UiO : Department of Chemistry
University of Oslo

SinoTropia

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

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2014.11 (Trondheim)

UNIVERSITY OF OSLO

NIVA Norwegian Institute for Water Research

NIBR Norsk institutt for by- og regionforskning

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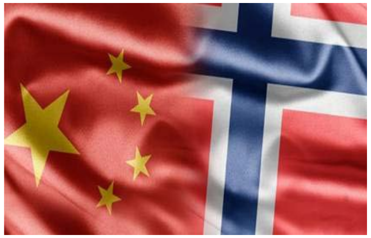
Working across borders



- Bilateral project between China and Norway (2011 – 2014)

- Funding supported by the Chinese Academy of Sciences (CAS) and the Research Council of Norway (RCN)

- Participating research institutes from China:
  - Tianjin Academy of Environmental Sciences (TAES)
  - Research Centre for Eco-Environmental Sciences (RCEES)
  - Institute for Urban and Environmental Studies Chinese Academy of Social Science （CASS）
- Participating research institutes from Norway:
  - University of Oslo (UiO)
  - Norwegian Institute for Water Research (NIVA)
  - Norwegian Institute for Urban and Regional Research (NIBR)

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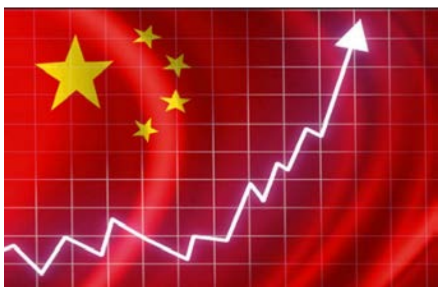
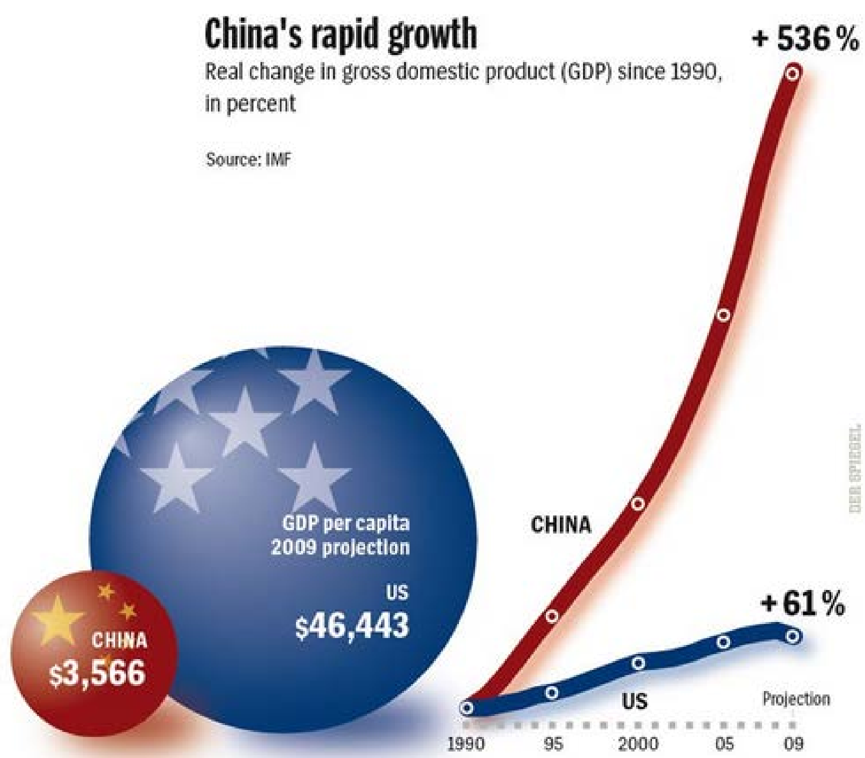
The main issue





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The main issue

- China is facing multiple environmental problems, severely deteriorating its natural environment and ecosystem services

Water pollution: Tai lake

Air pollution: Beijing haze

Soil pollution

Deforestation

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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

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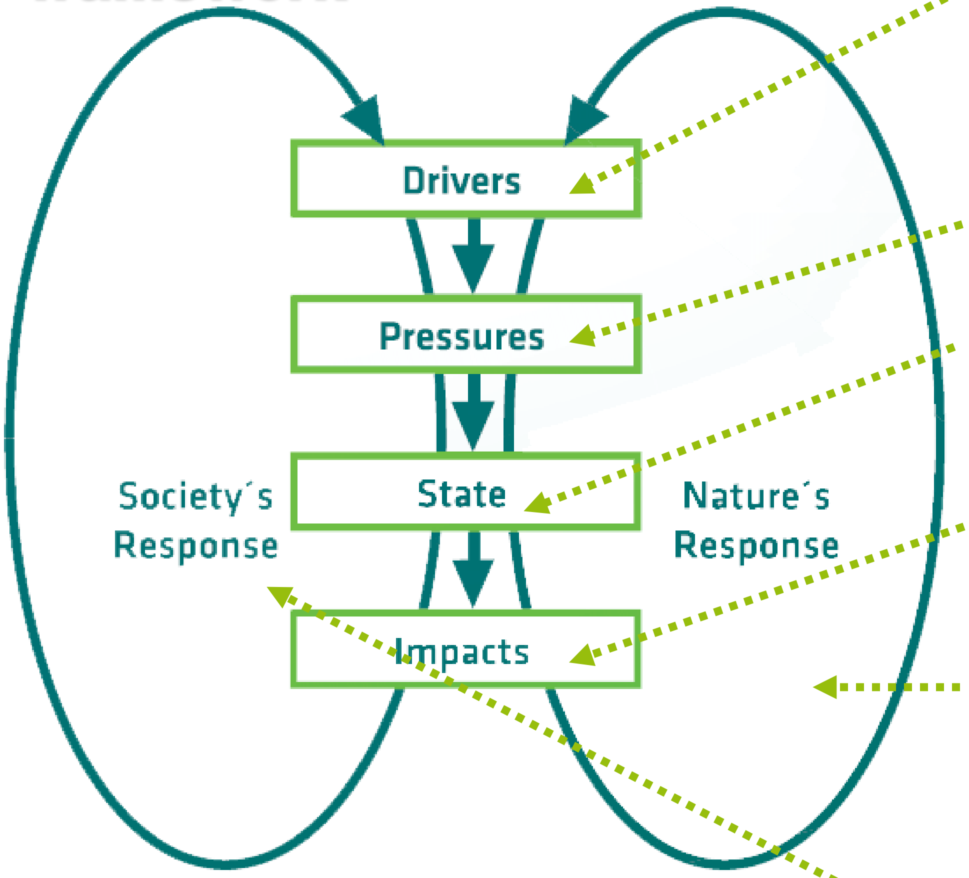
The approach forward

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

Outline

DPSIR - Conceptual framework



CIENS
Oslo Centre for Interdisciplinary Environmental and Social Research

Drivers: **Population increase, Economic development, climate change, Land use/cover change**

Pressures: **Nutrient leaching to water**

State: **High nutrient levels**

Impacts: **Eutrophication**

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

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

Hypothesis – Analytical methods

- Phosphorus is the main element result in eutrophication

- 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

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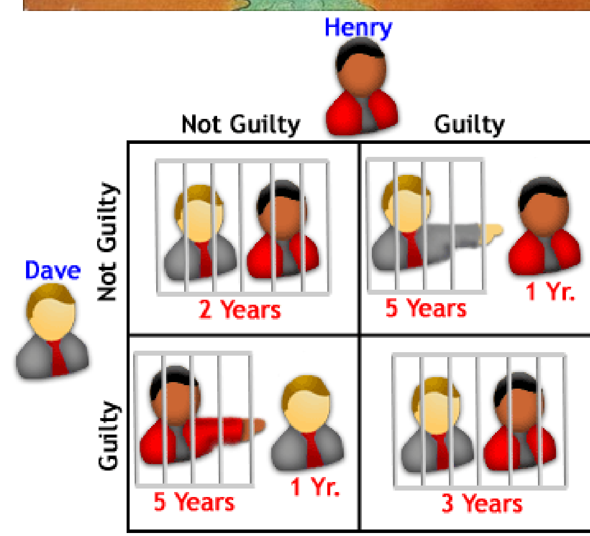
Hypothesis
– Societal response

- 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



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SinoTropia Research Strategy

