

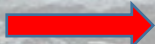


## **(Eutro-SED)**

**Eutrophication hotspots resulting from biogeochemical transformations and bioavailability of phosphorus in the fluvial suspended sediment of geologically contrasting agricultural catchments.**

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Prof. Kevin Bishop (SDU, Sweden),  
Dr. Yongfeng Hu (CLS and US, Canada)**

# Motivation

- Impact of fluvial and stream bed sediments in agricultural catchment streams on surface water quality  90% of P from agricultural catchments may be in particulate form within suspended sediments.
- Multidisciplinary, integrating state-of-the-art molecular biology, experimental biogeochemistry, geo-ecology and regional-scale hydrological modelling.
- Local-scale biogeochemical field work and laboratory-based experiments on suspended sediment bound P in agricultural catchment streams.
- New process understanding scaled up by developing more realistic representations of biogeochemical transformations in agricultural catchments to be included in catchment-scale hydrological models

# Objectives

- Delineate the role of fluvial sediments on the delivery of bioactive P from agricultural catchments with an emphasis on the macronutrient organic P and complexed P;
- Investigate the seasonal variation in inorganic (humic-metal P complexes) and organic P content (monoesters, di-esters, peptide, DNA etc.) in the fluvial suspended sediments between contrasting agricultural catchments.
- Advance the mechanistic and predictive understanding of the biogeochemical interactions and fluxes between fluvial and streambed bound P, particularly in the context of agricultural-induced land use changes.
- Identify likely sources of sediment associated organic P using multiple techniques to provide valuable information on organic P dynamics within agricultural catchments;
- Examine seasonal, geomorphological and land-use effects on sediment bound organic P bio-availability for in-stream algal and weed vegetation growth in contrasting geological agricultural catchments.
- Develop the modelling capabilities for interpreting and predicting the effects of low flow and episodic flood events on the export of suspended and streambed sediment bound bioactive P from agricultural catchments.

# Work Package 1

- Focus on biogeochemical processes and properties of suspended and streambed bound organic phosphorus and complexed inorganic phosphorus.
- Effects of redox oscillations on P exchanges and speciation will be examined in the field and in laboratory incubations using nano-scale analytical techniques (**electron microscopy and synchrotron-based spectroscopy**).
- **Chemical extractions** – comparison of solid-state P speciation under oscillating redox conditions.
- Analysis at Canadian Light Source (CLS) in Saskatchewan in Canada under the Prof. Yongfeng Hu. Sampling, extractions, bioavailability and bioassays experiments to take place in TCD (Ireland) and SDU (Sweden).



