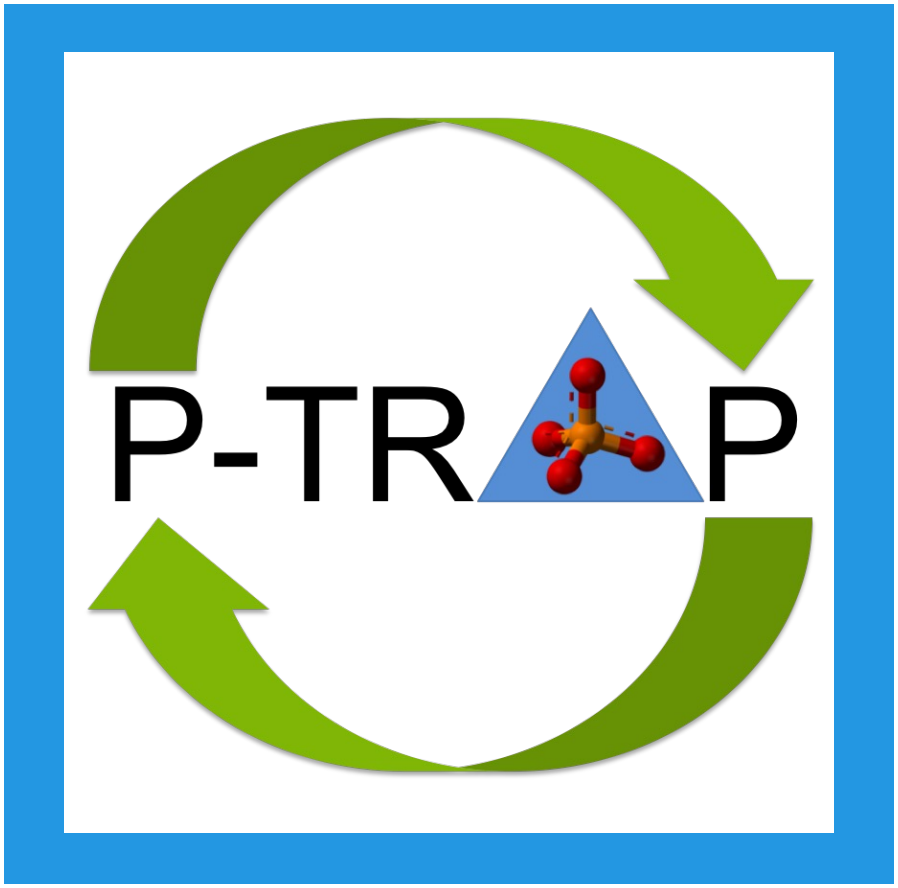


Website

ESPC4 / PERM5

Vienna, June 2022

P-TRAP in a nutshell

- H2020 Marie Sklodowska Curie Training Network
- 11 Early Stage Researchers (ESRs) in 7 countries

AIM

Improve surface water quality & recover phosphate leaching from agricultural watersheds by applying iron-containing side products of water treatment

CONTEXT

P-TRAP tackles two urgent interlinked global problems:

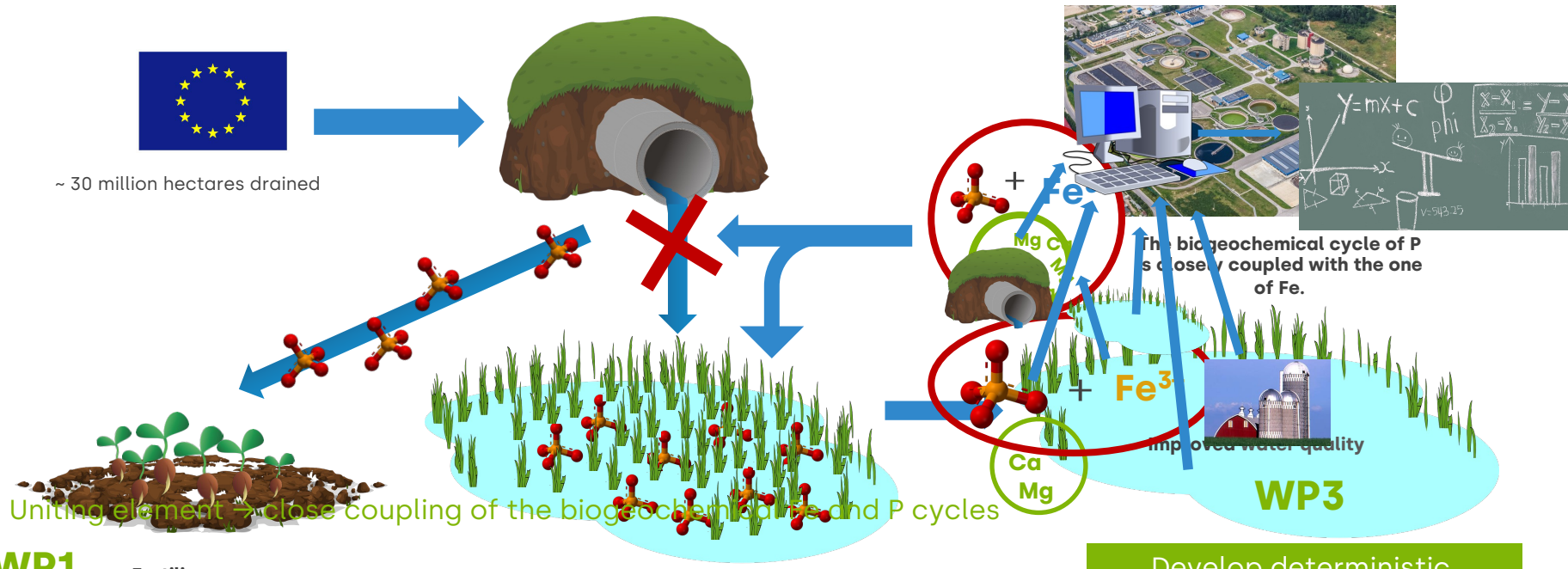
Shortage of essential P

Credit: Franklin D. Roosevelt Presidential Library & Museum (53227(1828), 00/00/1942, 27-0921a.gif),

Decline of surface water quality

Credit: takenbyphil, pixabay

Project structure



Uniting element → close coupling of the biogeochemical P and P cycles

WP1 Fertiliser

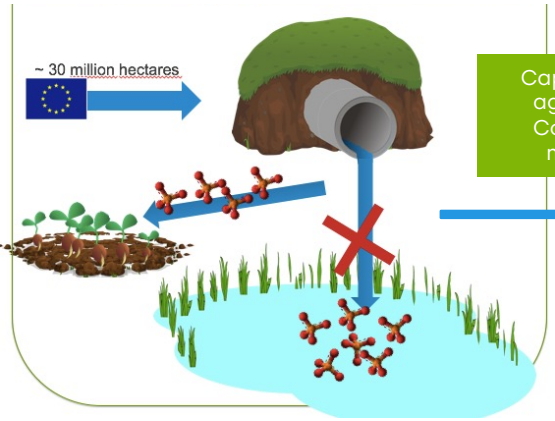
Capturing P in tile-drained agricultural watersheds
Convert captured P into marketable fertilisers

WP2

Establish an innovative method for mitigating eutrophication in lakes by using by-products from water treatment

Develop deterministic, quantitative models for processes and mechanisms controlling the behaviour of P during the transformation of Fe minerals

WP1



Capturing P in tile-drained agricultural watersheds
Convert captured P into marketable fertilisers

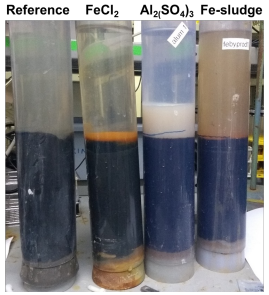
P-TRAP

Application of fertilisers to soils and effect of plant growth

Microbial transformation of filter material into soil conditioner & fertilisers

Experimental and field data

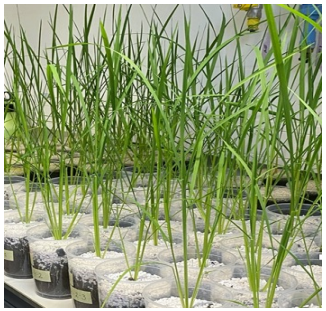
Improvement of system and material



Development of
- new P-TRAP cartridge system
- new filter-stable trapping material
- Production and characterisation of Iron Coated Sand (ICS)

