



## Urban EH demosite proposal

Pascal Breil, Gislain Lipeme Kouyi

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# Urban EH demosite proposal

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*Ecohydrology Workshop & Scientific Advisory Committee – 27/02-2/3/2018 – Faro, Portugal*



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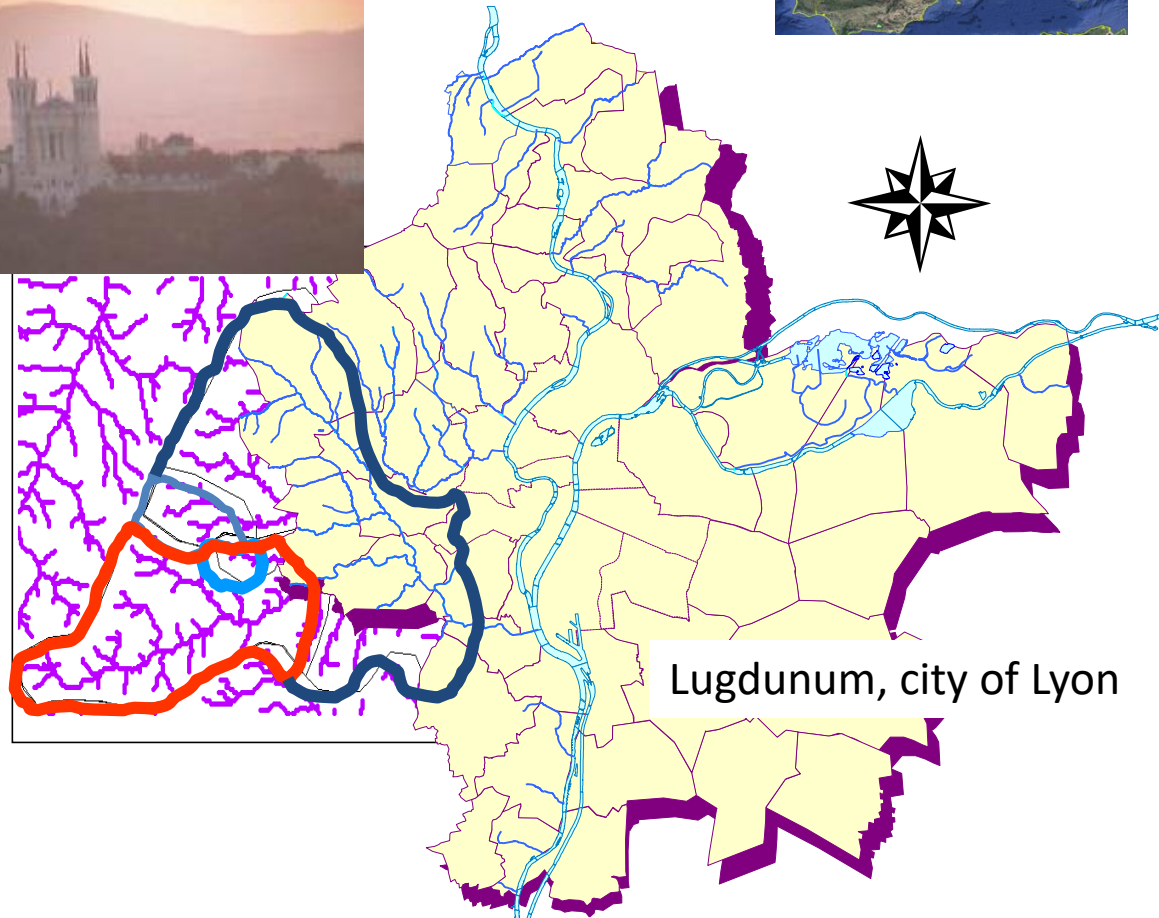


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# Where?



ecohydrology  
programme



Lugdunum, city of Lyon



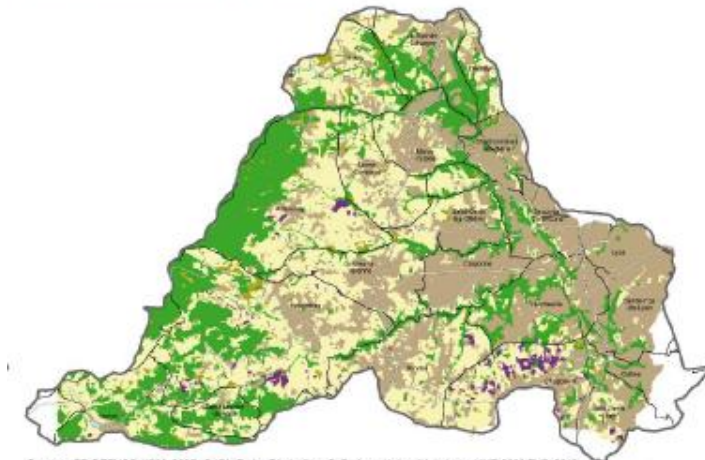
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# Problematic

## L'OCCUPATION DU SOL EN 2008

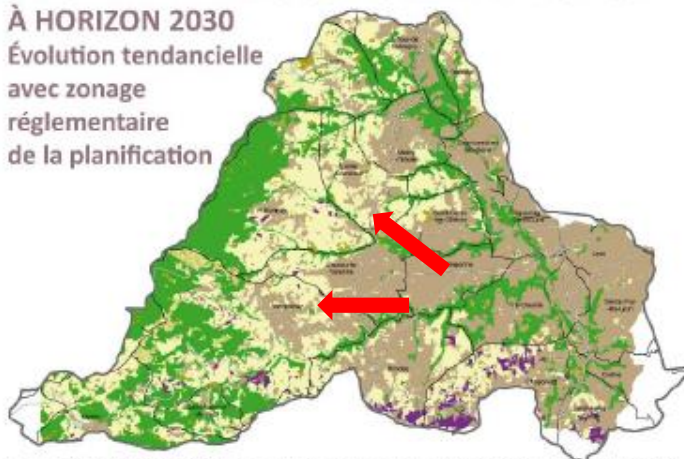


Sources : BD ORTHO (1990, 2008). © IGN Paris. Réalisation : C. Dodane, Université de Lyon, UMR 5600 EVS, 2010.  
Digitalisation des photographies aériennes : C. Jacqueminet, S. Kienast et K. Michel, Université de Lyon, UMR 5600 EVS, 2008-2010.

