UNIVERSITÀ DEGLI STUDI DI MILANO
DIPARTIMENTO DI SCIENZE AGRARIE E AMBIENTALI
PRODUZIONE, TERRITORIO, AGROENERGIA

PHOSPHORUS MONITORING AND MODELLING IN LOMBARDY REGION, ITALY

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International Interdisciplinary Conference on
Land Use and Water Quality
Agricultural Production and the Environment
Vienna, Austria, 21-24 September 2015

Introduction

COMMISSION DIRECTIVE 2014/80/EU

of 20 June 2014

amending Annex II to Directive 2006/118/EC of the European Parliament and of the Council on the protection of groundwater against pollution and deterioration

There is considerable potential for nitrogen and phosphorus in groundwater to present a eutrophication risk to associated surface waters and to directly dependent terrestrial ecosystems. Besides nitrates, already included in Annex I to Directive 2006/118/EC, and ammonium, included in Annex II to that Directive, nitrites, as a contributor to total nitrogen, and total phosphorus, either as such or as phosphates, should also be considered by Member States when establishing threshold values.

(2) in point 1 of Part B, the following entries are added:

'Nitrites

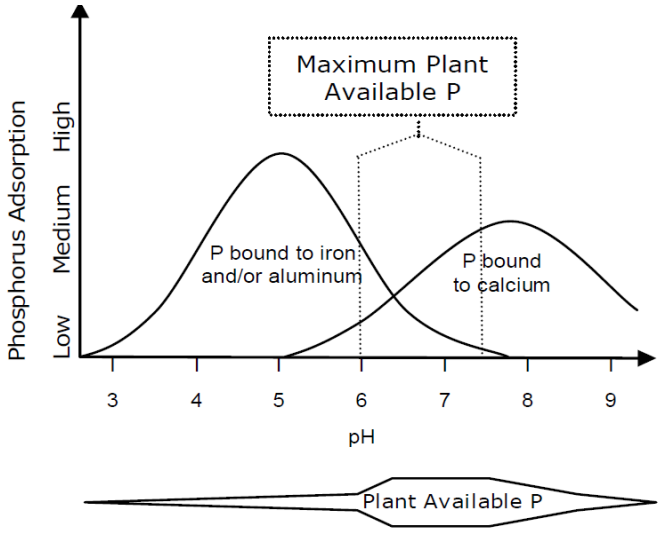
Phosphorus (total)/Phosphates (*)

(*) Member States may decide to establish threshold values either for phosphorus (total) or for phosphates.'

Introduction

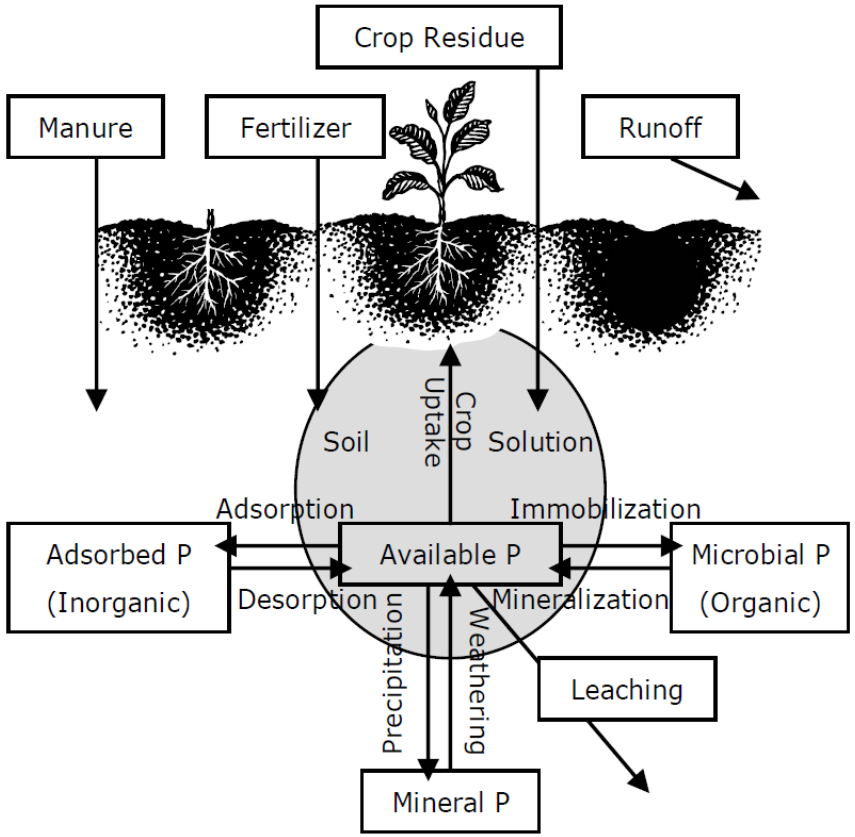
The P leaching was only marginally considered by agronomist before ‘80s year:
all the P is absorbed by the soil and no P leaching can occur (I remember my text book when I was a student!)
Due to the fact of presence of P in groundwater in most fertilized area become evident the P leaching phenomena

0.1 mg l^{-1} of P is considered a critical threshold for eutrophication



Introduction

The P cycle could be slow, but not simple (even if there is not an atmospheric component)!



