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Soil phosphorus pools and their relation to land-use and soil physiochemical properties

A case study of an agricultural watershed in north-eastern China

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Water shortage

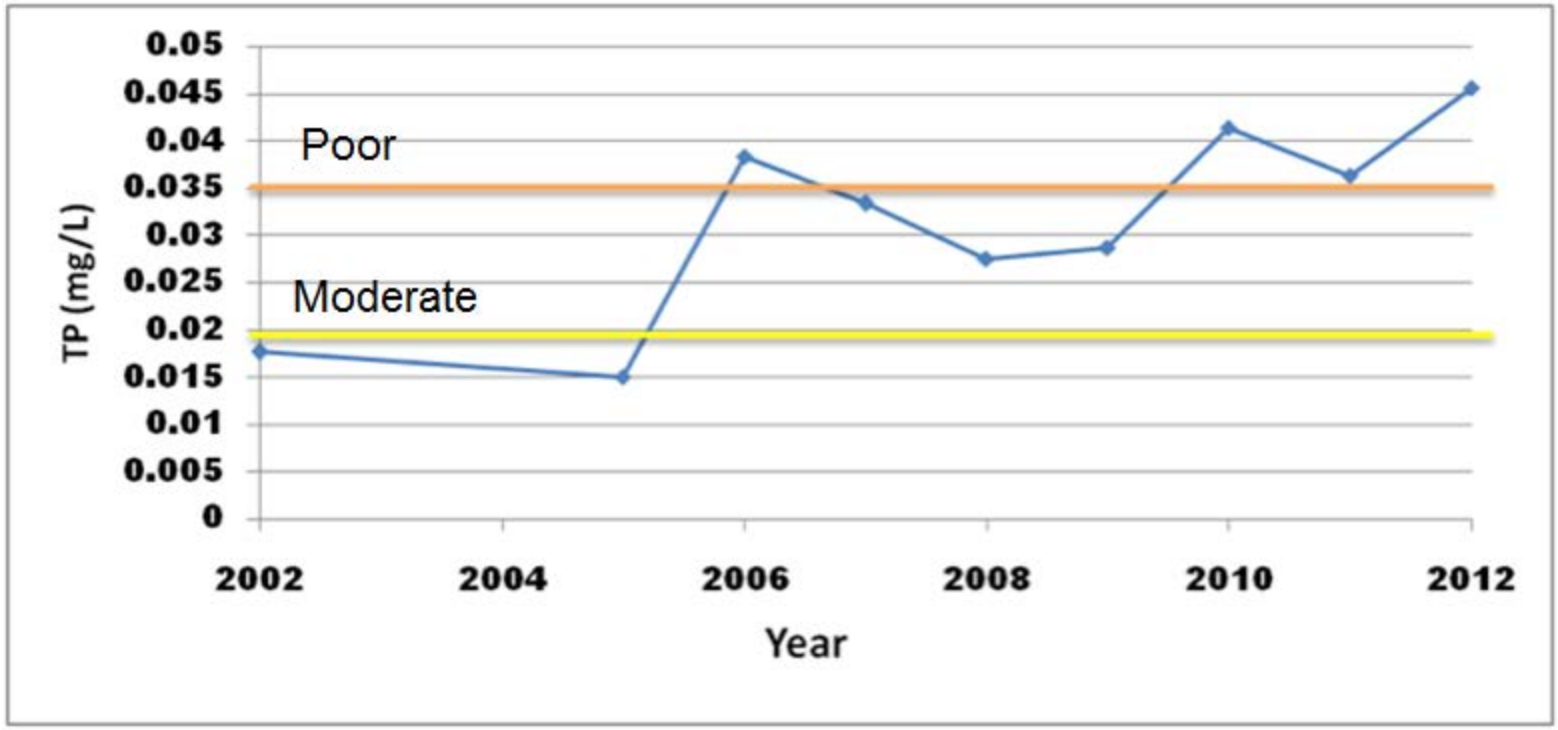
- Shortage of freshwater - A global problem
  - China - ¼ of the word average (per capita)
- UN development goal 7.C
  - *aims at reducing the the worlds population without access to safe drinking water with 50% by 2015*
- Eutrophication is the most widespread water quality problem in the world, and is one of the main environmental challenges in China

Eutrophication

- Increased flux of nutrients to surface waters
  - Phosphorus is usually the limiting nutrient in freshwaters
- Associated with several problems
  - Change in odour, colour and taste
  - Blooms of cyanobacteria that may produce toxins
  - Alterations in the ecosystems - decreased biodiversity
- Sources of phosphorus
  - Point
  - Non-point

Yuqiao reservoir

- Increasing trend of eutrophication



Photocredits:. Jon Naustdalslid & Ellen Pettersen

Yuqiao reservoir

- Increasing trend of eutrophication
- Main source of drinking water for 6.3 million people
- Recreational activities, fishing and a water source for industry