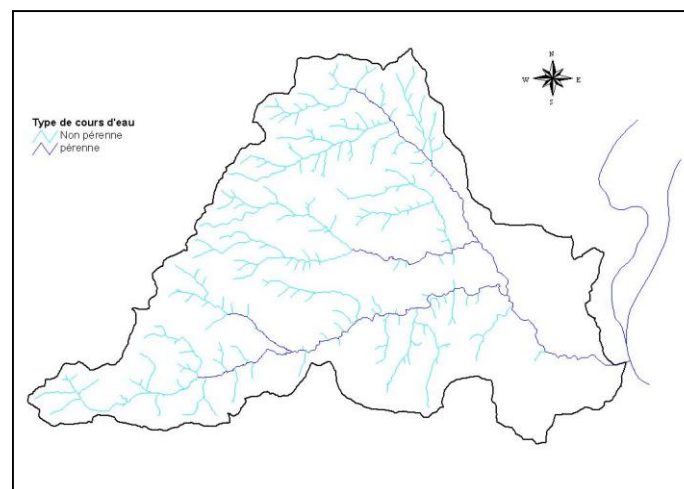
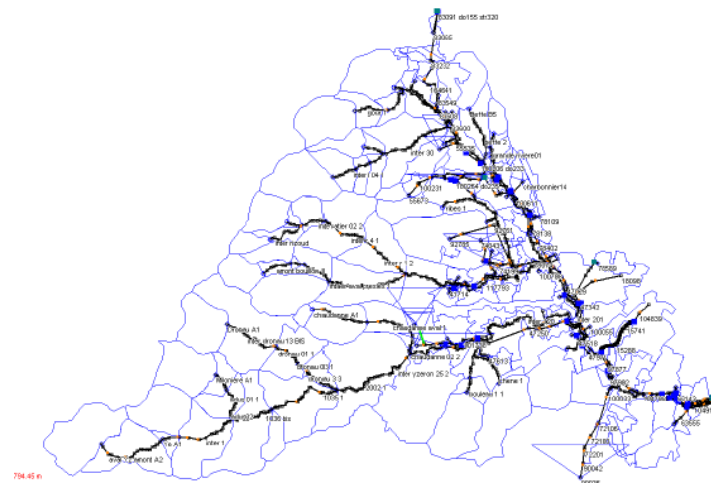
## SIMULER L'EFFET DES OUTILS DE PLANIFICATION

### À HORIZON 2030

Évolution tendancielle  
avec zonage  
réglementaire  
de la planification



Sources : BD ORTHO (1990, 2008). © IGN Paris. F. Jullien, C. Dodane, A. Honegger, C. Jacqueminet, K. Michel, S. Kienast, 2010. Carte de simulation des usages du sol dans le bassin versant de l'Yzeron en 2030 (scénario STDA) – Université de Lyon, UMR 5600 EVS. Simulation réalisée sur la contribution du rythme des changements d'occupation du sol jusqu'en 2030, avec deux scénarios réglementaires de la planification (1. prise en compte des zones d'urbanisation (ZOU) et des ALU ; 2. prise en compte des périmètres possibles de protection et de mise en valeur des espaces agricoles et naturels prioritaires dans l'agglomération lyonnaise) et sans effet (scénario STBA).





ELSEVIER

Contents lists available at SciVerse ScienceDirect

Ecohydrology & Hydrobiology

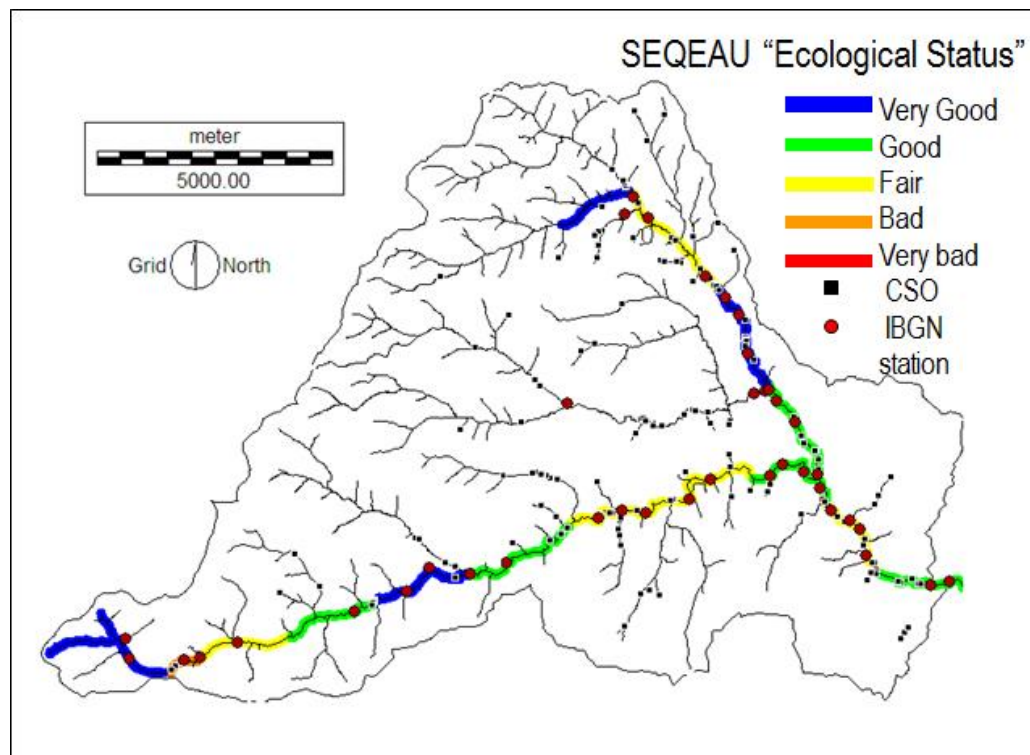
journal homepage: [www.elsevier.com/locate/ecohyd](http://www.elsevier.com/locate/ecohyd)