Chemical Extractions



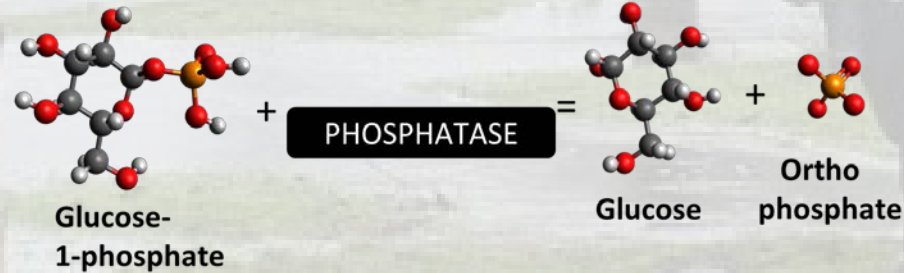
Mössbauer



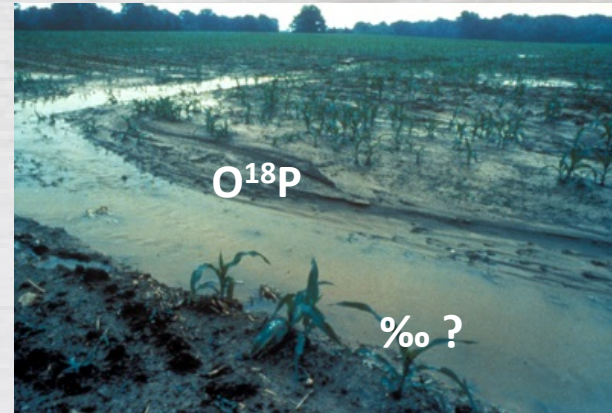
CLS – Canadian Light Source

# Work Package 2

- Test hypothesis that **strong biogeochemical gradients and fluctuations within suspended and streambed sediments of geologically contrasting agricultural catchment streams result in phosphorus bio-availability dynamics.**
- Methods involving **extra-cellular enzymatic hydrolysis** (Wang et al. 2010, Giles et al. 2015) will be used to identify and quantify the activity of organic P species specific enzymatic hydrolysis within suspended sediments and in-stream sediment profiles.

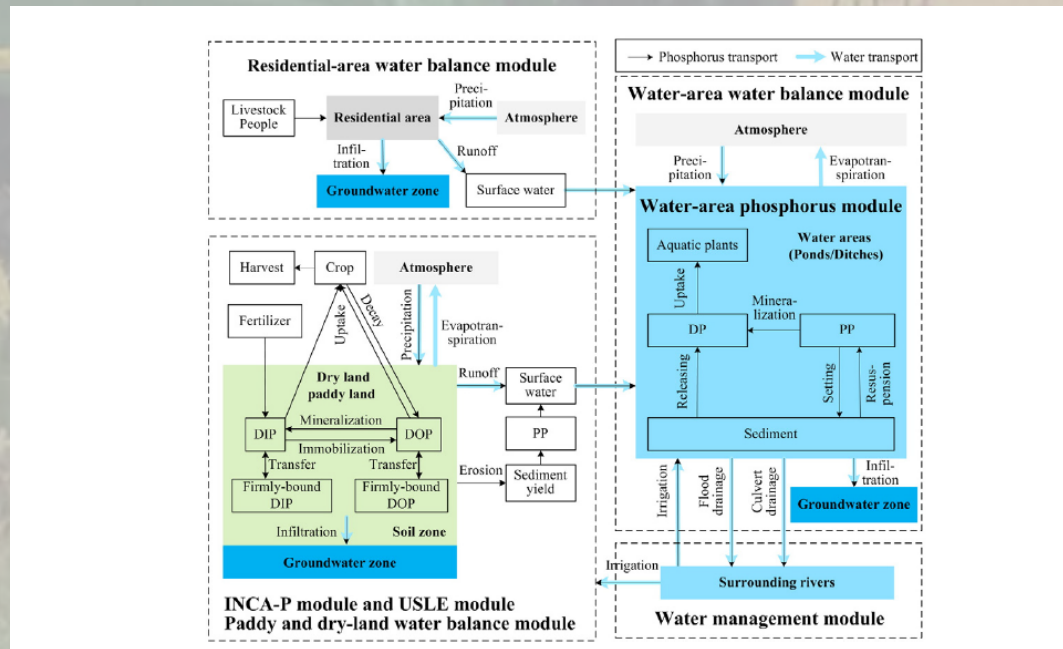


- Relatively new isotopic approach,  $\delta O^{18}p$  suspended and streambed sediments, based on the tracing of the oxygen stable isotopes of phosphate will be applied to tracing phosphate over multiple catchments.



# Work Package 3

- Package will address **regional scale impacts of biogeochemical transformations within suspended and streambed sediment bound phosphorus in geologically contrasting agricultural catchments.**
- Basis laid for refining and developing the mathematical formulations describing the suspended sediment exchanges of P (particularly organic P).
- Coupling of sediment transport and biogeochemical transformations can be better constrained in predictive P exchange models for agricultural catchments (Inca-SED P).



# Irish Agricultural Catchments

## Small Contrasting Headwater Agricultural Catchments (5-35 km<sup>2</sup>)

- Landuse (Dairy, Dry Stock, Tillage ?)
- Geology and Sediment Composition (Ca rich v Fe/Al rich?)
- Annual Precipitation (Comparable Stream discharges)
- Existing or historic hydro-chemical and suspended solid datasets
- Agricultural catchments of **particular interest or concern** to the Irish EPA catchments group in terms of nutrient export, suspended sediment flux stream water quality issues.