Simplified Presentation of the P cycle (from Cornell University)

…. And each point of the balance is difficult to predict: e.g. in maize uptake ranged from 35 to110 kg ha^{-1}

Introduction

- The Po valley is one of the most important aquifer systems in Europe.
- More than 1/3 to one half of P reaching groundwater and surface water are due to agriculture. (rough estimation)
- The 27% of the national bovine livestock and the 45% of swine raised in Italy are concentrated in Lombardy (ISTAT, 2011).

Lombardy is an effective case study for P management.

The basic knowledge

Baseline Information:

- **management data**: farms structure, land using of each cadastral unit, livestock distribution according to age, livestock housing, manure and slurry storage and treatment, (from SIARL **-** Agricultural Information System of Lombardy Region);
- **meteorological data** : 20-years time series of daily meteorological data measured at 14 sites;
- **soil data**: physical and chemical properties of soil (from a digital soil map at a scale of 1:50000).

Additional Information (from existing literature and farmers interviews):

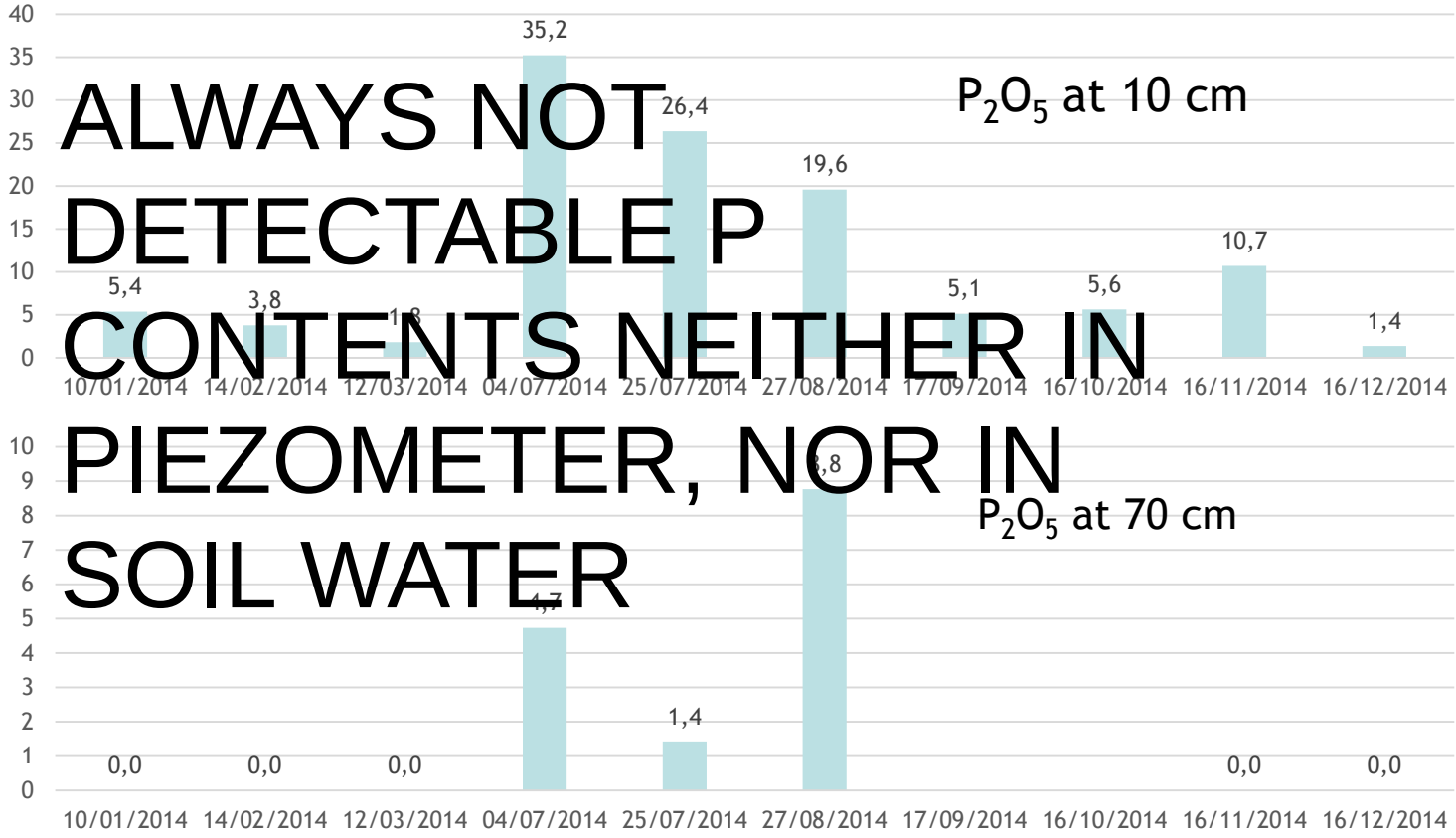
- technical and functional parameters of different housing systems and treatment and storage facilities;
- ration protein content;
- agricultural practices, sowing and harvest dates of the most common cropping systems;
- current NVZ rules on manure timing, application techniques and storage.

