

# Synergistic recovery of nitrogen (N) and phosphorous (P) from wastewater via regenerative adsorption



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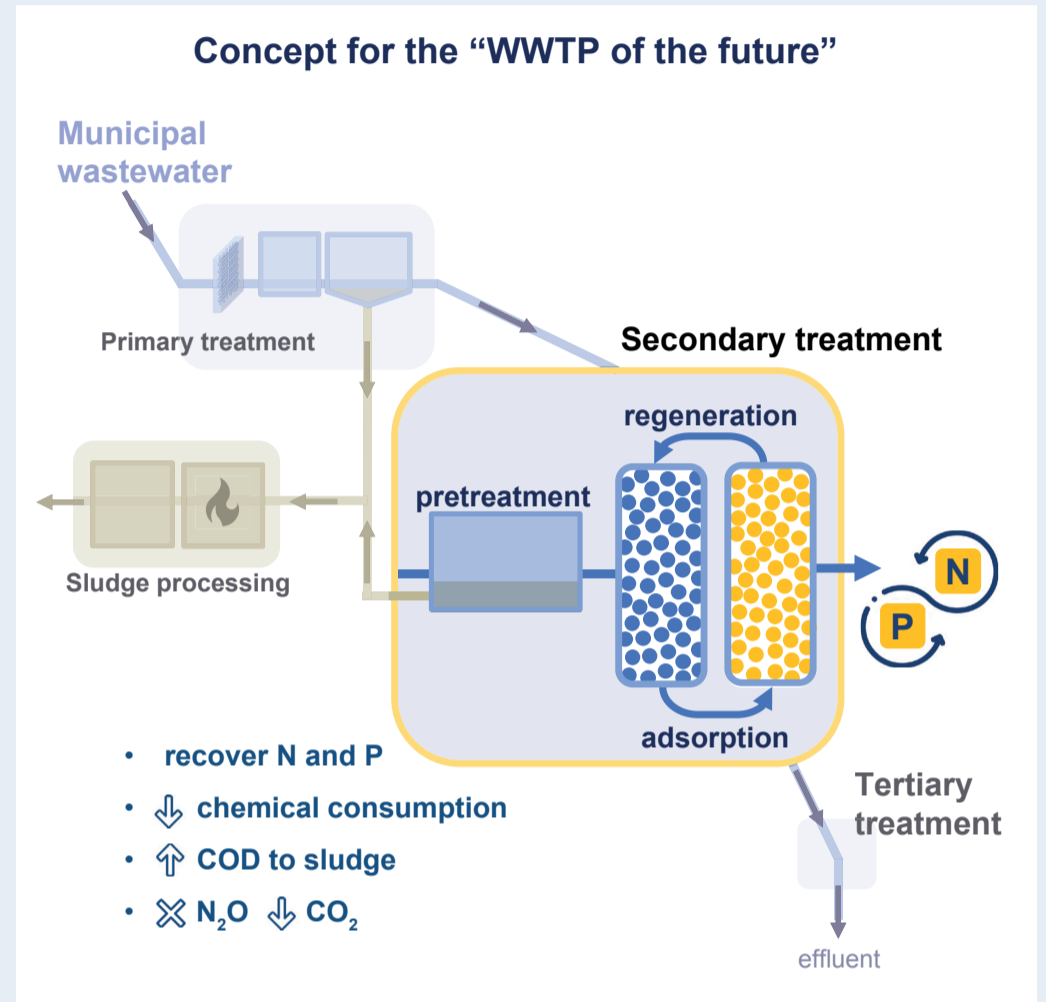
## Motivation

Conventional wastewater treatment processes focus on nutrient removal from sewage: carbon (C) is removed through oxidation by heterotrophs, nitrogen (N) via the nitrification/denitrification process and phosphorus (P) using enhanced biological (EBPR) or chemical (CPR) processes. While these technologies are well-established and reliable, they produce a significant amount of greenhouse gases ( $N_2O$  and  $CO_2$ ) [1] and do not allow for the full valorization of the COD to offset costs. At the same time N and P are both valuable resources for agriculture and are otherwise produced through energy-intensive chemical or mining technologies. Therefore, wastewater is a largely untapped resource of N and P, and it is estimated that up to half of the demand for both nutrients can be covered by fully recovering them from wastewater [2].

Regenerative adsorption is a promising approach to realizing the circular potential of sewage, provided a synergy can be found in the recovery of N and P, and the use of chemicals necessary for regeneration and system longevity can be minimized.

## Technological challenge

Generally, the regeneration part of the process when studying adsorption is comparably under-researched, while it dictates whether the use of adsorption can be economically viable to recover N and P in real sewage treatment. There is a need to explore the possibility of recovering both nutrients using a minimal amount of chemicals, while overcoming several challenges, such as the complex wastewater matrix [3], and the concentration disbalance between N and P as well as keeping an eye out for market-valuable compounds to be produced from the regenerant stream.



## Research goals

- Develop a proof-of-concept method for combined desorption of N and P using a single regenerant stream exploring simultaneous and sequential processes
- Transfer the design to a complex and COD-rich realistic feedstock to evaluate the effects of the wastewater matrix on the adsorption and regeneration processes
- Identify suitable pretreatment steps, place the system in an optimal stage of existing WWTPs and/or propose what a "WWTP of the future" utilizing the system might look like
- Explore the extent of recirculation for the regenerant and approaches to prolong its reuse
- Find ways to recover the nutrients in the form of market-attractive products

## References:

[1] Falk et al., Water Environment Research 85 (2013) 2307–16  
 [2] Schoumans et al., Ambio 44 (2015) 180–192.  
 [3] Kumar et al., Water Research X 4 (2019) 100029.

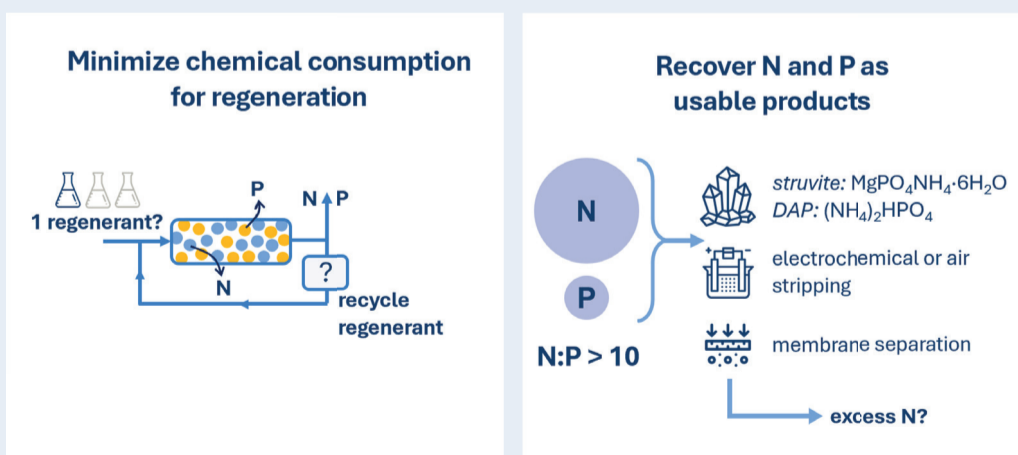


Fig. 1 Some of the main research directions of the project