Water electrical conductivity and turbidity as surrogate for chemical composition in high frequency monitoring of stream water in headwater catchments

High Frequency Water monitoring Workshop

INRA, UMR 1069 Soil and Agrohydrosystems, Rennes, France

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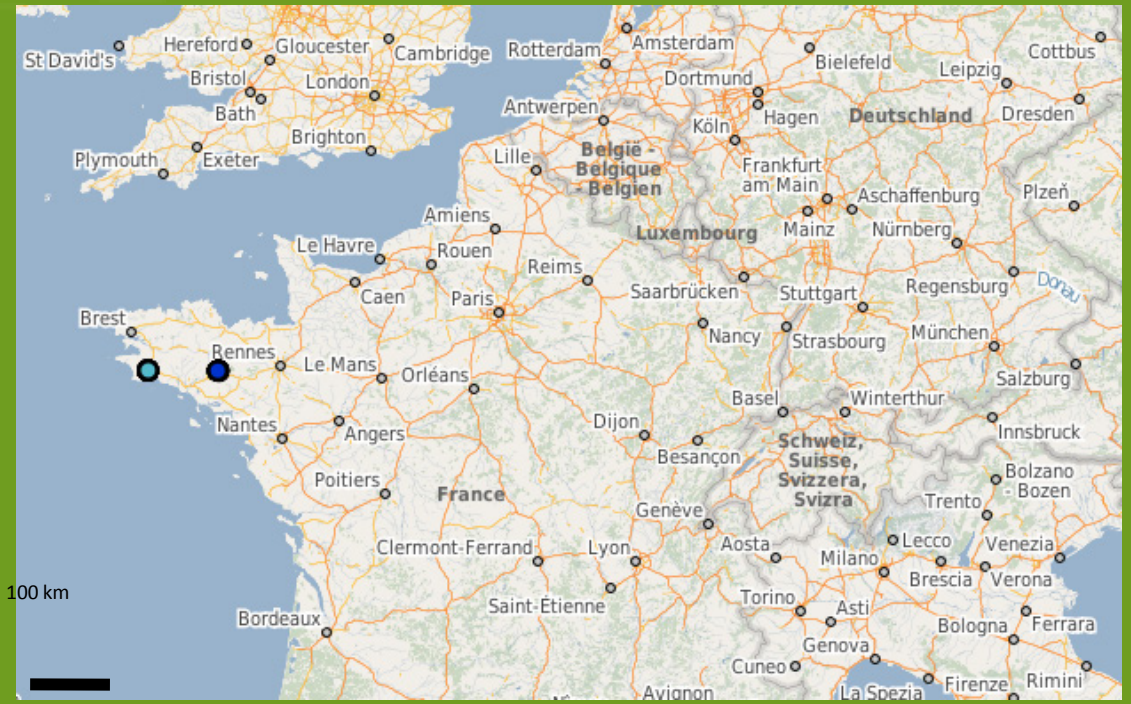
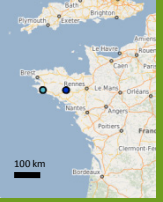
20-21/07 /2014

The Environmental Observatory ORE AgrHys

https://www6.inra.fr/ore_agrhys
http://geowww.agrocampus-ouest.fr/web/

RBV
RÉSEAU DES BASSINS VERSANTS





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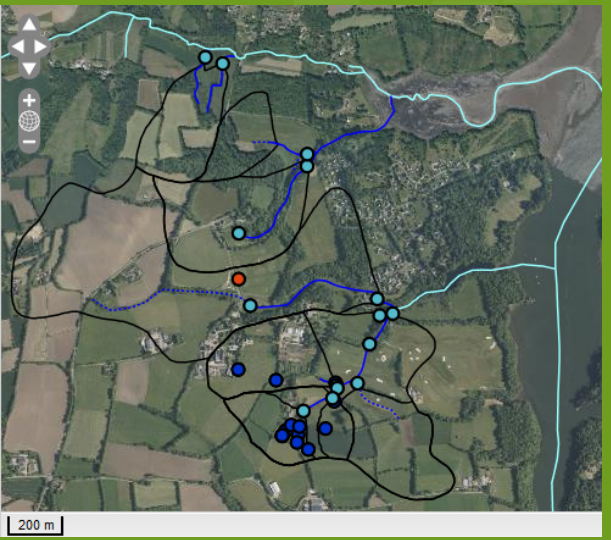

- **Weather station**
  - Hourly Rainfall
  - Daily PET
  - Monthly Rainfall chemistry
- **Piezometers**
  - Continuous water level & t°
  - GW chemistry 1/3 months to weekly
  - (+ continuous soil moisture)
- **Streams stations**
  - Continuous stream flow
  - Daily to monthly stream chemistry
  - Continuous temperature, conductivity, turbidity
  - Continuous Spectrophotometer Scan