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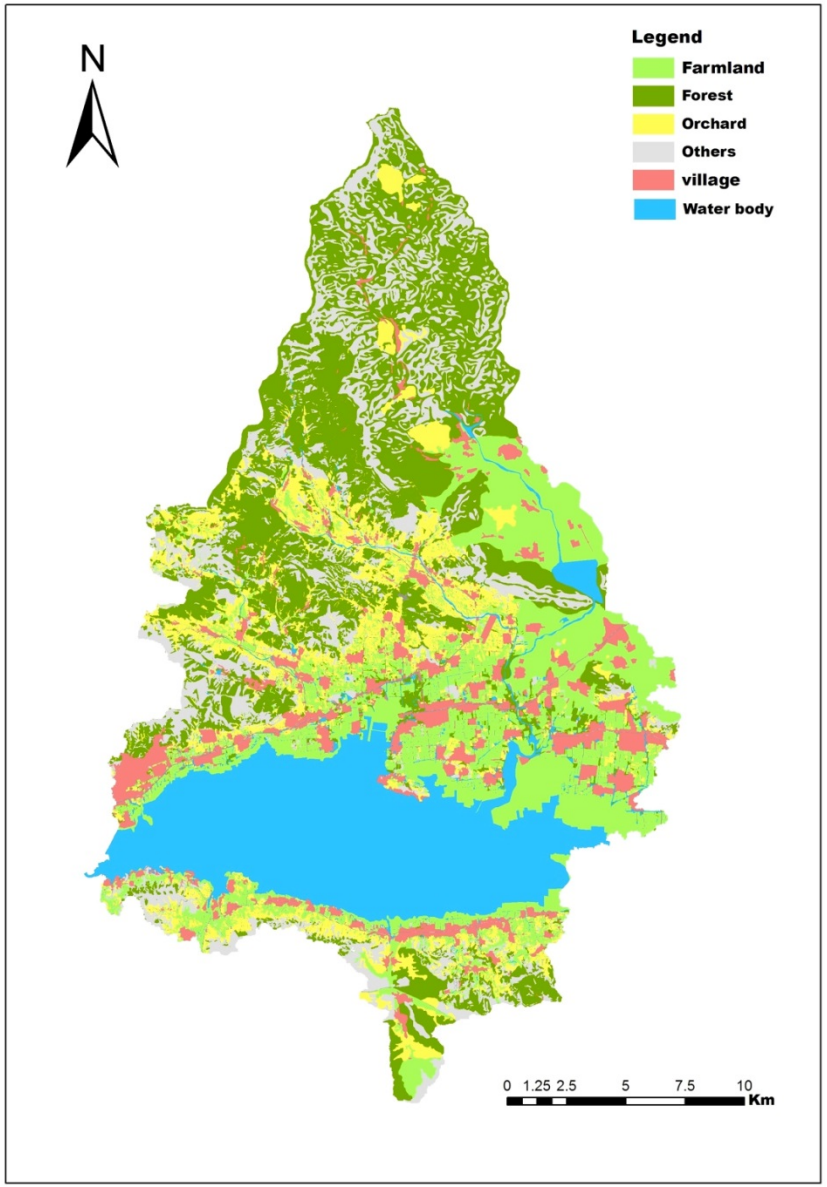
Site description

- Between 120 000 and 140 000 habitants
- Farming and animal husbandry
- Main agricultural land-use are farmlands, orchards and vegetable areas
- 25% of the area is covered by forest



Site description

- Extensive use of fertilizers
  - Farmers apply ~17.4 g P/m^2 every year
  - The average in Norway is 1.9 g P/m^2

- In addition there is limited sewage and waste water treatment in the area

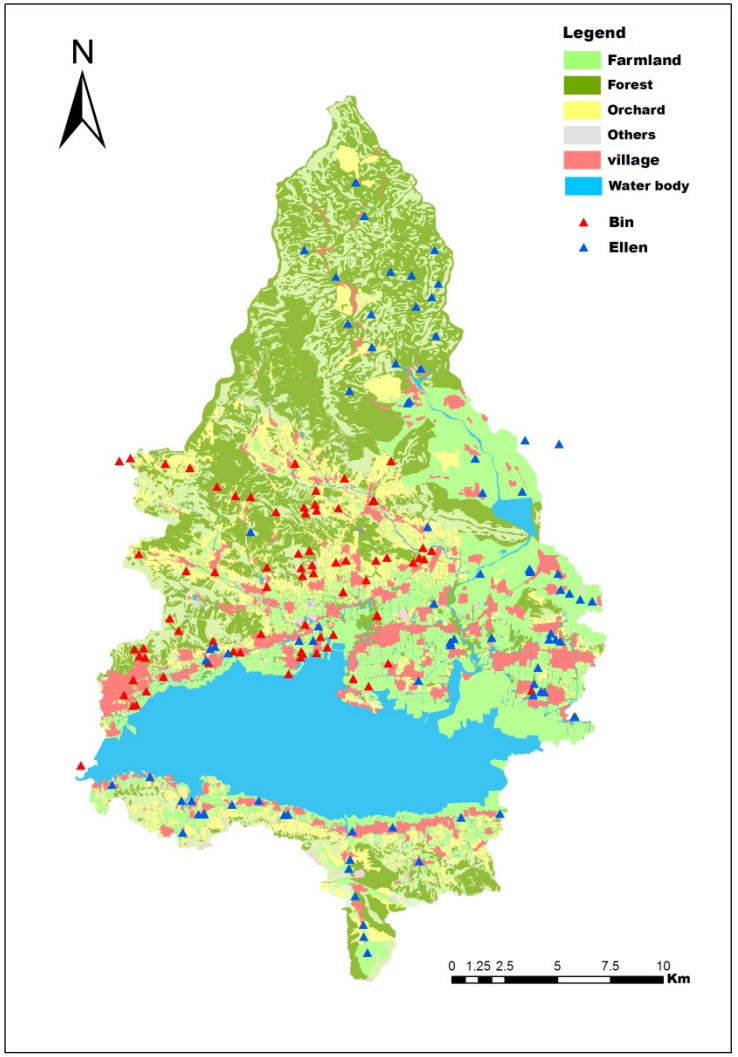
Aim of study

- Assess the spatial variation of phosphorus pools and how it is related to land-use management

- How the physiochemical properties of the soil are related to the phosphorus pools and how they affect the phosphorus leaching

Soil sampling and analysis

- Sampling in January and June 2013.
  - Geographical distribution
  - Land-use
  - Soil horizons.
- Follow-up to a previous master study.



Soil sampling and analysis

- Pre-treatment
  - Dried and sieved
  - Stored dark at room temperature
- Physiochemical parameters
  - Organic matter, pH, soil texture, mineralogy and phosphorus pools
  - CEC_e, phosphorus sorption capacity and ^{31}P-NMR
- Compilation of data