Materials & methods

- In 4 places, for 1-3 years we have sampled soil water and ground water and soils for P Olsen content ($NaHCO_3$ extraction) in calcareous and non calcareous soil.
- For ground water piezometers was used, close to the monitored fields (at 2 and 3 m depth)
- For soil solution ceramic cups tested for no P adsorption was used (from 30 to 120 cm) (plastic cups)
- Soil was sampled using an auger at 10 to 50 -100 cm (depending on soil)
- >Continuous flux P analysis, 0.01 mg l^{-1} LoD

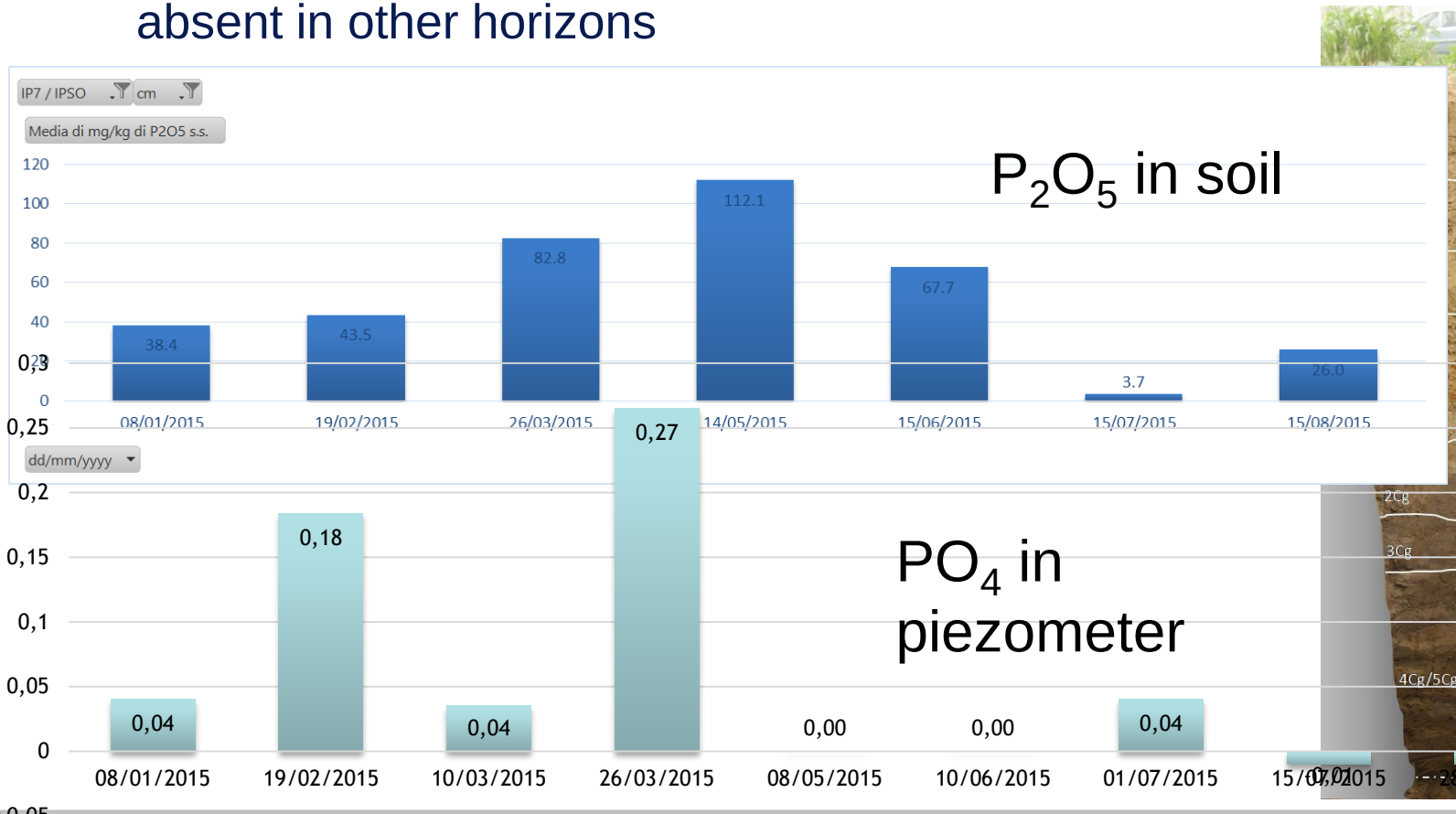
Results

> *Hapli-Hypercalcic Calcisol (ruptic,siltic,)* Soil with > 20% CaCO3, and clay > 30%:



Results

Endogleyi-Fluvic Cambisols (Calcaric, Ruptic,Clayic) sand 26% in the AP, >80 % in B and C horizons, pH 8, CaCO3 10% in AP, absent in other horizons



