Phosphorus removal from dilute sources

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Where water meets chemistry
ICL Fertilizers
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Waterschap Brabantse Delta
GREEN WATER SOLUTION

Global problem, large economic damages

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Economic damages: Hoagland, 2006, Sanseverino 2016;

Additional actions needed

88 % of all sewage plants comply to EU UWWT for advanced P removal

BUT, of all EU lakes:

- 38% do not meet water quality standards (Voulvoulis, 2017)
- 15% do not meet WHO risk thresholds for recreational use (Carvalho 2013)

MAIN SOURCES:

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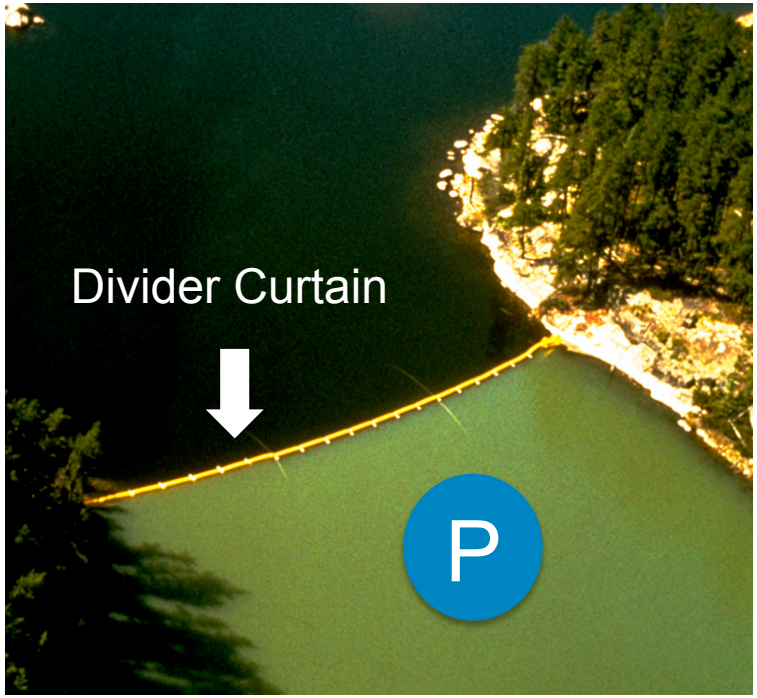
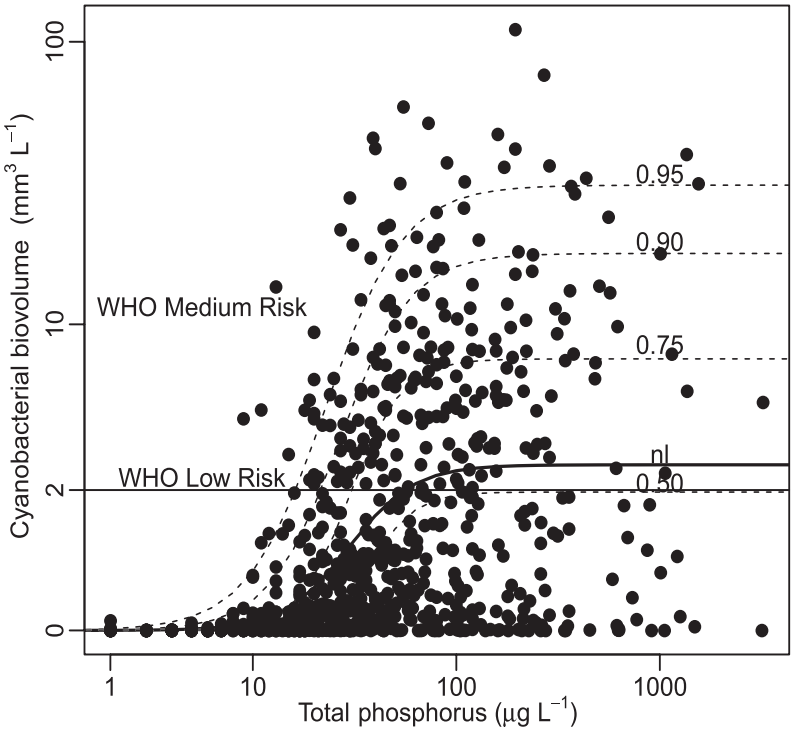
Fresh water: P is the limiting nutrient



