Local hydro-morphology, habitat and RBMPs: new measures to improve ecological quality in South European rivers and lakes

INHABIT results: Nutrient retention, habitat and hydro-morphological river features

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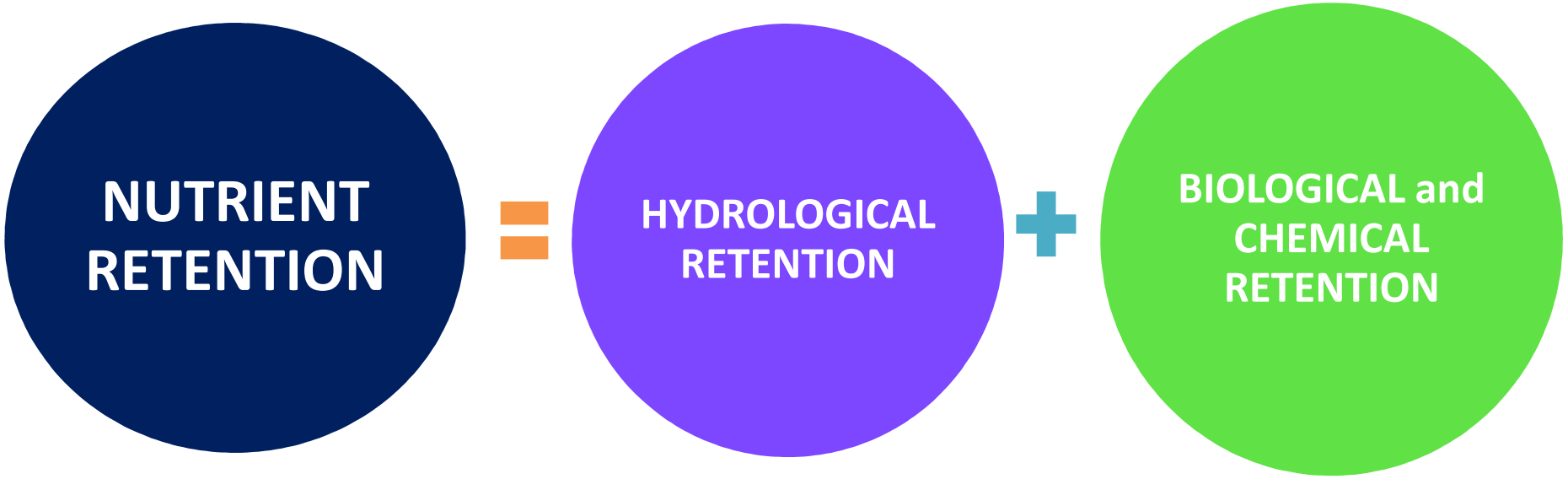
Why nutrient retention in the INHABIT project?

NUTRIENT RETENTION
removal, storage, transformation

Functional property of river ecosystem

ECOLOGICAL STATUS



from Valett et al. 1996

Alteration of water-sediment linkage

HYDROLOGICAL RETENTION

- Discharge
- Transient storage
- Width
- Depth
- substrate

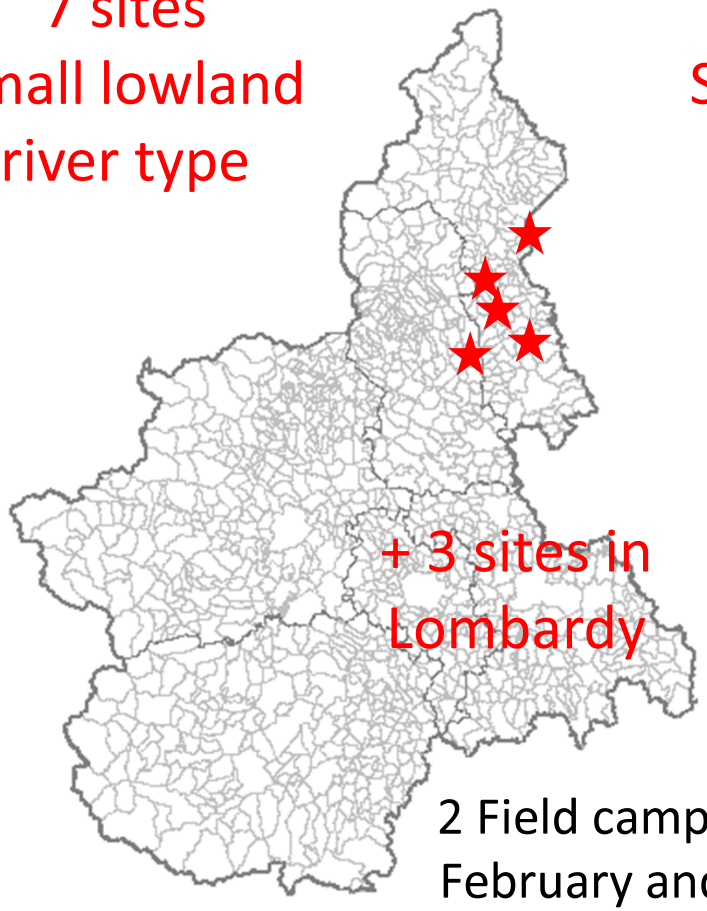
- Longitudinal connections (ex. channelization, floods)
- Vertical connections (siltation rates in hyporheic zones)

Decrease in nutrient retention efficiency

HYDROMORPHOLOGICAL ALTERATION

Investigated sites

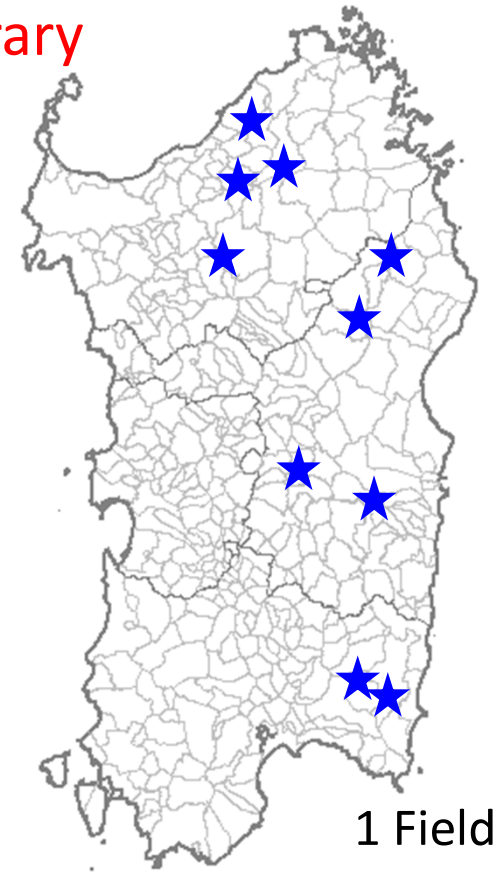
7 sites
Small lowland river type



+ 3 sites in Lombardy

2 Field campaigns
February and July

13 sites
Small temporary streams



1 Field campaign
May

LIFE08 ENV/IT/000413 INHABIT

Selection criteria:

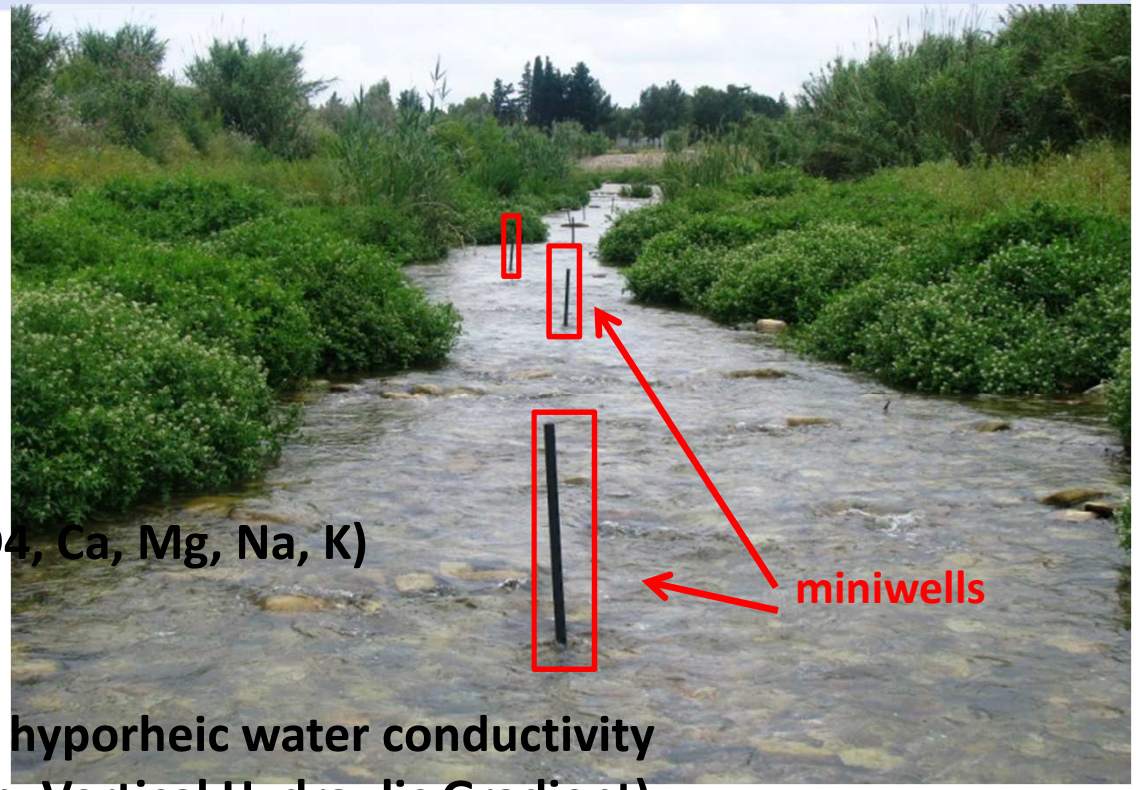
– order 1-3 , discharge < 300 l/s, not braided

– gradient of hydro-morphological and habitat alteration

- Natural condition sites – "Reference"
- Slightly altered sites
- Heavily altered sites

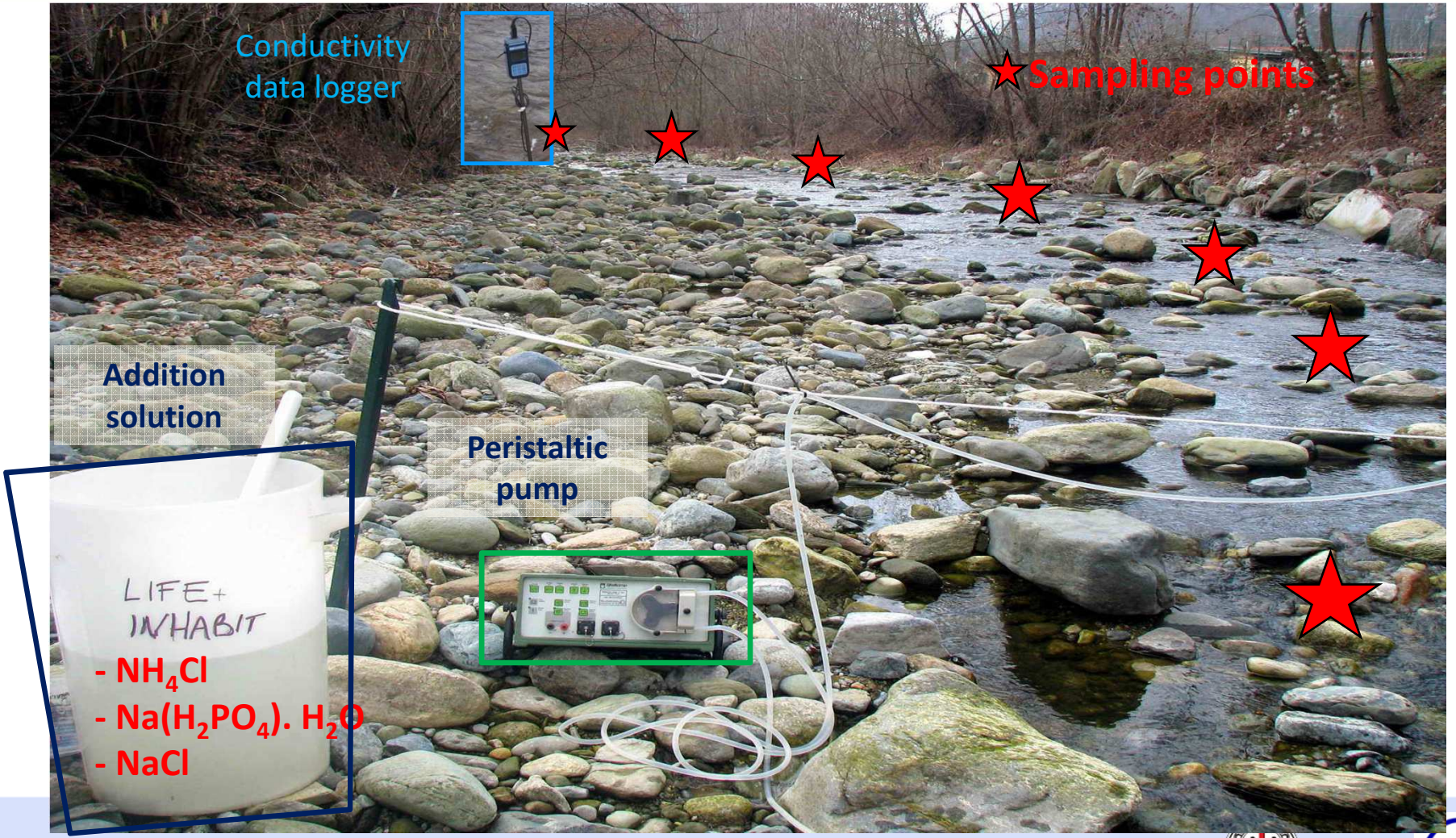
Hydromorphology and chemistry characterization

- Discharge (flow-meter)
- Width, and depth of channel
- Fluxes and substrate
- Chemical analysis
  (N-NO3, N-NH_4, P-PO_4, Cl^-, SO4, Ca, Mg, Na, K)