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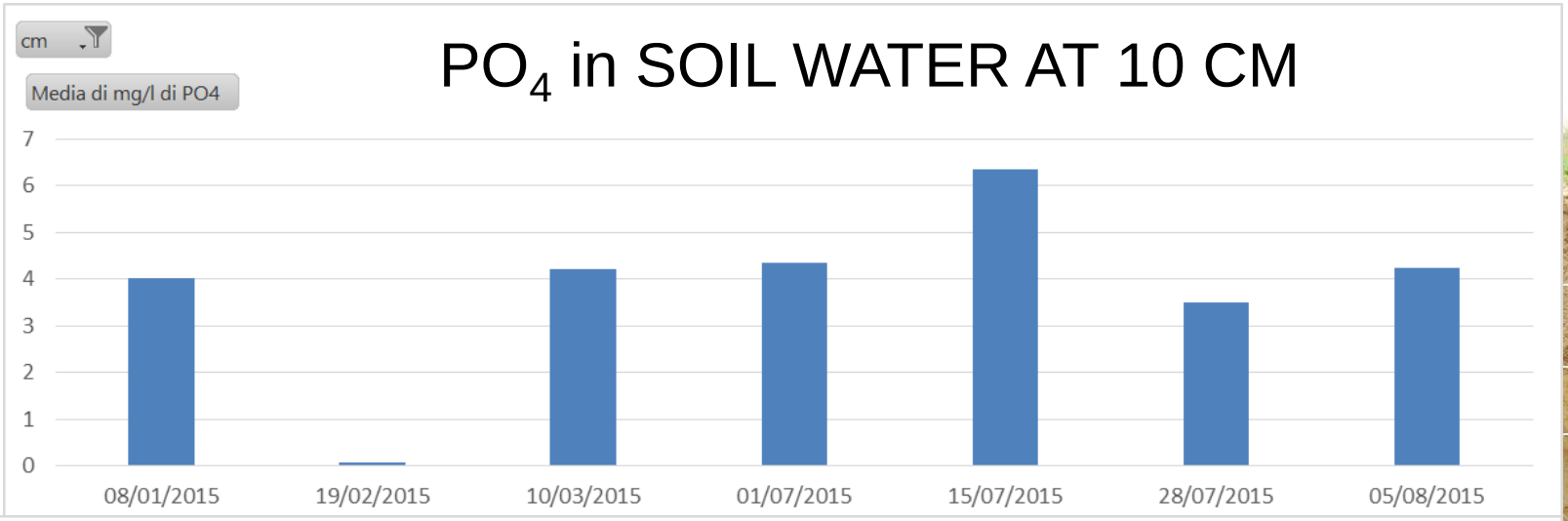