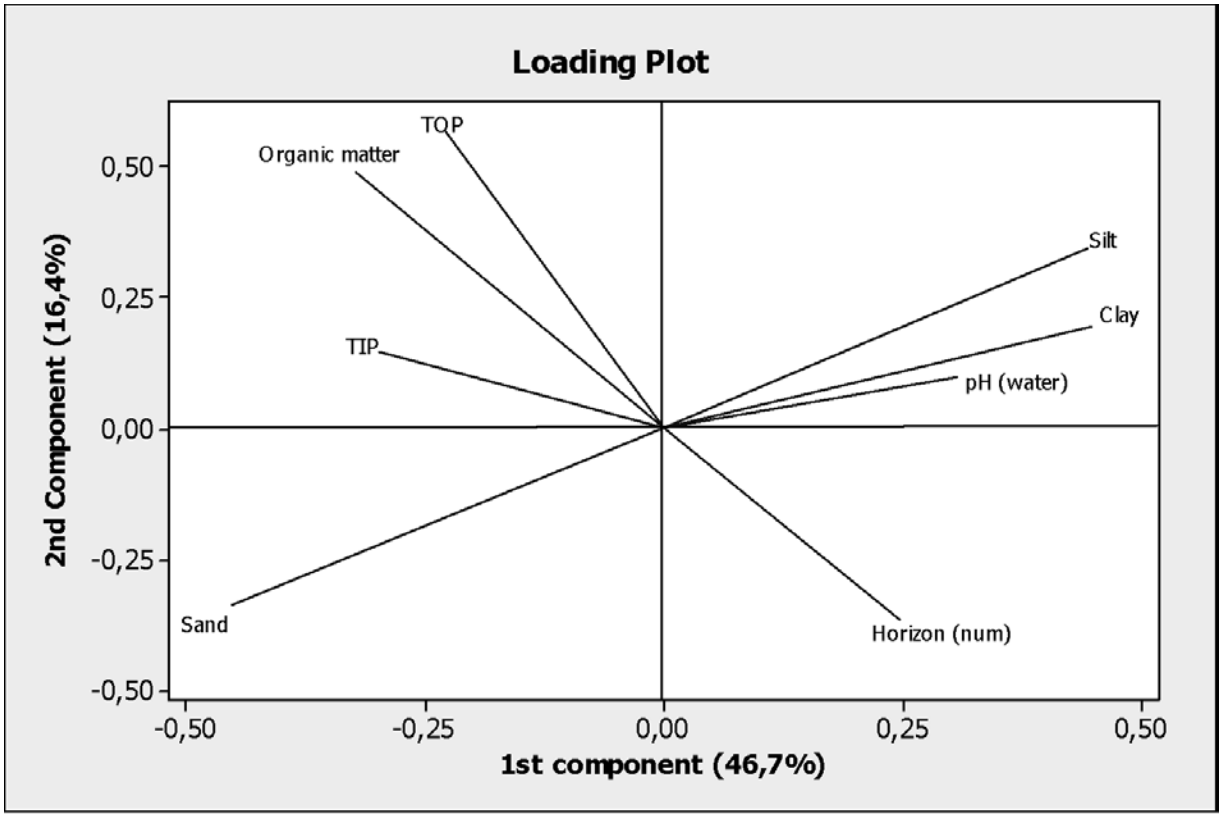
Soil-water sampling and analysis

- Lysimeters
- Soil-water analysed at TAES
  - pH, TOC, Major ions and phosphorus fractions

Physiochemical properties through the soil horizons (A, B and C layer)

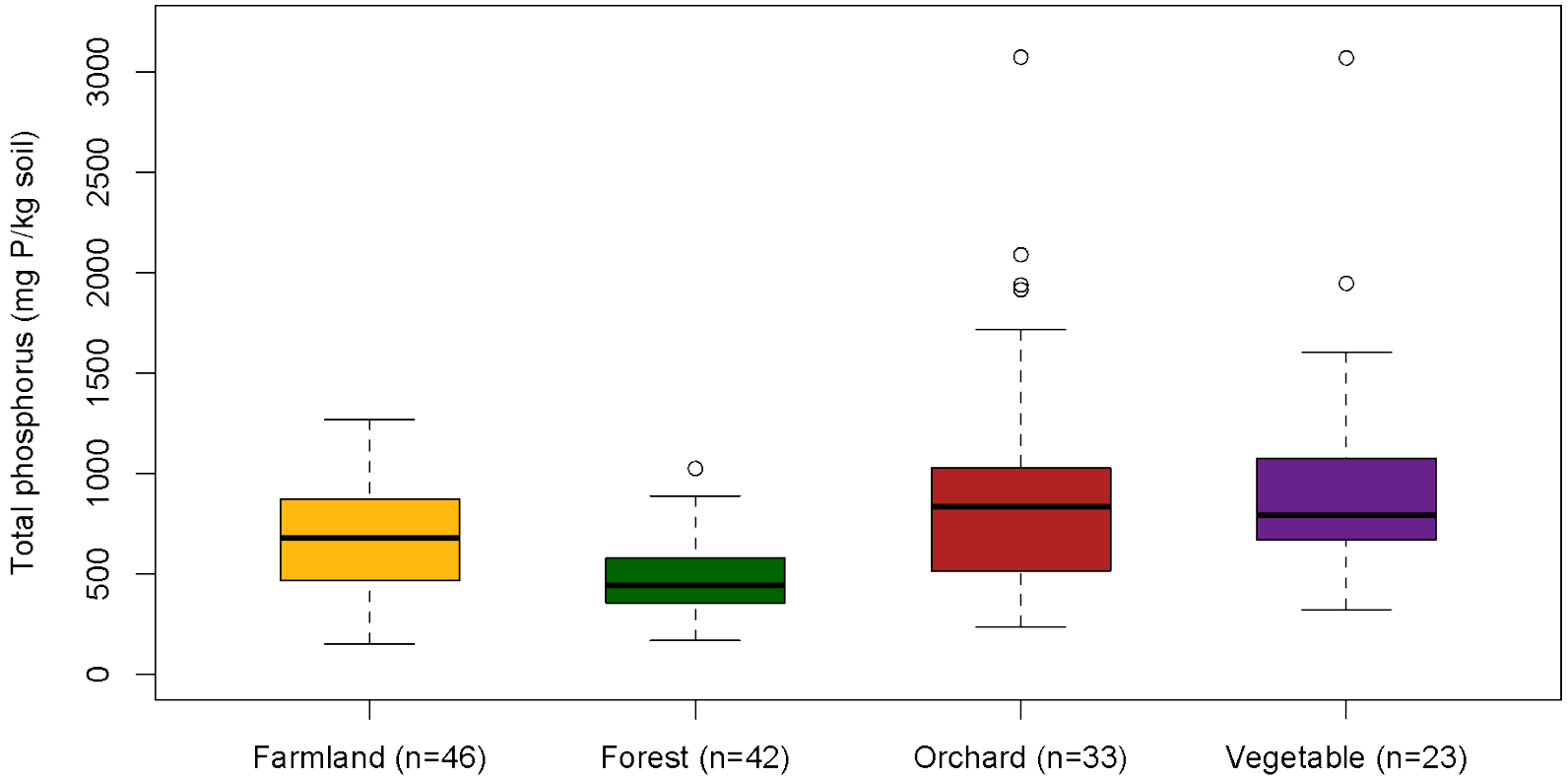
- Expected
  - Decreasing pH
  - Decreasing OM content
  - Decreasing TP concentrations
- Observed
  - No clear trend in pH
  - Decreasing OM content in orchards and vegetable fields. No trend in farmlands
  - Decreasing TP concentrations