Original research article

## The role of ecohydrology in creating more resilient cities

Iwona Wagner<sup>a,b,\*</sup>, Pascal Breil<sup>c</sup>

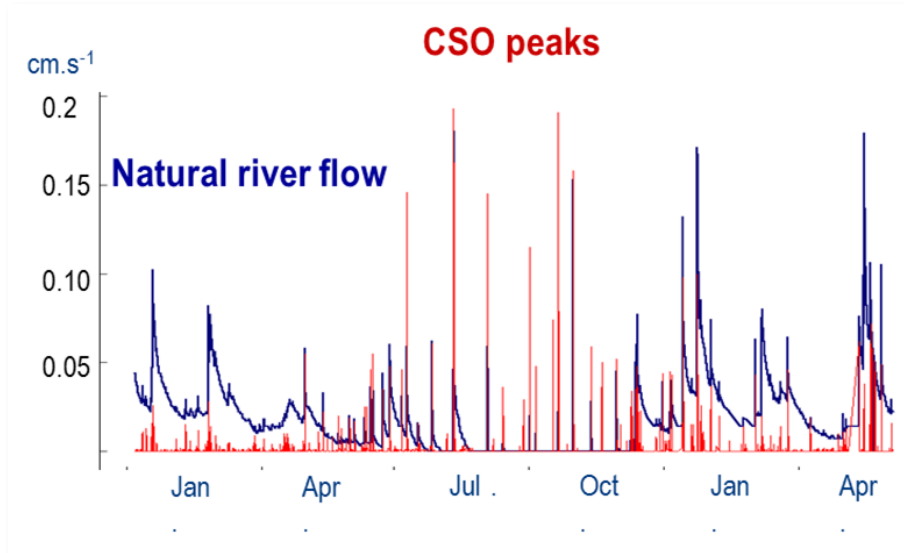




# Hydrological perturbation



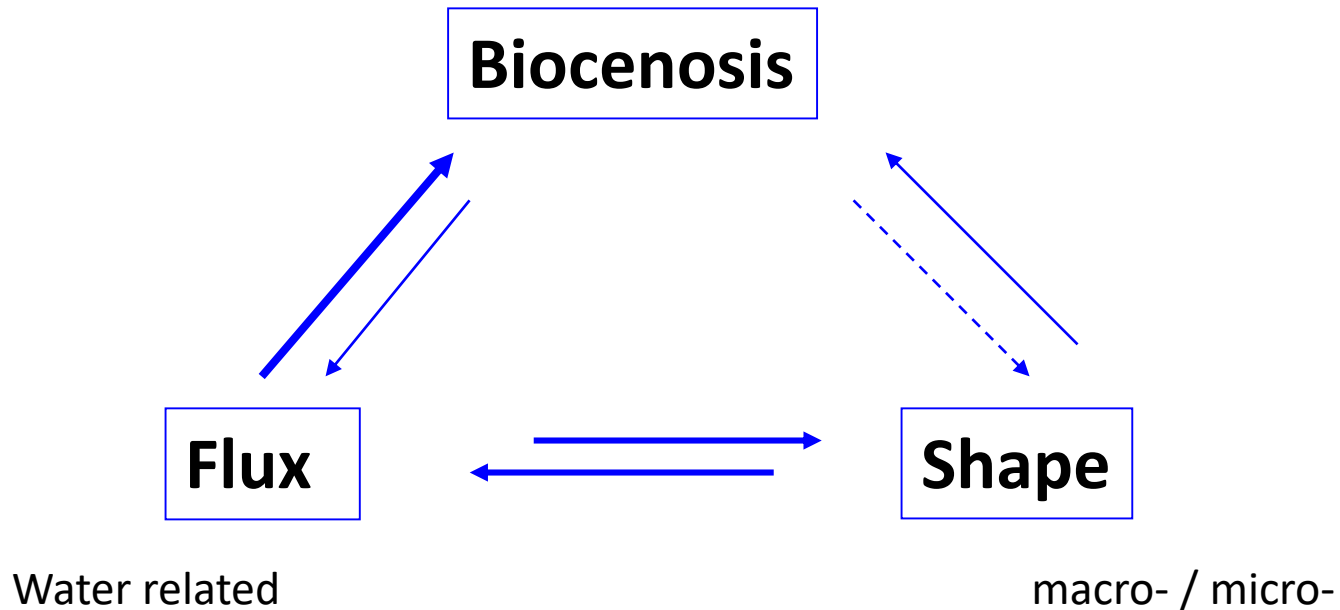
Erosion



Deposits



# EH dual regulation principle



How to enhance self purification capacity of seasonal “little” streams?

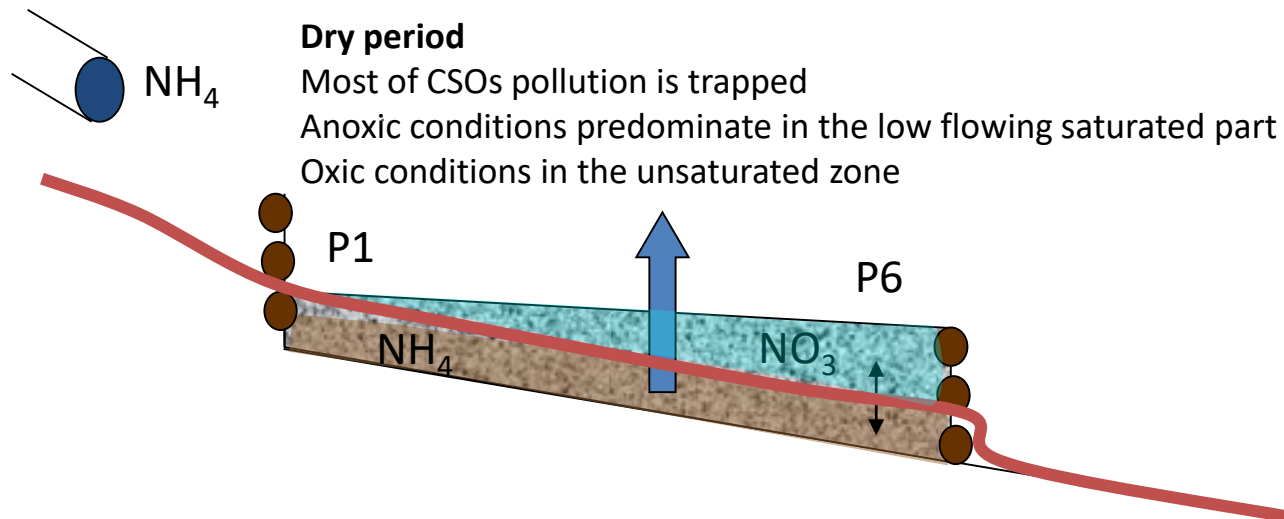
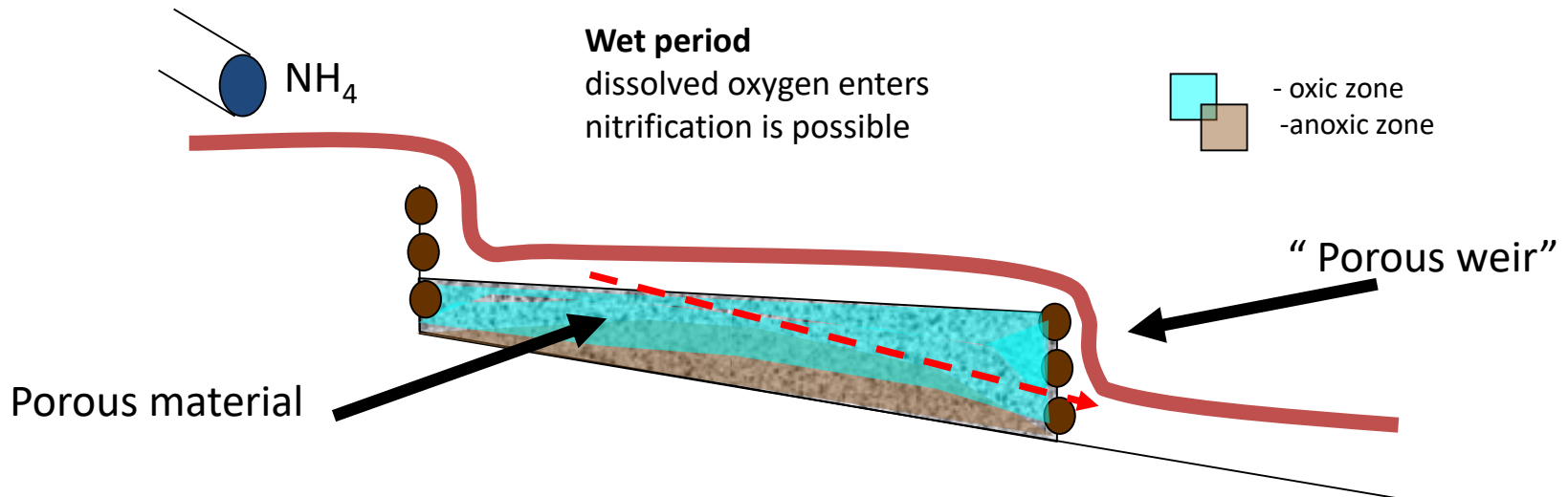


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# Constructed riffle... functioning hypothesis







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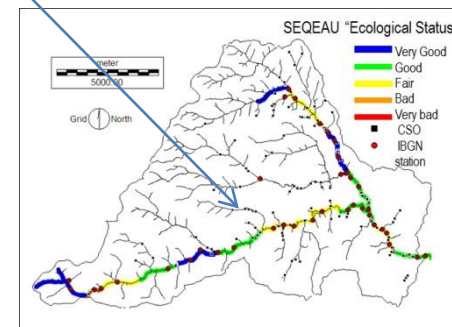
# Experimental seasonal creek