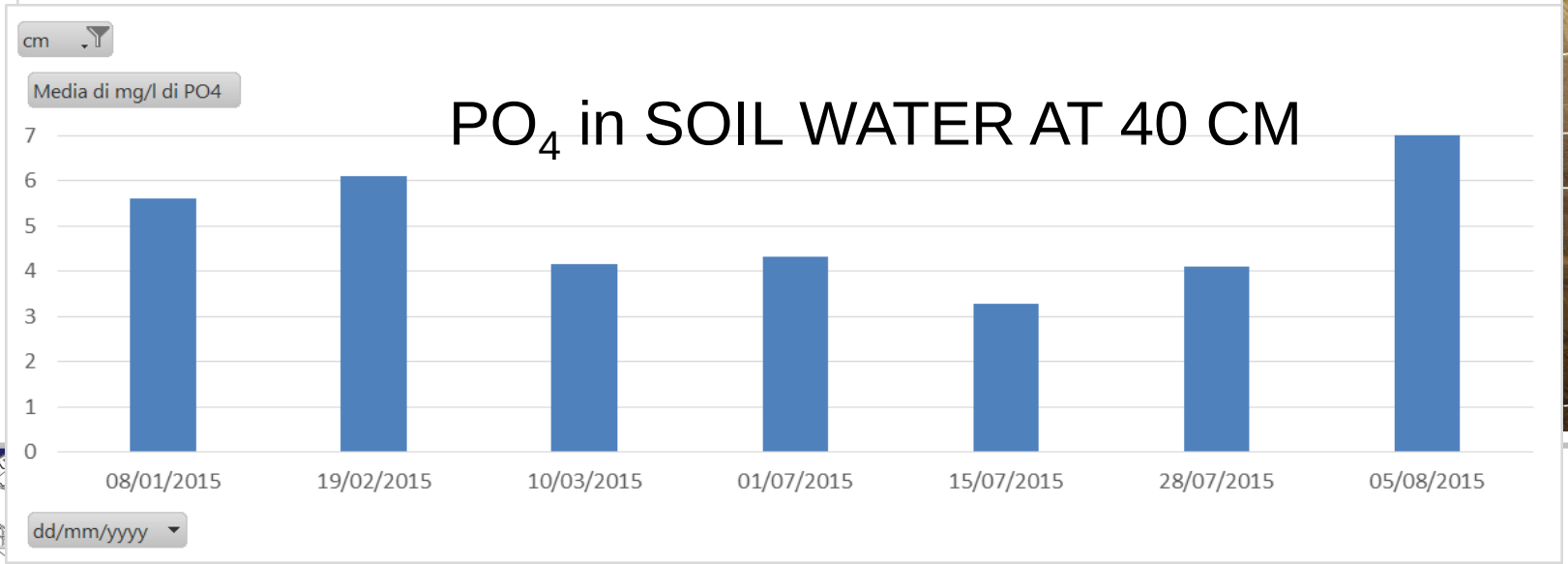
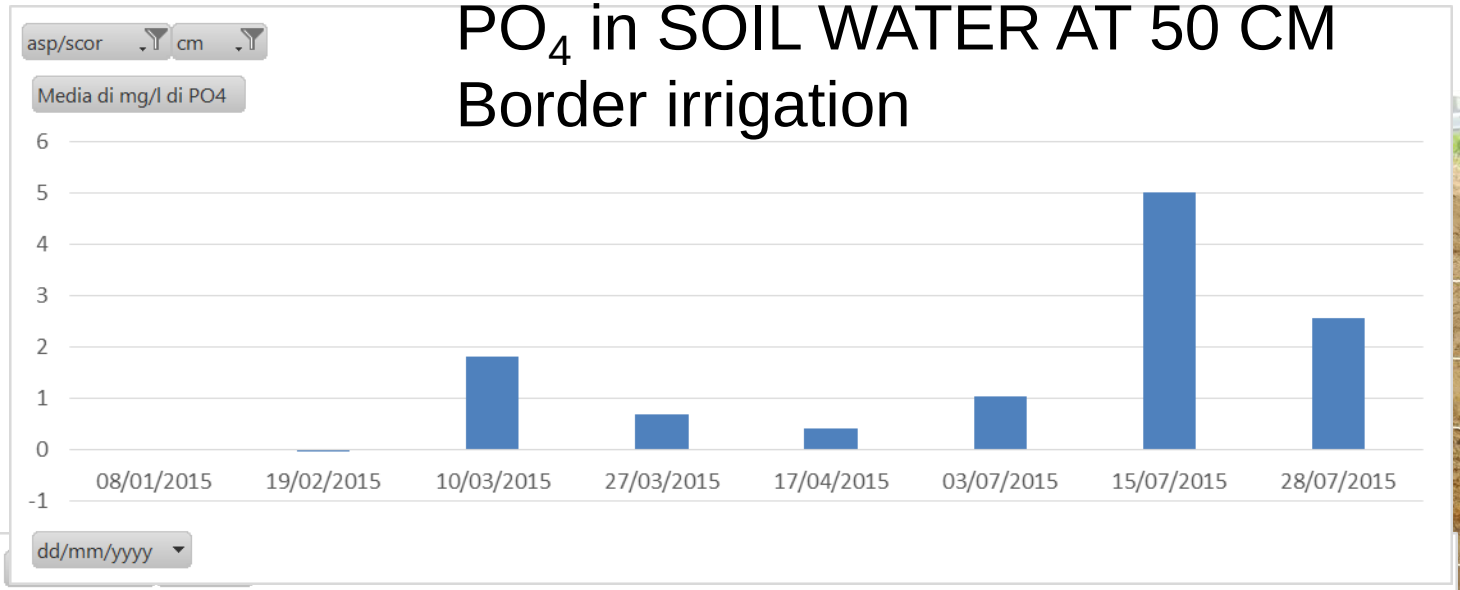