Lake 227, Canada
Schindler, 1974



EU lakes
Carvalho, 2013

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Example Florida

THE GEORGE BARLEY WATER PRIZE

10 Million $ prize!

EVERGLADES FOUNDATION

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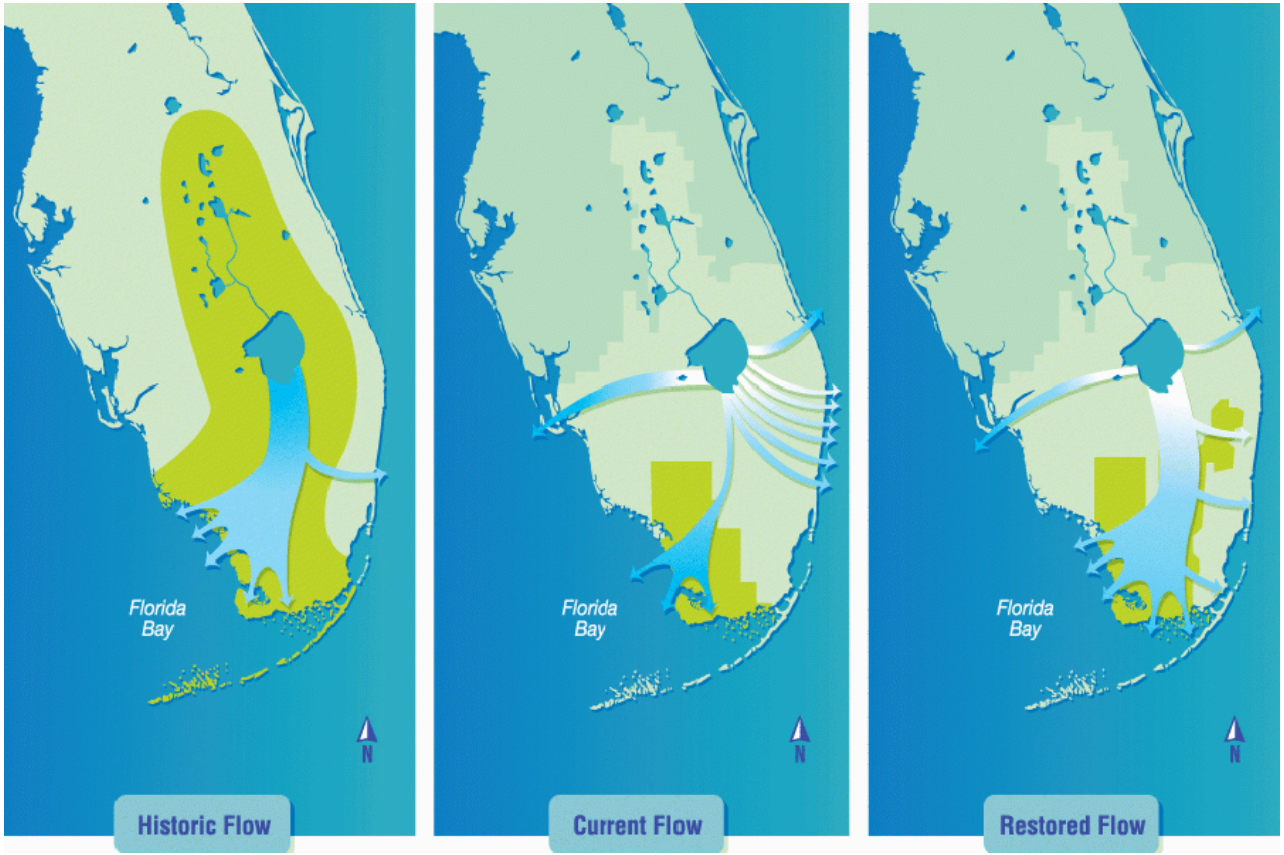
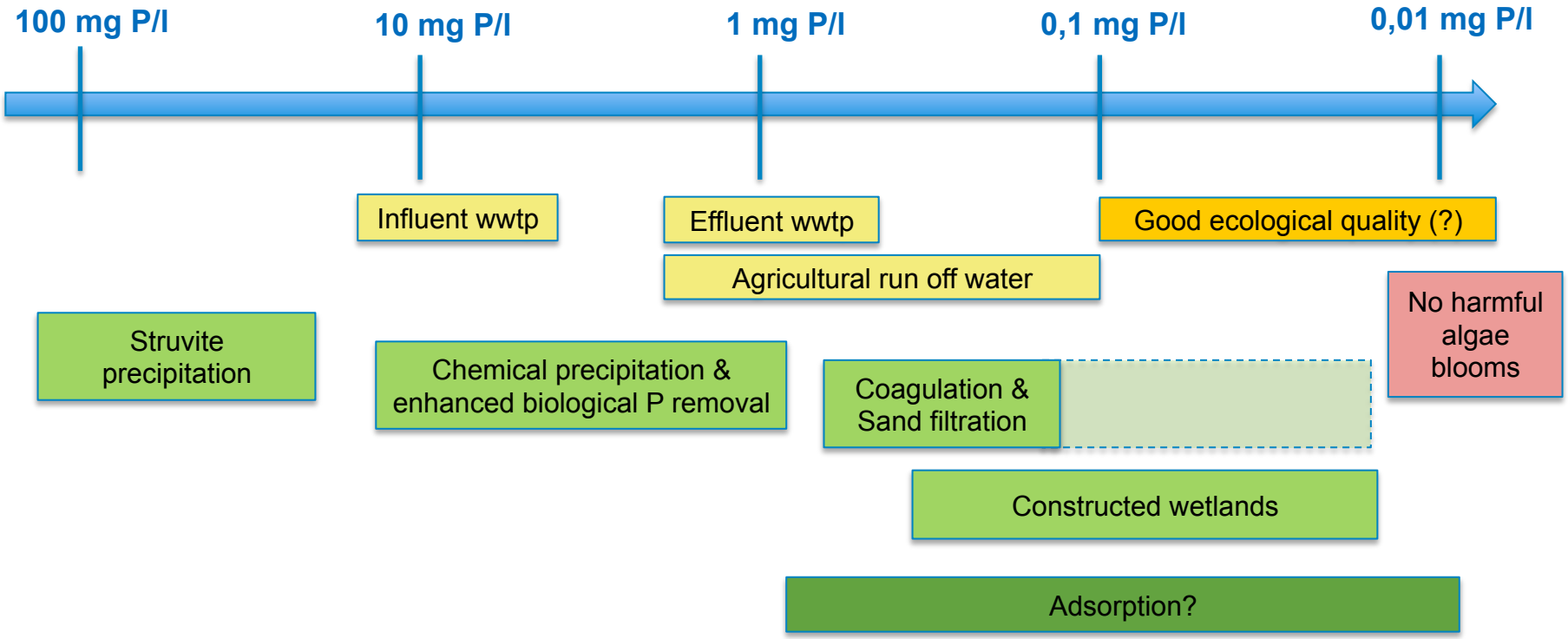