Principal component analysis



- Soil horizon is main explanatory factor for the size of phosphorus pools

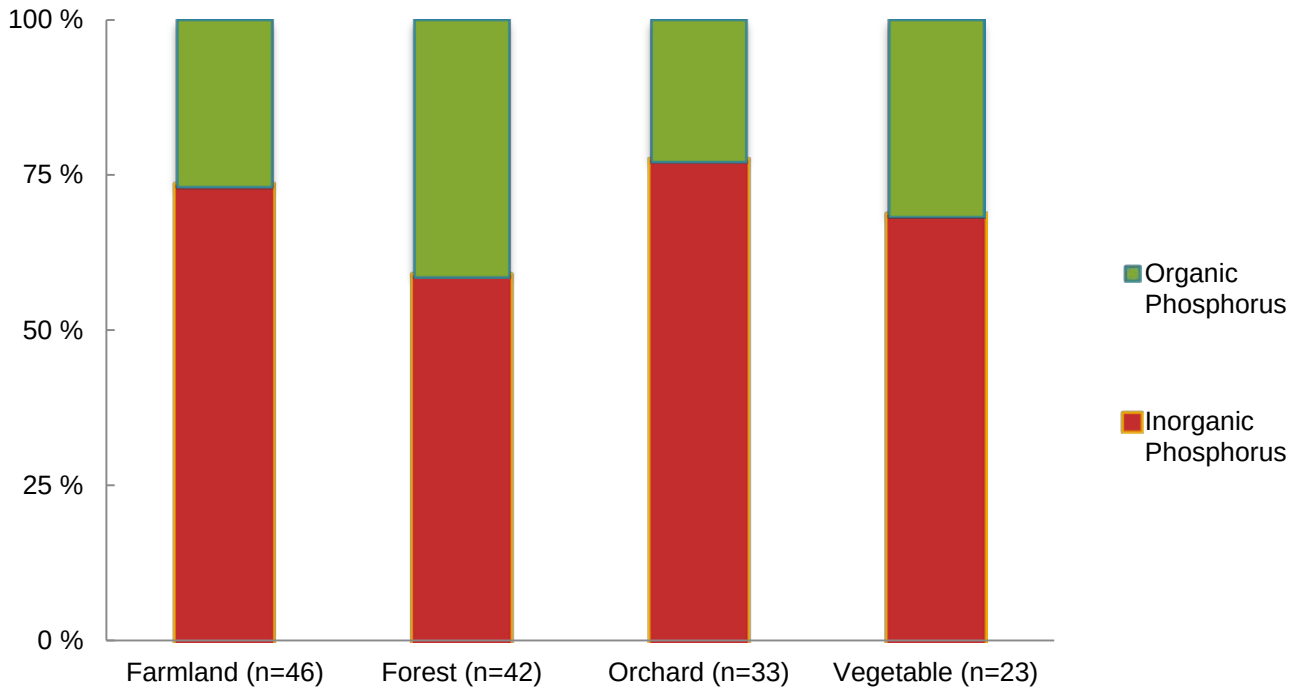
Soil phosphorus pools (A horizon)



- Low concentrations
  - Median values < 1000 mg P/kg
- No large difference between land-use

Soil phosphorus pools (A horizon)