Substratum essentially  
**crystalline & metamorphic**  
(granite, gneiss)

Surface formations thin and  
soft, types **arenas**

Catchment area: 2.7 km<sup>2</sup>  
Wet season mean flow: 18 L/s





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# Riffle design...empirical

Coupe type d'un seuil en bois

Ensemencement des  
surfaces travaillées  
(mélange grainier adapté)

Couverture des surfaces  
travaillées au moyen de  
géotextile biodégradable  
de coco

Géotextile non-tissé  
synthétique

Moise  
diamètre 18-22 cm,  
longueur 3 à 6 m  
saigrier fendu

Moise  
diamètre 18-22 cm,  
longueur 3 à 6 m  
chataignier fendu

place d'une couche  
matériaux graveleux  
(sables, graviers...)

en place de blocs  
nature granitique  
classe de dissipation

Longrine,  
diamètre 30-40 cm,  
longueur 5 à 7 m

Remblais argileux

Moise  
diamètre 25-35 cm,  
longueur 3 à 6 m

Géotextile  
synthétique  
Remblais à  
matériaux

Ec

Fixation  
au moyeu  
courbés

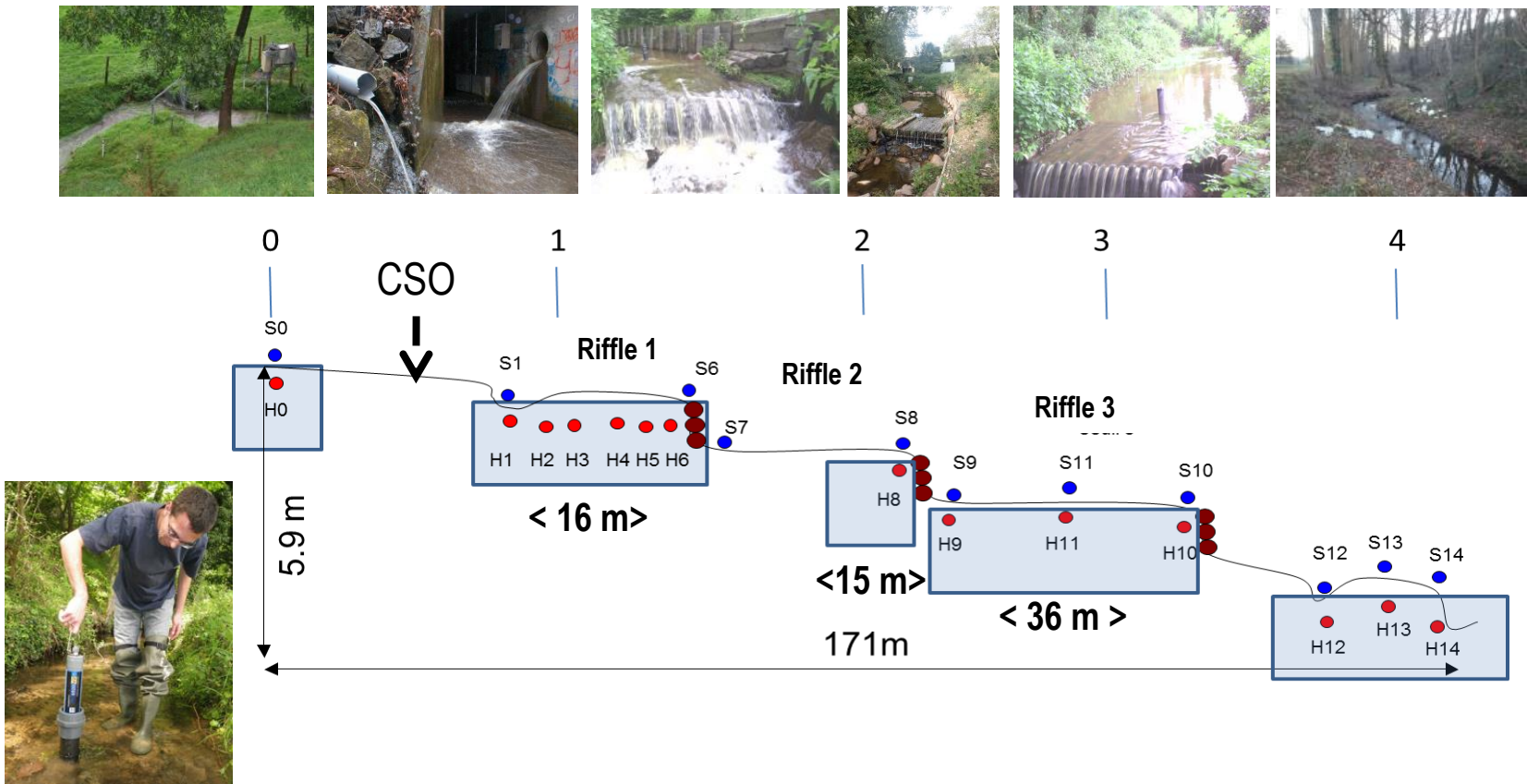
Longrine  
diamètre 30-40 cm,  
longueur 5 à 7 m

Moise  
diamètre 25-35 cm,  
longueur 6 à 9 m



20/04/2010

# Monitiring strategy





# Proof of concept..trapping effect



0



CSO



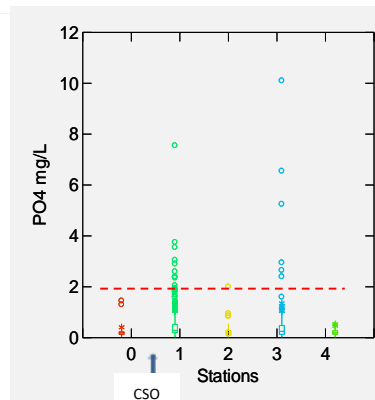
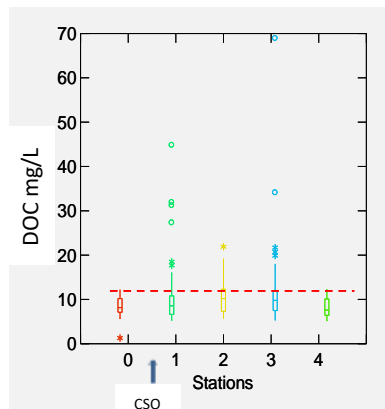
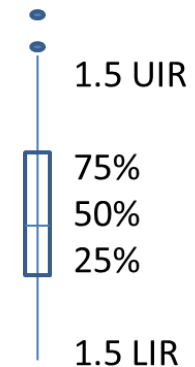
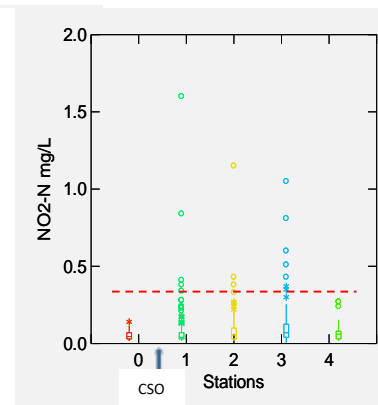
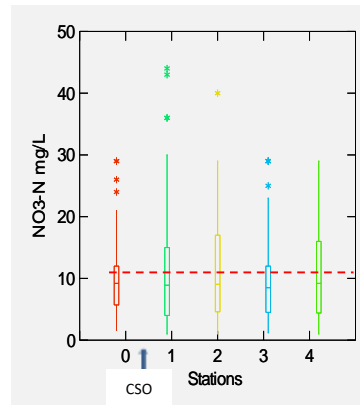
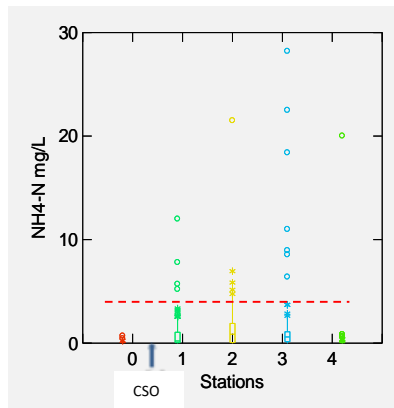
1