Ultra low P removal



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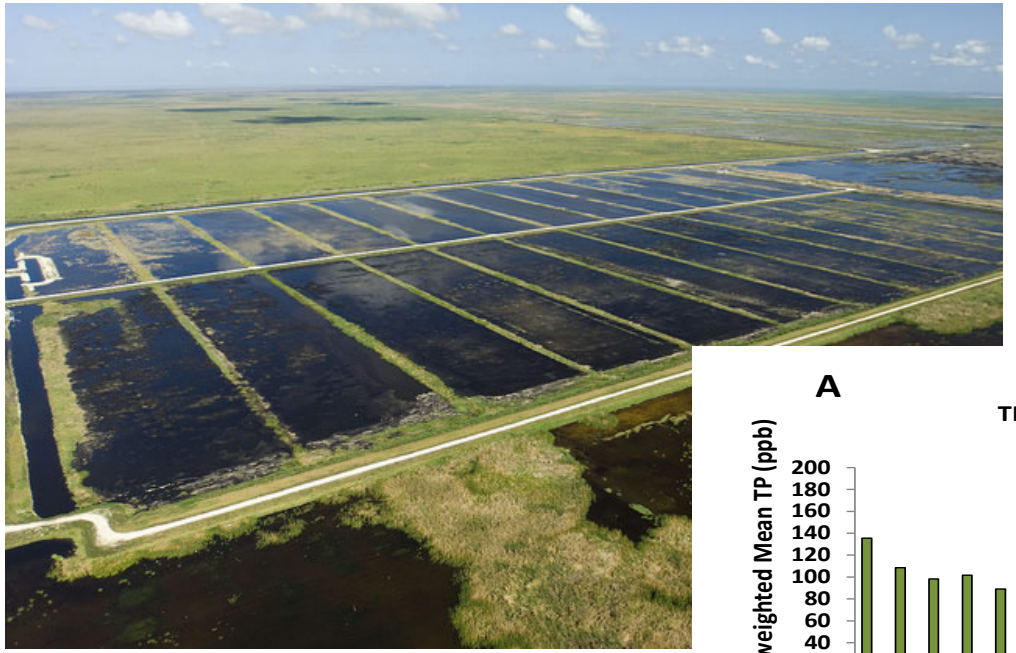
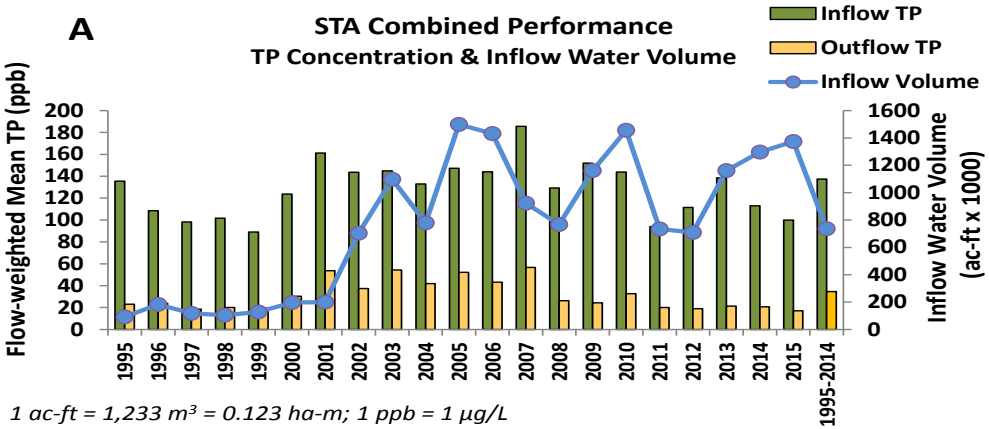
Constructed wetlands