- Inorganic phosphorus dominant in all land-use

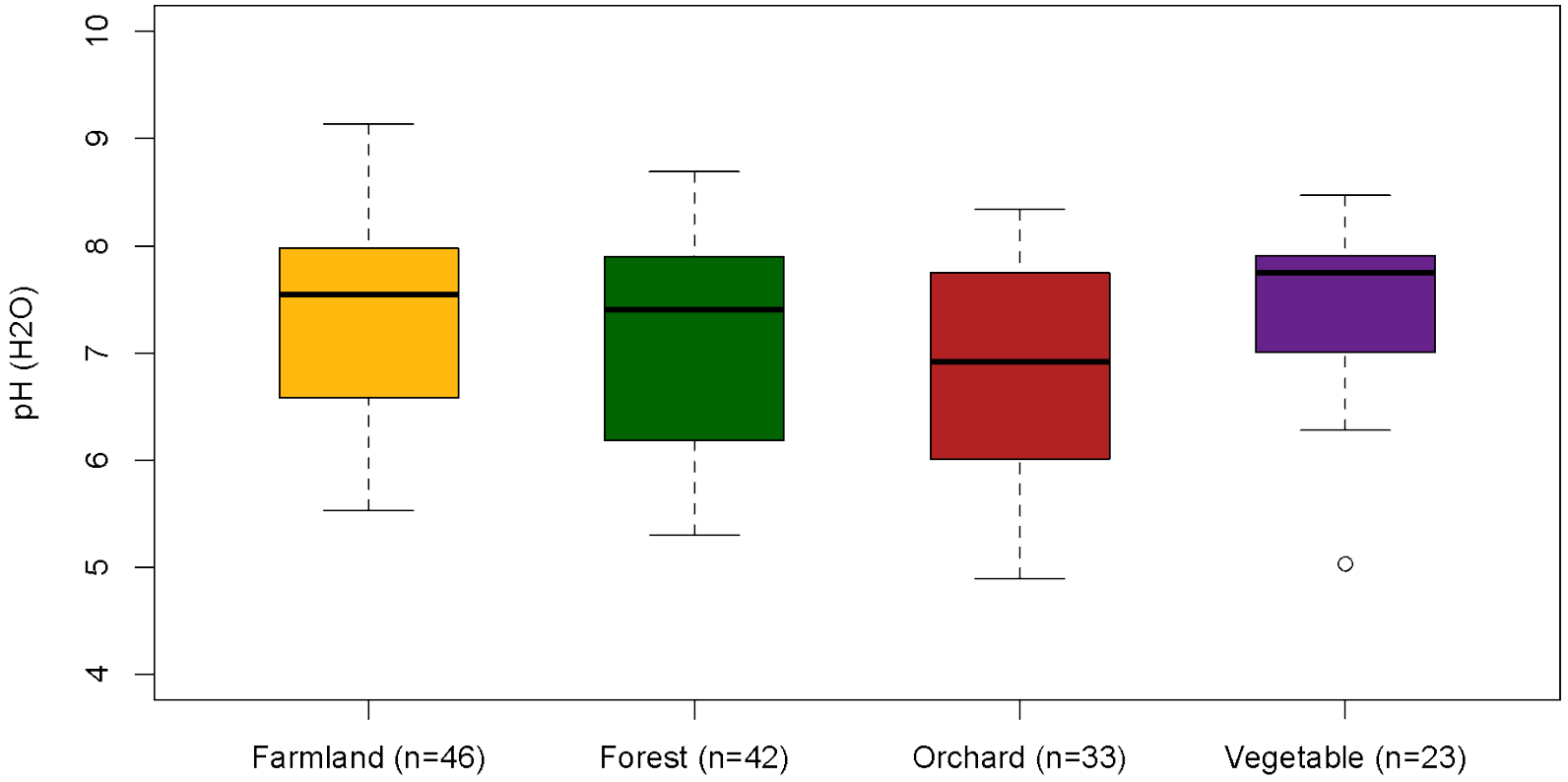


Soil phosphorus pools (A horizon)

- Why is the soil phosphorus concentrations so low in the Yuqiao watershed?

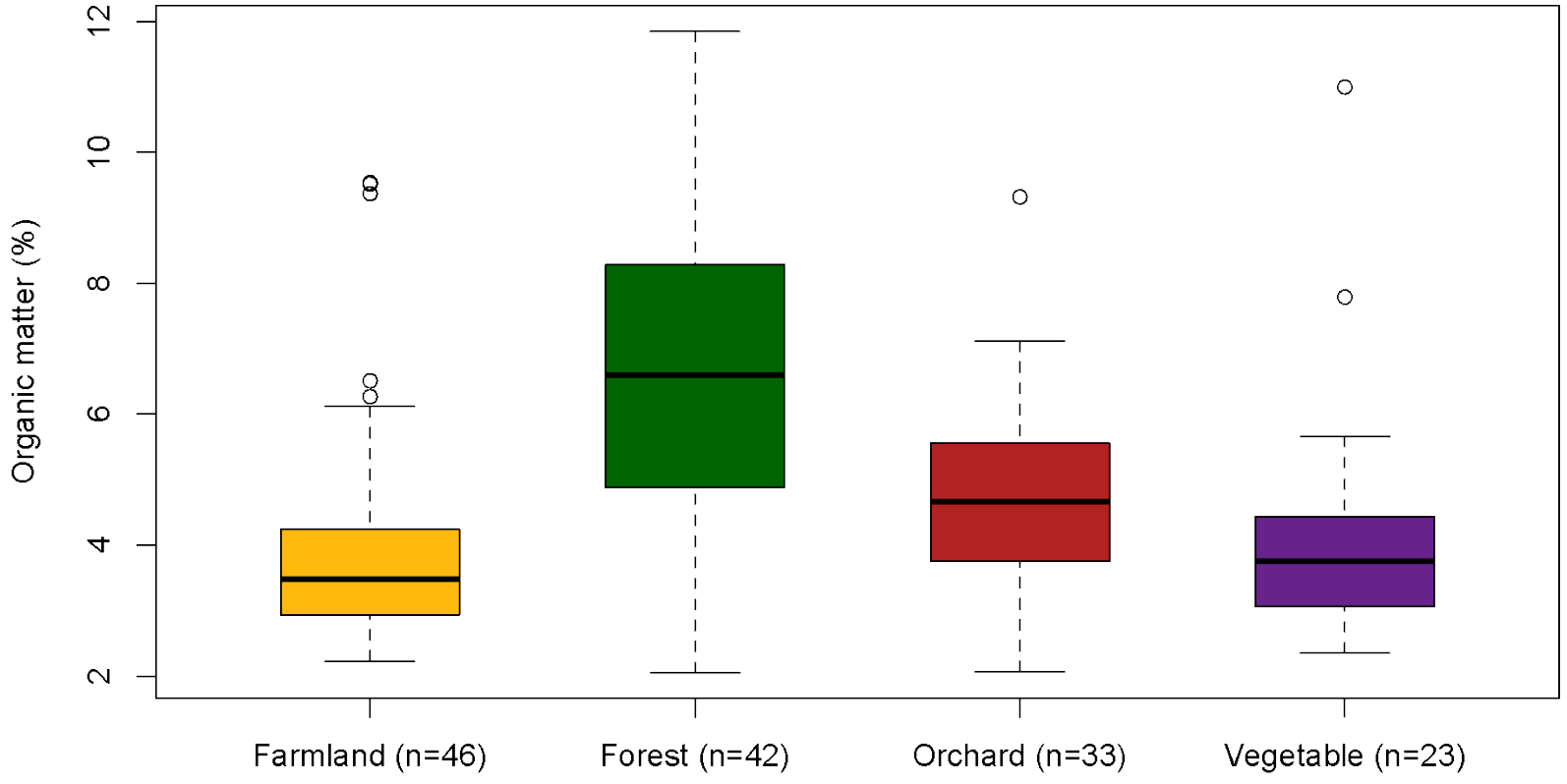
Soil physiochemical properties (A horizon)