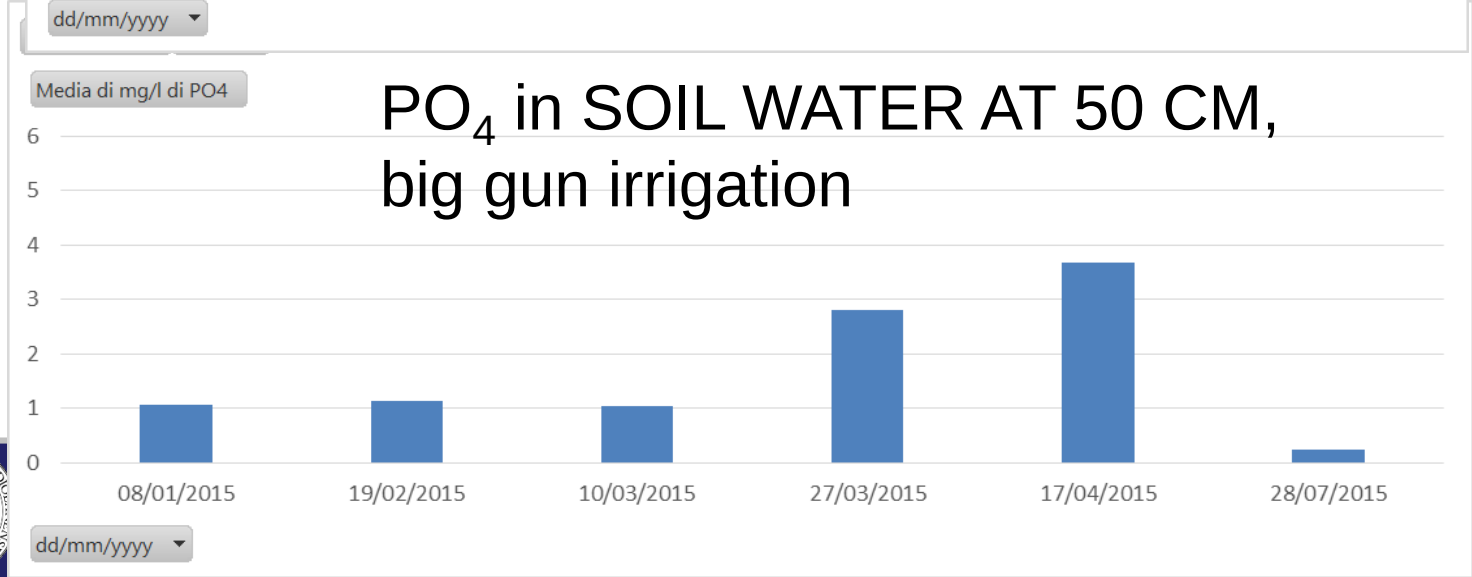


Results

Sand 60% clay 7%, pH 6.7



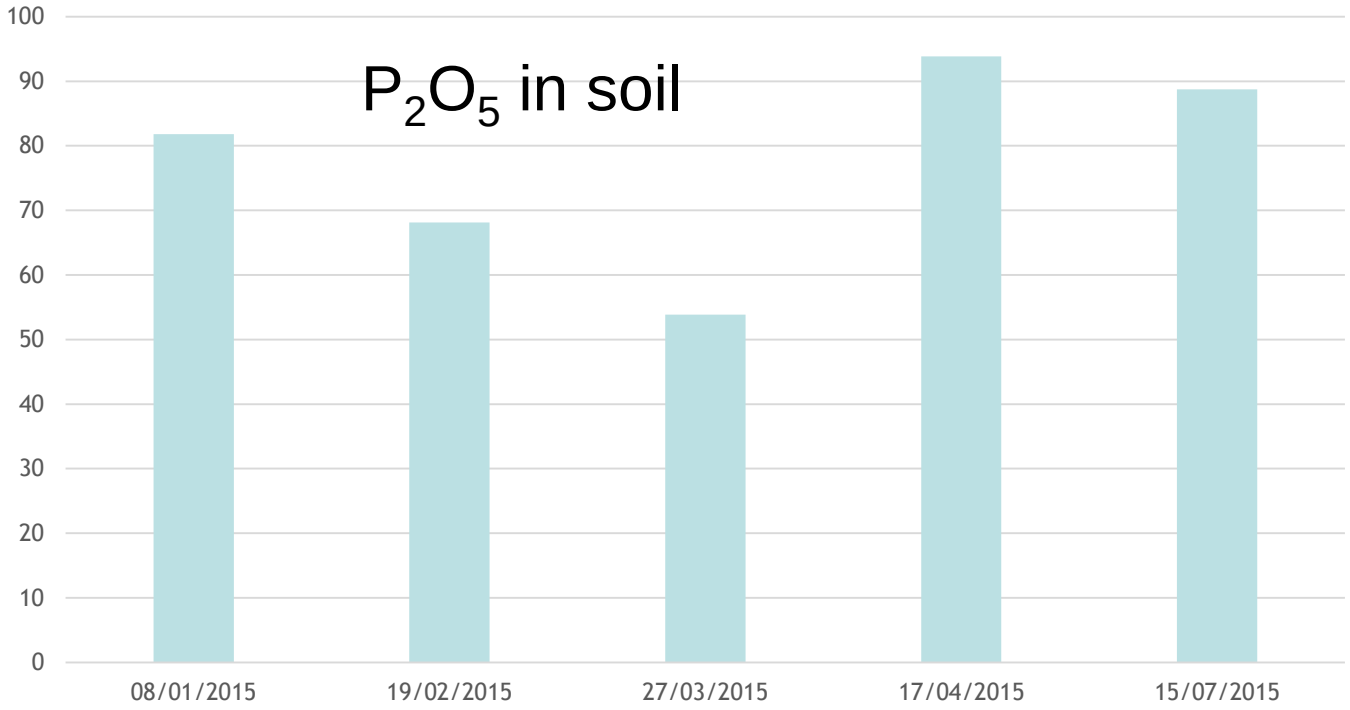
PO_4 in SOIL WATER AT 50 CM
Border irrigation