Everglades, Florida

2015:
4.400.000 m3/day
83% P retention
17 ppb P in effluent

Ch. 5B, Florida Env. Report 2016



1 ac-ft = 1,233 m^3 = 0.123 ha-m; 1 ppb = 1 µg/L

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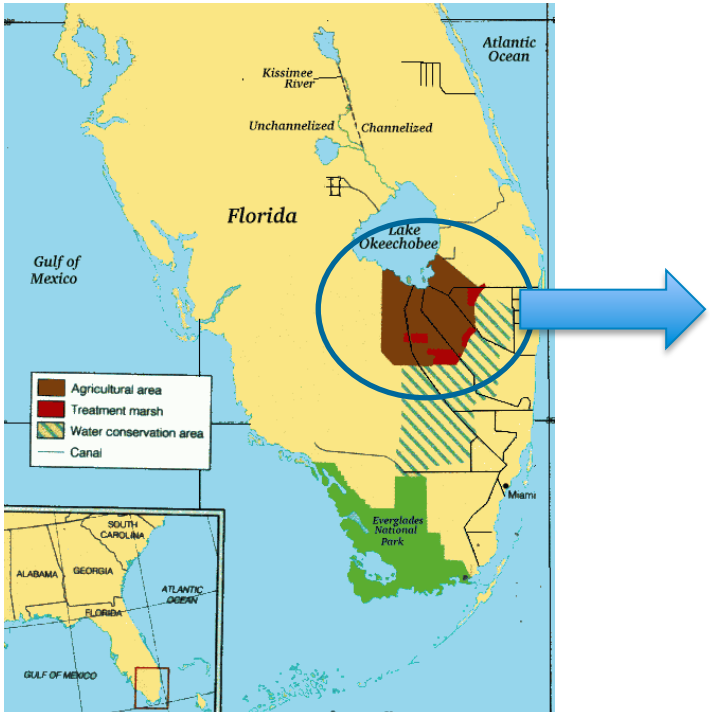
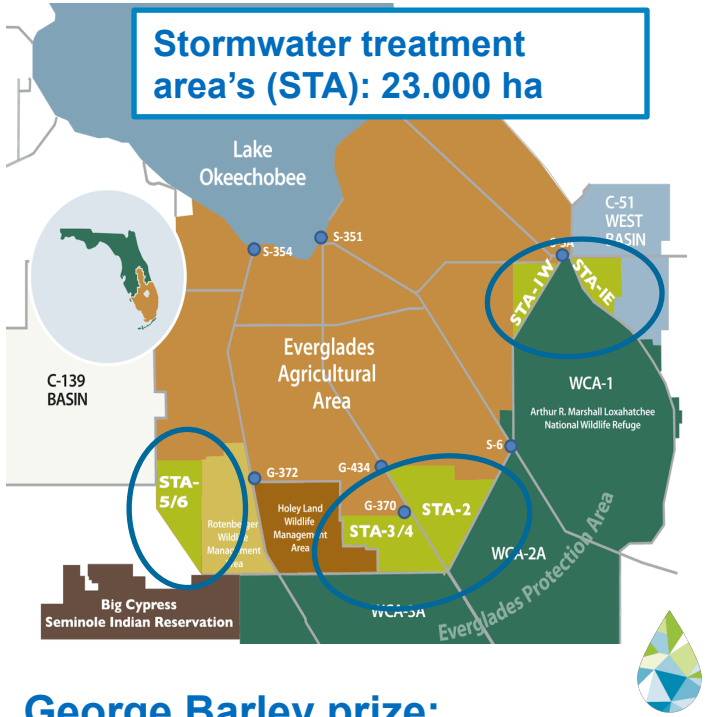
Large area's required





THE GEORGE BARLEY WATER PRIZE

George Barley prize:
100 x more compact technology required

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Sand filtration

- Effluent quality generally >= 0,15 mg/l
- Coagulant dose (Fe or Al): Me/P = 3-6
- High chemical dosages
- Large sludge production

- US: removal shown to ca 0,05 mg/l

  ⇒ High Me/P ratio's

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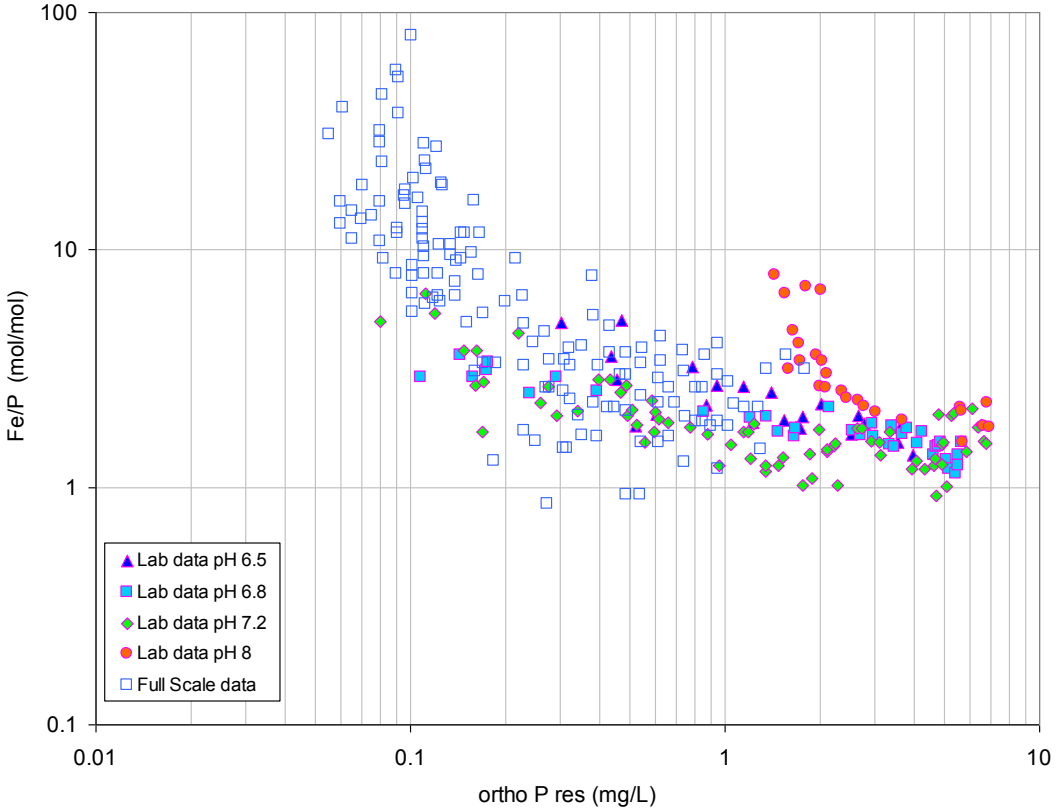
STOWA, 2006, EPA 2007