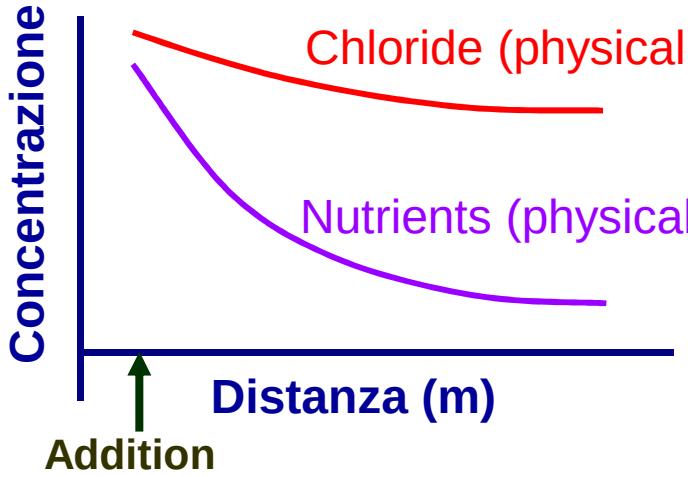


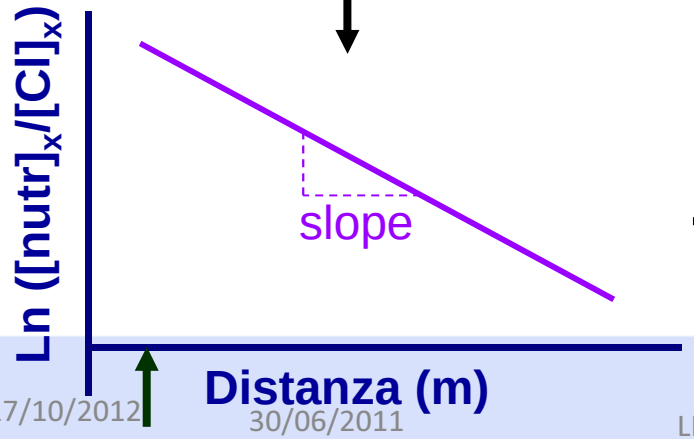
- Hyporheic zone (surface and hyporheic water conductivity and temperature comparison, Vertical Hydraulic Gradient)
- CARAVAGGIO application
- Macroinvertebrate and diatom community

Short-term constant rate additions



Nutrient retention parameters: three retention metrics





UPTAKE LENGHT (Sw) = average distance travelled by a nutrient molecule before being removed from the water column

Uptake length (m) = -1/slope

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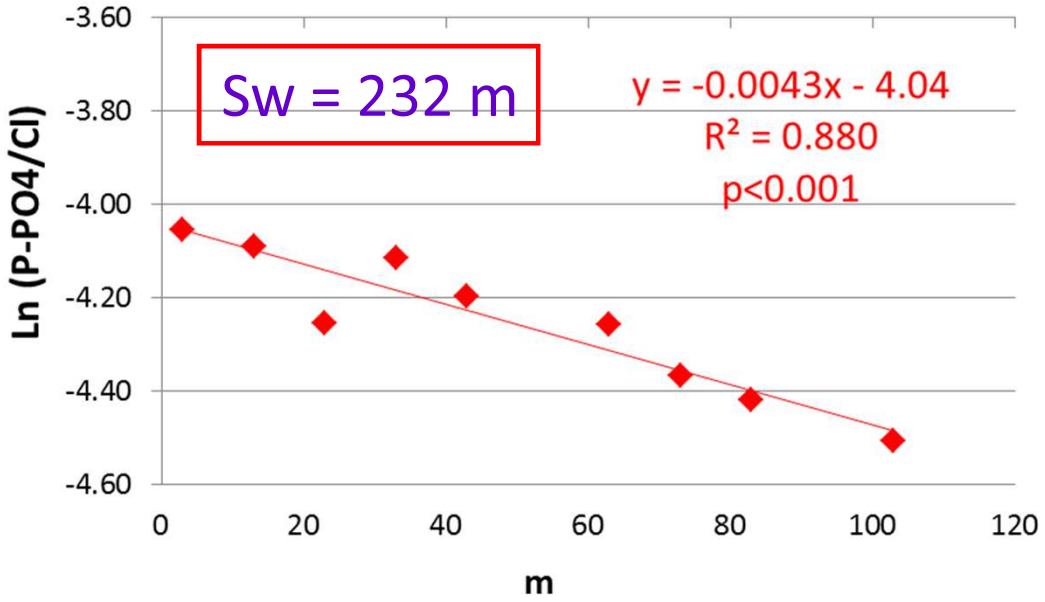
An example:

Guarabione 24/2/2011



$Vf = d \times v/Sw$

9.2 mm min^{-1}

MASS TRANSFER COEFFICIENT : Vertical velocity by which a nutrient molecule moves through the water column to the sediment

NUTRIENT UPTAKE RATE: mass of a nutrient taken up from the water column per unit stream bed area and time.

$$U = \frac{C_b * Q}{S_w * w} * 60 = 0.014 \text{ mg m}^{-2} \text{ min}^{-1}$$

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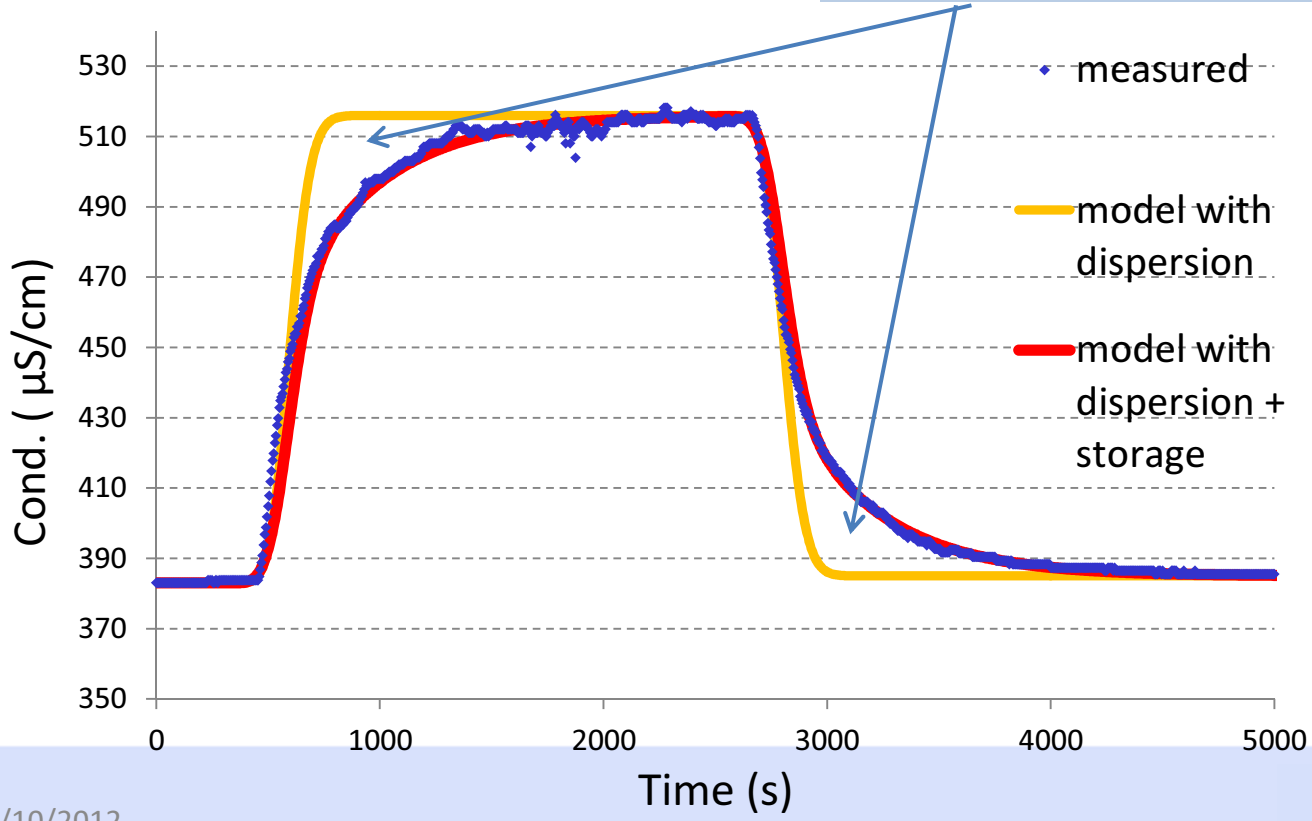
Hydrological parameters