- pH



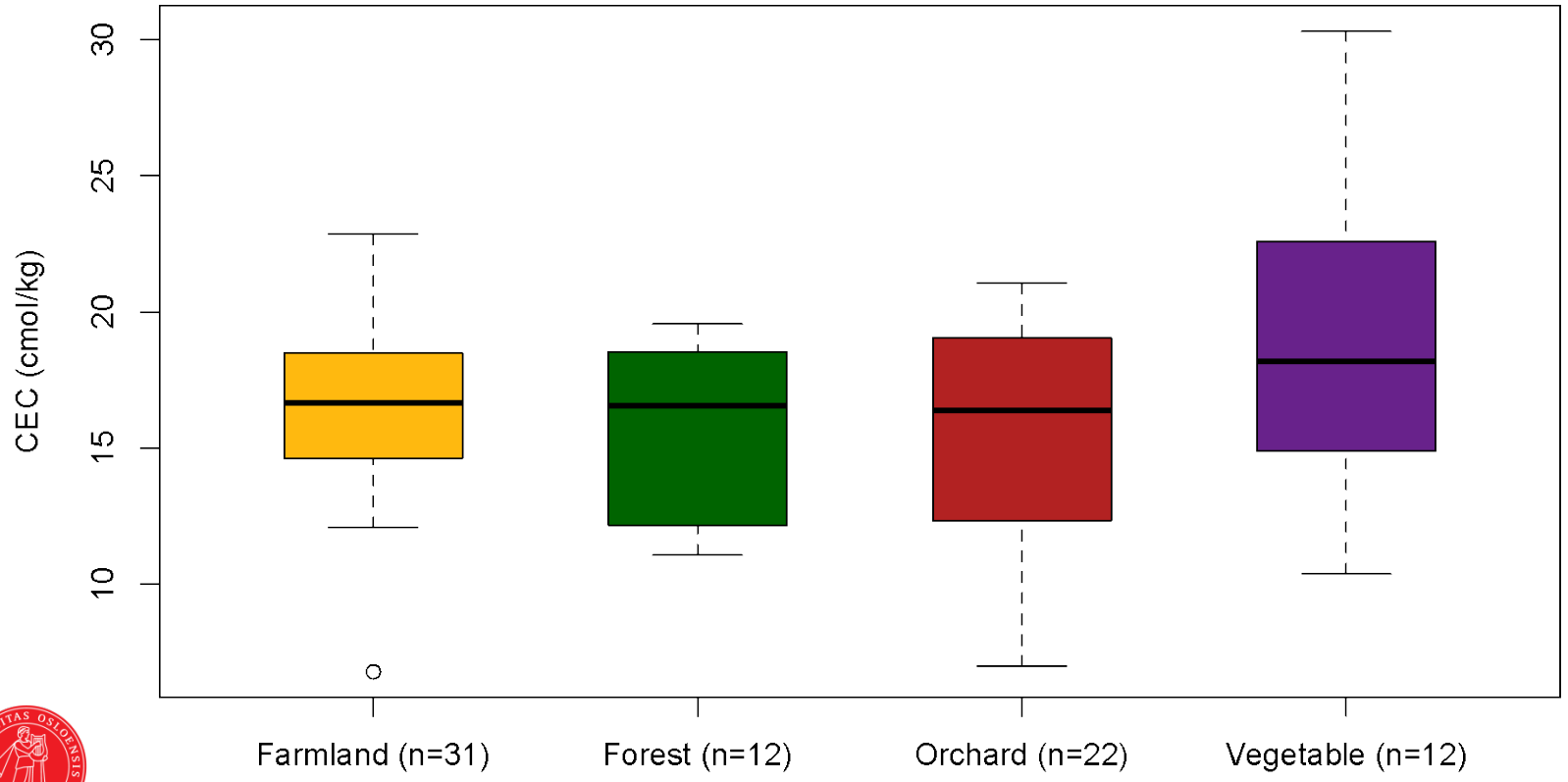
Soil physiochemical properties (A horizon)

