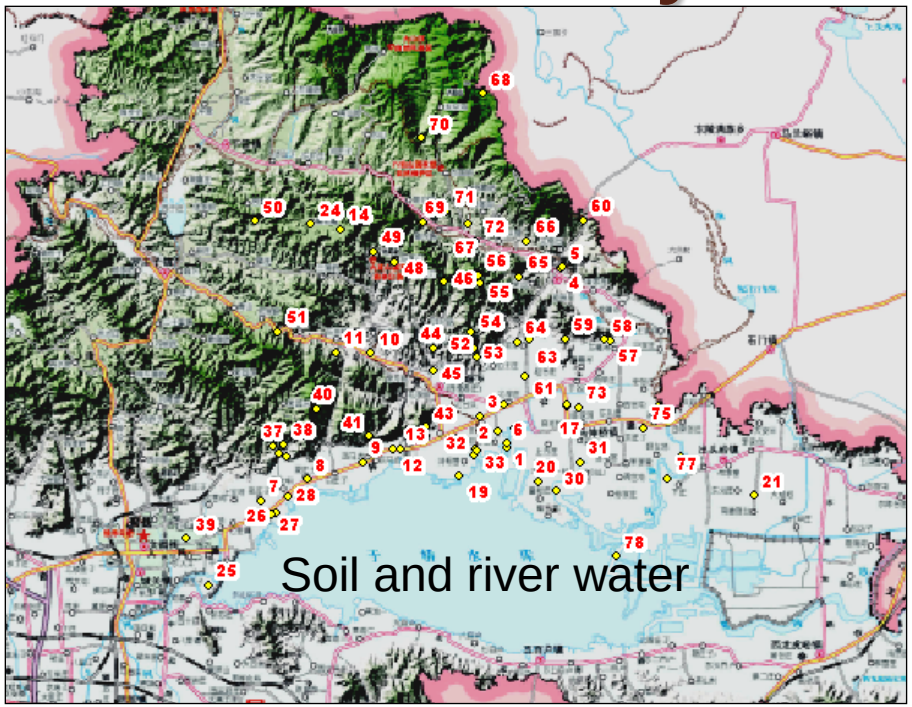


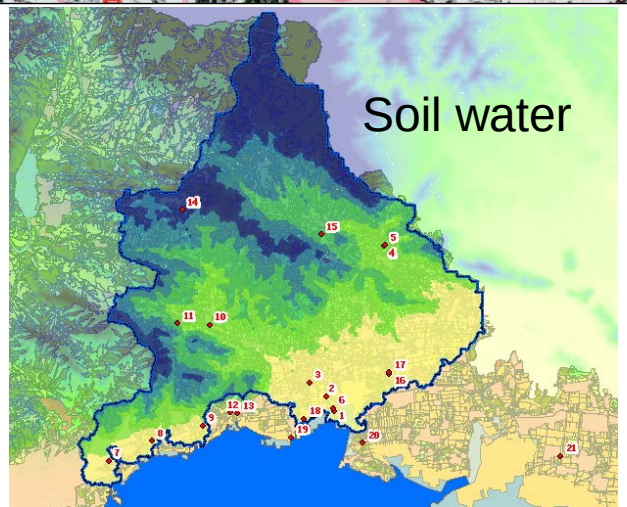
NIVA intercalibration, Summing up for TAES (and RCEES)

- TAES has delivered ca 30 components
- The results required for the SINOTROPIA project, are mostly acceptable, i.e.
  - Major components (pH, Cond, Turb, UV-abs) are good
  - Anions/Cations (Na, K, Ca, Mg, Cl, SO_4-S) are overall very good
  - Nutrients: TOC, PO_4-P, Total-P, Total-N range from very good to acceptable
- RCEES lack data for a thorough evalution

Water samples collected and analyzed

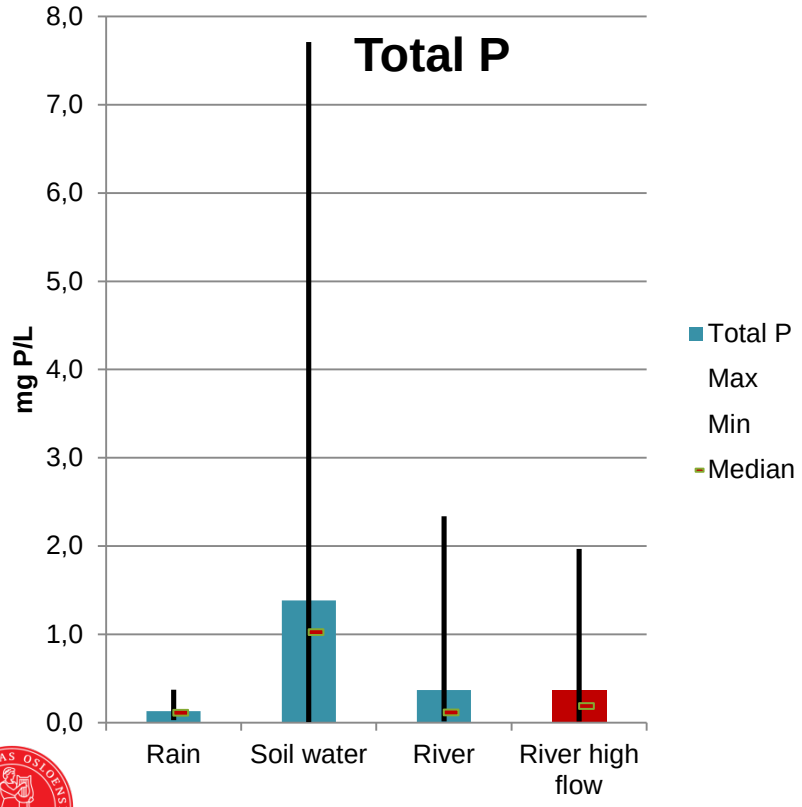
- 154 water samples
  - River: 37
  - River - high flow: 75
  - Soil water: 25
  - Rain: 11
  - Ground water： 2
  - Reservoir: 1