The hypotheses are tested through integrated works packages

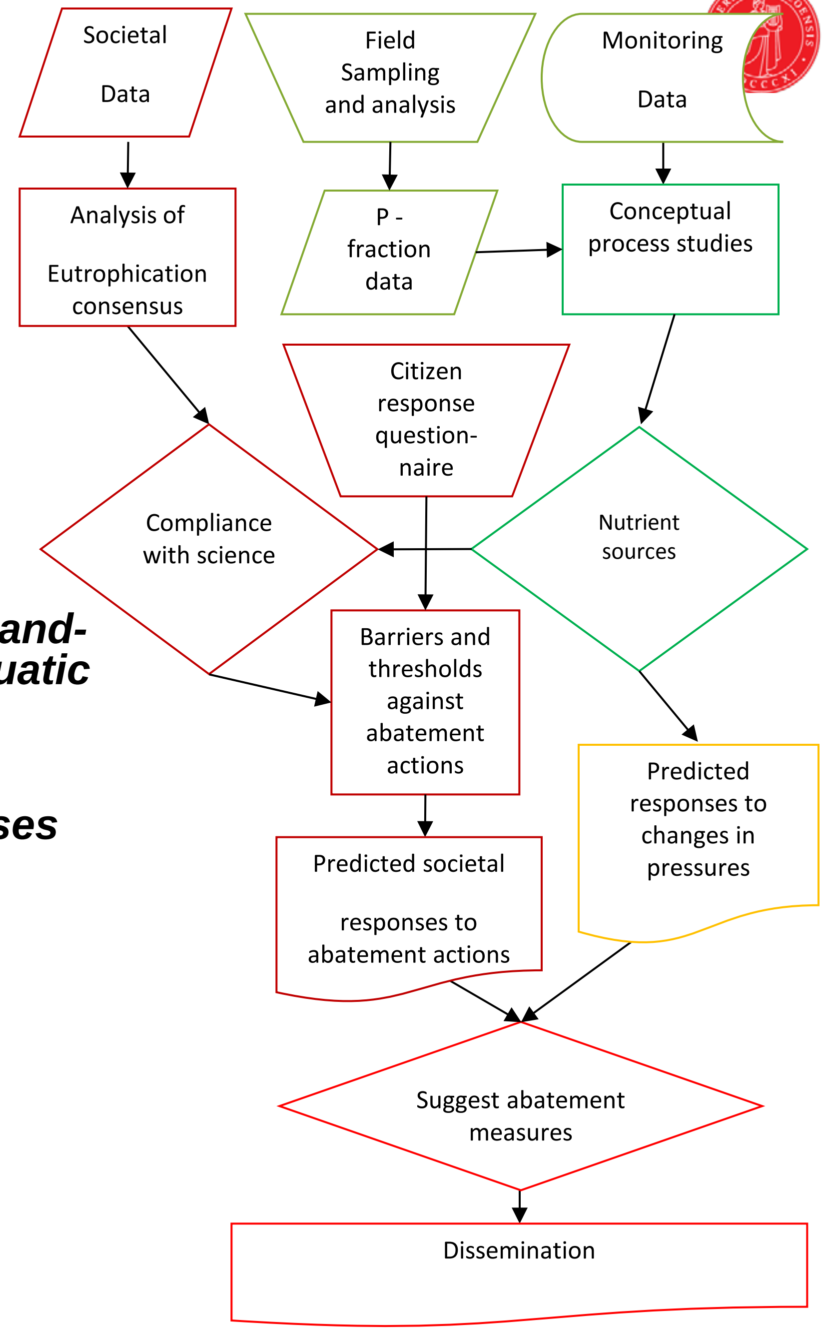
WP1 ***Field sampling and chemical analysis***

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***



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Study site description：

Local watershed of Yuqiao Reservoir

Why?

Yuqiao Reservoir

Local watershed

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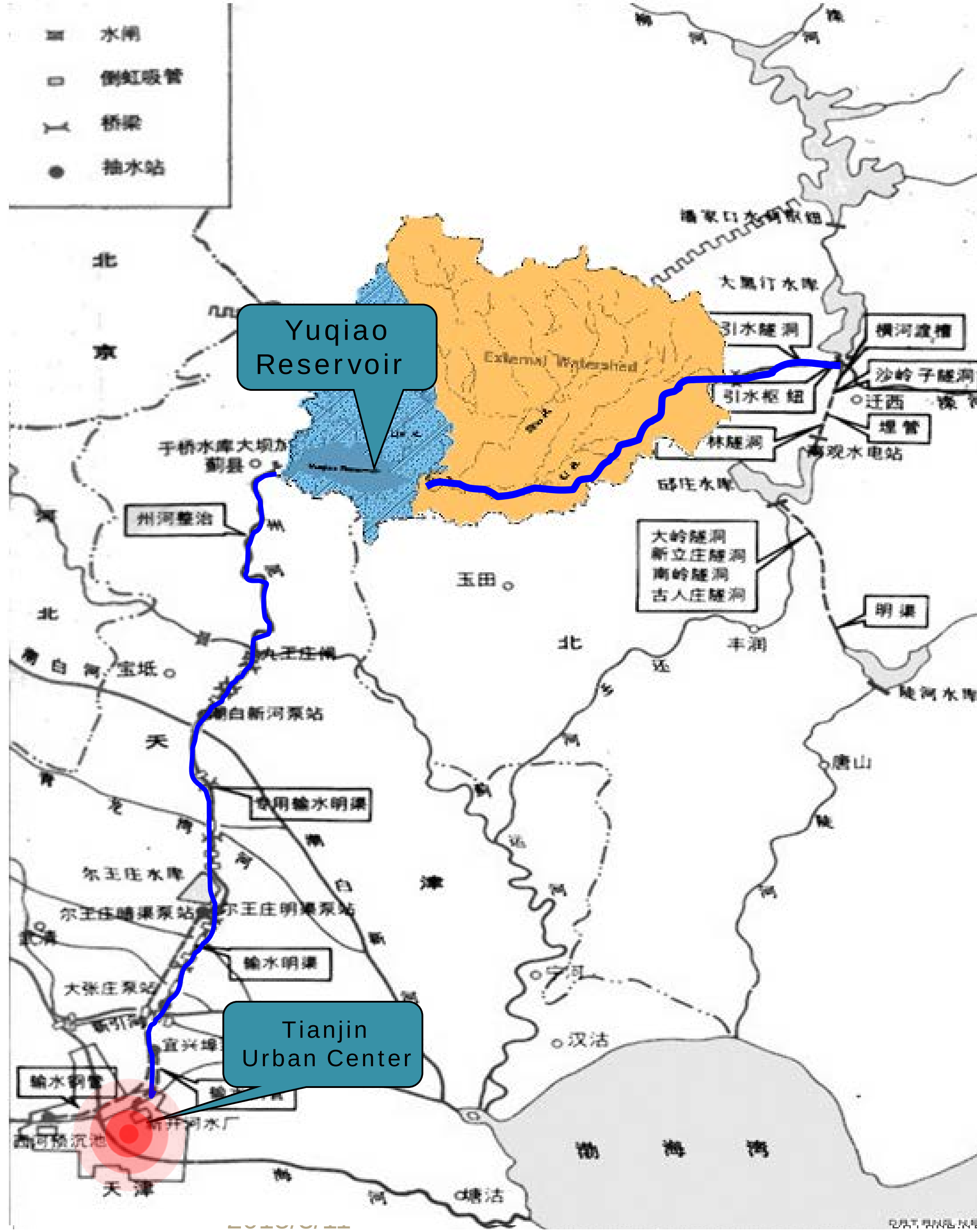
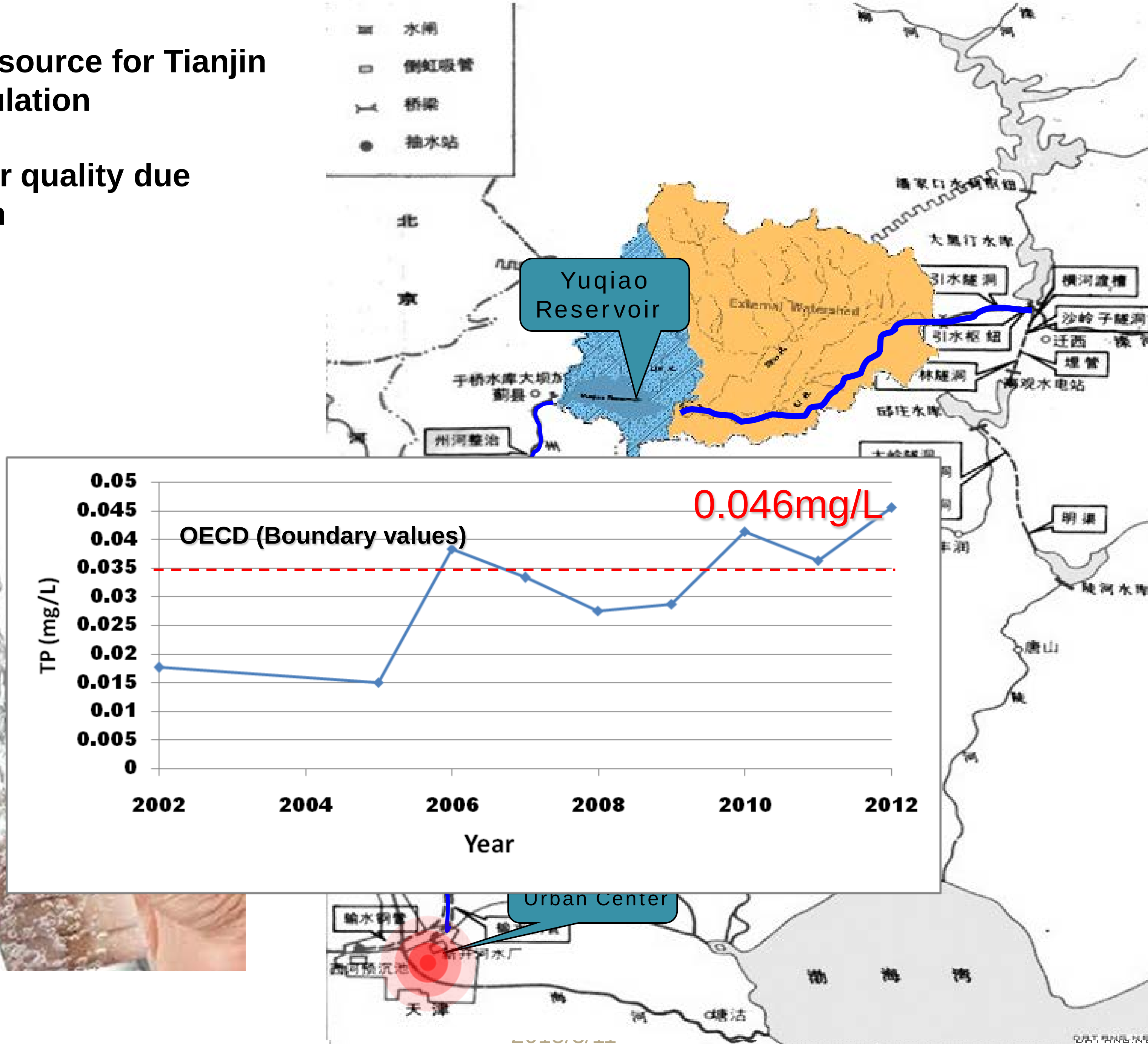
●**Drinking water source for Tianjin**
6.36 million Population