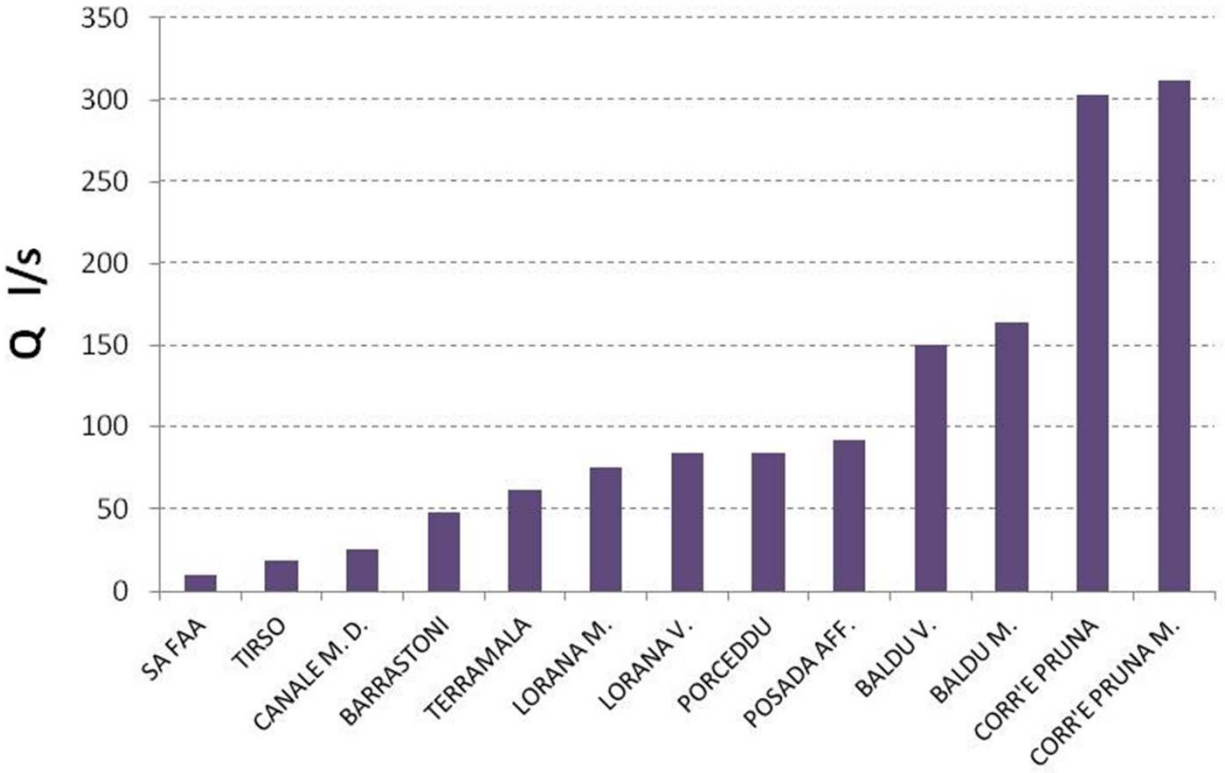
- Discharge
- Max, min and average velocity
- Surface cross sectional area
- cross sectional transient storage area, As

As =regions of the stream channel where water moves at a slower velocity than the average surface velocity.



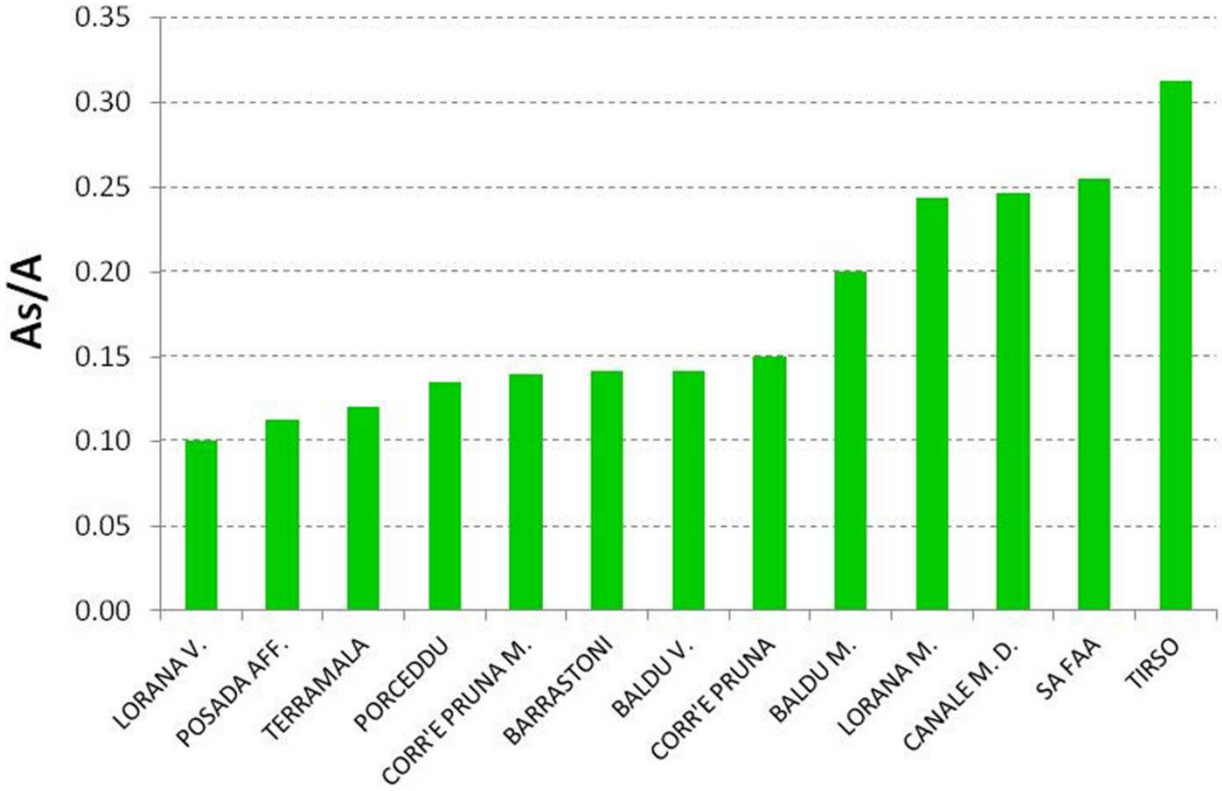
RESULTS: Hydrological parameters

- Discharge: 10 – 312 l/s



RESULTS: Hydrological parameters

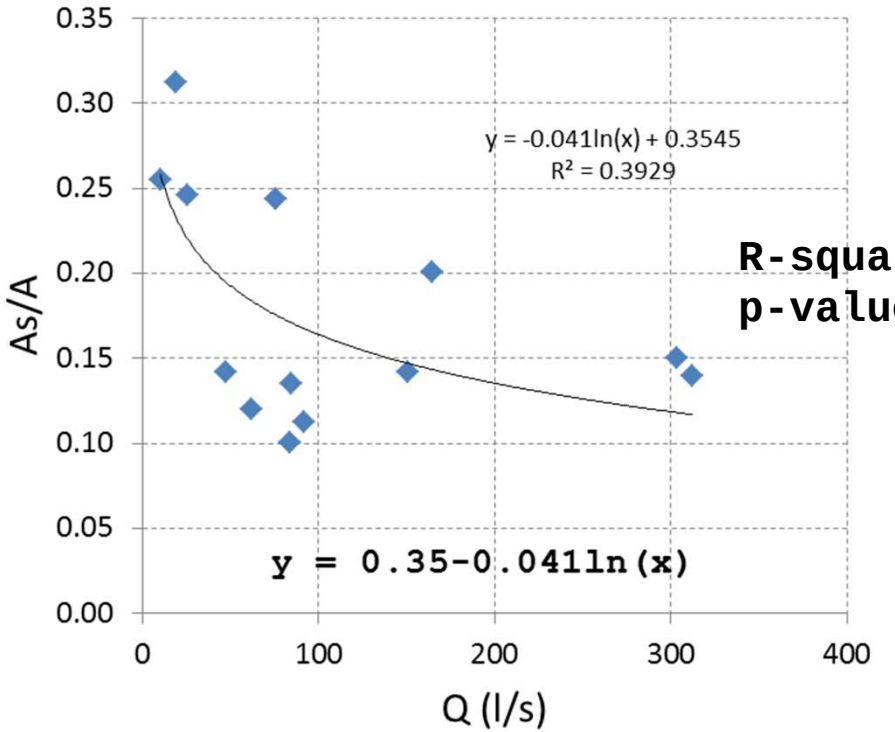
- Normalised transient storage cross sectional area: 0.10 – 0.31