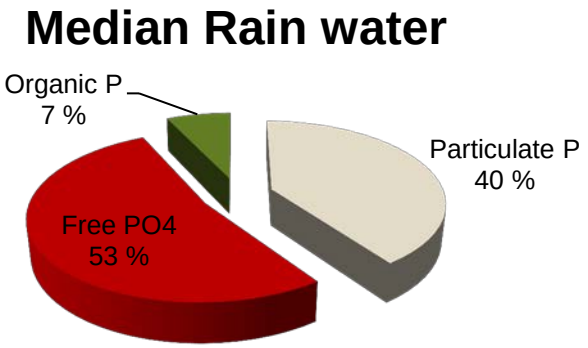


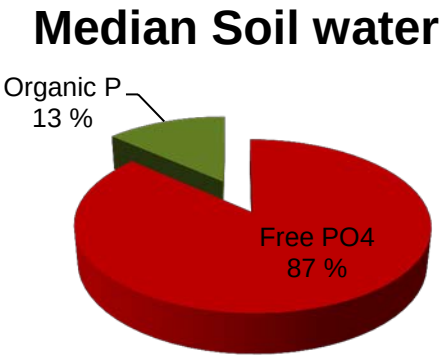


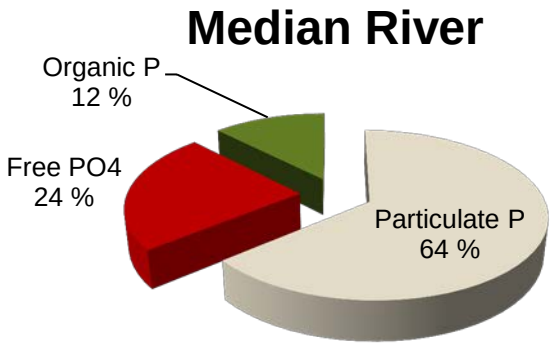
P fractions

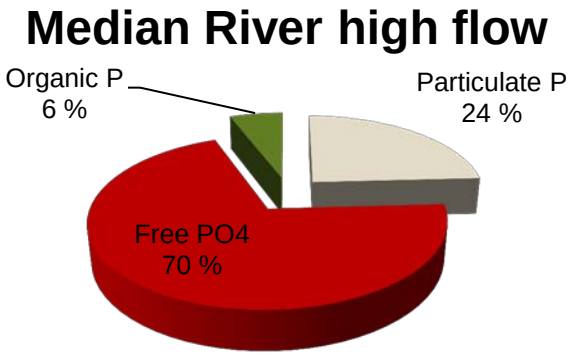
Large variation in soil water
Surpriced that P is not higher at high flow, especially the particle bound P