- Organic matter

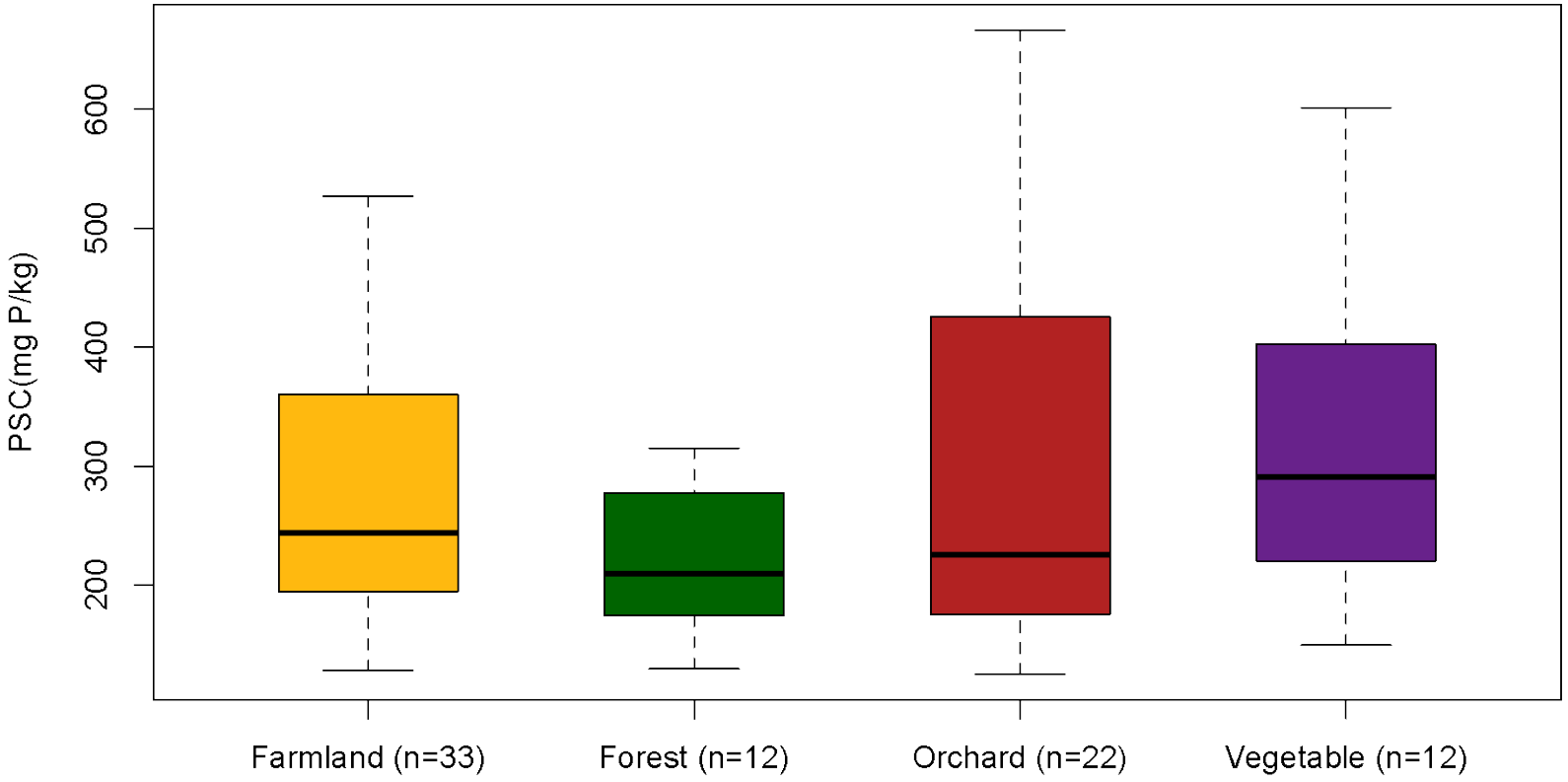


Soil physiochemical properties (A horizon)

- Soil texture
  - Silt and sand dominates
- CEC_e

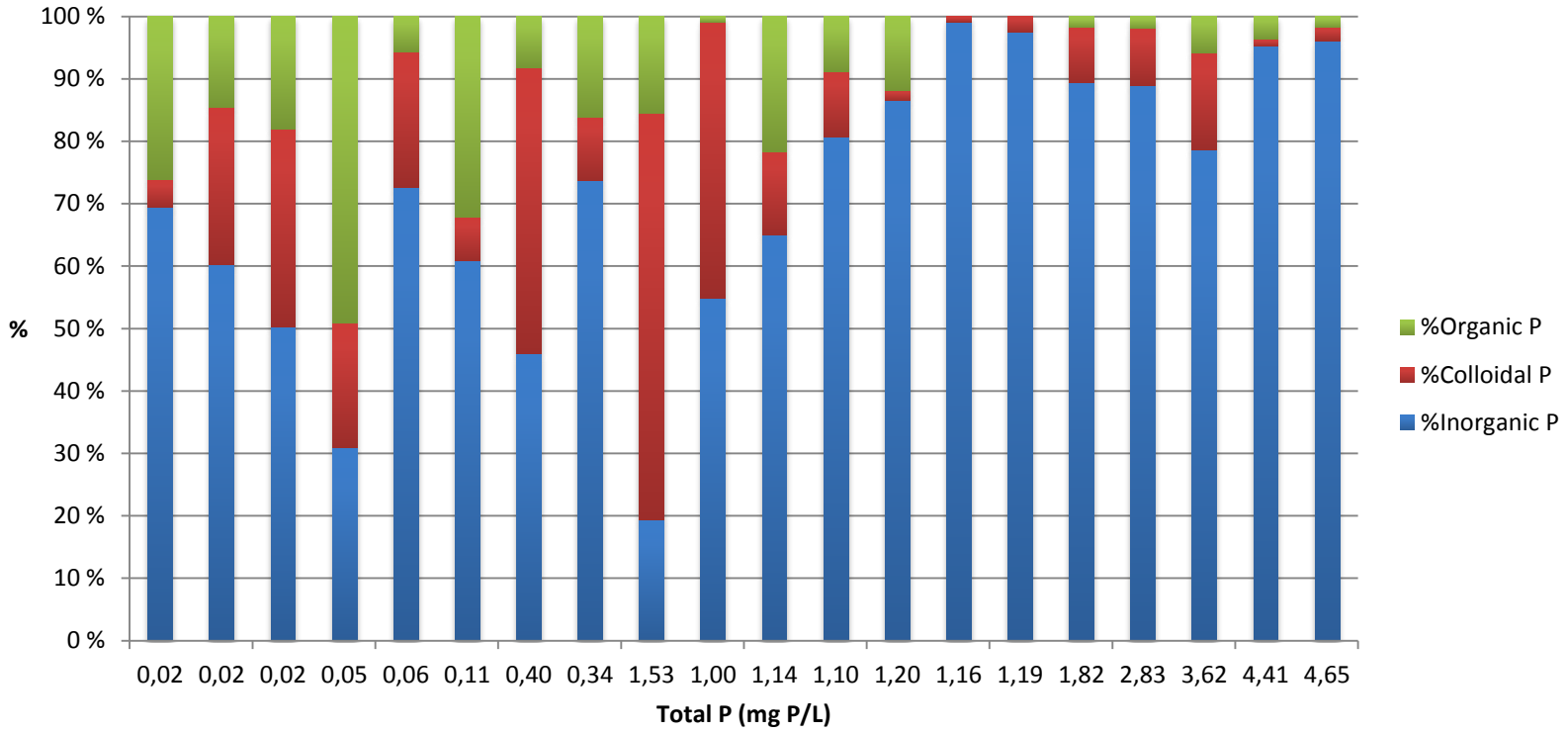


Phosphorus sorption capacity



- Median values between 200 and 300 mg P/kg
- Oversaturation of phosphorus

Soil-water phosphorus pools (A horizon)