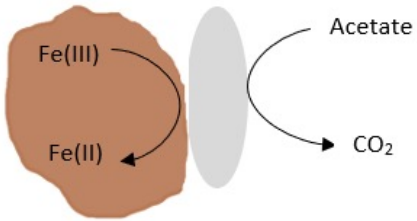
Progress & results so far

- Lower P uptake compared to commercial fertilisers
- Reduced conditions did not increase plant P availability



Progress & results so far

- Fe-reducing bacteria produce vivianite
- Results demonstrate high impact of process parameters and offer opportunities for optimisation

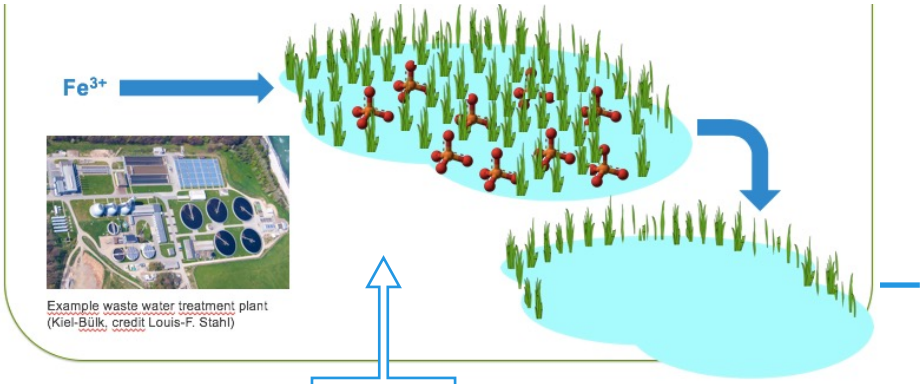


Progress & results so far

- Cartridge system ready for testing under field conditions soon
- Presence of P impacts Fe-redox cycling and stabilise the more reactive phase
- P sorption on ICS is diffusion controlled and sorption kinetics are modelled

WP2

Establish an innovative method for mitigating eutrophication in lakes by using by-products from water treatment

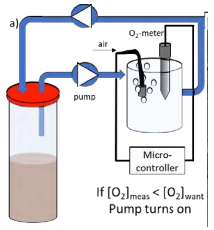


P-TRAP

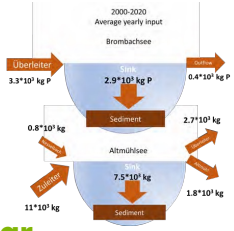
Improve lake water quality

Determine Fe-P coupling in lakes

Intensive field sampling & long-term monitoring of several lakes (D/NL)



Modelling Fe-P dynamics



Progress & results so far

- Diagenetic model developed to study Fe-P dynamics in lakes and P mobility in sediments
- Mass balance for Franconian lake system established, demonstrating the importance of the sediment as P
- O_2 micro controlling device developed and tested to investigate redox sensitivity

P-binding efficiency of Fe-containing water treatment by- products

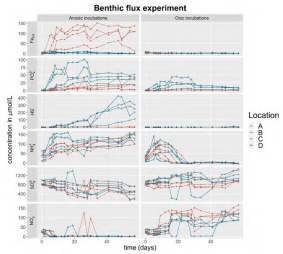
Study of P adsorption capacities from schwertmannite-based materials and ICS

Progress & results so far

- 5 novel granular materials based on water treatment residuals developed and characterized, in the process of production on lab and field scale
- Adsorption capacity and kinetics affected by pH and also aging of the material

Determine potential of Fe addition to lakes

survey on long-term effects of Fe-addition has been started



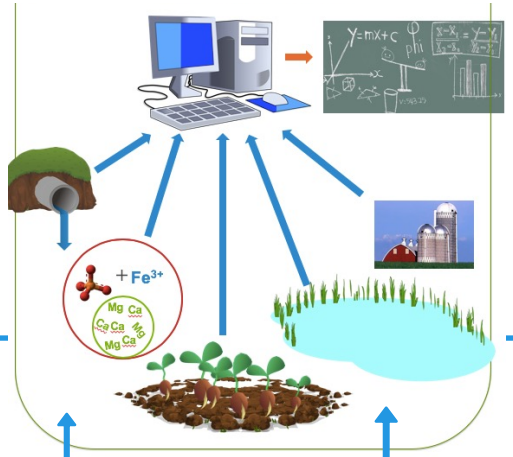
Design Fe supply protocol for lakes

Progress & results so far

- Fe sludge promising additive as it does not enhance OM mineralisation and reduce P and S load
- Comparable data sets to constrain timescales and determine Fe sludge addition under evaluation