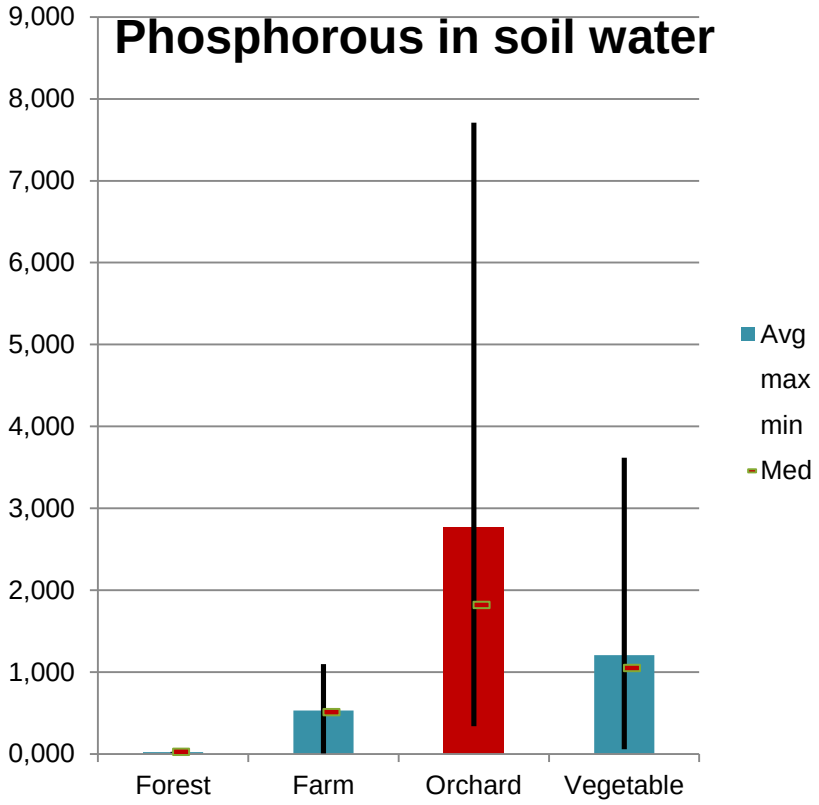




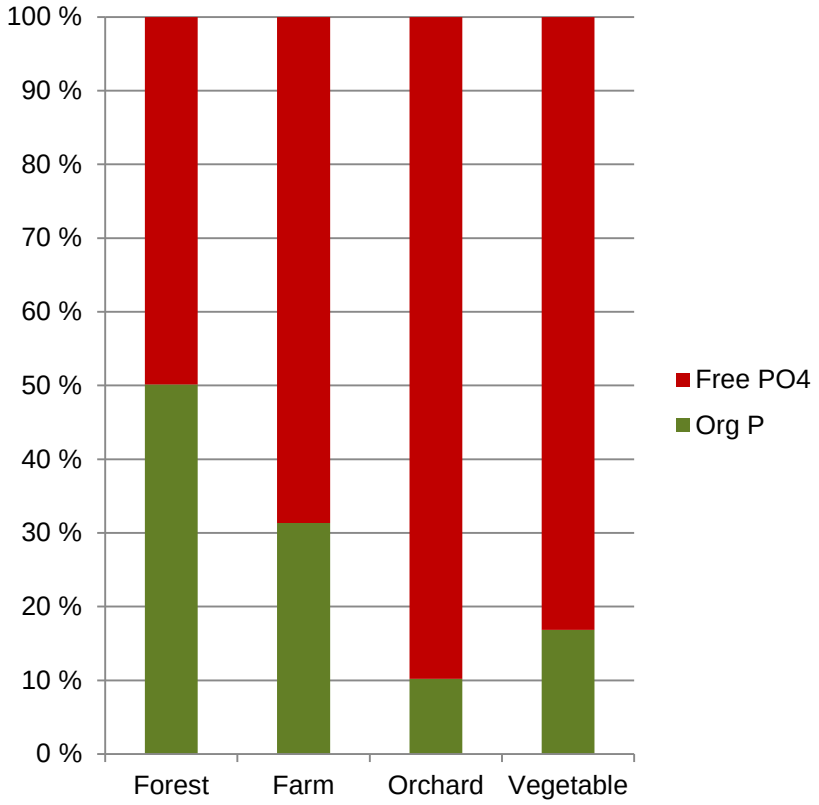


P in soil water

