How to balance the ecohydrological functioning of headwater streams with their surrounding anthropogenic pressures?

Pascal Breil

United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme · ecohydrology programme

How to balance the ecohydrological functioning of headwater streams with their surrounding anthropogenic pressures?

¿Cómo equilibrar el funcionamiento hidrológico ecológico de los ríos con las presiones antropogénicas que lo rodean?

Pascal Breil y coll.

Instituto Nacional de Ciencia y Tecnología de Investigación del Medio Ambiente y Agricultura

irstea

www.irstea.fr

Coloquio Posgrado Facultad de Ingeniería – 23 de noviembre 2018 – UAQ – Querétaro -Mexico

United Nations Educational, Scientific and Cultural Organization

International Hydrological Programme

What is Ecohydrology?

ecohydrology programme

IHP's Eighth Phase

United Nations Educational, Scientific and Cultural Organization · International Hydrological Programme · Sustainable Development Goals

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What is Ecohydrology?

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- Is an **integrative** science studying the **interaction** between hydrology and biota and using natural processes as management tools to **reinforce ecosystem services** on a broad range of landscapes (e.g.: coastal, urban and agricultural areas)

- Ecohydrology aims to increase resilience of river basins by managing multi-dimensional parameters which are **W**ater, **B**iodiversity, Ecosystem **S**ervices for society, **R**esilience to climatic changes and Cultural dimension (WBSRC), all in order to achieve sustainability in both ecosystems and human population

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Ecohydrology- WHY?

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- **Sustainable management of landscapes** should be an integral part of the IWRM that must address the big questions of our time - questions about **eradicating poverty, enhancing food security, promoting sustainable energy, managing water and environmental resources, controlling disease, mitigating natural and man-induced disasters, and fostering sustainable cities**

- The development of solutions to these global challenges need to based on **trans-disciplinary approaches** recognizing **cultural and time dependent dimensions** of human wellbeing.

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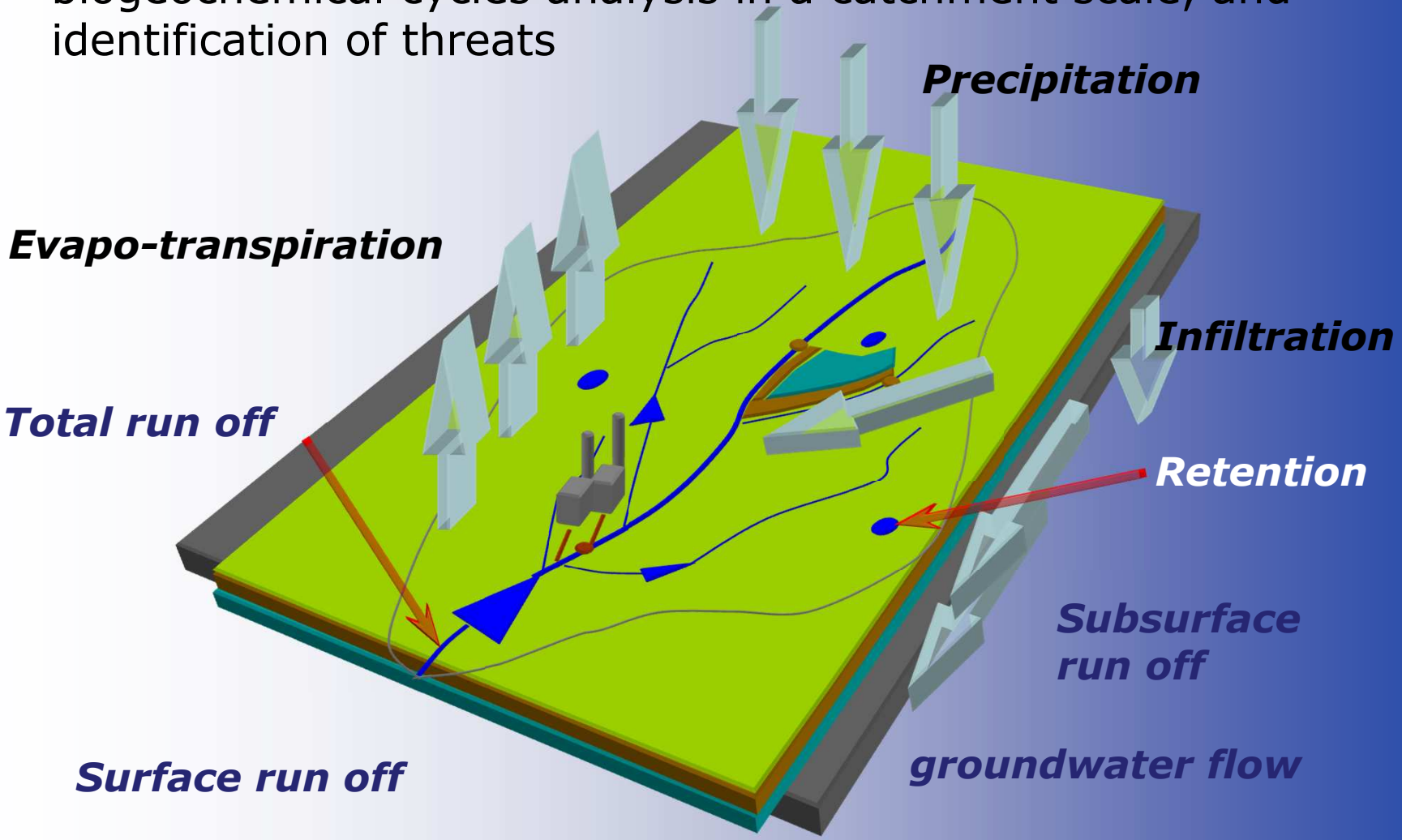
I – FIRST PRINCIPLE (Zalewski 2010)
Hydrological principle