Increasing Me/P ratios for low P effluent



Hermanoviczs, 2006

Adsorption: small footprint

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Adsorption

- Promising for low effluent values
- Lots of literature
- Often single use:
  - Iron coated sand
  - Waste materials impregnated with Fe, La or other doping materials
  - Fancy high performance adsorbents

- Very little real life applications
  - Research is often not directed to economic relevant parameters

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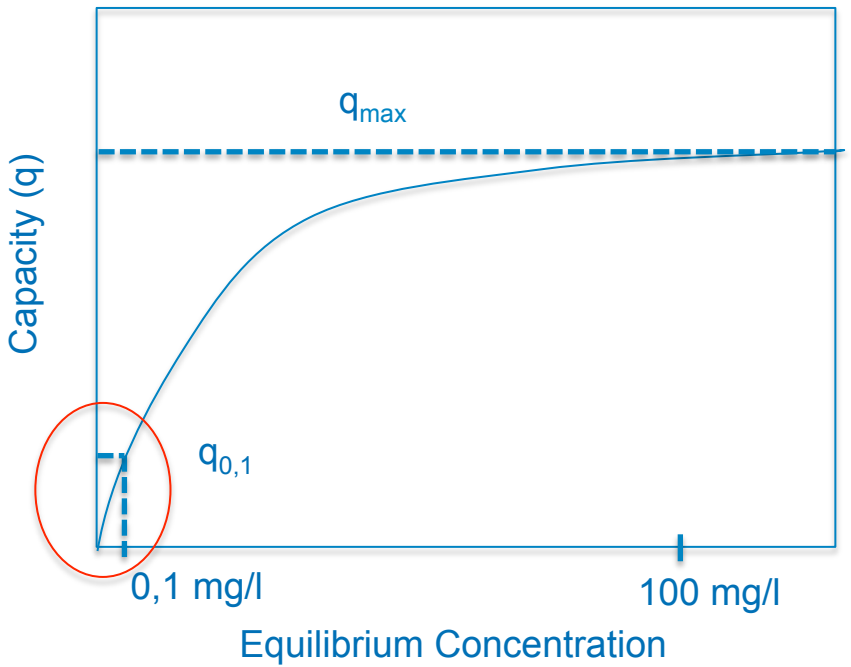
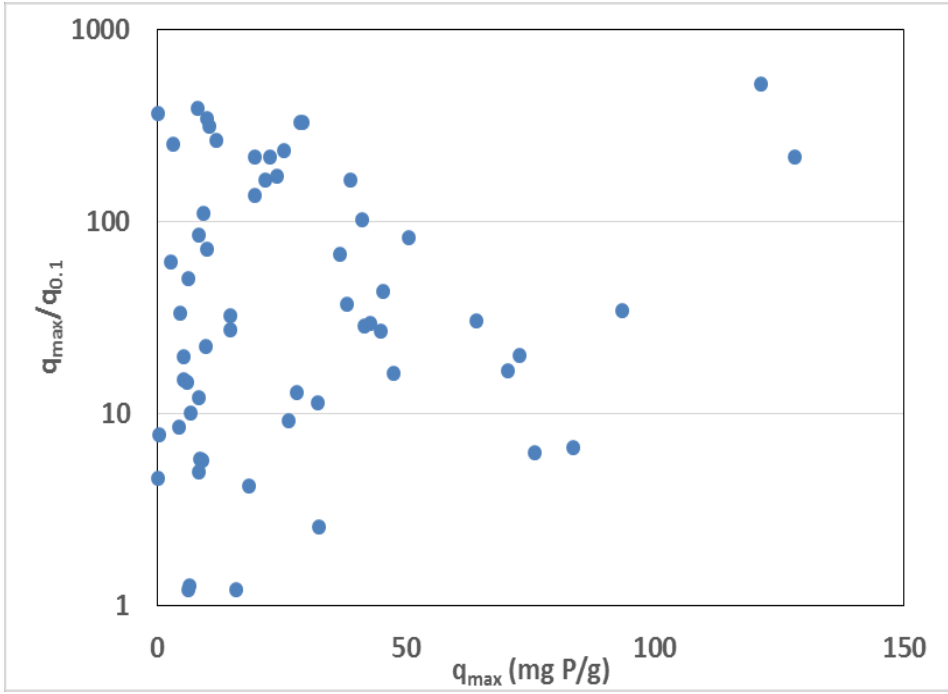
Adsorption: capacity