2 & 3



4

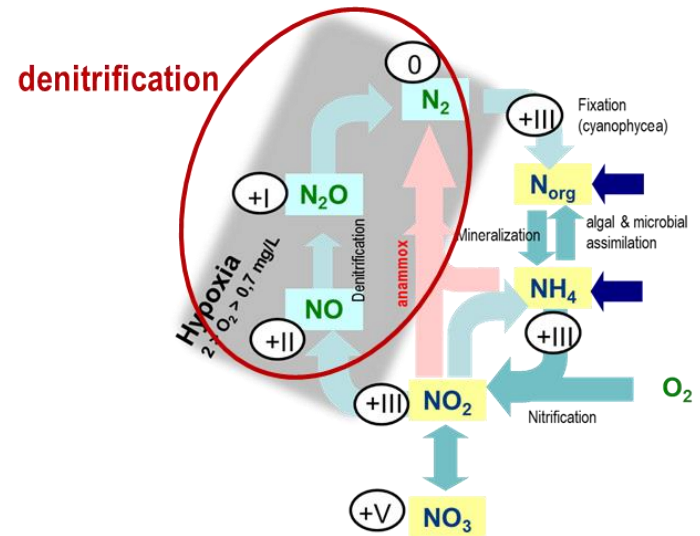
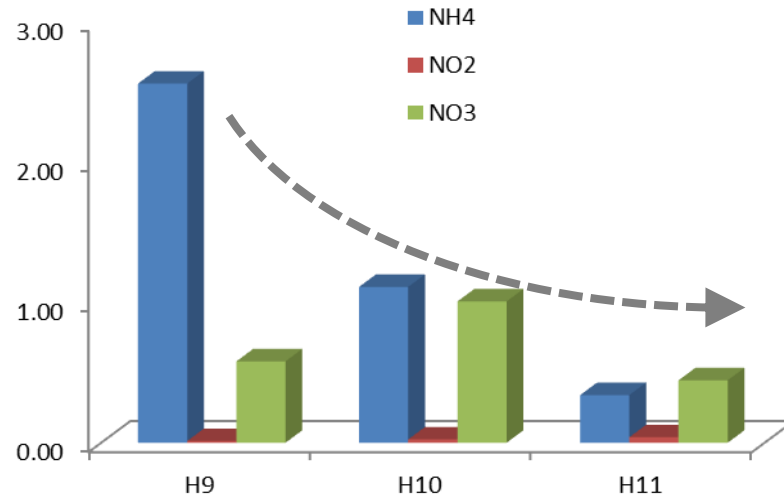


- $\text{NO}_3$  fertilizers in excess
- CSOs pollution is trapped
  - Organic N, Organic C, P
- Is the pollution reduced?

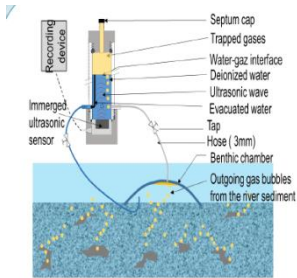
# Proof of concept....

## biodegradation process / uptake..

Nitrogen amount (mg/L)



# Microbial activity measurement



Gas  
sampling  
device



Figure 2 : System in operation on the field.

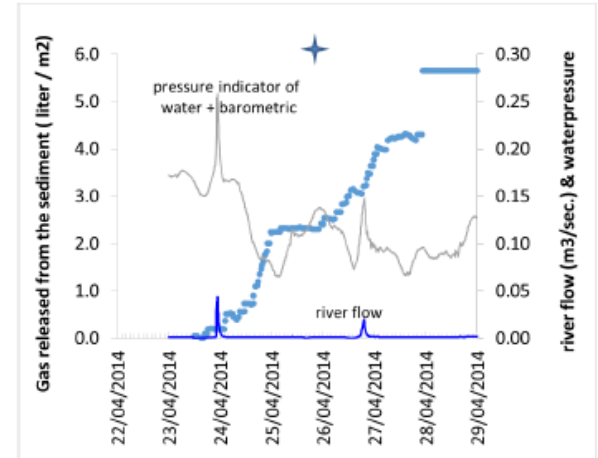
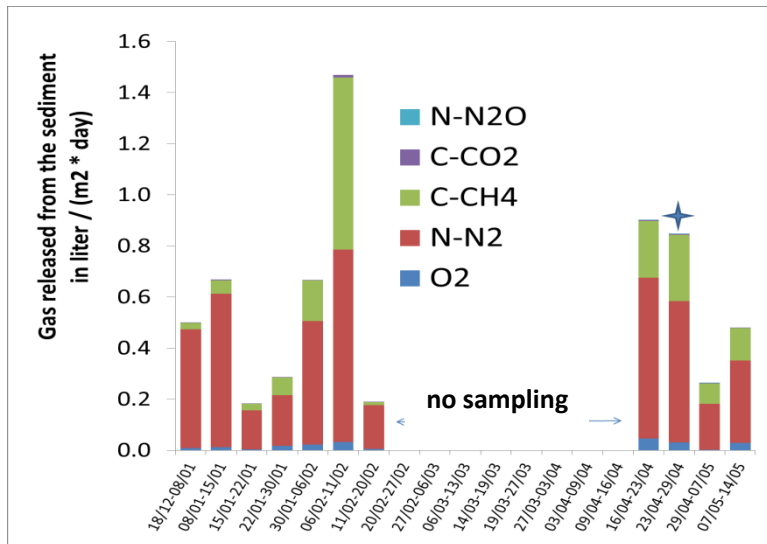
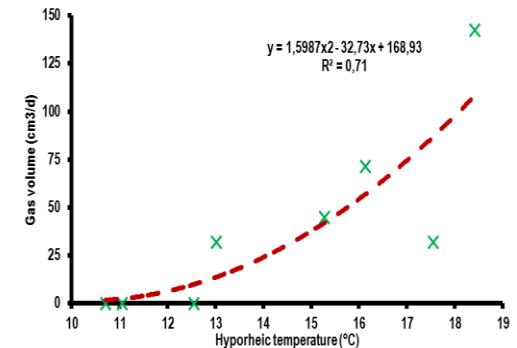


Figure 3 : dynamic of the gas production per m²  
Influence of the barometric pressure.