RESULTS: Hydrological parameters

Transient storage (As/A) vs. Discharge (Q)

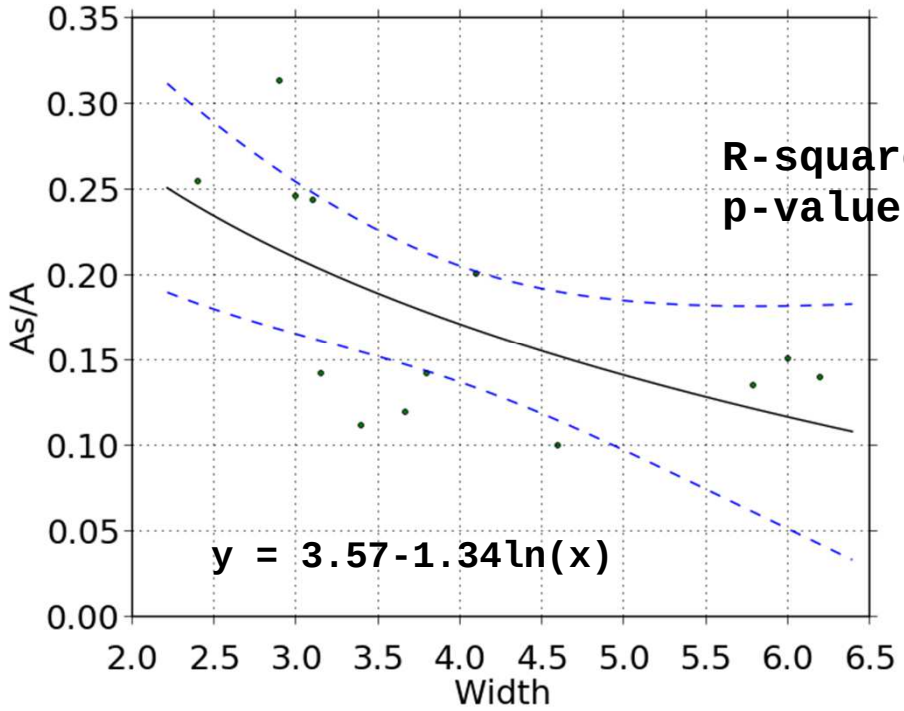
Significant relationship!



R-squared: 0.393
p-value:0.022

RESULTS: Hydrological parameters

Transient storage (As/A) vs. Width

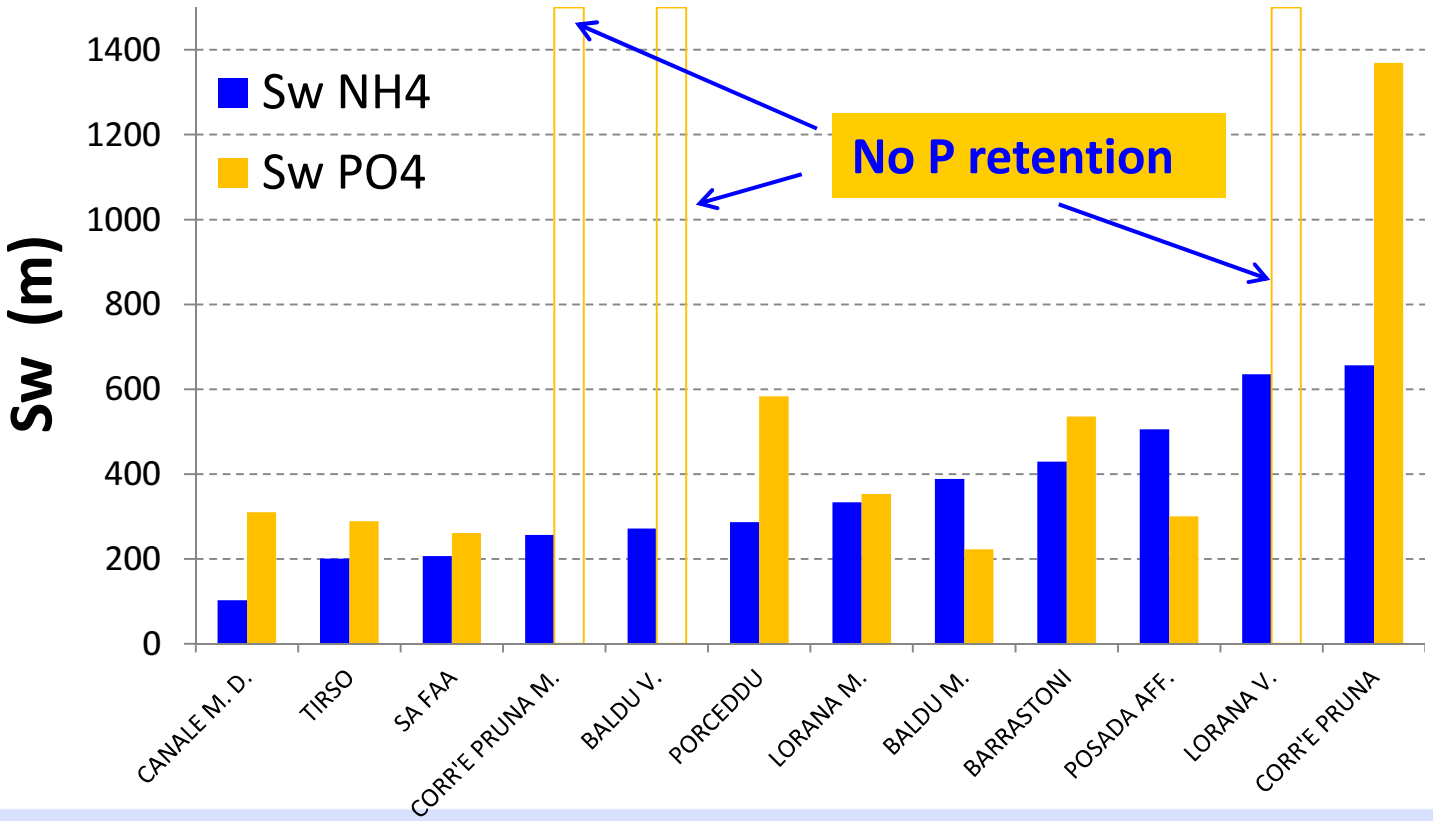


R-squared: 0.366
p-value:0.028

Significant relationship!