Surprising high values in orchards

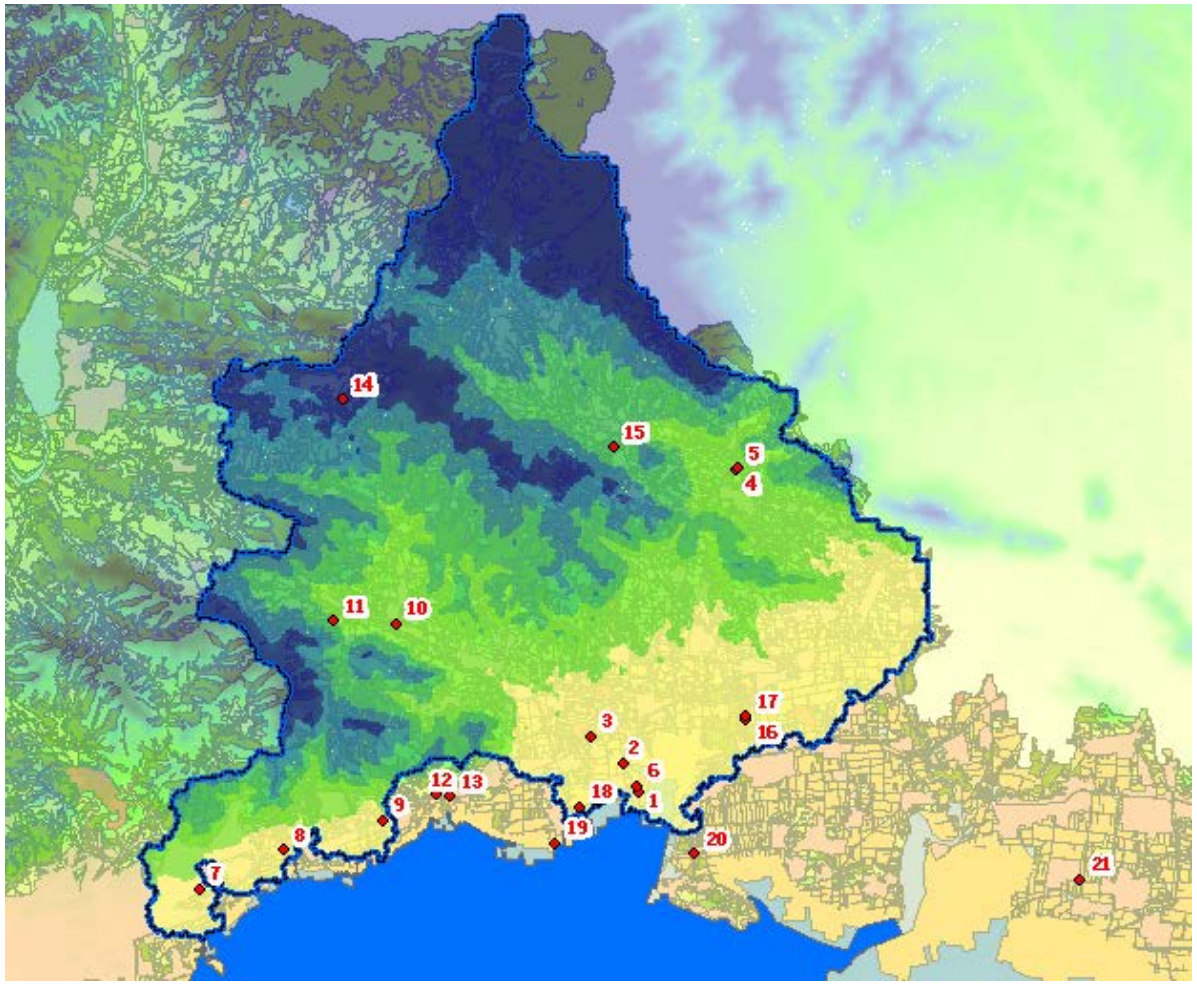


High Free PO_4 in Orchards
- Due to over-fertilization?