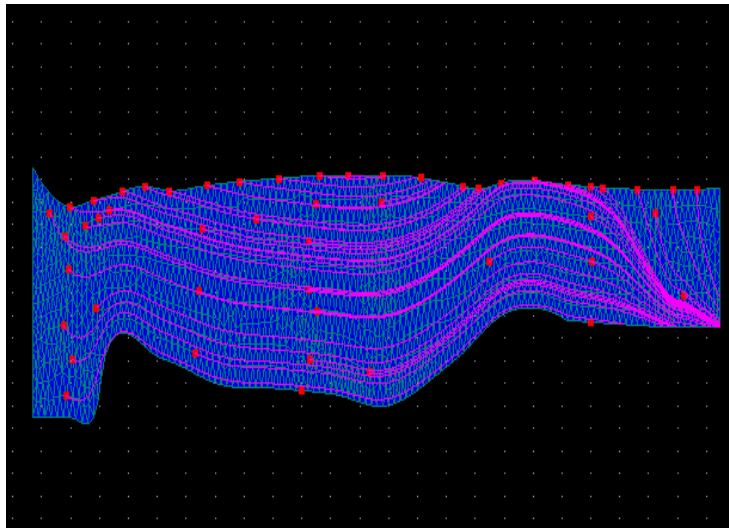


Hyporheic gases were essentially CH<sub>4</sub> and N<sub>2</sub> & measured rate of production was 1L / m².day  
Nitrogen gaseous export was estimated to represent 5% of available N amount per day

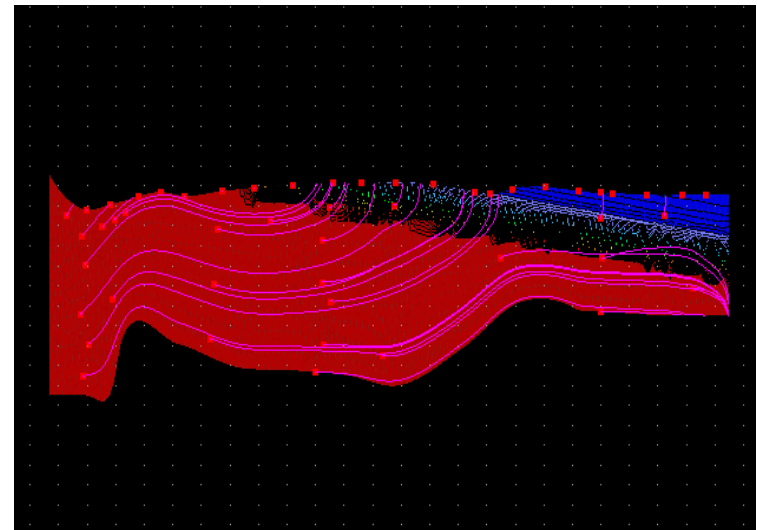


# Understanding the hydrodynamics...

« low flow condition...trapping phase»



« high flow condition...regeneration phase »



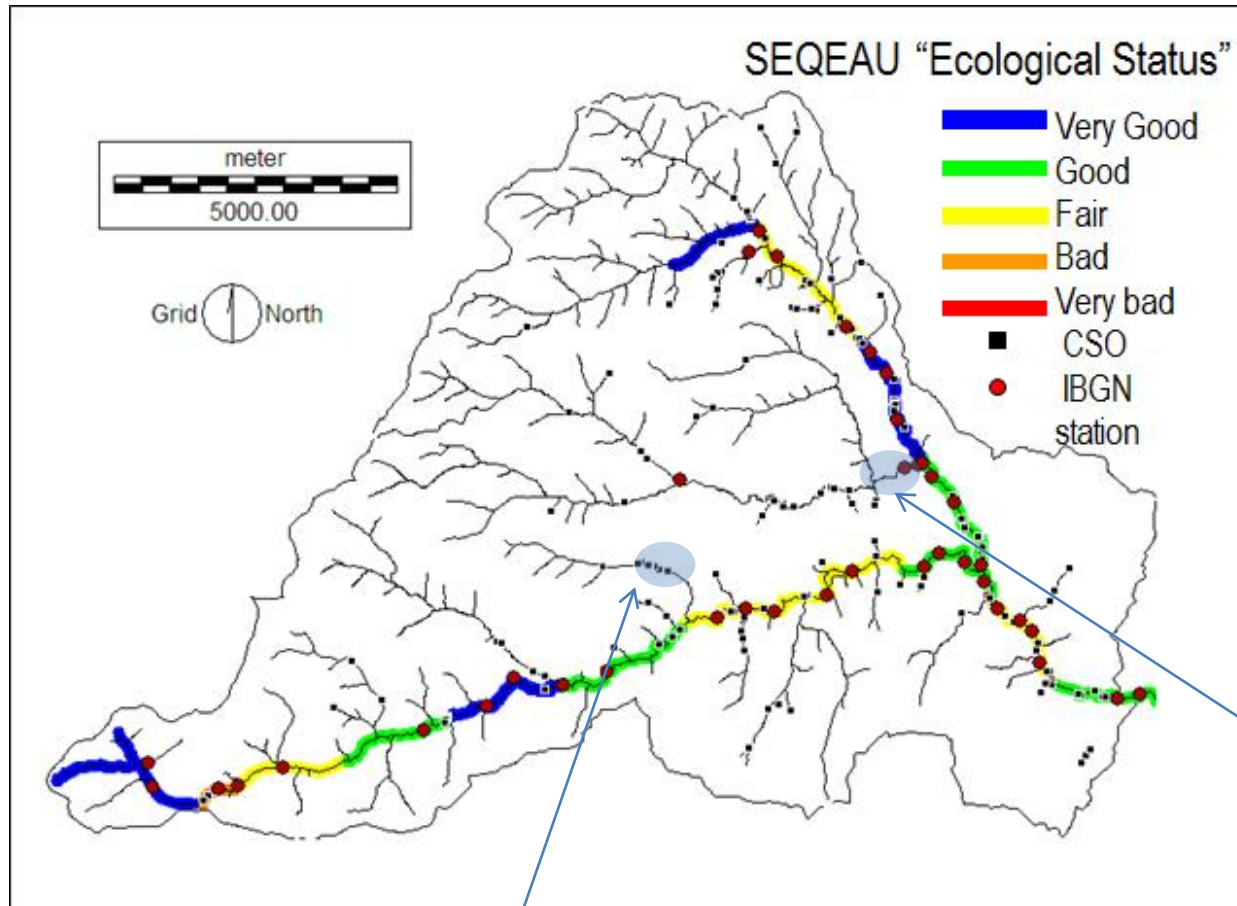


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# Implementation strategy with the support of the river basin manager