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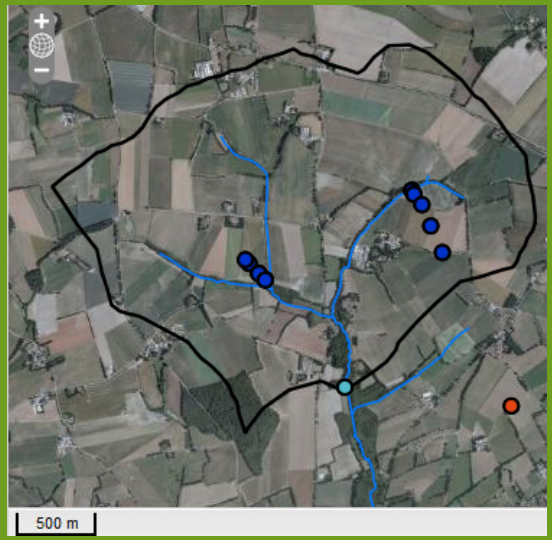

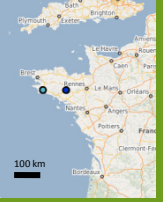

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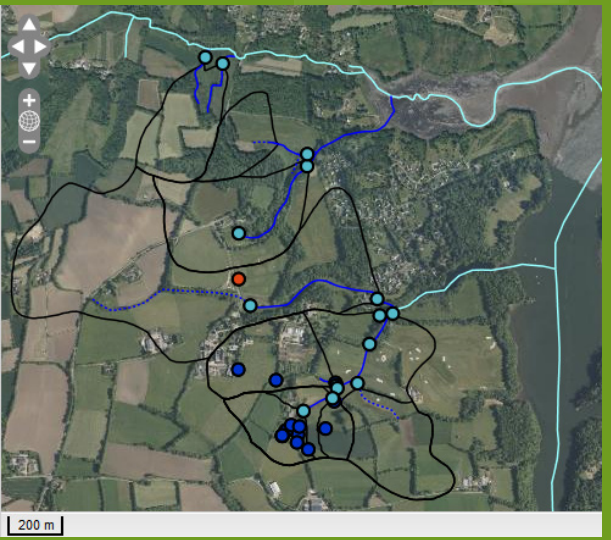

- Weather station
- Piezometers
- Streams station

Objective :
Long term environment monitoring in intensive agricultural catchments

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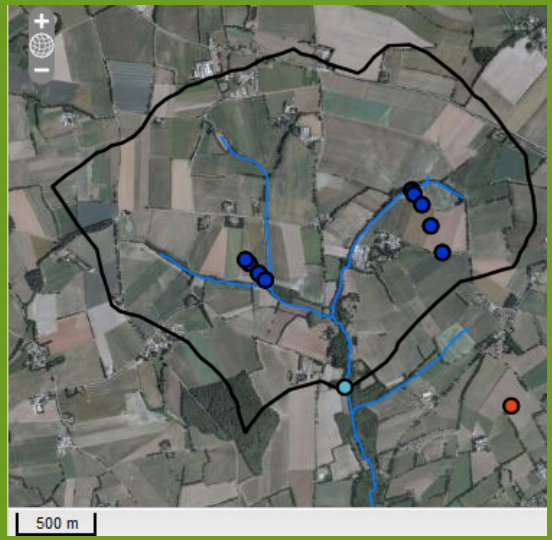
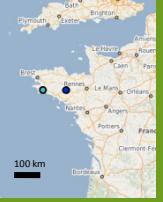


Missions: (1) Acquisition of multi parameters records on water quality, in the different compartments -> processes understanding, models development, calibration and assessment



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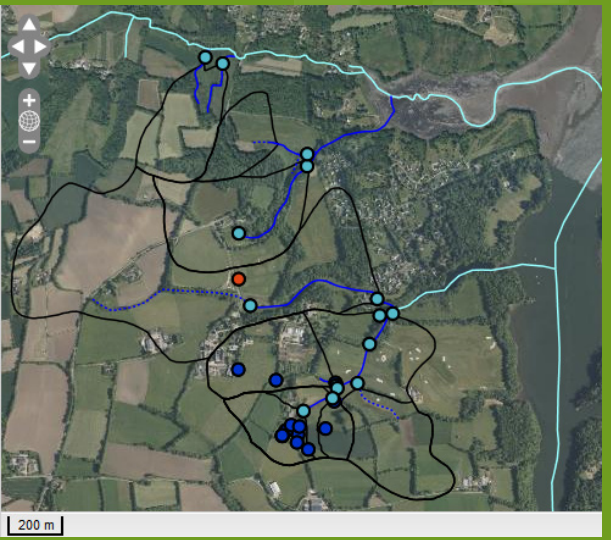