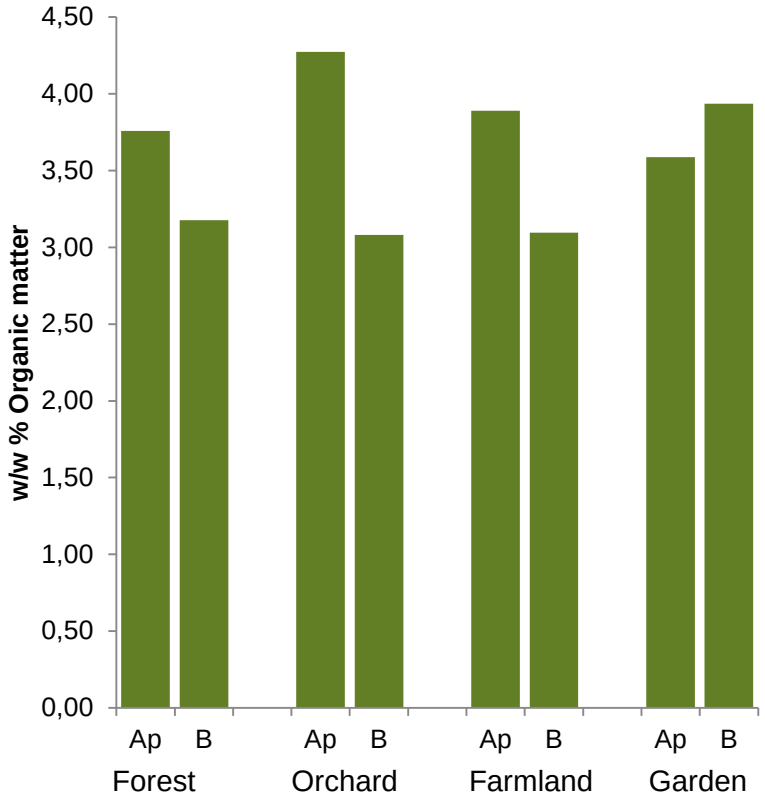
Soil samples

- 44 soil samples from sites where lysimeters are installed

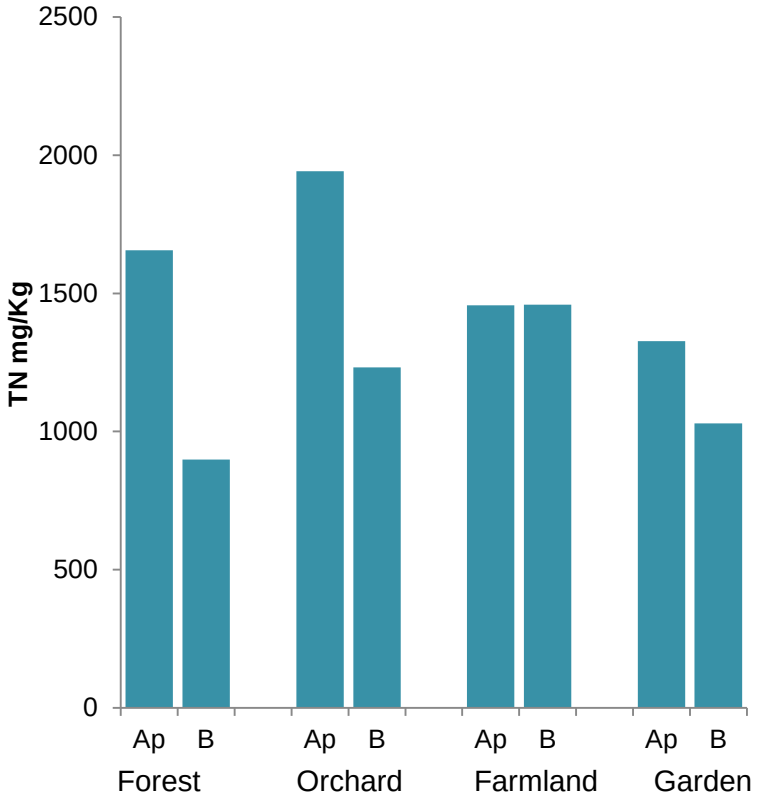


Soil chemistry

Low organic content
Typically it is usually higehst in the Ap



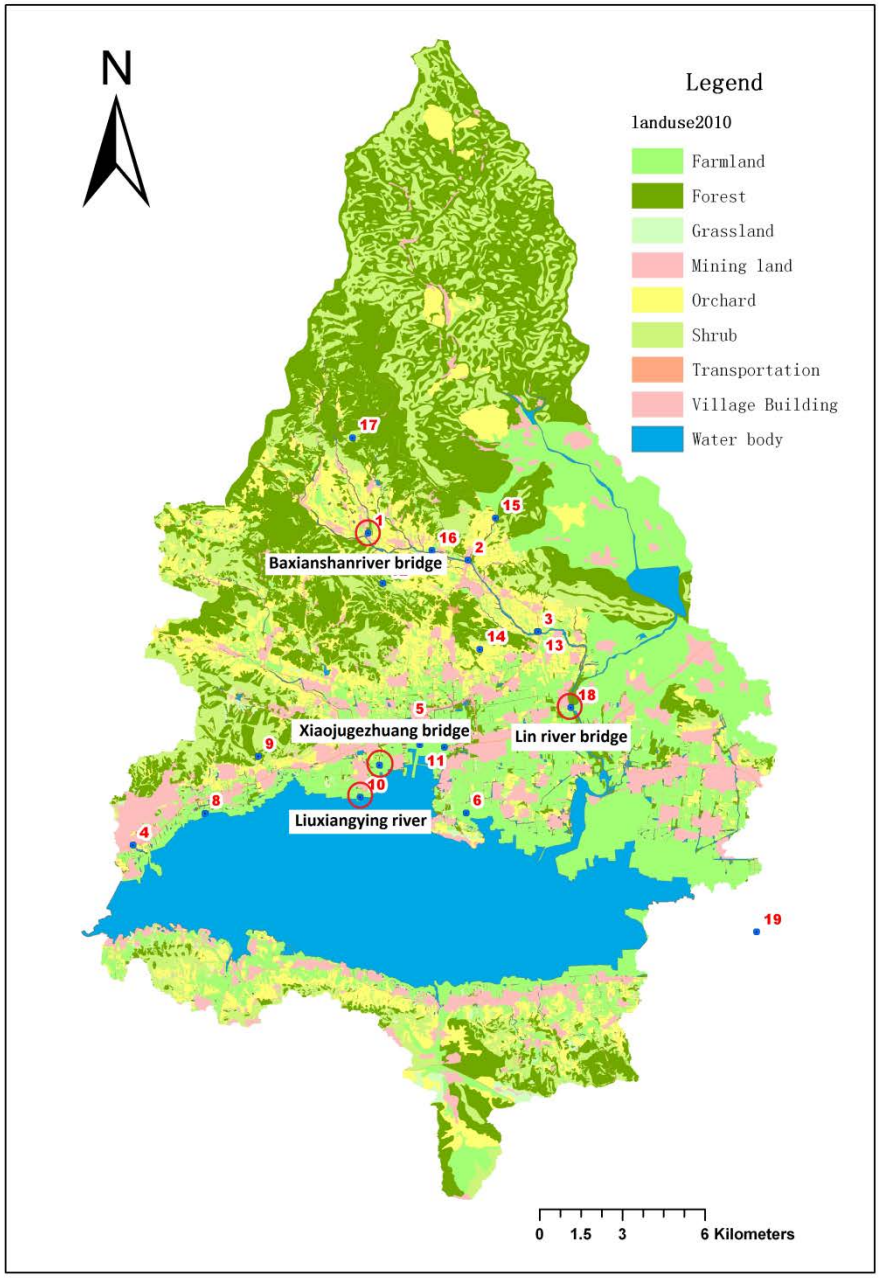
Not large differences in Total N
Highest in the Ap of the Orchards



Episode studies

4 streams:

- Baxianshan river bridge
  - Mountain stream
- Lin river bridge
  - Major river
- Liuxiangying river
  - Small stream
- Xiaojugezhuang bridge
  - Typical stream