Replication site  
planned on 2018  
for proof of  
transferability

Demosite – proof of concept running since 2006

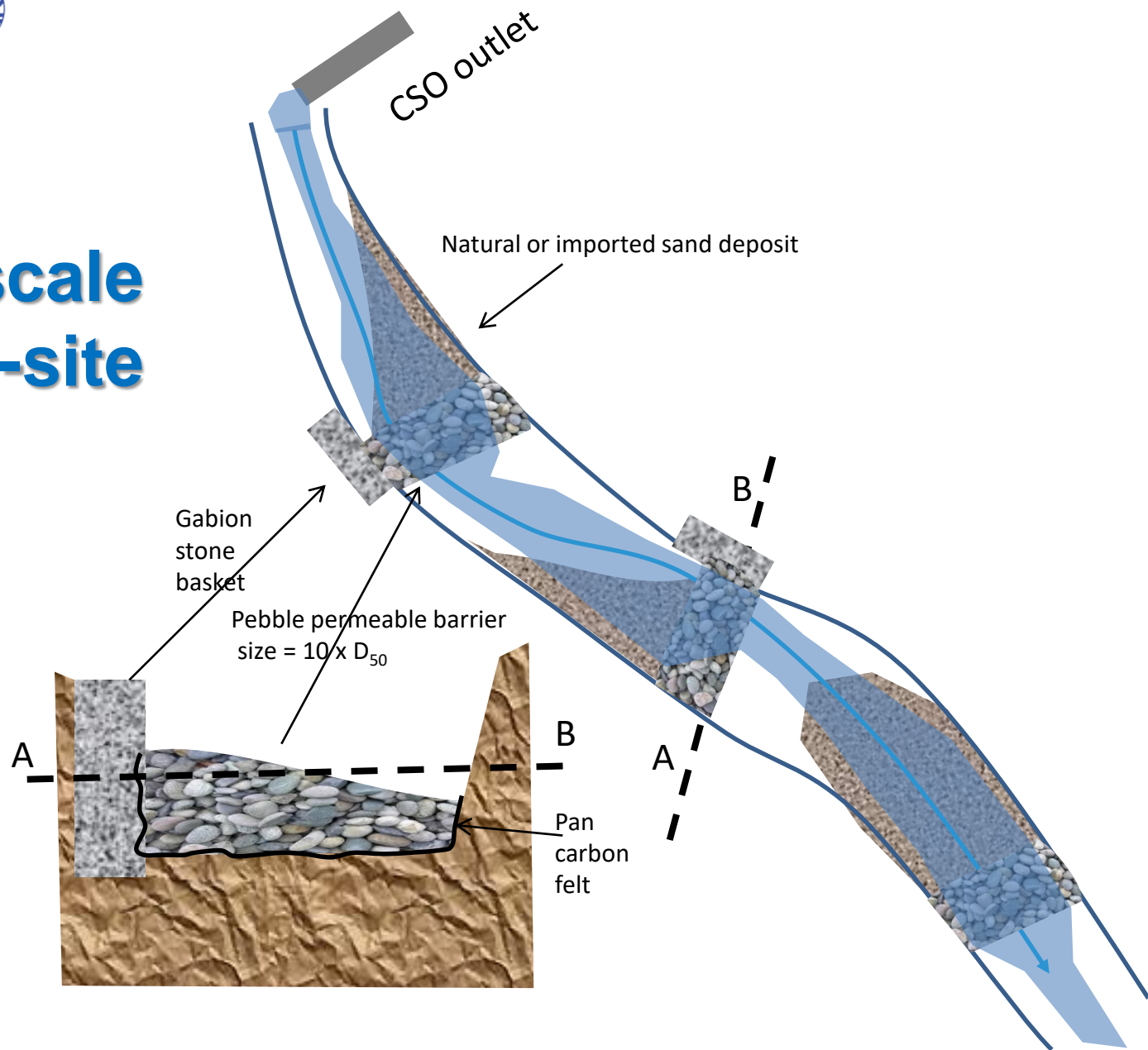


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# Real scale demo-site



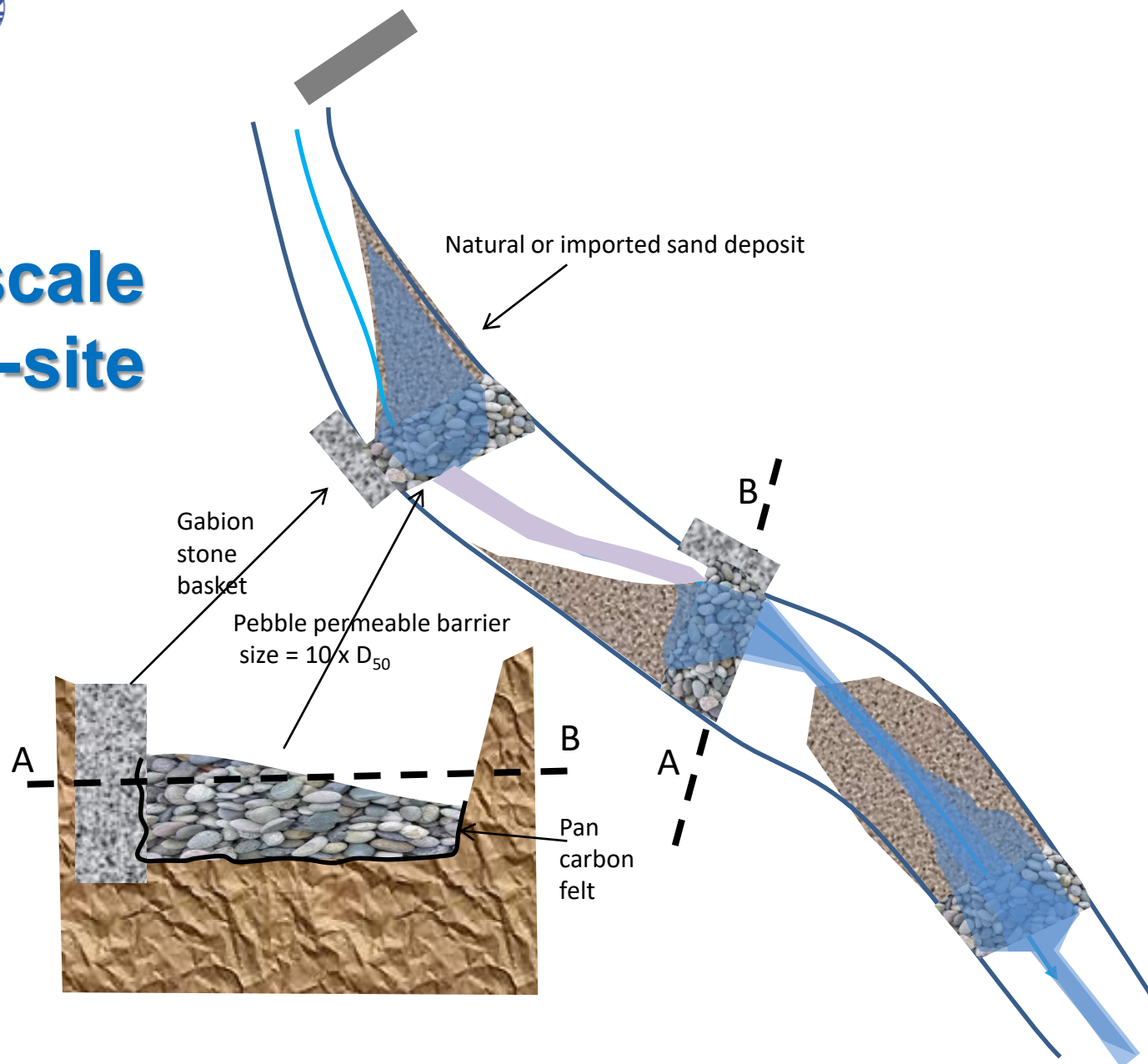


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# Real scale demo-site







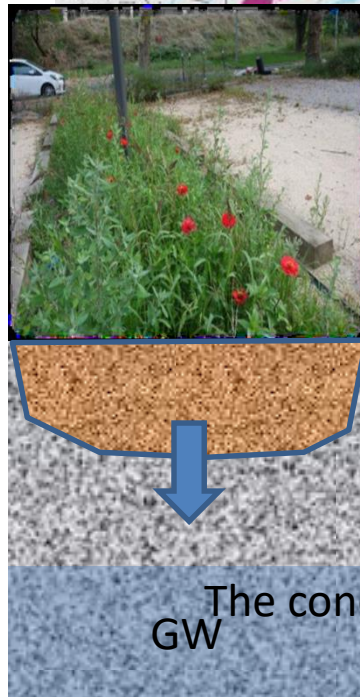
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# Could this large renovation project be part of the Lyon demosite ?