- ●Drinking water source for Tianjin 6.36 million Population

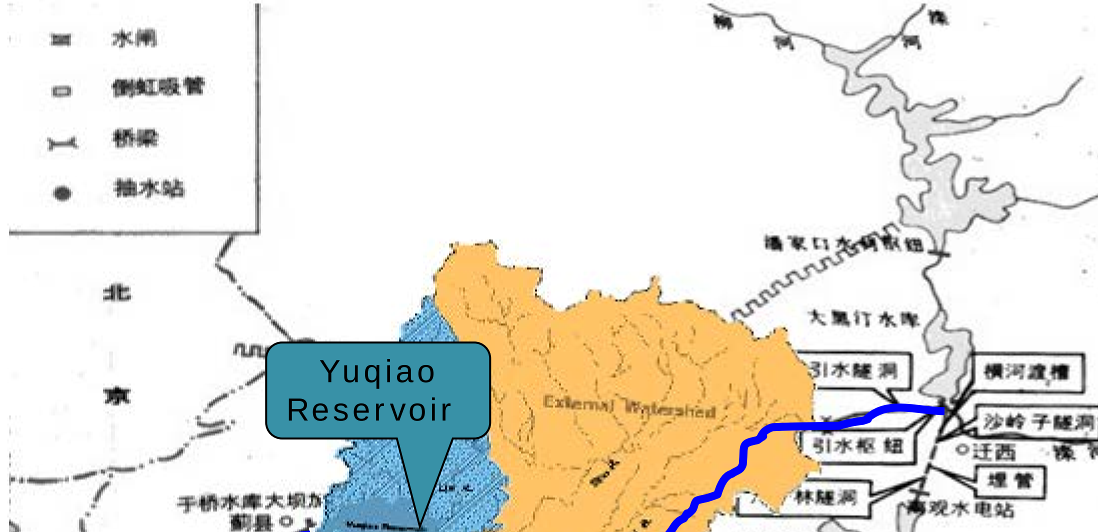
- ● Declining water quality due to Eutrophication



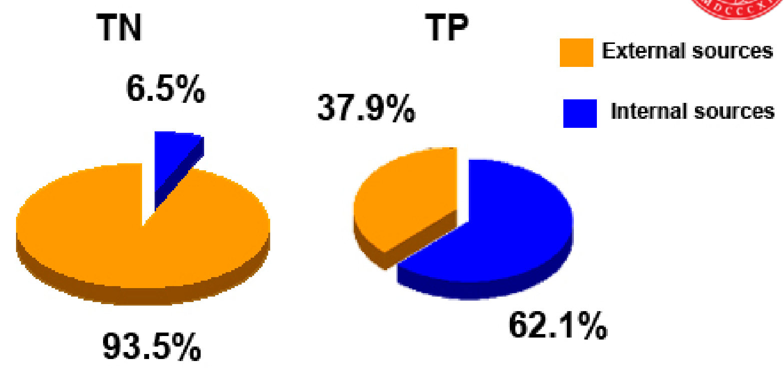
●Drinking water source for Tianjin 6.36 million Population

● Declining water quality due to Eutrophication

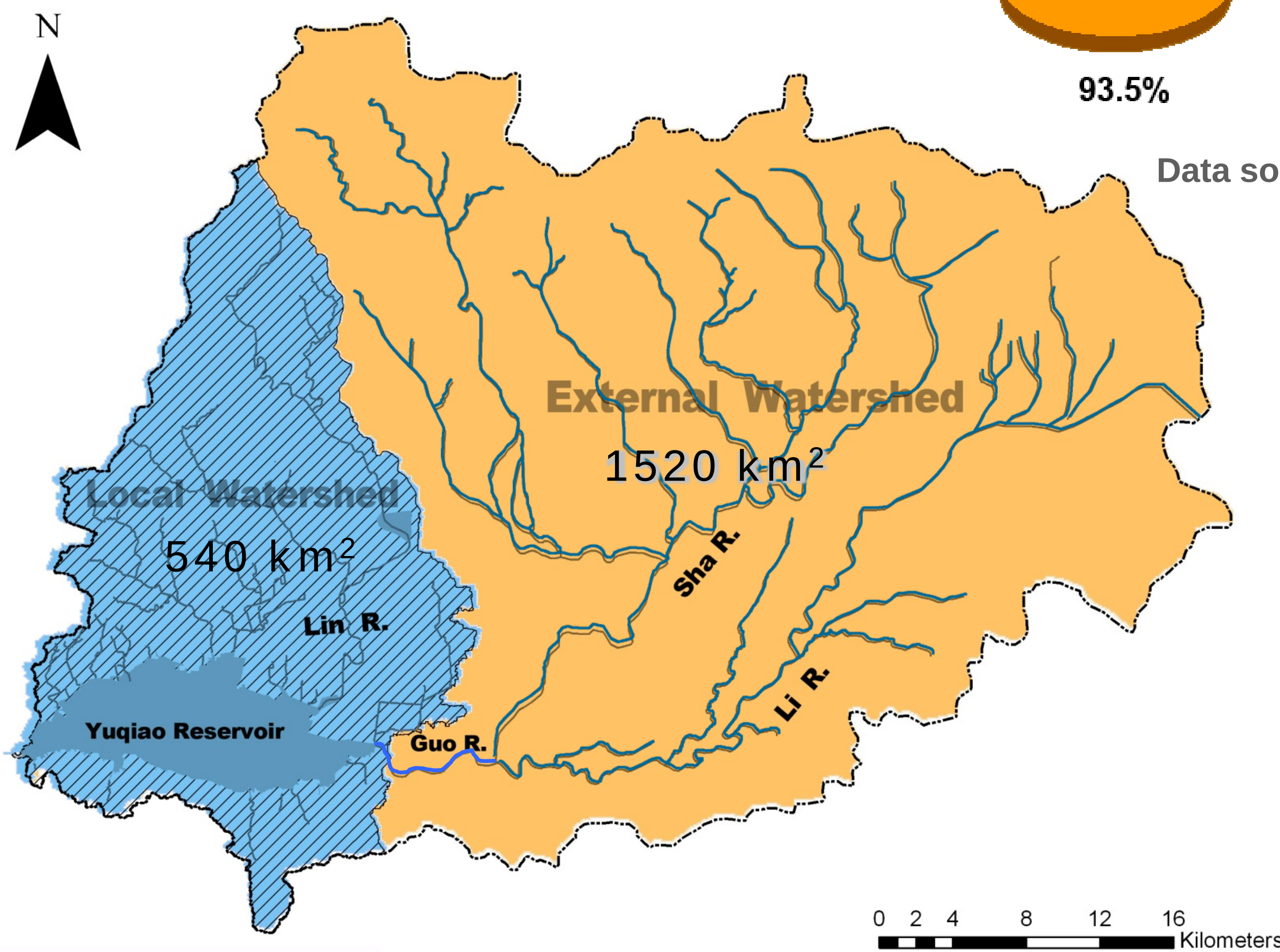
● Eutrophication is the result of excessive nutrient loading to water bodies, with phosphorus being the main problem.