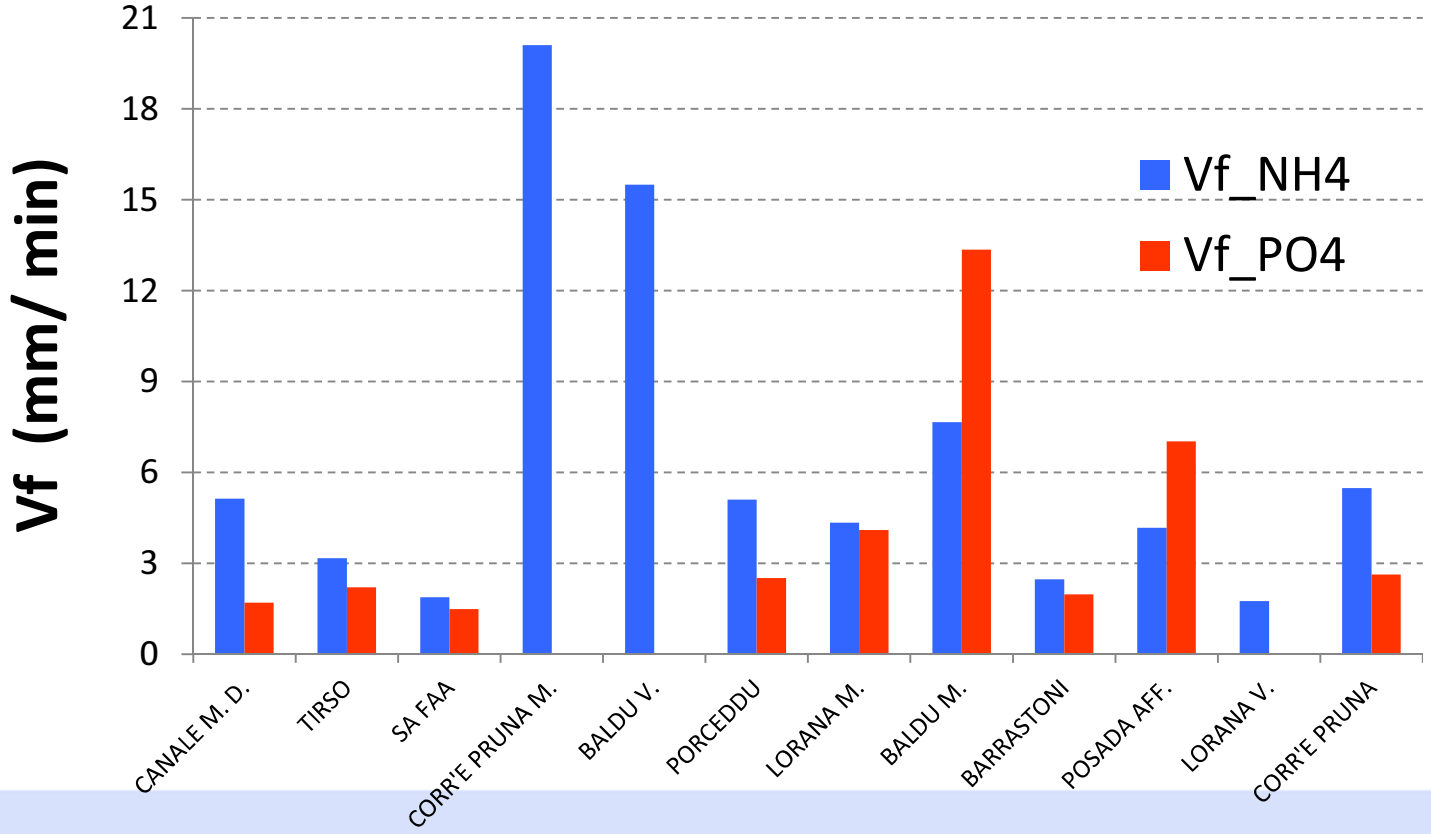
RESULTS: Nutrient retention parameters

Uptake length NH4: 103 – 656 **<** **Uptake length PO4: 310 - 1369**



RESULTS: Nutrient retention parameters

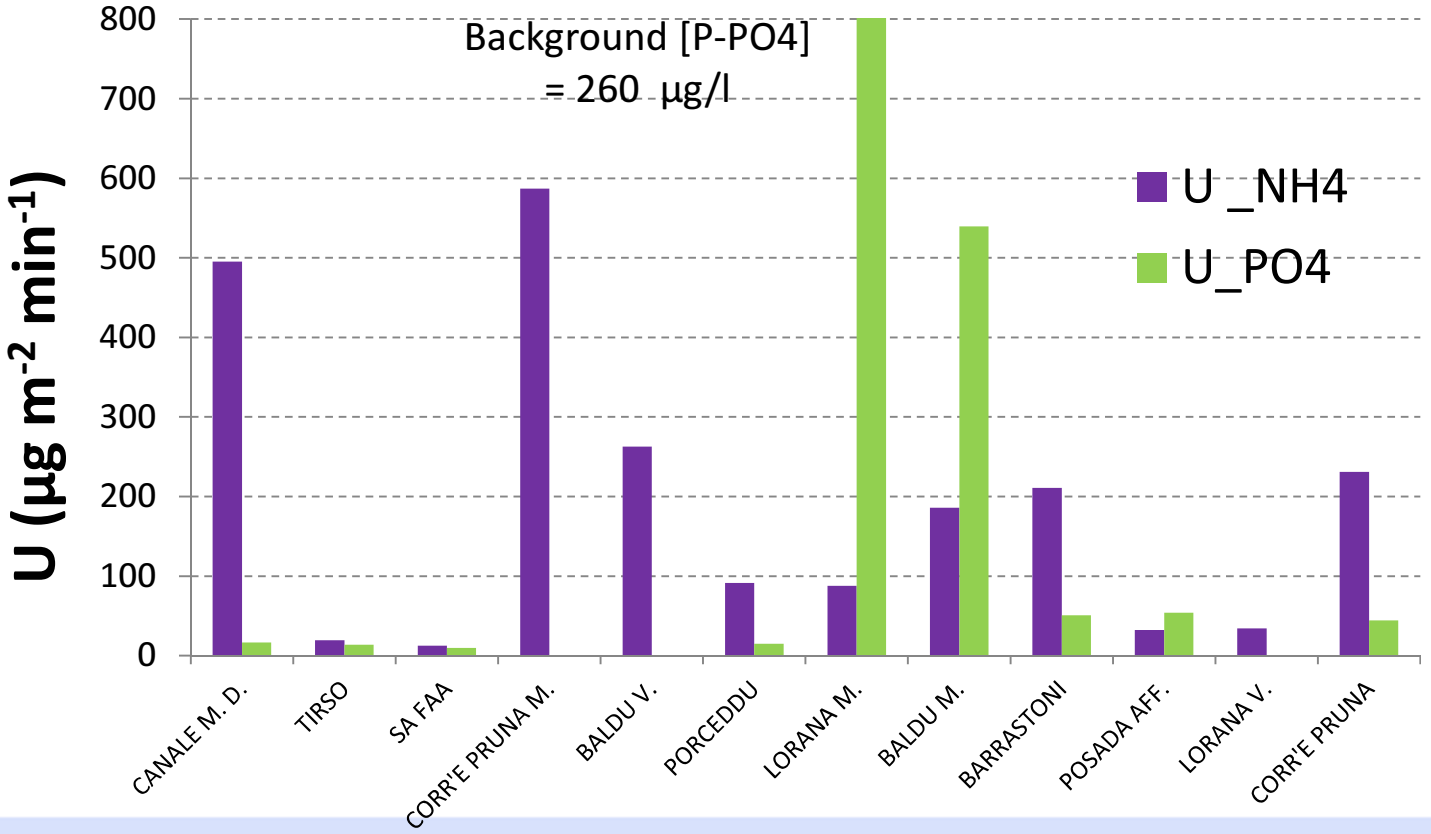
Mass transfer coeff. NH4: 1.8 – 20.1 > **Mass transfer coeff. PO4: 1.5 – 13.3**