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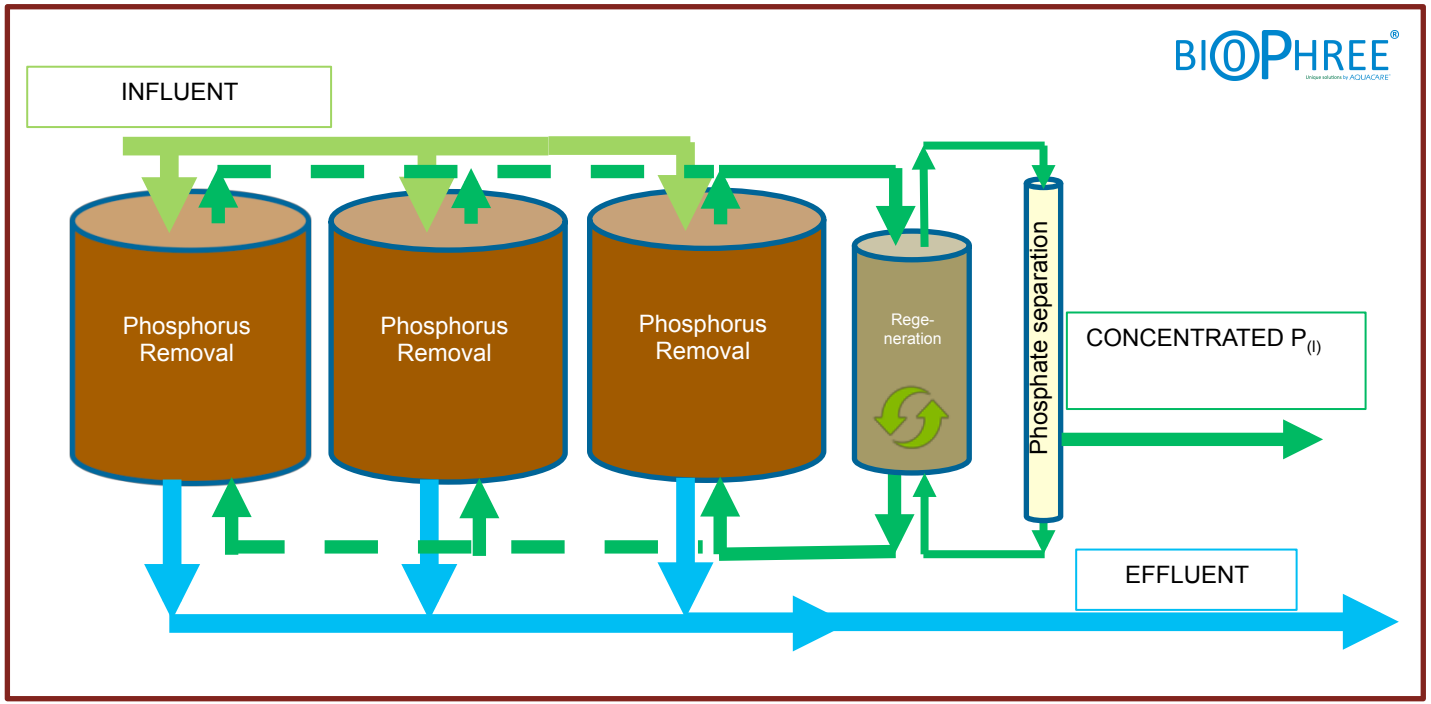
Kumar, 2018