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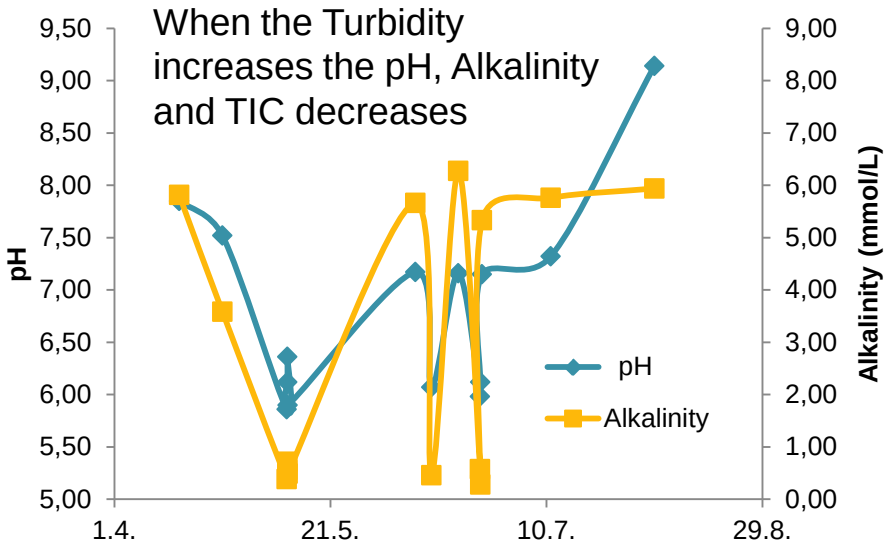
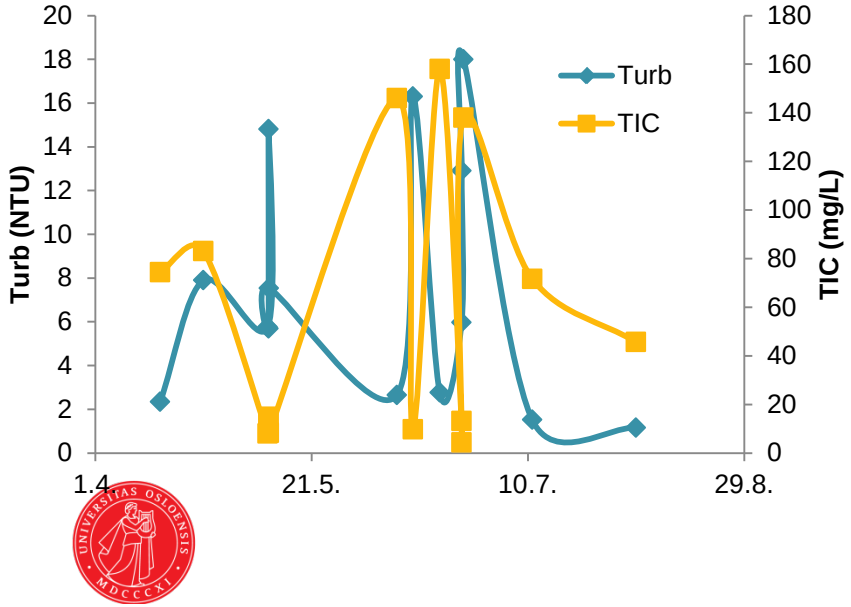
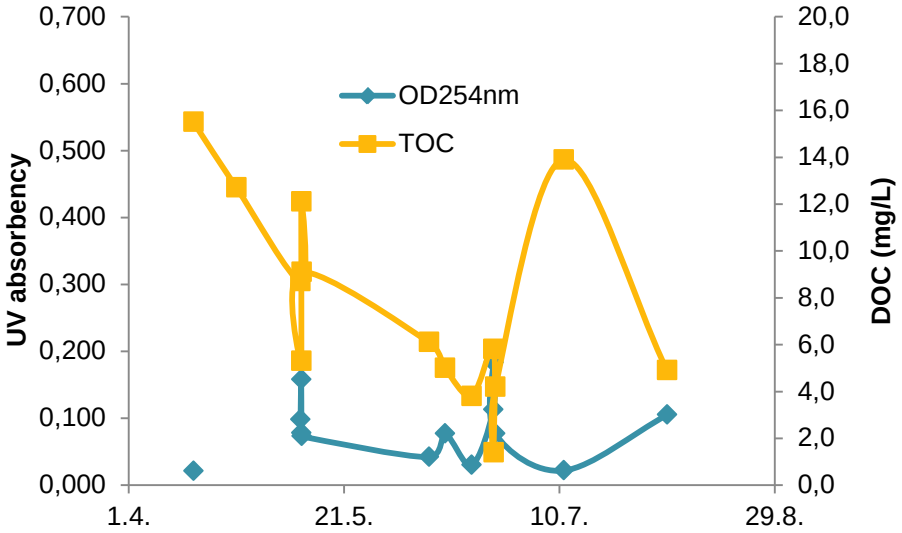
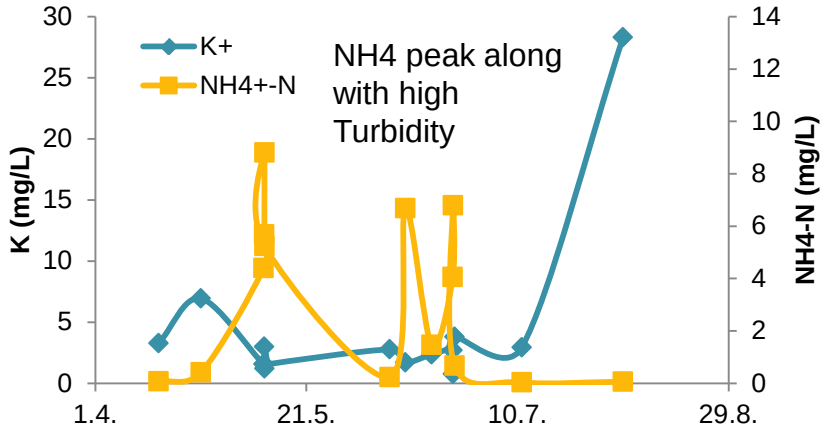
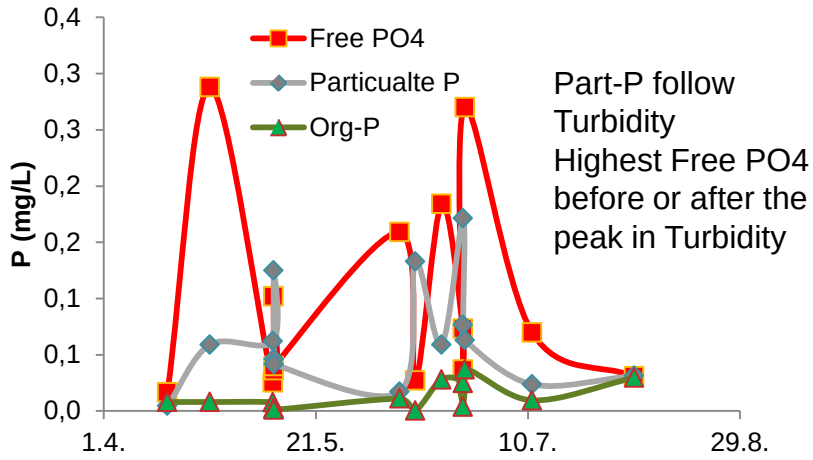
Liuxiangying river