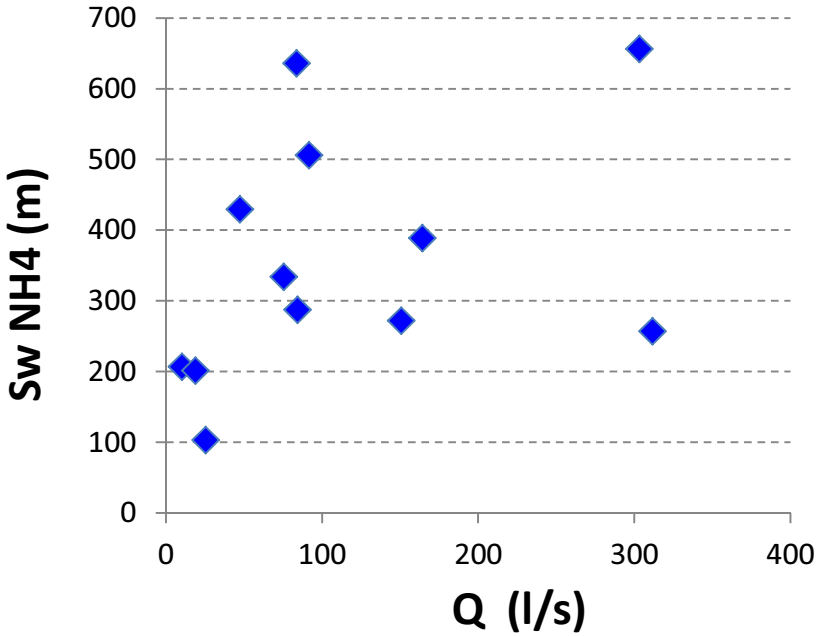
RESULTS: Nutrient retention parameters

Uptake rate NH_4: 12.5 – 587

Uptake rate PO_4: 9.9 – 1078

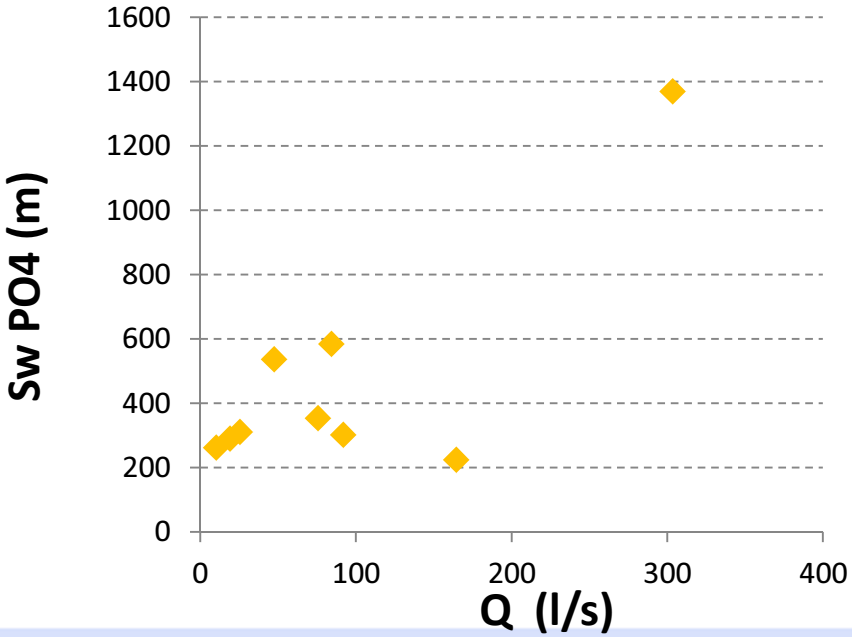


Relations between nutrient retention metrics and hydromorphological parameters

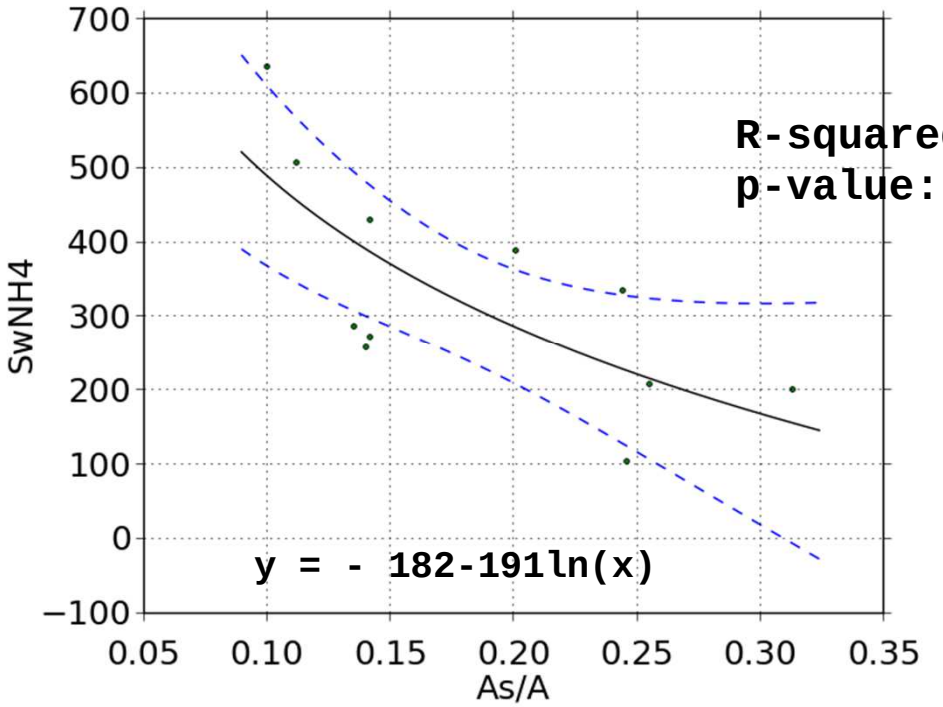


No significant relationships

Uptake lengths vs Discharge



Relations between nutrient retention metrics and hydromorphological parameters

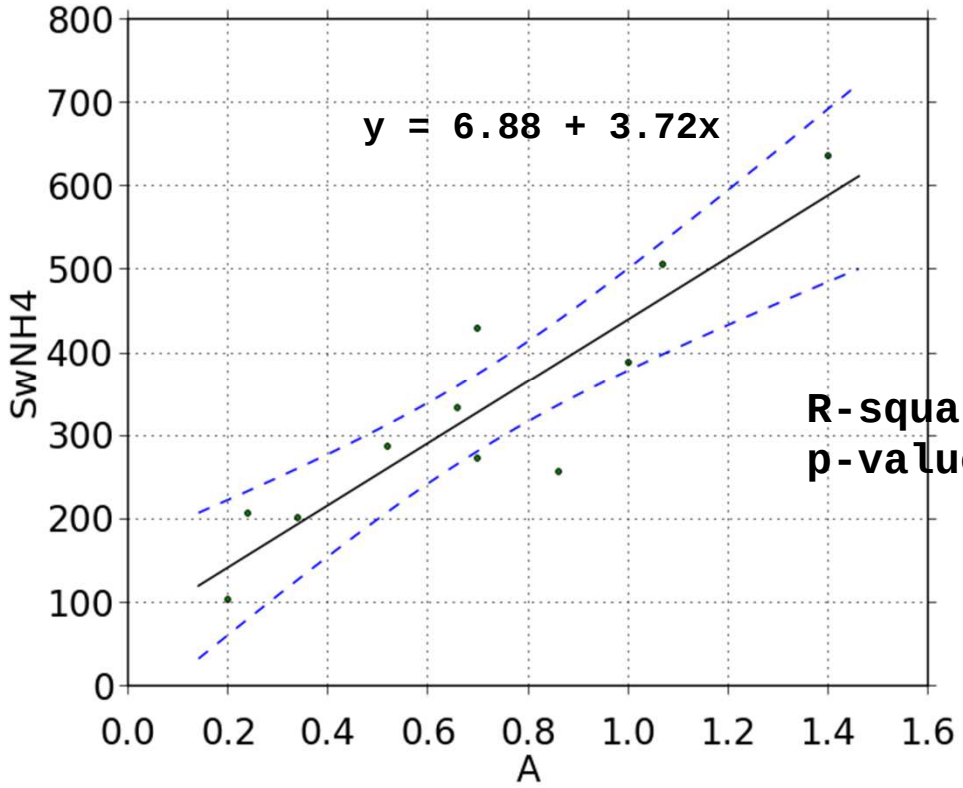


R-squared: 0.529
p-value: 0.011

Uptake length NH4 vs Transient storage area

Significant relationship!