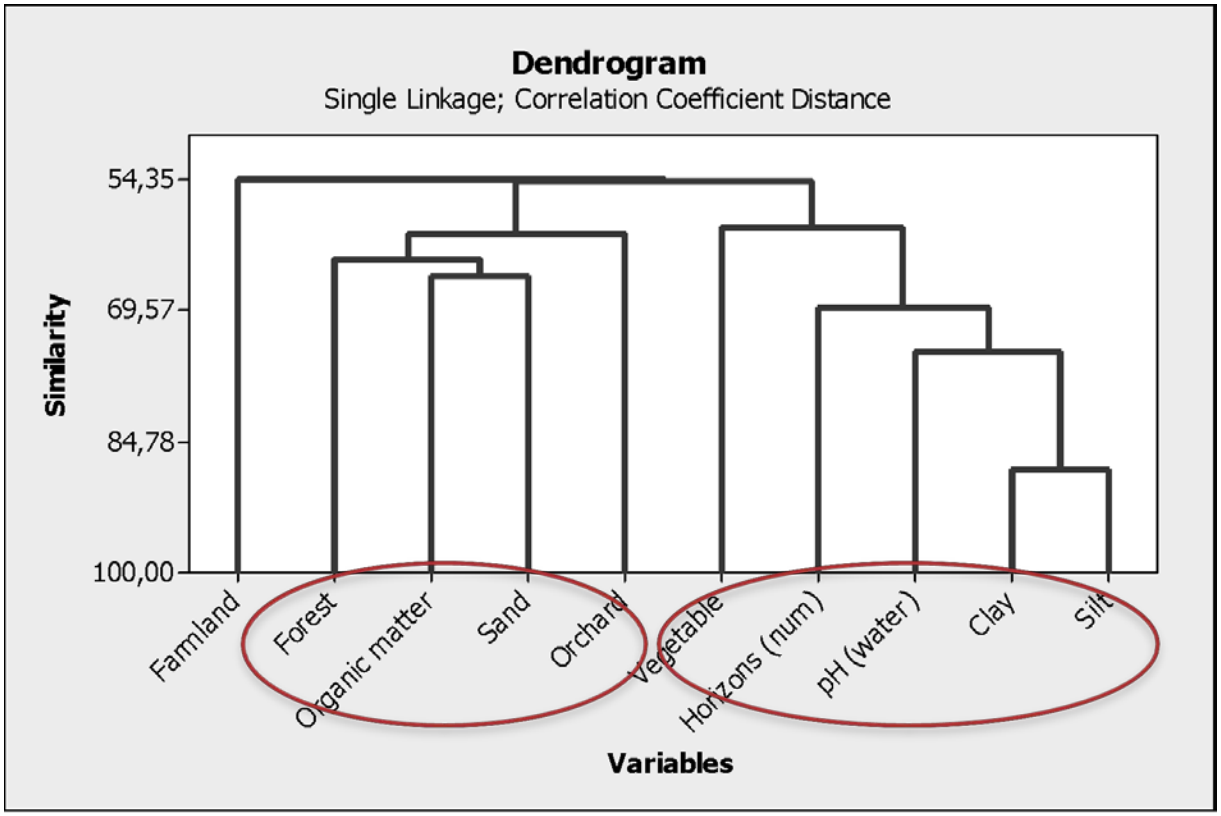


- Free inorganic phosphate dominates

Transport of phosphorus

Cluster analysis

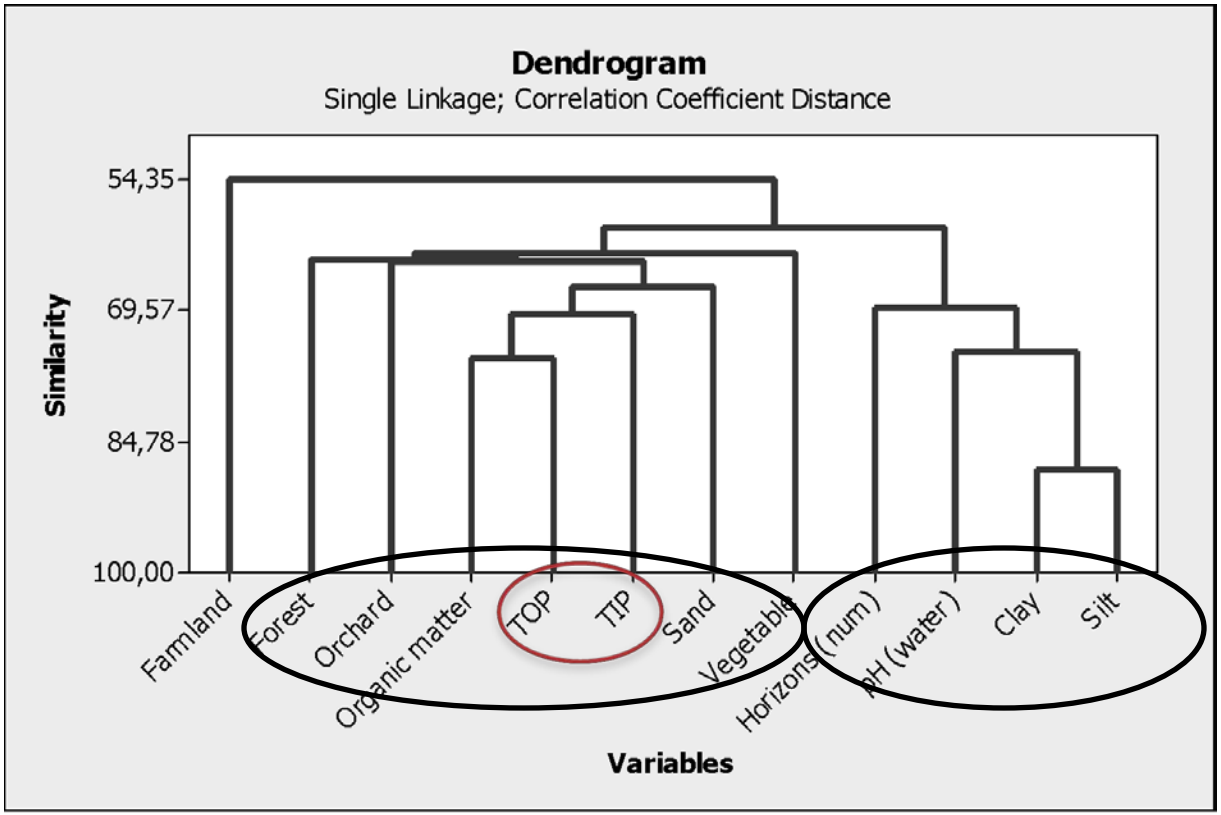
- The cluster analysis where performed on 68 samples and all the physiochemical parameters.



- Two clusters:
  - Forest and orchard together with OM and sand
  - Vegetable fields, soil pH and finer soil particles

Cluster analysis

- When including P-pools there is a shift in the clustering



- Phosphorus pools are independent of soil properties.

Conclusions

- No clear trends in physiochemical parameters through the soil horizons – exept for total phosphorus
- The soils from different land-use do not differ significantly with regards to the studied physiochemical parameters
- Low P concentrations due to the low sorption capacity – oversaturation of phosphorus
- Erosion and surface runoff important transport mechanisms.
- Cluster and PCA analysis indicates that phosphorus pools are dependent on the land-use practises.