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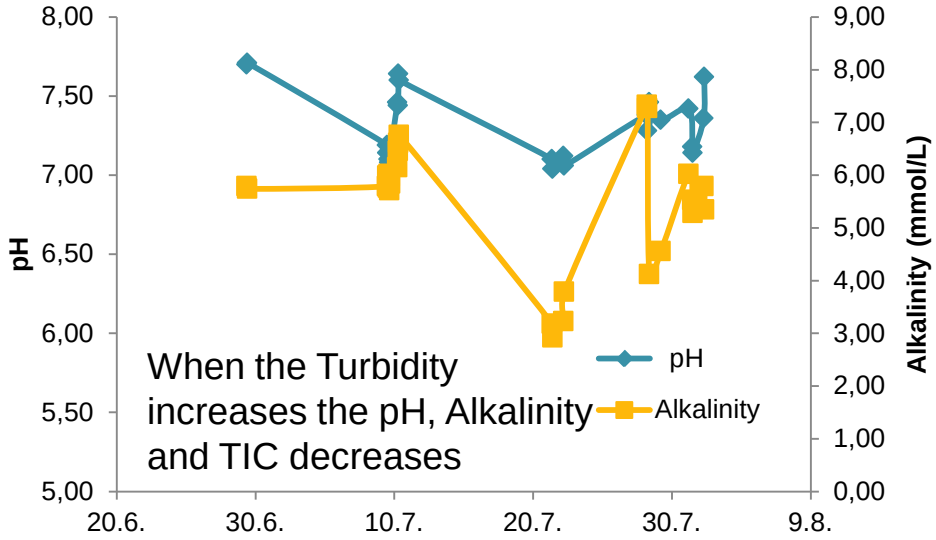
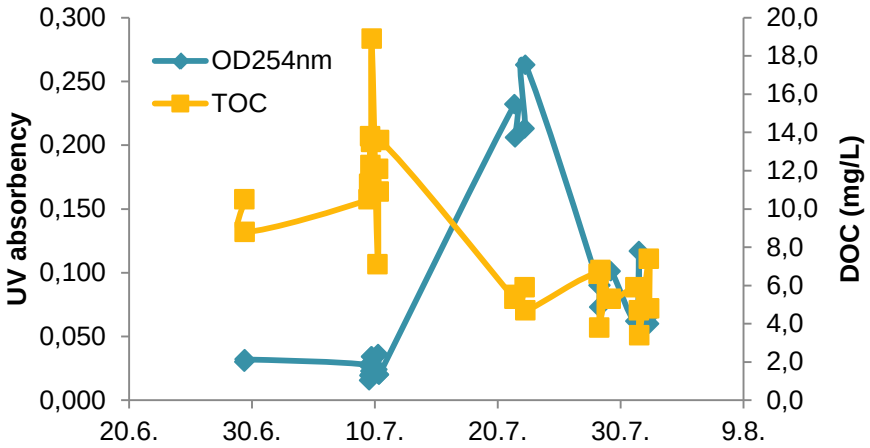
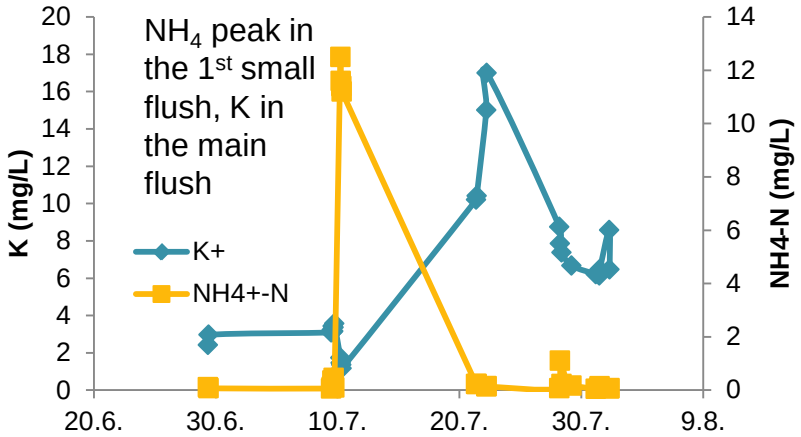
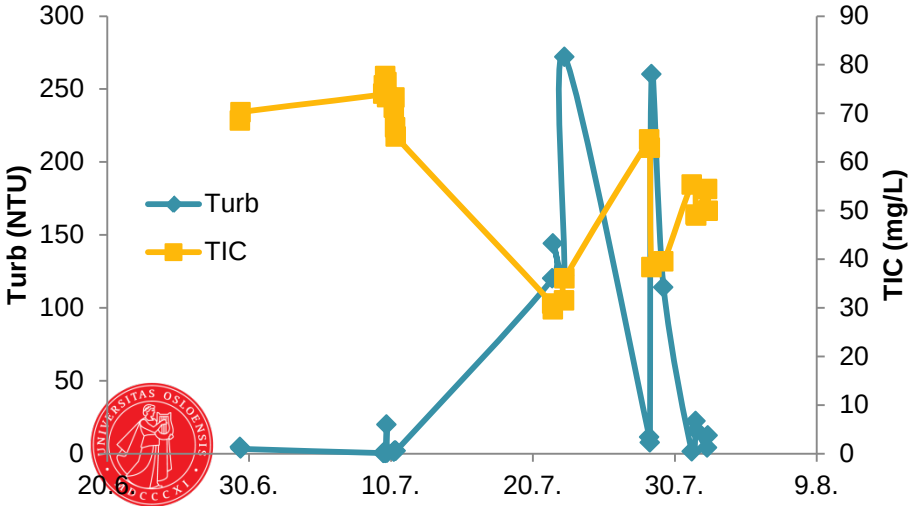
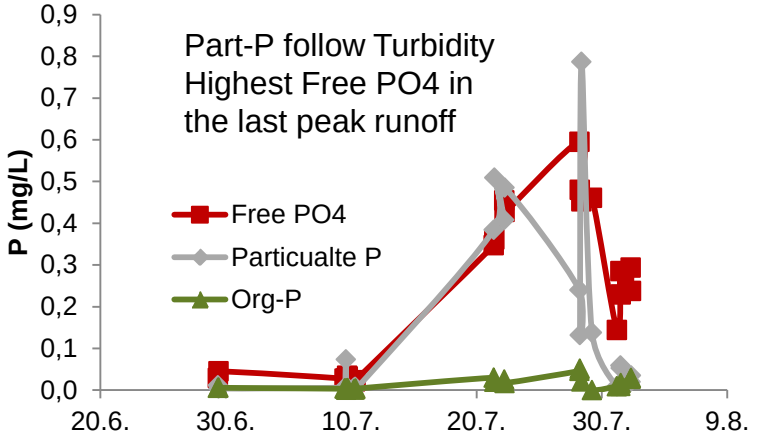
Xiaojugezhuang bridge