PO_4 in SOIL WATER AT 50 CM,
big gun irrigation

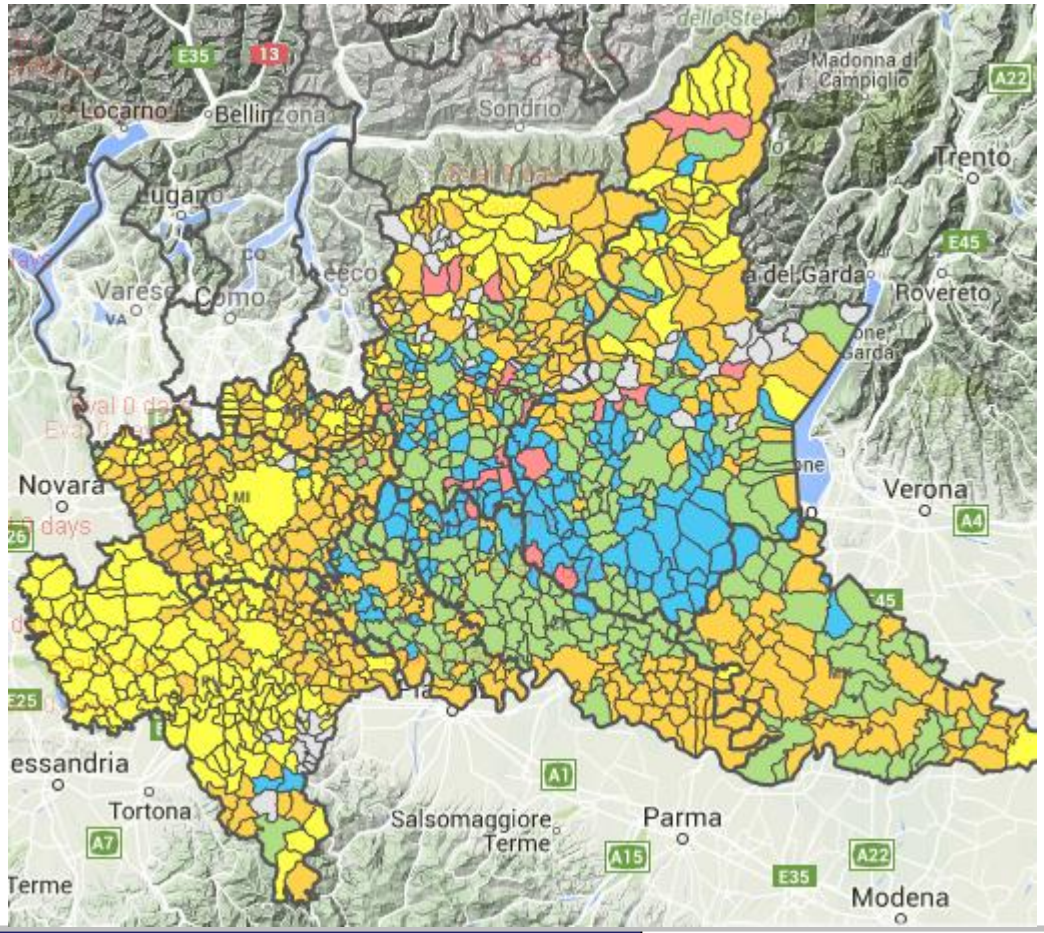
Results

Sand 60% clay 7%, pH 6.7



Results

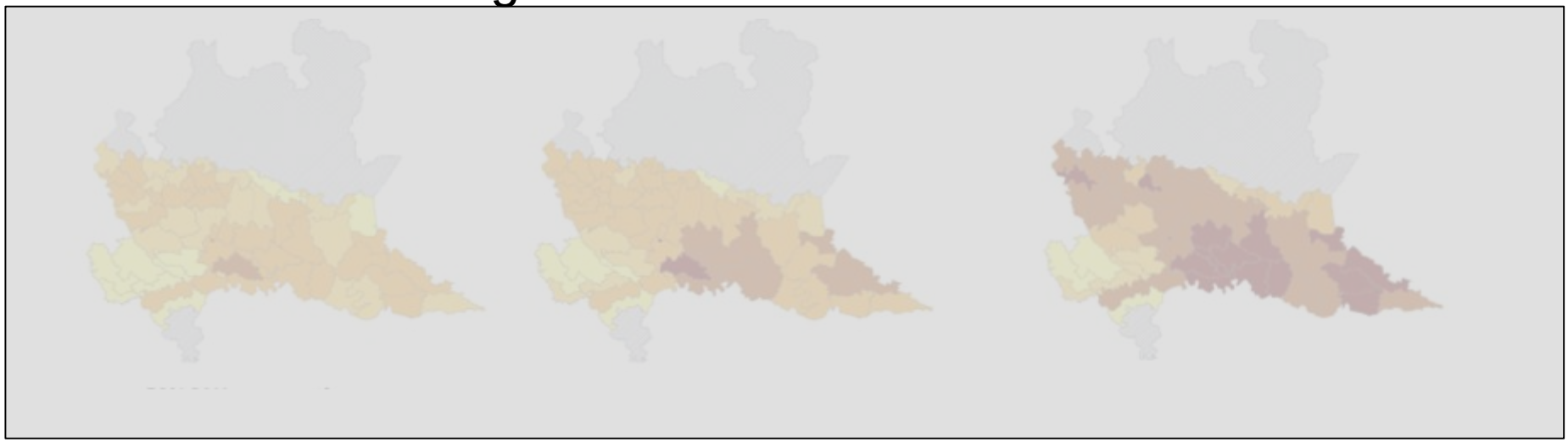
P_2O_5 load from organic sources



- <30 kg ha^{-1}
- <60 kg ha^{-1}
- <90 kg ha^{-1}
- <120 kg ha^{-1}
- >120 kg ha^{-1}