WP3

Develop deterministic, quantitative models for processes and mechanisms controlling the behaviour of P during the transformation of Fe minerals

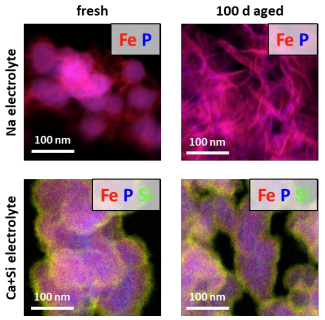


P-TRAP

Temporal dynamics of solid-bound Fe and P in the studied systems

Extensive lab experiments

Transformations and aging of P-containing Fe(III) oxides

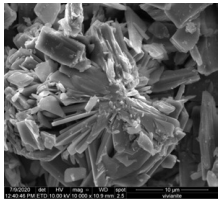


Develop kinetic models for transformations of P containing Fe phases

Progress & results so far

- Kinetic model developed to describe temporal trends in P and S over the course of lepidocrocite sulfidation
- Extensive experimental data sets available for vivianite (trans)formation
- Electrolytes and organic ligands affect the P sorption
- Aging and transformation of Fe(III)-precipitates have a high impact on P retention
- Adsorbed and co-precipitated P both effectively inhibit Fe^{2+}-catalysed transformation pathways

Characterising solid-bound Fe and P



Microscopy & spectroscopy techniques used to study association of Fe and P on atomistic level

Progress & results so far

- Extensive data sets under evaluation, e.g.

<u>X-ray absorption spectroscopy</u>
Assess spatial variations in Fe oxidation state within partially oxidized vivianite crystals

<u>Electron microscopy</u>
Study morphology and elemental heterogeneity of Fe(III)-precipitates with respect to aging and organic compounds

Progress & results so far

<u>Soil</u>
Release of P from vivianites

<u>Filter systems</u>
Kinetics of P uptake on ICS

<u>Lake & ditch sediments</u>
Chemical fractionation in sediment cores and release rates

P-TRAP
at ESPC4 / PERM5

- **This session**
  - The impact of P on Fe(II) catalyzed ferrihydrite transformation under oscillating redox condition, Xingyu Liu, University of Bayreuth, Germany
  - Potential of recycled vivianite as P and Fe fertilizer – from a mechanistic point of view, Rouven Metz, University of Vienna, Austria
- **Parallel breakout sessions II**
  Phosphorus interactions in soils
  Moderator: Victoria Barcala, Deltares, Netherlands
- **Posters**
  - Phosphorus balance, release rates and mechanisms in a eutrophic coupled - reservoir system, Karel As, Bayreuth University, Germany
  - Use of vivianite obtained from water purification as phosphorus fertilizer, Tolulope Ayeyemi, University of Seville, Spain
  - Effect of rain variability and water retention measures on phosphorus loads at the farm scale, Victoria Barcala, Deltares, Netherlands
  - Granular iron-based materials for phosphate removal from waters, Oleksandr Bolielyi, GEOS, Ukraine
  - Strategies for optimizing the scalable microbial synthesis of vivianite, Lordina Eshun, Manchester University, United Kingdom
  - Reduction kinetics of iron-rich by-products from drinking water treatment, Mingkai Ma, Utrecht University, Netherlands
  - Effect of Fe addition on P retention in peaty freshwater sediment, Melanie Munch & Karel As, Utrecht University, Netherlands
  - Phosphate retention by Fe(III)- and Ca-phases formed upon oxygenation of anoxic groundwaters, Ville Nenonen, Eawag, Switzerland
  - Recycled iron phosphates are not effective phosphorus fertilizers in the short term on lowland rice, Rochelle Joie Saracanlao, KU Leuven, Belgium