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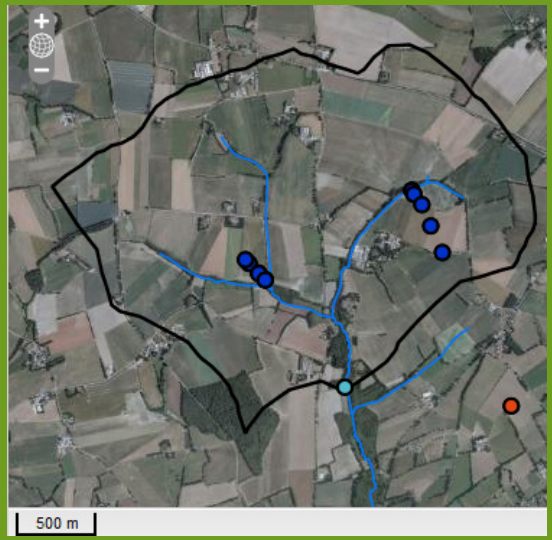


Missions: (2)Development of new technologies for water and environment monitoring

Why do we need high frequency water quality monitoring to understand the transfer of chemical species from agricultural lands to streams

- Chemical species?
  - Subsurface /deep transfer, associated with base flow: NO3, Cl
  - Surface transfer, associated with flood/storm events: Phosphorus, Particulate C, N or P, Suspended Sediment
- Why high frequency is important for understanding these species transfer?
  - Subsurface transfer: guiding the interpolation between samples, punctual events, new variability
  - Surface transfer: flood events are hard to sample, to extrapolate/interpolate for fluxes computation, improving the monitoring strategy.

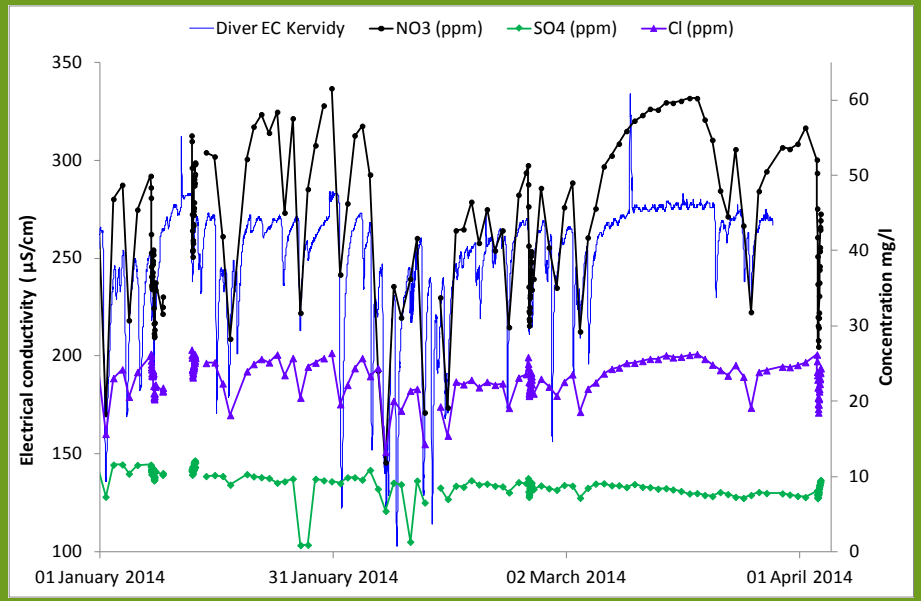
Some robust continuous sensors related to water chemistry

- Temperature
- pH
- EC ⟶ Major dissolved ions
- Turbidity ⟶ Suspended Sediment, nature, size

- Their advantages: cost, maintenance, easy for routine monitoring by managers

Electrical conductivity as a proxy of the major anion concentrations?