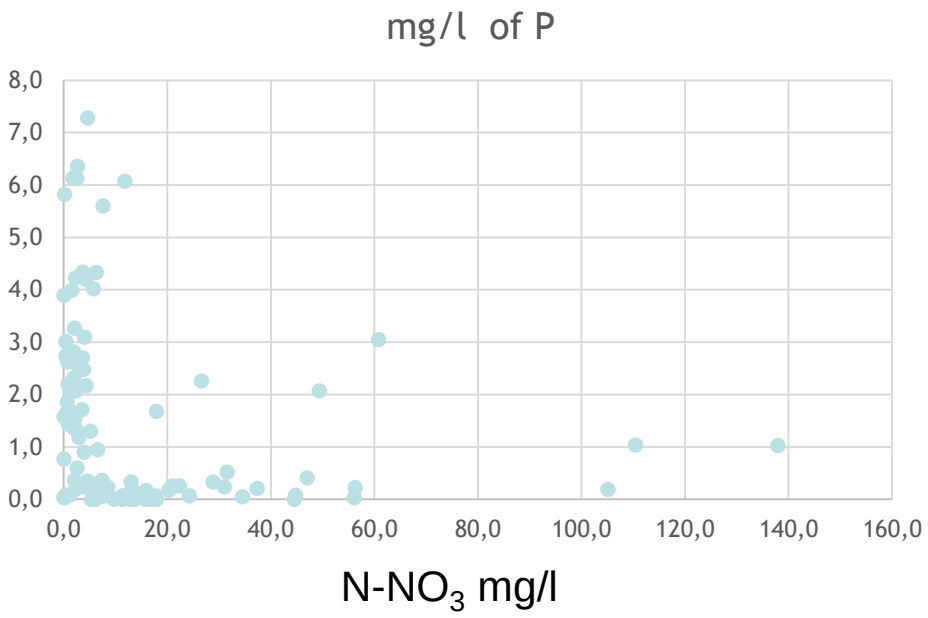
Results

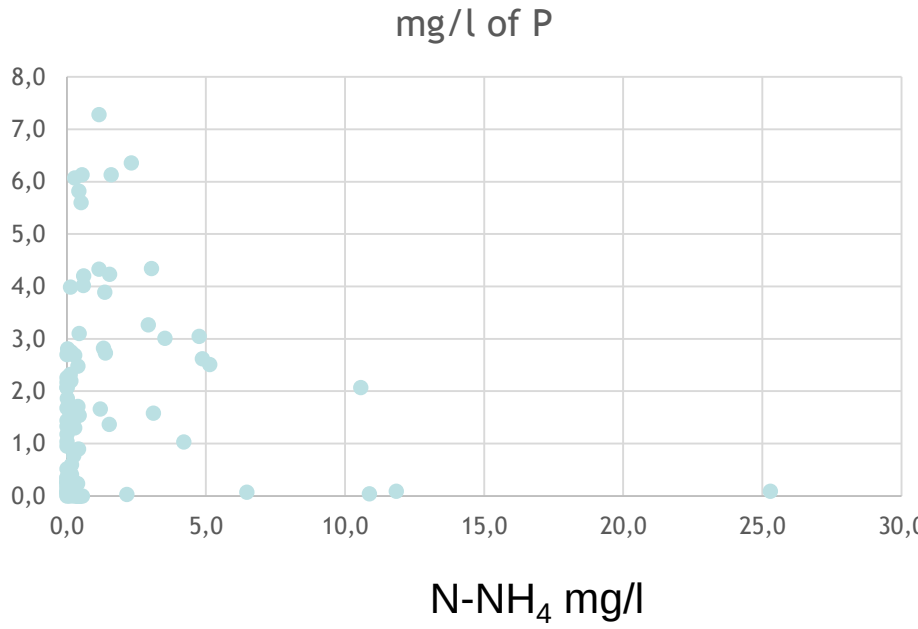
Modelling the P leaching at regional scale
Models (ANIMO) show good performance at point scale but requires calibration. Extension at regional scale requires more data and more works. So I put in grey these maps and I do not discuss it … from 0 to 10 kg ha^{-1} of phosphorus leaching



Results

There are some relation between P in soil water and nitrate or ammonium?





This is in my experience one of the best example of no correlations……

Conclusions

- Phosphorus is very difficult to manage, the behavior is linked to several site specific factors as pH, water dynamics, clay contents, $CaCO_3$ contents, but also microbiological activities.
- Modelling of P is at embryonal phase even if well know models exists and work well after calibration.
- Try to use all information available from regional database and scientific knowledge to help the farmers and the decision makers to improve their global results
- Professional organization are worried by the possibility to better monitoring of farms and their activity and by the risk of new limitation in manure usage (risk of penalty for the farmers)