Regenerative adsorption: removal & recovery



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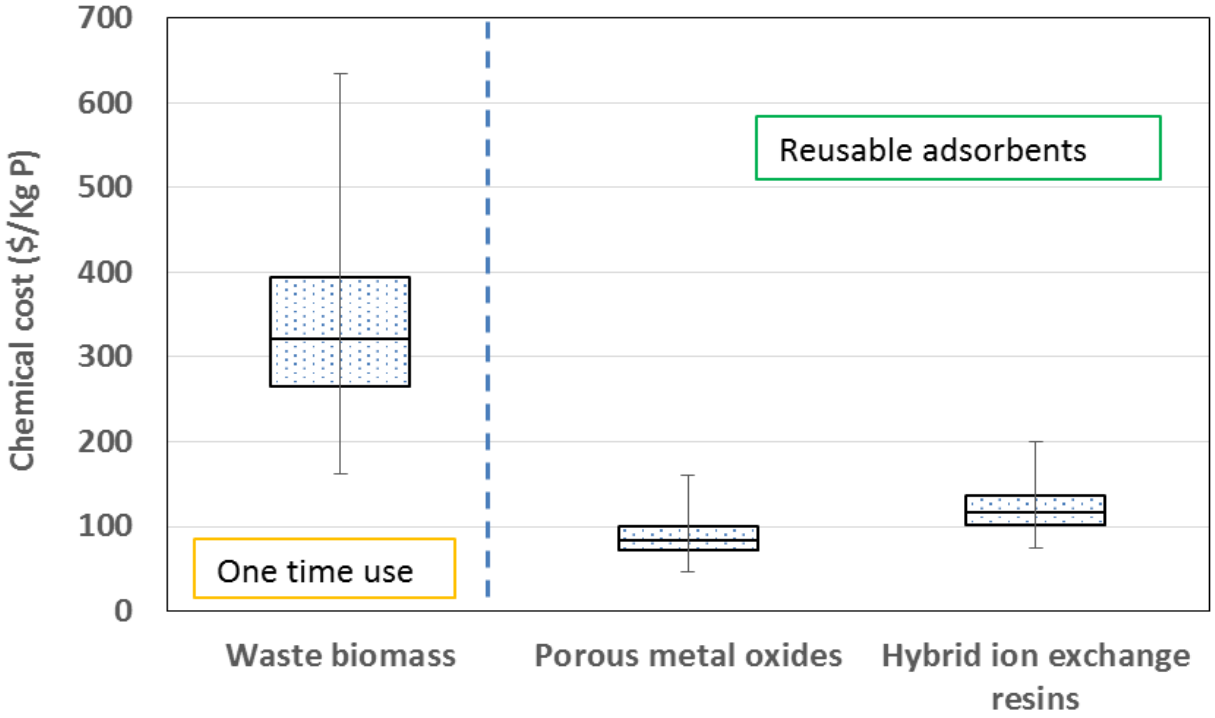
BONUS RETURN

AQUACARE Science in water! EUROPE & SERVICE

Regeneration reduces costs



More expensive adsorbents

Kumar, 2018

Pilot stage 10 M$ George Barley prize

Objectives:

- P-removal to 10 ppb
- Less than 120 $/kg P
- Restricted footprint

- 8 out of 9 teams use adsorption
- At least 6 teams regenerate the adsorbent

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Take home message

Ultra low P removal:

⇒ Adsorption is an interesting & promising approach

⇒ Close to real life application (George Barley Prize)

However:

- Research often not considers practical applications
  - Affinity at low concentrations, kinetics, selectivity
- Regeneration: essential, but is in development
  - Stability adsorbent
  - Reuse regeneration liquid
  - Phosphate product

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european centre of **excellence**
for sustainable **water technology**

Wetsus P-recovery theme members

TU Delft – Delft University of Technology

kemira – Where water meets chemistry

ICL Fertilizers

stowa

Waterschap Brabantse Delta

GREEN WATER SOLUTION

SNN

Ministry of Economic Affairs
Ministry of Infrastructure & Environment

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combining scientific excellence with commercial relevance