Agricultural catchment -> main contributors to EC are NO3 and Cl

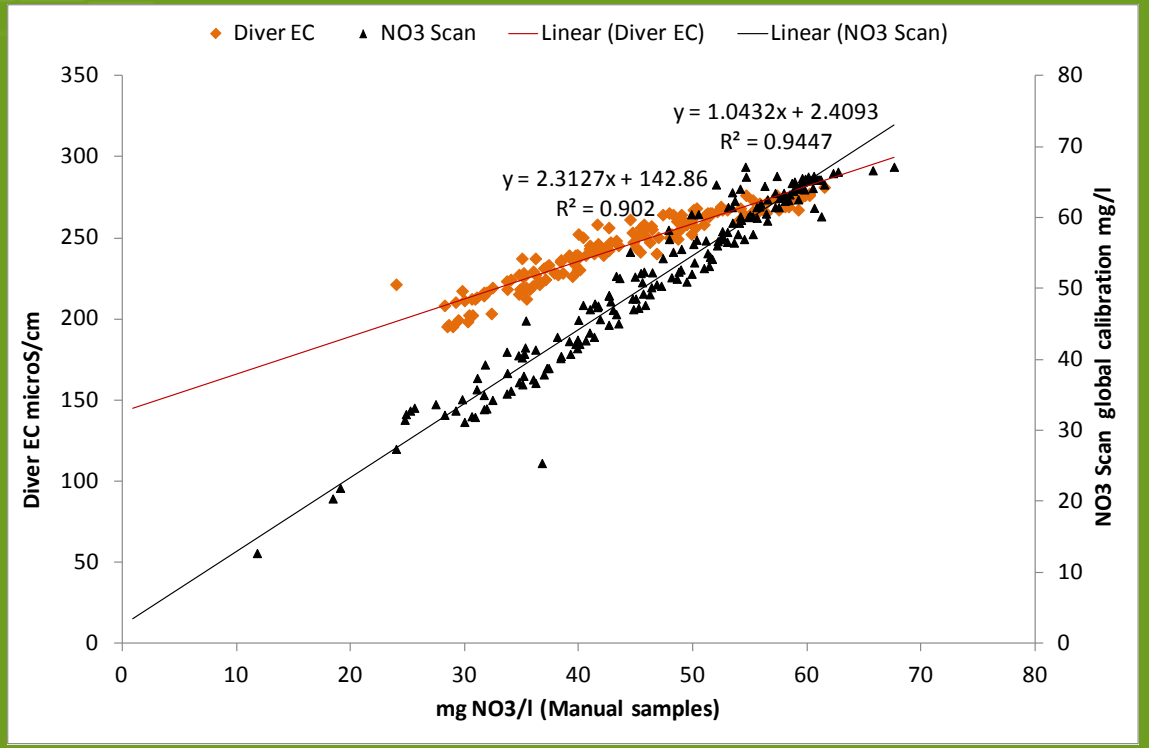


DIC~2.5-8 mg/l
pH~6-8

	Cl (ppm)	SO4 (ppm)	NO3 (ppm)
Mean concentration (mg/l)	22	9	50
Mean concentration (mEq/l)	**620**	**187**	**806**
l (S/m2/mol)	7.63	16	7.14
M (g/mol)	35.5	96.1	62
Ionic conductivity (S/m)	**4.73**	**1.50**	**5.76**

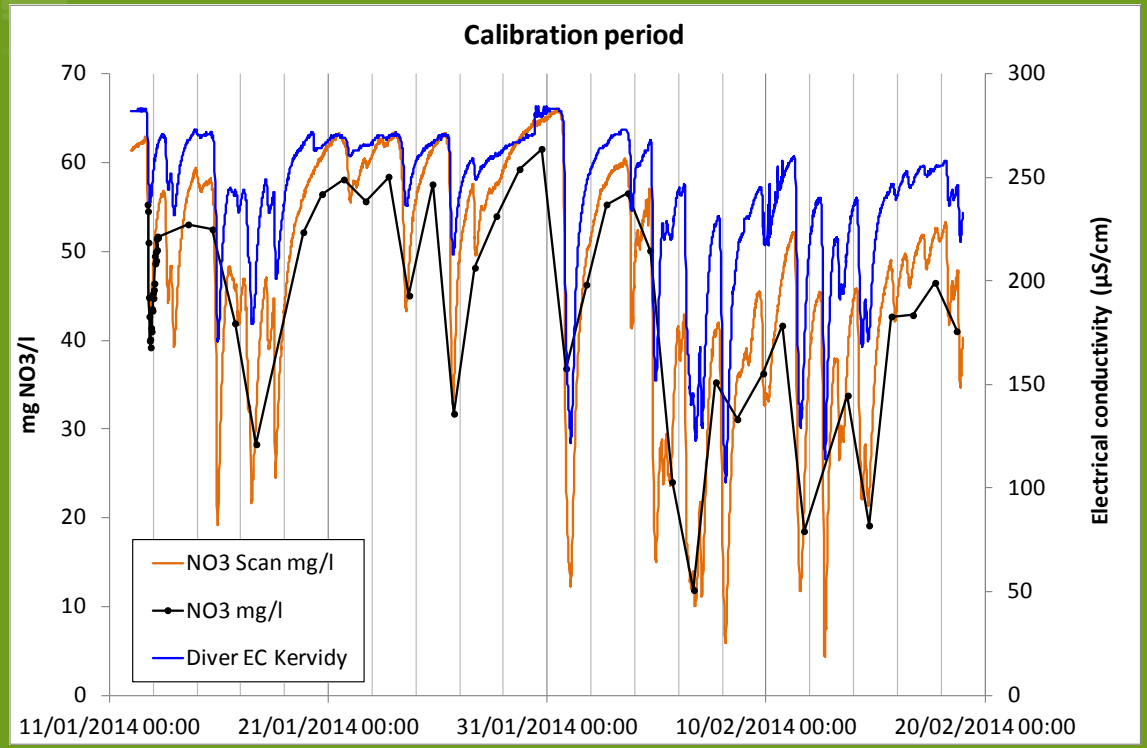
Electrical conductivity as a proxy of the major anion concentration?