Main P flux is from local watershed



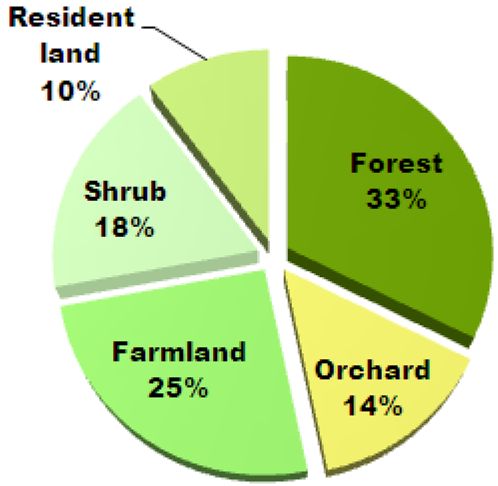
Data source: Ji County EPB(2009)

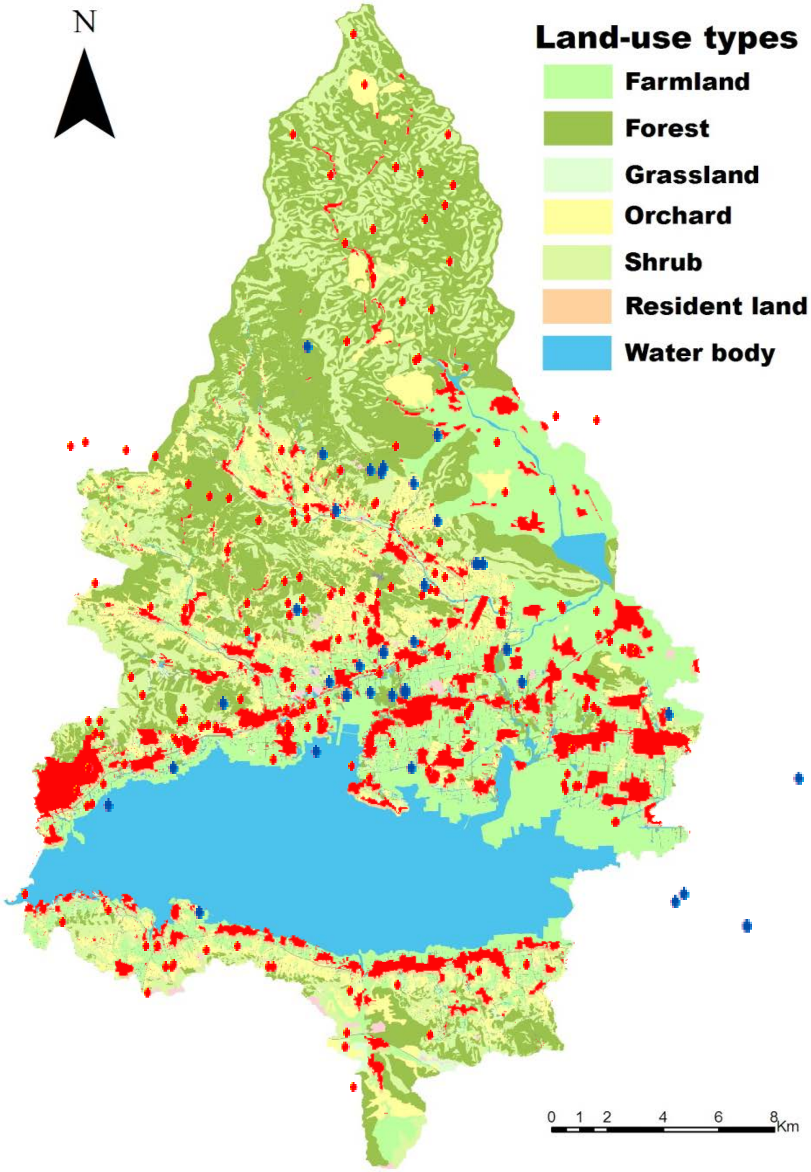


Background

Land use types

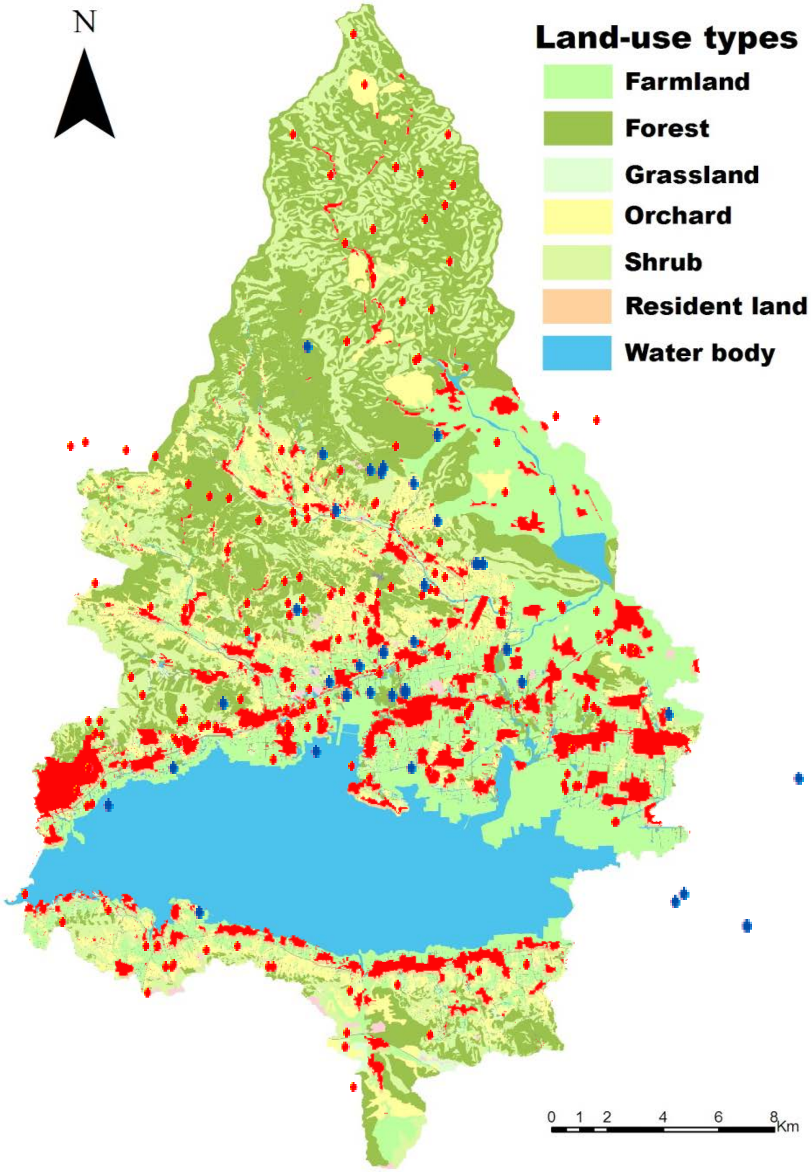
Sampling





Farmland + orchard: 39%


General introduction

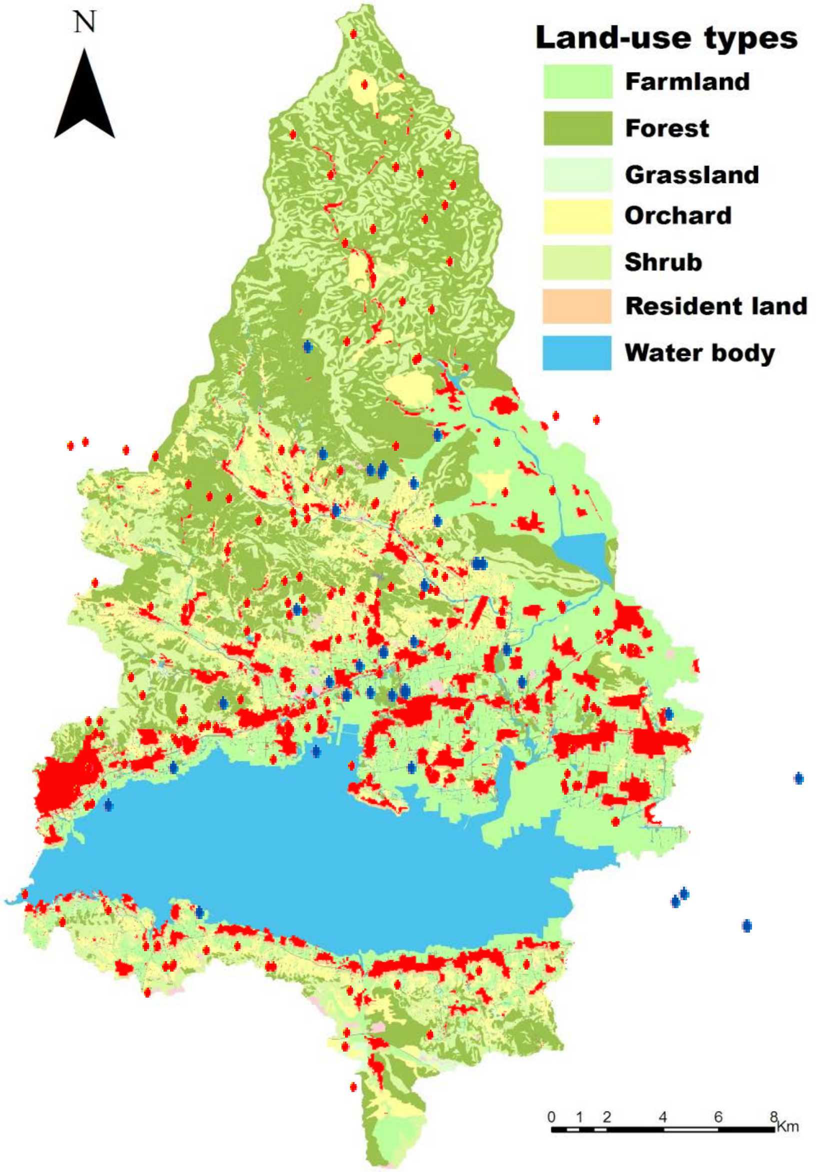


- 152 villages
- 130 000 residens in the local catchment
- Agriculture with abundent use of fertilizers
- Relatively fine soils with poor water infiltration in the flats
- Sandier soils in the mountain region

General introduction

226 soil samples from **126** different soil sampling sites were collected

287 surface water samples, **80** soil water samples and 25 DGT samples were collected



Water and soil analysis

➢ Soil sample

- **General characteristics**

pH, Organic matter (LOI%), PSD (Clay, Silt and Sand%), bulk density, CECe, Soil mineral composition (XRD)

- **P pools**

Tot P, TIP, TOP

- **P potential loss risk indices**

BAP: Olsen P, Bray-1 P, Mehlich 3 P

PSI: P sorption index

DPS%: Degree of P saturation

- **P Soil P composition** ^{31}P NMR
- **Phosphatase activities**

AcP, AlP, PD and PY

➢ Water sample

- **P pools**

Tot P, TIP, TOP, PP,
TDP, DIP, DOP

- **Main cation and anion**

H^+, Ca^{2+} , Mg^{2+}, Na^+, K^+ , NH_4^+
Cl^-,NO_3^-, SO_4^{2-}

➢ Hydrological sample

2 sets of temperature and light intensity loggers

3 water level loggers

Social Part