Relations between nutrient retention metrics and hydromorphological parameters



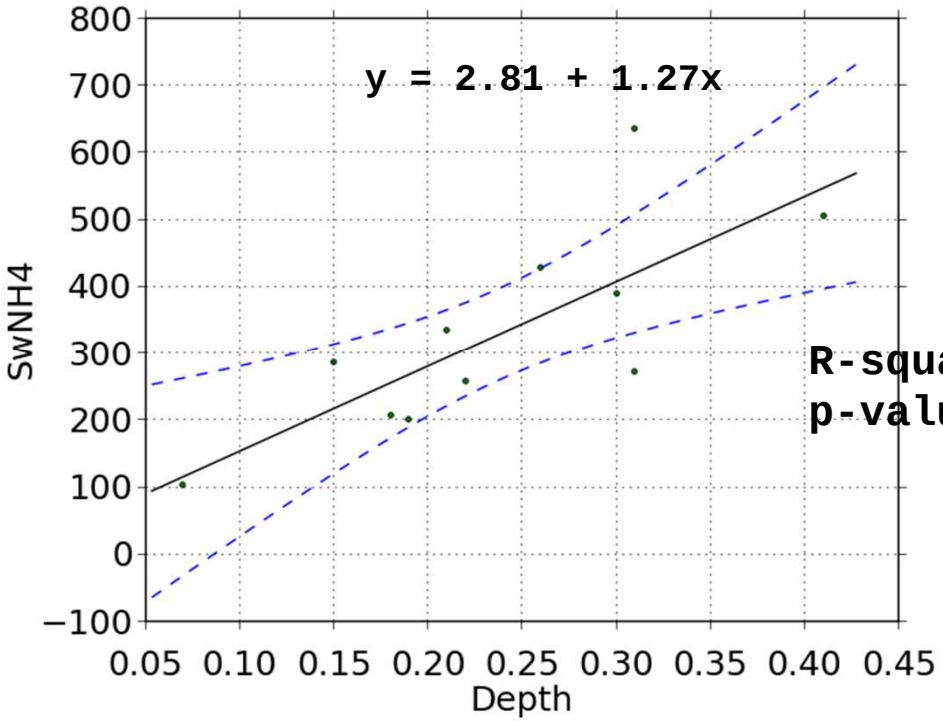
Uptake length SwNH4
vs
Cross sectional area (A)

Highly significant relationship!

R-squared: 0.819
p-value: 0.0001

In reaches narrow and shallow the amount of solutes in contact with the sediments is higher than in greater reaches, for constant length.

Relations between nutrient retention metrics and hydromorphological parameters



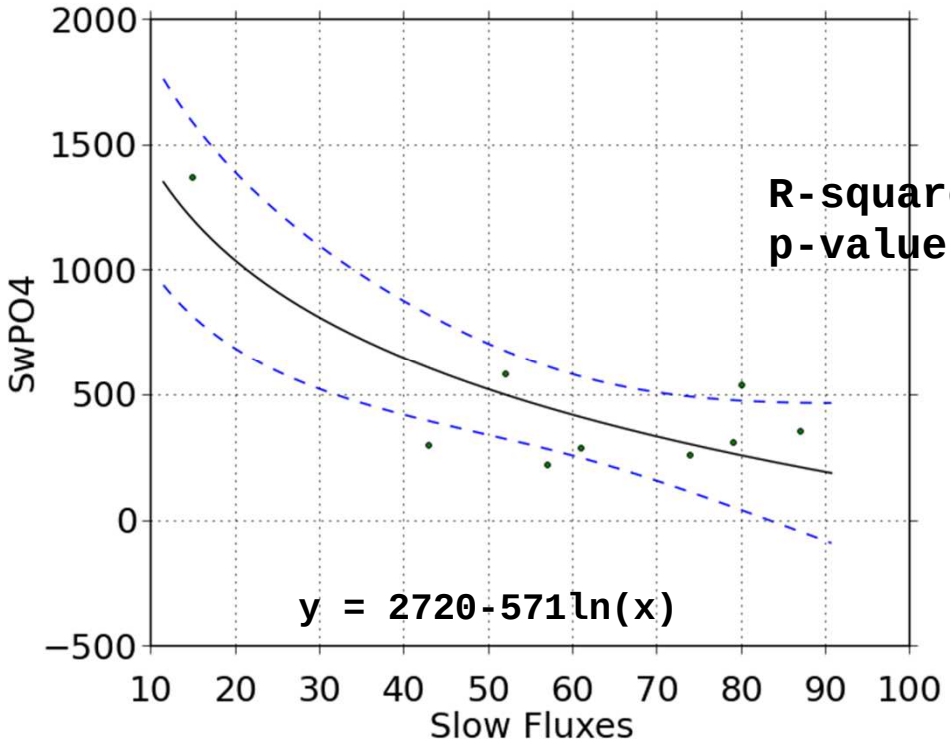
Uptake length NH4 vs Water depth

Highly significant relationship!

R-squared: 0.604
p-value: 0.004

At shorter depths the epilithic biofilm and the filamentous algae are strictly in contact with the surface waters

Relations between nutrient retention metrics and hydromorphological parameters



Uptake length PO4 (Sw)
vs
Slow fluxes %

Significant relationship!

Relations between nutrient retention metrics and hydromorphological alterations

No relationships between retention metrics and Caravaggio indices (HMS, HQA, LRD)

absence of shading

Sw NH4 = 656 m
Sw PO4 = 1369 m
As/A = 0.15

Sw NH4 = 103 m
Sw PO4 = 310 m
As/A = 0.25

Relations between nutrient retention metrics and hydromorphological alterations

Rio Lorana Monte

Sw NH4 = 334 m
Sw PO4 = 353 m
As/A = 0.24

- 3 Culverts
- Concrete fords

Rio Lorana Valle

Sw NH4 = 636 m
Sw PO4 = 7500 m
As/A = 0.10

Relations between nutrient retention metrics and hydromorphological alterations

Rio Baldu Monte

Culvert

Rio Baldu Valle

Sw NH4 = 389 m
Sw PO4 = 223 m
As/A = 0.20

Sw NH4 = 272 m
Sw PO4 = no retention
As/A = 0.14

CONCLUSIONS

Preliminary results: too small data set for the chosen experimental approach (further campaigns …)

The results are surely encouraging and suggest the importance of hydrological and morphological factors in the nutrient retention processes

The section of the channel, in particular depth, seems to be a key factor able to explain most variability of the NH4 uptake length; indirectly, this finding, suggests the crucial role of peryphiton, algae and macrophite in the uptake of NH4.

Need to quantify the microbial, algae, and macrophyte community as well as the shading and the irradiation in the cold season too.

The application of a multivariate approach to a wider data set, including also some more detailed information derived from Caravaggio, will allow to evaluate the sinergic effetc of multiple factors.


Thank you
for your attention!