CTD Diver
Schlumberger

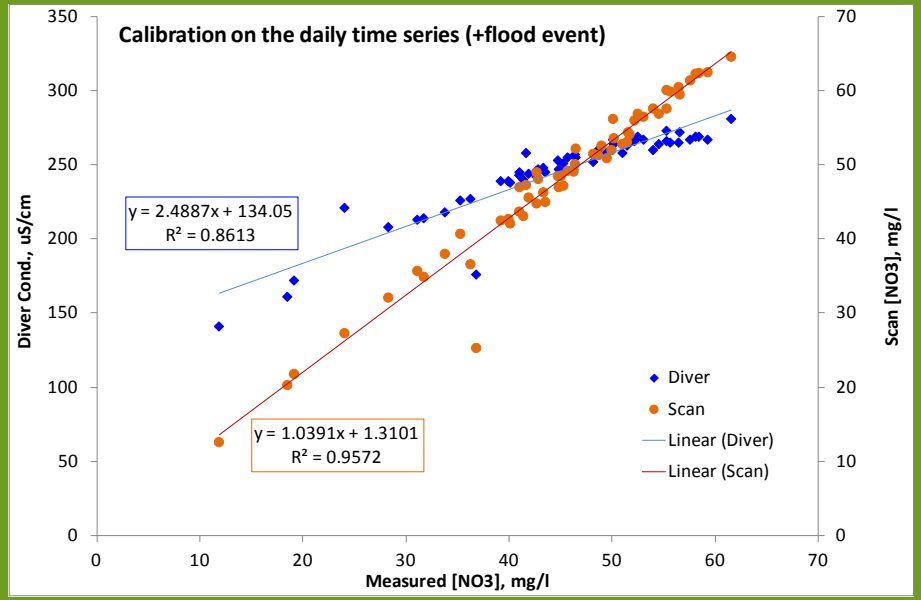


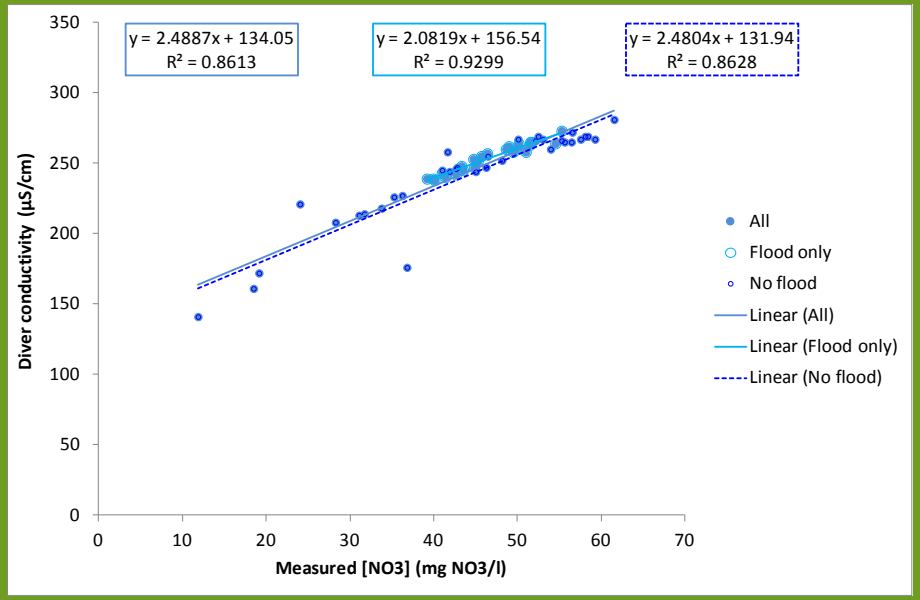
Spectrolyser
UV vis
S:CAN

Electrical conductivity as a proxy of the major anion concentration?