Survey questionnaire among farmers and face-to-face interviews were conducted on the following topics:

- Environmental values/attitudes
- Place attachment
- Learning and knowledge about farming and the use of fertilisers
- Water resource issues

Main findings

Soil chemistry

Table 1 Soil physiochemical characteristics and P pools of each land use type

Land-use	Horizon	pH(H_2O)	Organic matter (%)	P pools mg P/kg	
				TIP	TOP
Forest	A	7.0	6.8±2.2c	248±13a	167±7a
Orchard	A	7.3	4.2±1.5ab	537±35ab	229±16ab
Cropland	Ap	7.2	3.5±0.4a	638±20b	203±15ab
Vegetable fields	Ap	7.2	5.2±3.2b	993±70c	543±38b

The same letters are not significant at 5% level (Duncan).

- pH:

➢ **Neutral or slightly alkaline soil: pH value of all test soil was generally around or higher than 7.**

- SOM:

Forest (6.8%)>Vegetable (5.2%)>Orchard(4.2%)>Crop(3.5%)

Main findings

Soil chemistry

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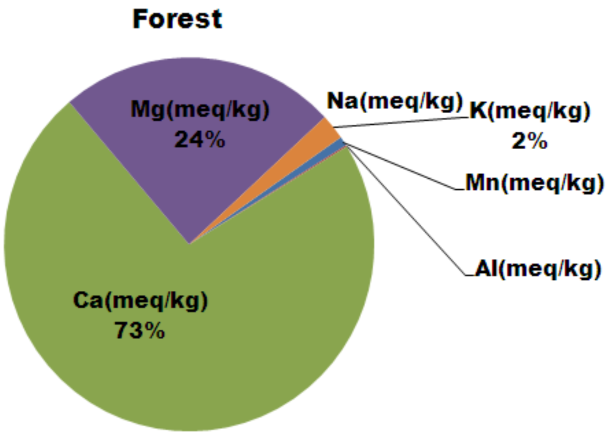
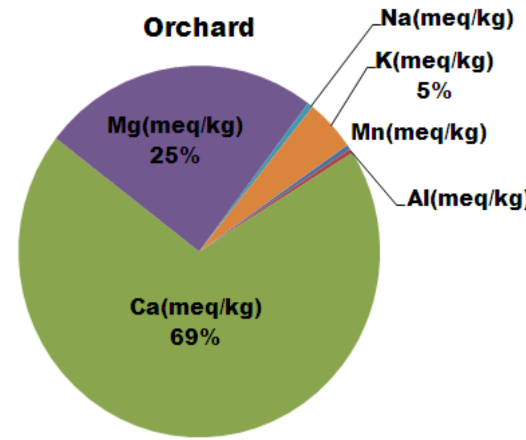
P pools

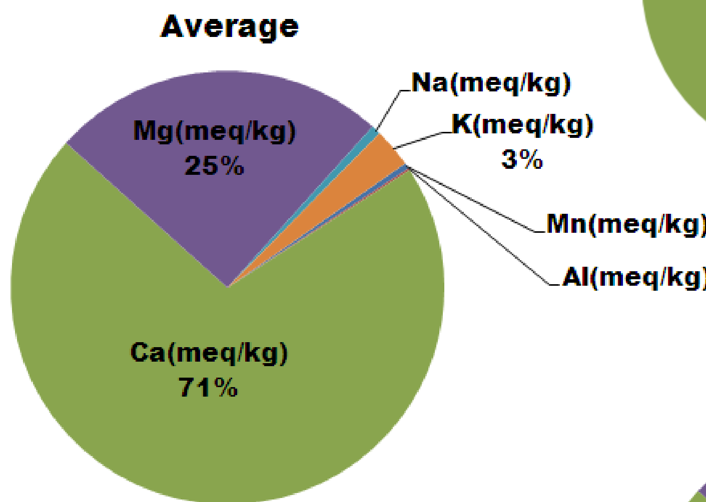
- Total inorganic P (TIP) is the major fraction (60~80%) to the total P in all test soils
- Local inorganic P fertilizer application strongly influenced the soils' TIP and BAP level as the following order:

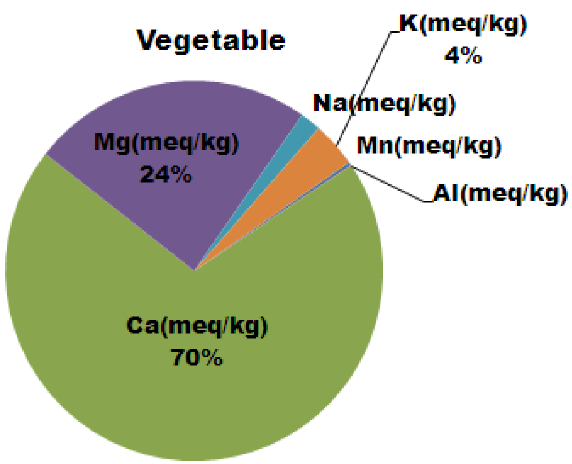
  Vegetable farming > Crop>Orchard >Forest
- Vegetable field showed a relatively high level of TOP (542.6 mg P.kg-1), which could stem from the large amounts of organic fertilizers applied