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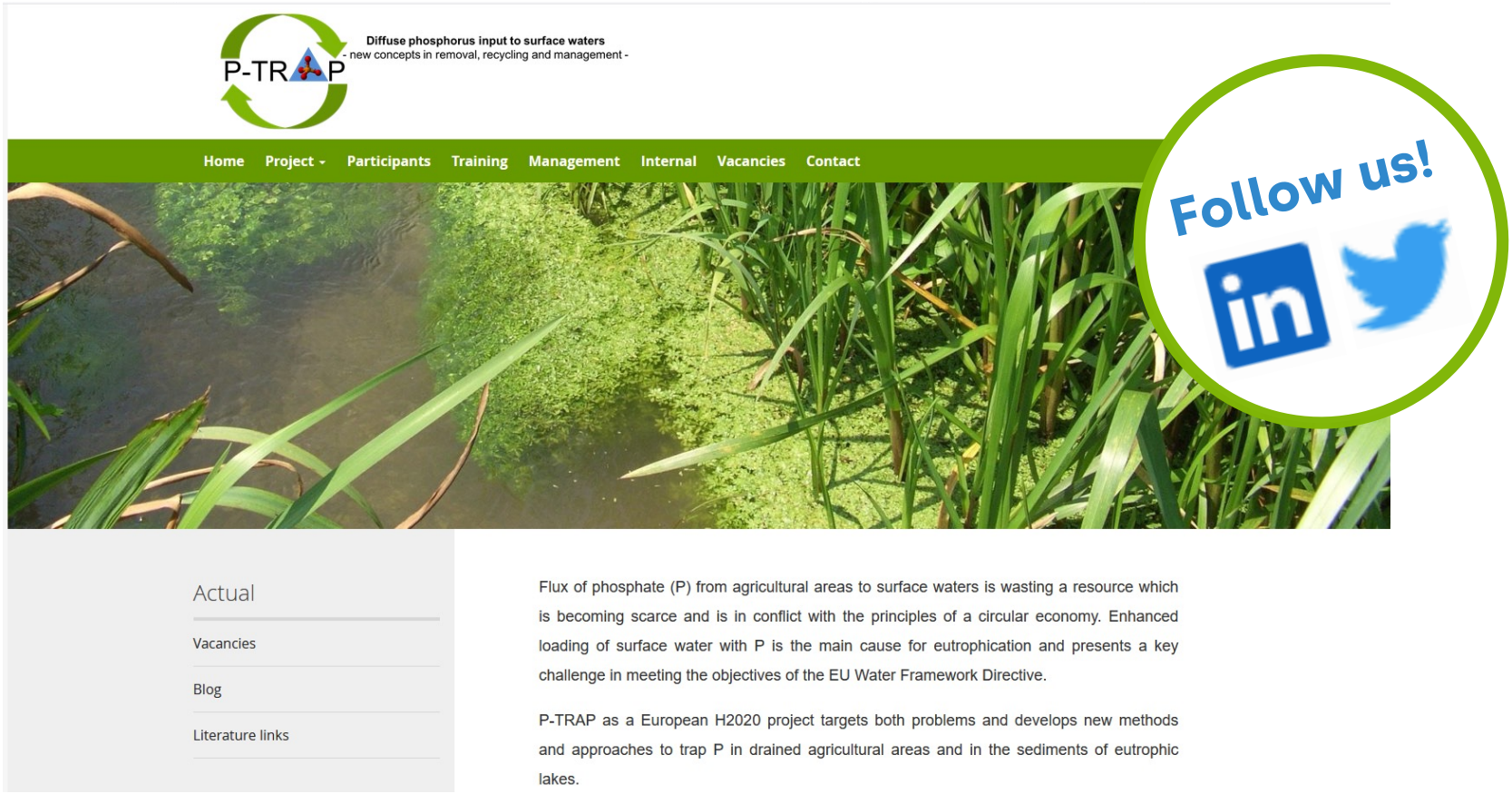
https://h2020-p-trap.eu



Questions?


Kysymyksiä?
Pytanie ?
Vragen
¿Preguntas ?
Frågor ?
Mga tanong?
Domande
Küsimused
Fragen
Spørgsmål
Kérdések
Questions
Ceisteanna
Wèntí ?
Probleme
有問題嗎？