Electrical conductivity as a proxy of the major anion concentration?





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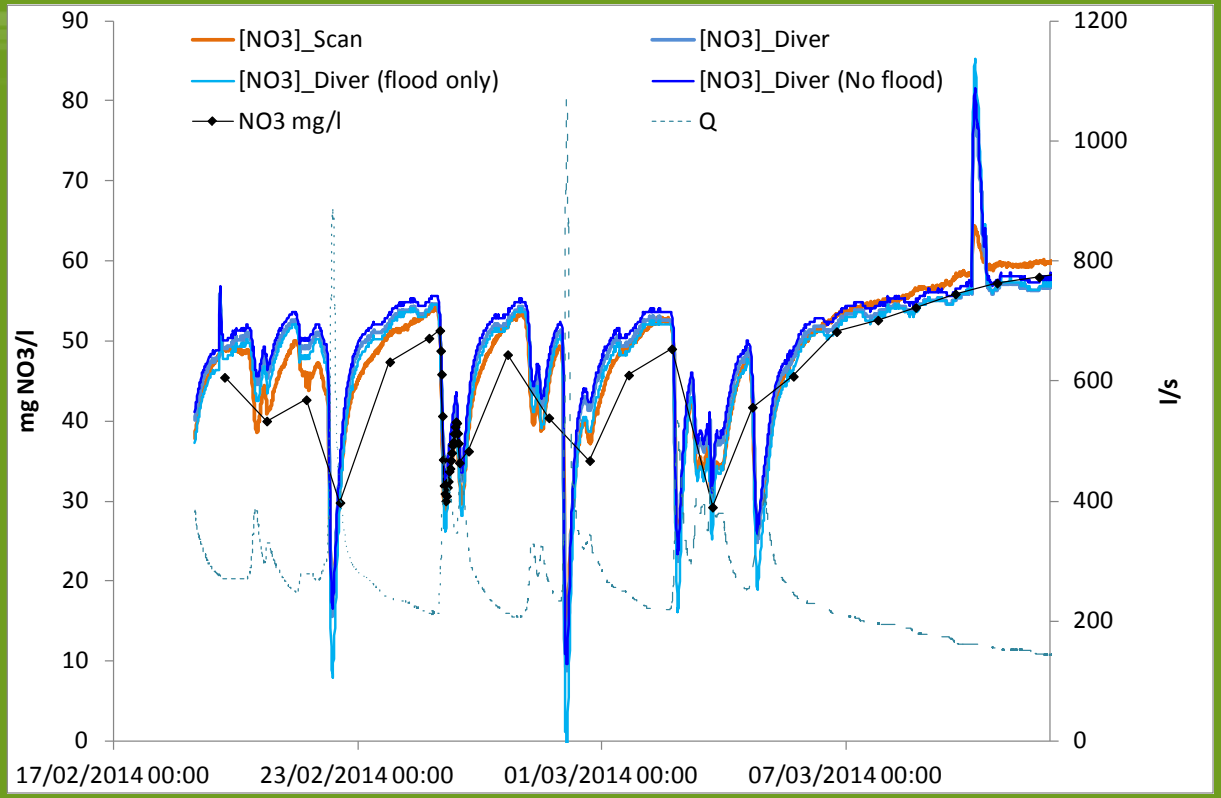
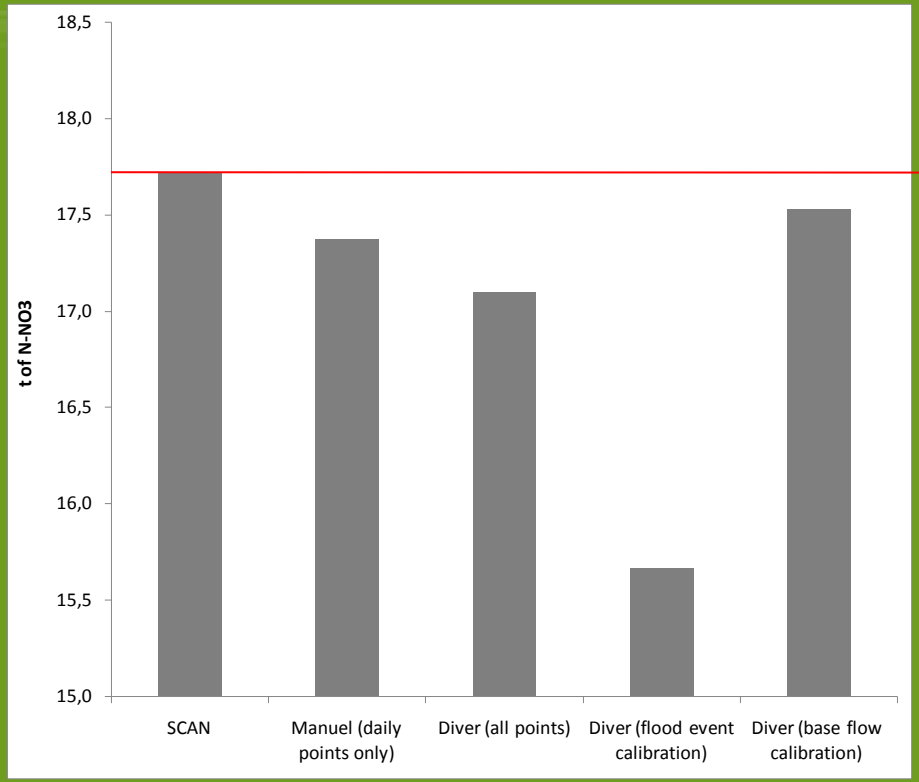