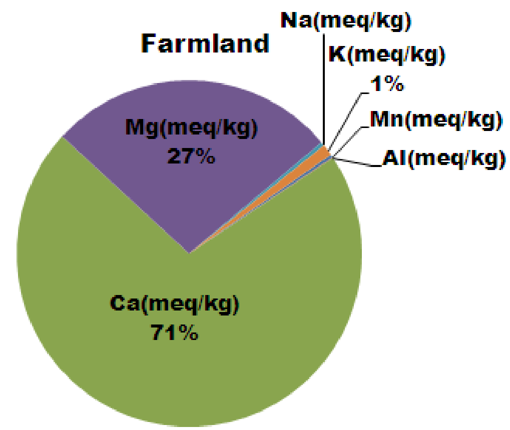
Soil cations composition











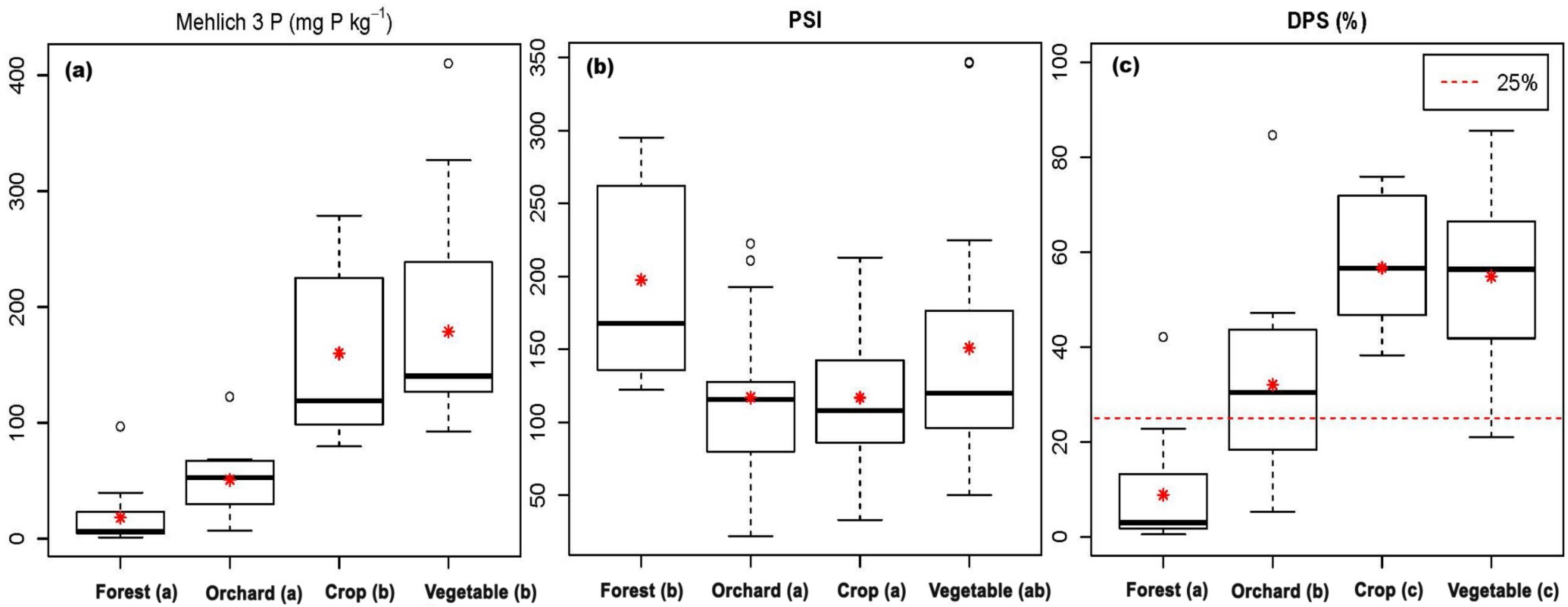
Calcareous soil

$Ca^{2+} > Mg^{2+} > K^{+} > Na^{+} > Mn^{2+} > Al^{3+}$

Main findings

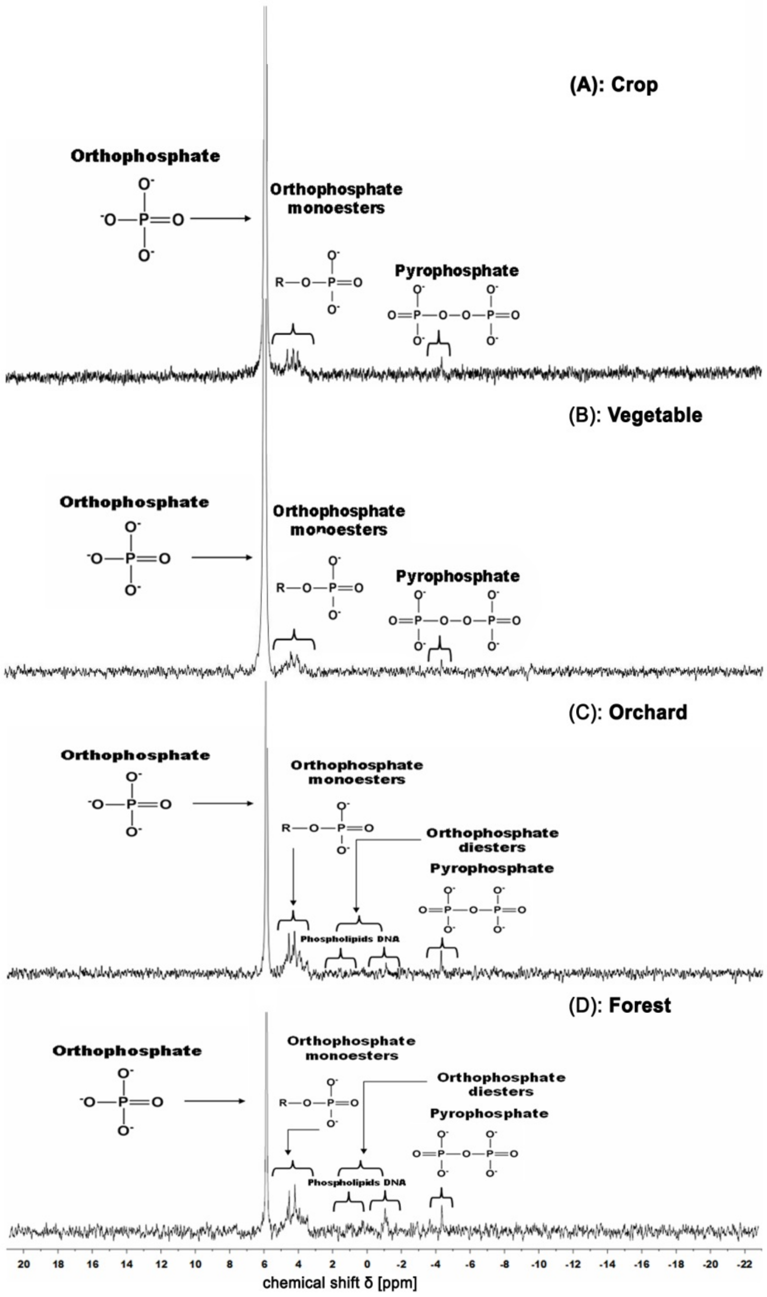
Soil chemistry

P sorption capacity



Mehlich 3 P: bio-available P
PSI: P sorption index, to estimate the empty phosphate sorption sites
DPS%: Degree of P sautration

Soil chemistry



31P NMR spectra of NaOH-EDTA extracts of the studied four land-use

Table 2 Concentrations (mg P kg-1 soil) of different P species, measured using ^{31}P NMR

Land-use	NMR-P_i			Total monoester-P
	Ortho-P	Pyro-P	Poly-P	
Forest	79±7a (50.7%)	7±0.6b (4.5%)	2.3±0.2ab (1.5%)	63±5a (40.9%)
Orchard	287±14b (76.7%)	3±0.5a (0.8%)	1.5±0.1a (0.4%)	80±6c (21.5%)
Cropland	360±13b (88.1%)	2.9±0.1a (0.7%)	2.3±0.3ab (0.6%)	39±6bc (9.7%)
Vegetable fields	770±43c (93.3%)	2.9±0.2a (0.4%)	1.3±0.1a (0.2%)	49±3b (5.9%)