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

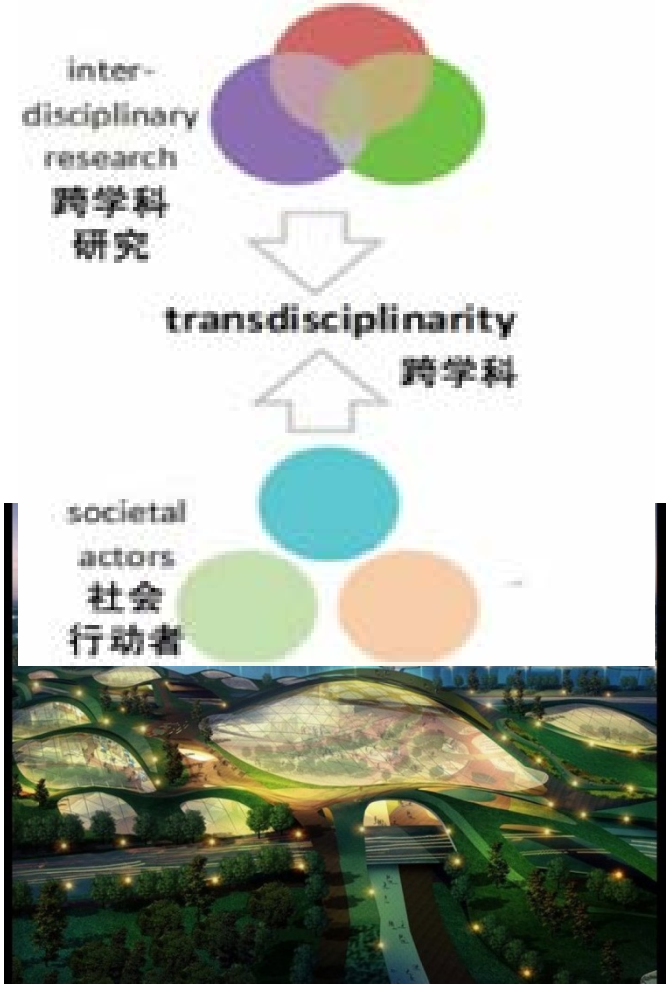
- Achieving aims of transdisciplinary research/process:
  - Input and discussions with on-going work in other work packages
  - Contact with and interaction with local leaders:
    - Policy-makers and management (on different adminstrative levels)
      - Village leaders, county officials in Ji county
      - 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



Thank you for your attention