Electrical conductivity as a proxy of the major anion concentration?

Application to flux estimates



Specific turbidity as a proxy of particles phosphorus content ?

Flood event monitoring

SS and PP (dt=20-30 min)

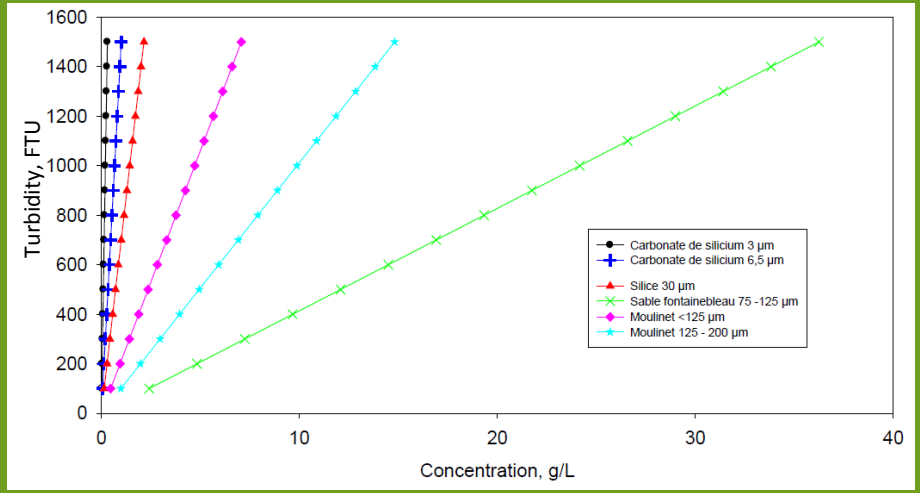
Tb (dt=1min)

Specific turbidity as a proxy of particles phosphorus content ?

Analyzing flood events using:

Specific Turbidity : Tb/TSS is a proxy of the particles size *(Vongvixay PhD thesis 2012)*

- 3 µm
- 6.5 µm
- 30 µm
- 75-125 µm
- <125 µm
- 125-200 µm



And Particles phosphorus content: PP/TSS

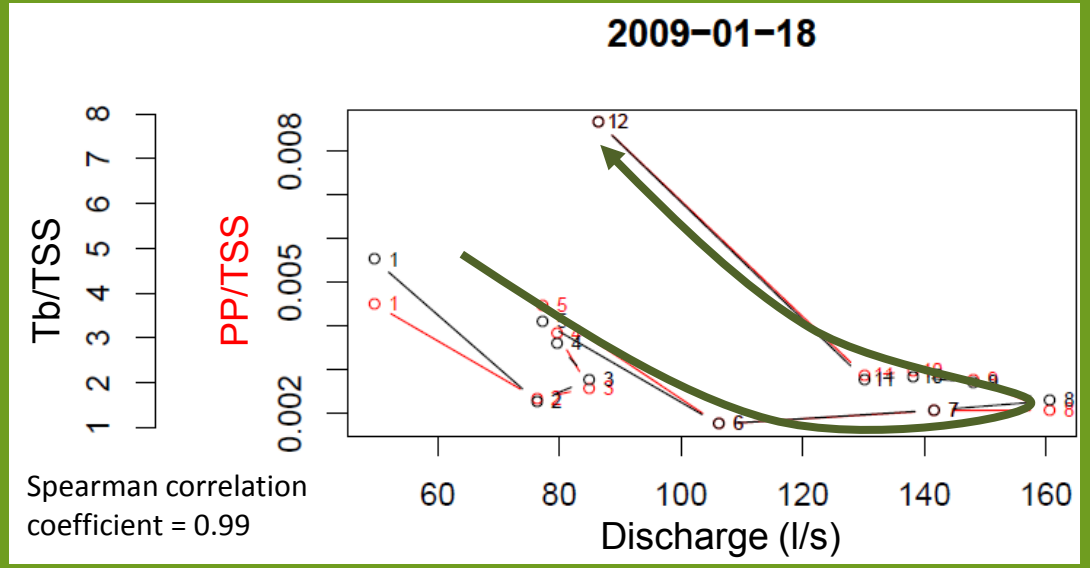
Specific turbidity as a proxy of particles phosphorus content ?