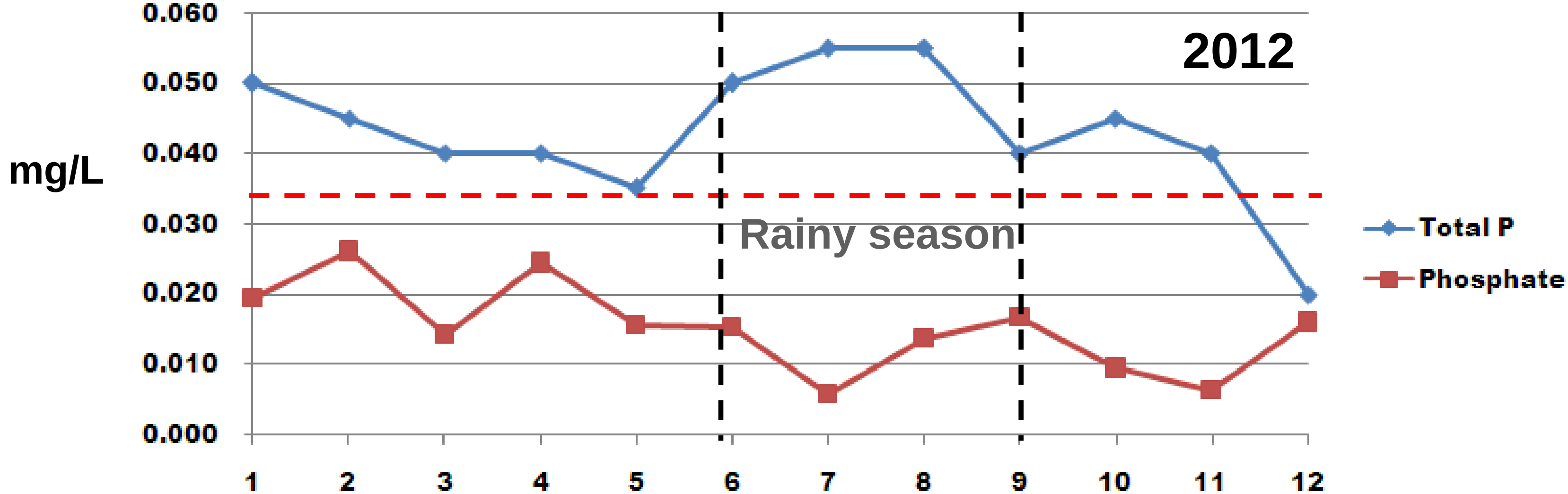
The same letters are not significant at 5% level (Duncan).

■ Orthophosphate and monoester-P were found to be the dominated P species.

■Long-term intensive agricultural practice of access P application causes an increase in orthophosphate pools and a decline in the soils content of monoester-P.