Aims of SCMs (Stormwater Control Measures) regarding micropollutant in urban wet weather effluent :  
Comparison of the performance of source control vs “end of pipe” systems



The concept of “sponge city”

## Constructed porous riffle

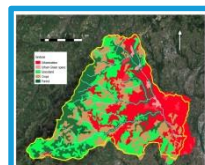
### Demonstration site description

#### Lithology/geochemistry

Gneiss and granite bed-rocks covered with allocrisol (granitic brown acid soil) and sandy-silt to silty-sand colluvial into valleys.



N 45°44'30.37"; E 4°41'53.88"



Yzeron River catchment

#### Main Description

- Main description** : The Yzeron river basin is 147 km<sup>2</sup> in area with a population of 144 000 inhabitants (1 354 000 for Lyon metropolitan). Demosites are located N45°44'38.50"-E4°41'24.49" and N45°45'28.24"-E4°45'04.09" on seasonal rivers and at N45°47'05.92"-E4°52'18.43" in a car park.
- Principal services provided by the demosite (ecosystem services)**: This project focuses on the enhancement of natural regulating services by increasing local biodegradation capacity of soils and stream sediments to trap and naturally process polluted waters delivered by urban sewage systems.
- Links with international/National conventions or programmes**: The demosite are part of the Field Observatory for Urban Water Management (<http://www.graie.org/othu/index.htm>) itself included in the European-LTER network ([https://data.lter-europe.net/deims/site/czo\\_eu\\_fr\\_030](https://data.lter-europe.net/deims/site/czo_eu_fr_030)).

#### Conserve Ecohydrological processes in Natural ecosystems

✓ Yes o X NO

#### Enhance Ecohydrological processes in novel ecosystems

✓ Yes o X NO

#### Apply complementary Ecohydrological processes in highly impacted systems

✓ Yes o X NO

### Ecohydrology Principles and solutions

#### EH IMPLEMENTATION PRINCIPLES

- \* Quantification of the hydrological processes at catchment scale and mapping the impacts
- \* Identification of potential areas for enhancement of ecosystem sustainability potential (carrying capacity).
- \* Managing biota to control hydrological processes and vice versa (ecological engineering)

#### EH SOLUTIONS

**Into seasonal urban stream** : constructed porous riffles to enhance the trapping of sewage organic pollution by porous sediment and its biodegradation by microbial activity. In the car-park : constructed soil for microbial processing and phytoremediation of urban runoff water before its returning to ground water.



Ecohydrological infrastructure



Hydrological flow



Phytotechnology



Faunatechnology

#### Life zones

**Life Zone**  
Moist forest

Precipitation 734mm/yr  
123

Temperature 11.56°C  
123

PET Ratio: 0.92  
Elevation: 314m  
Humidity: 80.5



demosite in Yzeron

### Major issues

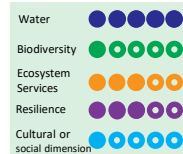
#### Pollutants & Nutrients

W Water over-abstraction D Droughts

### Social-ecohydrological system

#### Catchment Ecohydrological sub-system

##### EH Objectives



Are inputs to:

##### Methodology EH

This EH methodology is to amplify the self-purification capacity of soil and river bottom sediment that receive polluted urban runoff. It makes use of the hydrological rinsing and dewatering natural phases to promote the pollution storage, biodegradation and natural renewal of the biofilter installed.

Set conditions for:

##### Objectives

From several years of field experiment with a huge recording data set we can confirm that a sequence of 3 porous weirs installed in a small seasonal water course can fully trap and process organic pollution introduced during rainy events. This system is self maintained by high flow waters which regenerate the biofilter in place. The principle is in course of replication in another small water course where it should help the receiving main stream to recover its good ecological status.

Set conditions for:

#### Catchment sociological sub-system

##### Stakeholders

**SAGYRC** : The river syndicate office is a legal entity in charge to meet the WFD objectives. WWw

The OTHU field observatory for urban water management gathers 20 research labs since year 2000, working on innovative solutions to reduce the urban footprint on the local water resource. WWW.....

The Lyon metropolitan water direction is both a partner of the SAGYRC and the OTHU.

Participate in:

#### Activities

SAGYRC is in charge to meet the WFD objectives. It implements actions all over the river systems since 2000, regarding for water quality, ecological quality, rules for water resource sharing during low flow period, protection of riverine inhabitants against flooding, river geomorphological rehabilitation, education and training of people to river functioning, protection and rehabilitation of cultural heritage. The SAGYRC supports the implementation of the demosite in 2018 for the river selfpurification amplification in coordination with a project for flood control.

The Water direction of Lyon metropolitan supports the OTHU research project for more than 18 years. It is involved in the second demo-site where the objective is to reinfiltrate urban runoff after cleaning by soil and plant filter. The water direction is also in charge to renew of old main sewers that collect urban waters from the upper watershed to a centralized WWTP.

### Results

#### Main Expected Result

- Reach WFD objective for the water mass of concern, by increasing the carrying capacity of seasonal small water courses to cope with urban unmanageable runoff pollution, increase their resilience to future urban development.
- Develop a river reach scale mapping of the naturally varying carrying capacity all along the river network as to consider it in future land developments.

- Confirmed that artificial riffles can help to trap and process the organic pollution issued by a combined sewer overflowing system.
- Result for the car park.....

#### LATEST RESULTS

- Confirmed that artificial riffles can help to trap and process the organic pollution issued by a combined sewer overflowing system.
- Result for the car park.....

#### Contacts:

**River demo** : BREIL Pascal / [pascal.breil@irstea.fr](mailto:pascal.breil@irstea.fr) / IRSTEA- Rivery research unit  
**Car park demo** : LIPEME KOUYI Gislain / email / INSA-Lyon – DEEP lab.



Developed by:



An initiative of:





# Obrigado pela sua atenção

## Ref papers

Breil P., Gervais J., Namour Ph., Pons M.N., Potier O. (2018) Biodegradation of Urban Stormwater Pollution in a Sequence of Constructed Porous Riffles in a Mediterranean Creek. In book: Recent Advances in Environmental Science from the Euro-Mediterranean and Surrounding Regions. DOI10.1007/978-3-319-70548-4\_48

Namour, Ph., Schmitt, L., Eschbach, D., Moulin, B., Fantino, G., Bordes, C., Breil, P. (2015) Stream pollution concentration in riffle geomorphic units (Yzeron basin, France). Science of the Total Environment 532 (2015) 80–90

Wagner I., Breil P. (2013) The role of ecohydrology in creating more resilient cities Ecohydrology & Hydrobiology 13, 113–134.

Breil P. (2017) Measuring, Modeling and Managing of the natural processes related to water flows - Social values of linked ecosystem services. Ecohydrology & Hydrobiology – Vol. 17, Issue 1, Pages 1–3; Special Issue guest Ed.  
<http://dx.doi.org/10.1016/j.ecohyd.2017.02.001>