-Identifying sources of SS and P-

Same hysteretic patterns

- on the particle size exportation
- on their P content

Dupas et al., Vol. 16, EGU2014

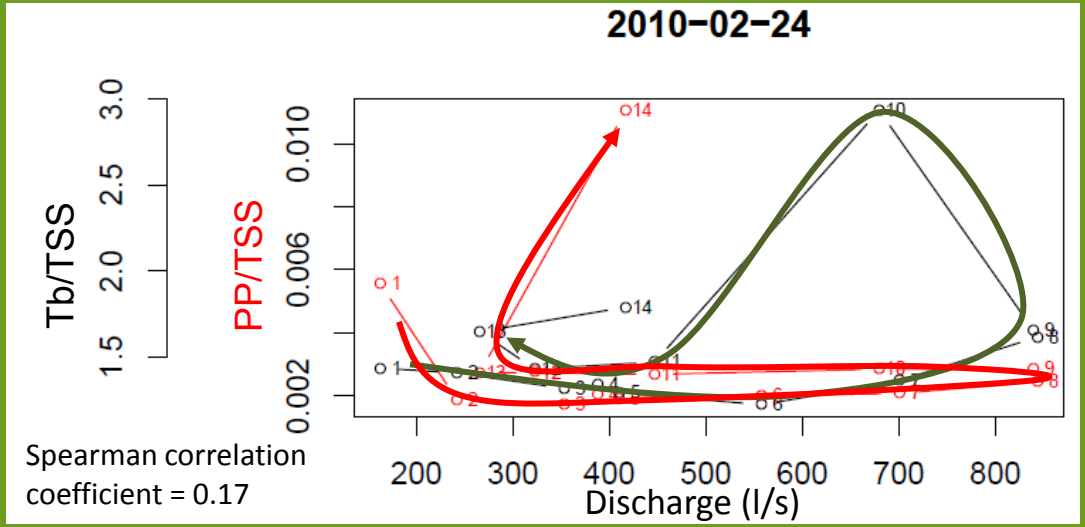


- Particles sorting by size
- A unique source of particles and PP (hillslope or bed)

Specific turbidity as a proxy of particles phosphorus content ?

-Identifying sources of SS and P-

Often observed but not systematically



•A mixing between sources of particles and PP

Specific turbidity as a proxy of particles phosphorus content ?

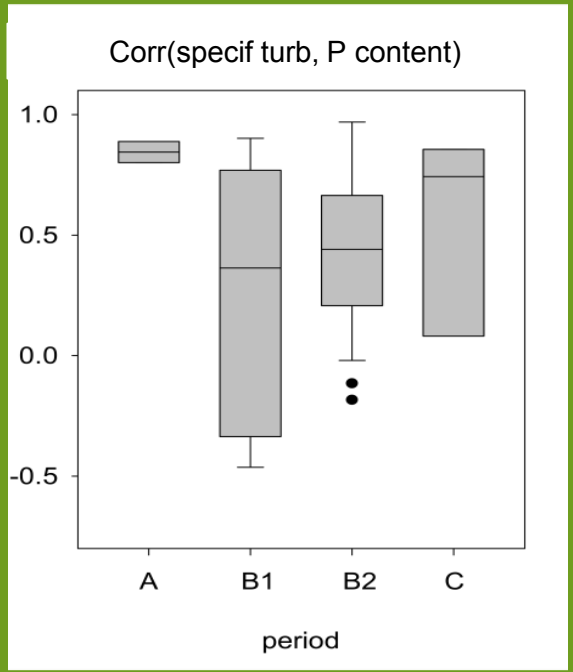
-Identifying sources of SS and P-

Variability of the correlation between specific turbidity and P content

•A: rewetting period, 1 source of PP in channel (bed or bank)

•B: high flow period, Mixing between different sources in channel and in the hillslope

•C: recession period, 1 source of PP identified in the hillslope



Conclusion

Classical water quality robust sensors may be used as indirect proxies of water composition

Such proxies have to be used carefully

But their use in practice is quite easy and their cost are affordable

To lighten classical monitoring protocols or to complete them