Yuqiao Reservoir

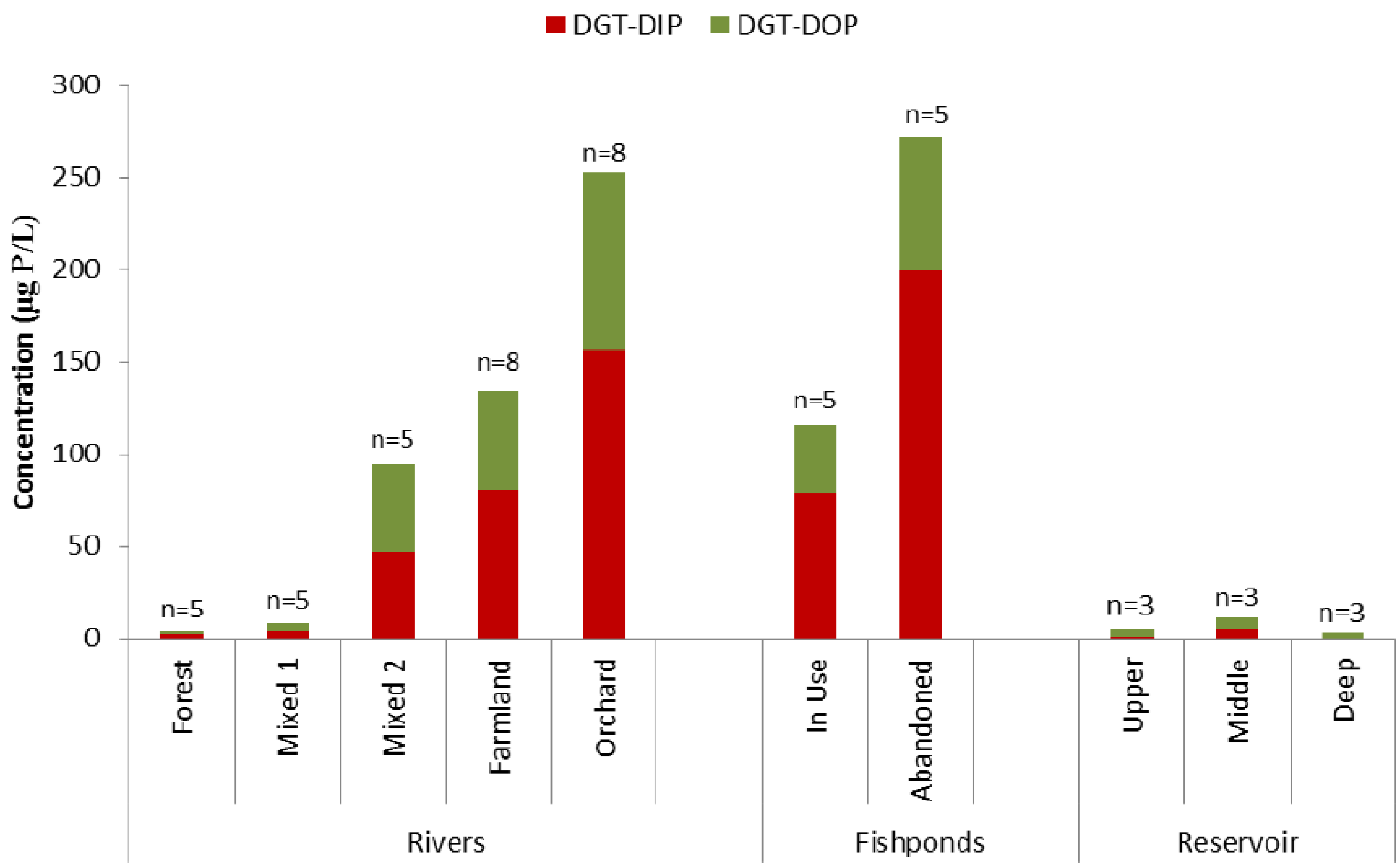
Water chemistry



Particulate phosphorus

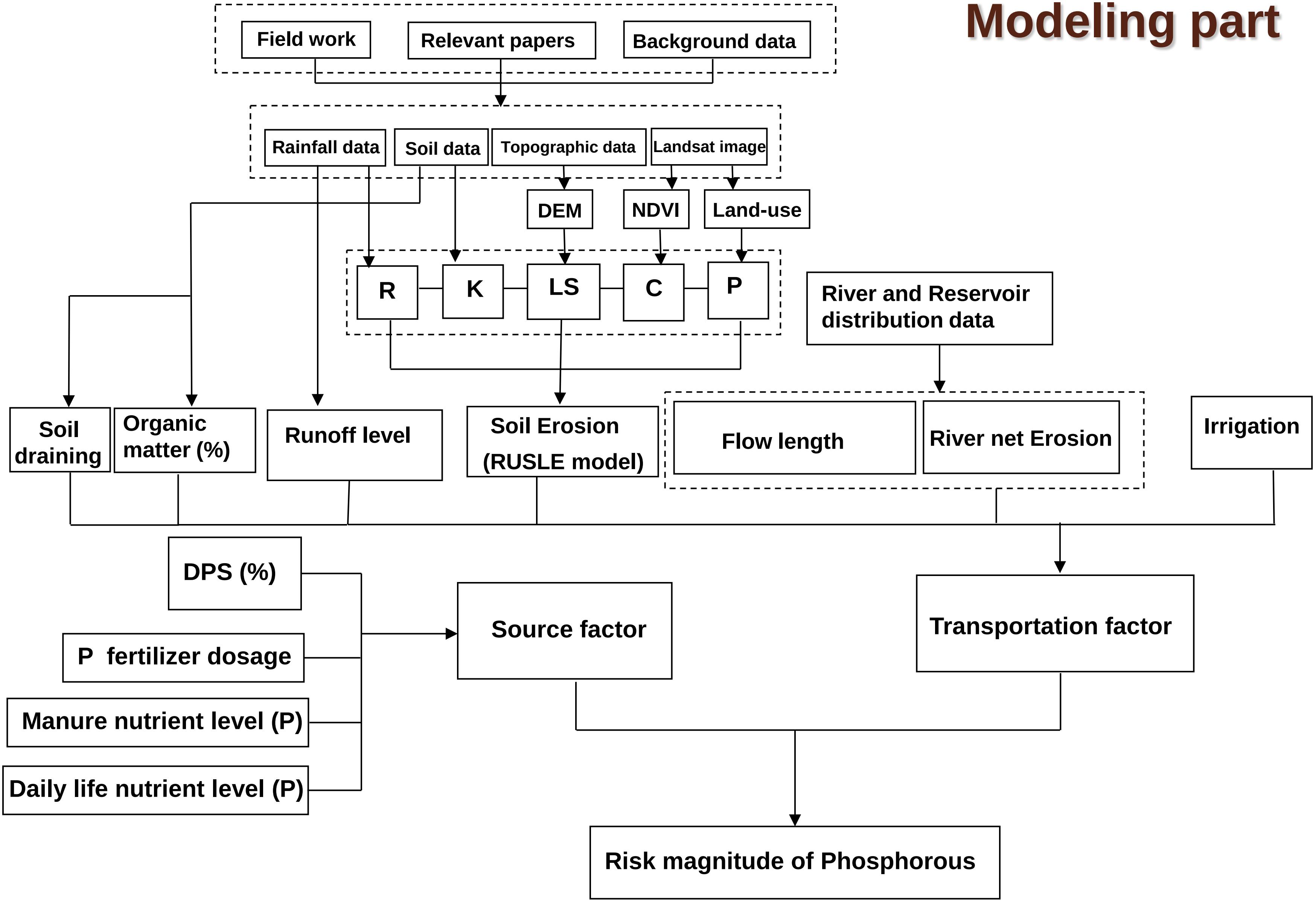
Absorbed by algae

Water chemistry



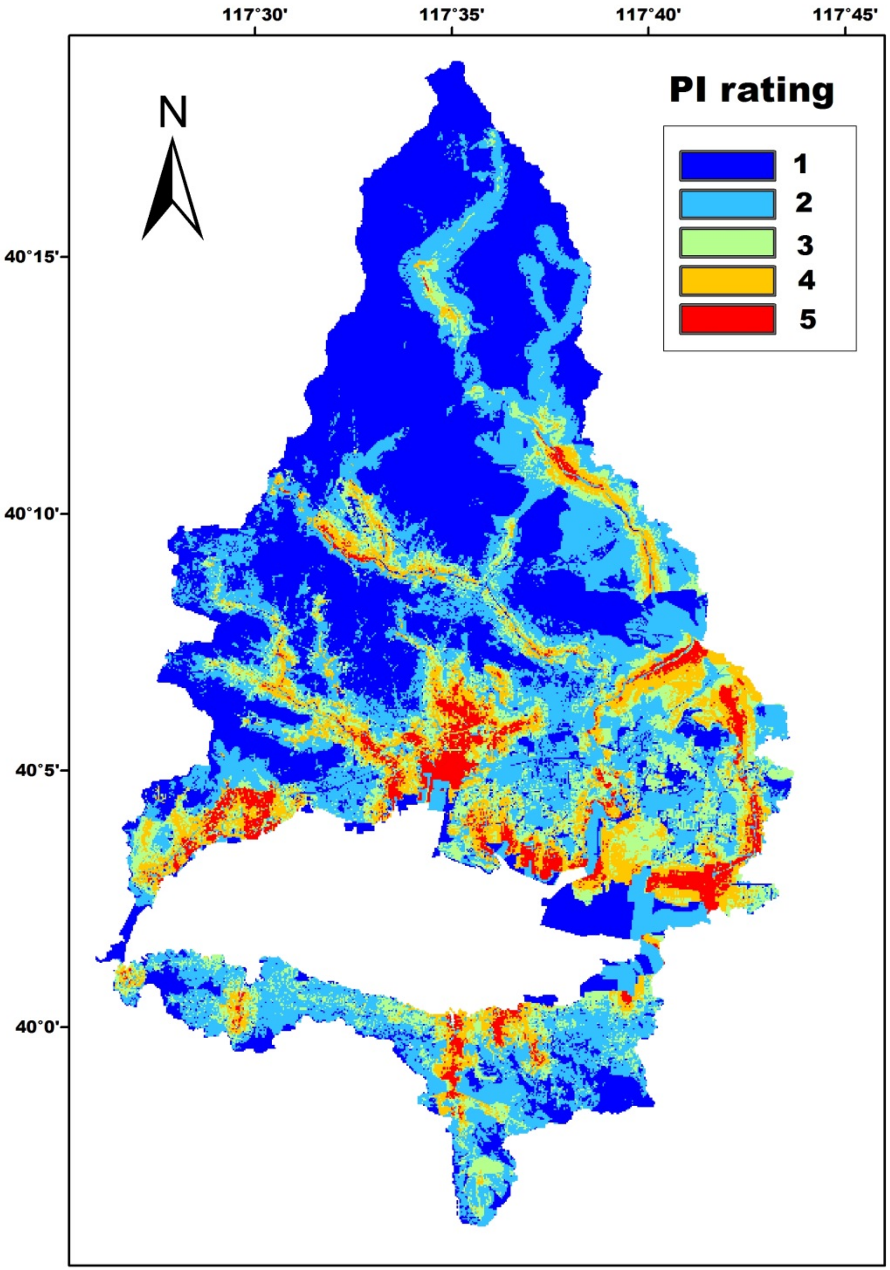
Phosphorous concentrations as sampled by DGTs

Modeling part



Schematic representation of the modular structure of the PI

Modeling part



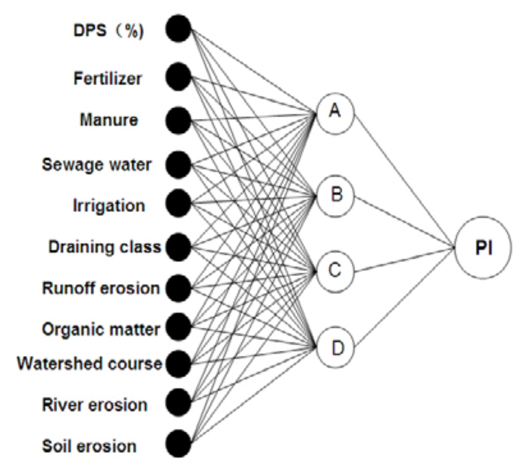
Water Air Soil Pollut (2014) 225:2103
DOI 10.1007/s11270-014-2103-x

Establishment and Validation of an Amended Phosphorus Index: Refined Phosphorus Loss Assessment of an Agriculture Watershed in Northern China

Bin Zhou · Rolf D. Vogt · Chongyu Xu · Xueqiang Lu · Hongliang Xu · Joshi P. Bishnu · Liang Zhu

Received: 14 May 2014 / Accepted: 24 July 2014

Abstract Phosphorus (P) loss from non-point sources is a main cause of freshwater eutrophication in agricultural regions. Knowledge-based watershed management plans, aimed at reducing the diffuse flux of phosphorus from specific land-use and site characteristics to freshwater resources, are needed in order to curb eutrophication in agriculture regions. In this context, the use of a phosphorus index provides a simple and practical method for identifying hot-spot source areas and to estimate their potential for contributing a flux of P to the surface waters. However, as a semi-quantitative tool, the P index is usually difficult to validate due to inadequate data representation relative to large spatial and temporal variation in P fluxes. An amended P index scheme is therefore developed and validated, based on comprehensive source factor scheme, adoption of flow length factor and modified water course erosion factor into the P transportation scheme, and an adjustment of the organization structure of the P index scheme. The validation of the amended P schemes was performed by comparing the modeled average P index values with the corresponding measured P fluxes for 12 different sub-catchments. The results indicate an improved precision in the simulated potential for P loss using the refined P index scheme. Measured fluxes of total P (r=0.825), particulate P (r=0.867), and less-studied yet more relevant dissolved P (r=0.627) all showed significant correlations with the modeled P index values in the amended P scheme. The primary direct finding of the current research is that the areas with close proximity to rivers and the reservoir, as



A multi-parameter sensitivity analysis based on artificial neural networks and Garson algorithms

Main findings from societal response


Ronaldiño

Takk for oppmerksomheten!