Quantification of hydrological processes (cycle) as a template for biogeochemical cycles analysis in a catchment scale, and identification of threats

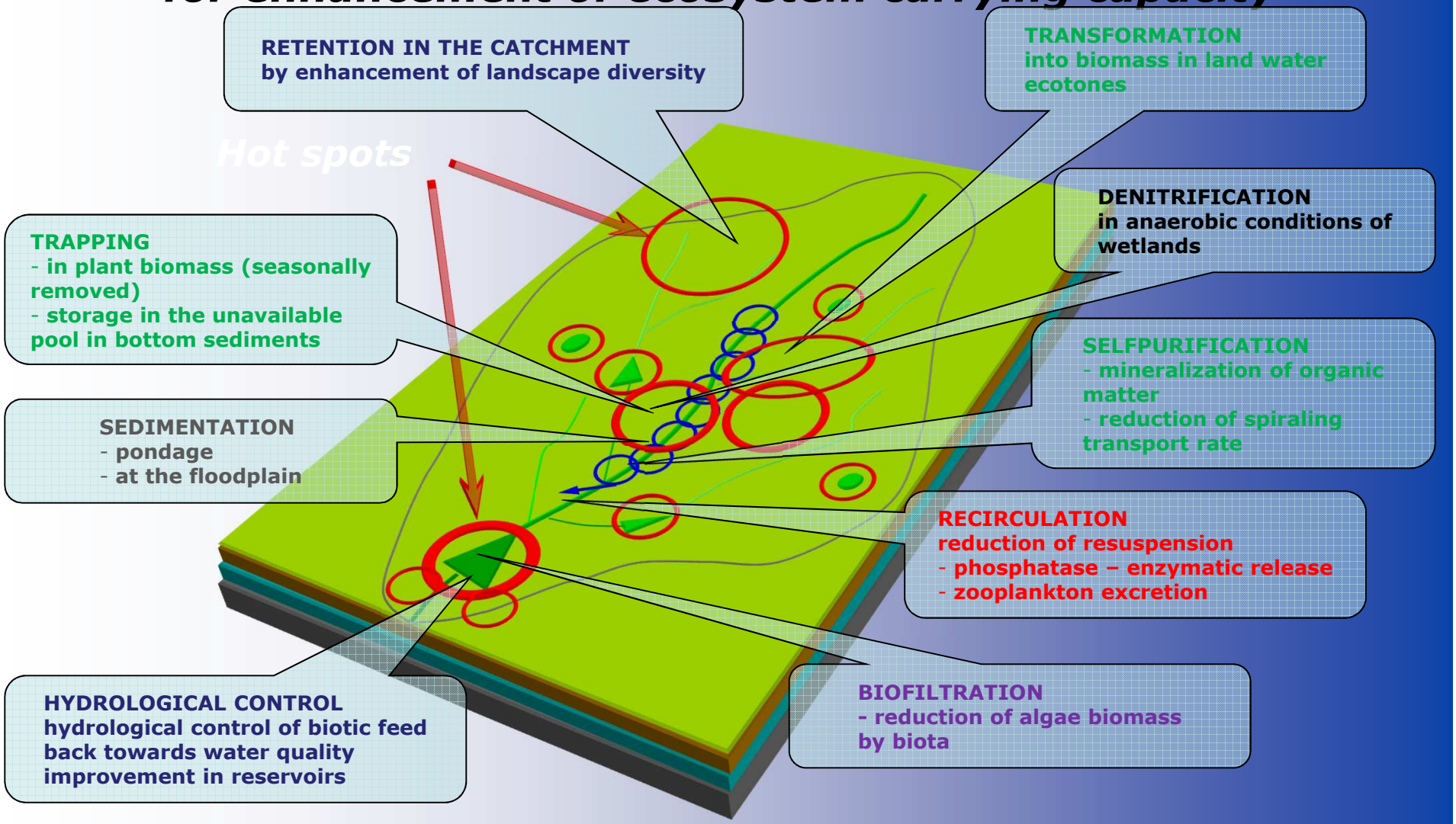


Diapositive 6

kb2 proponuje dodać:
biogeochemical cycles "analysis"
oraz
"and" identification of threats
kb; 31/05/2013

II – SECOND PRINCIPLE
Ecological principle

Identification of biological processes and of potential areas for enhancement of ecosystem carrying capacity



III – THIRD PRINCIPLE

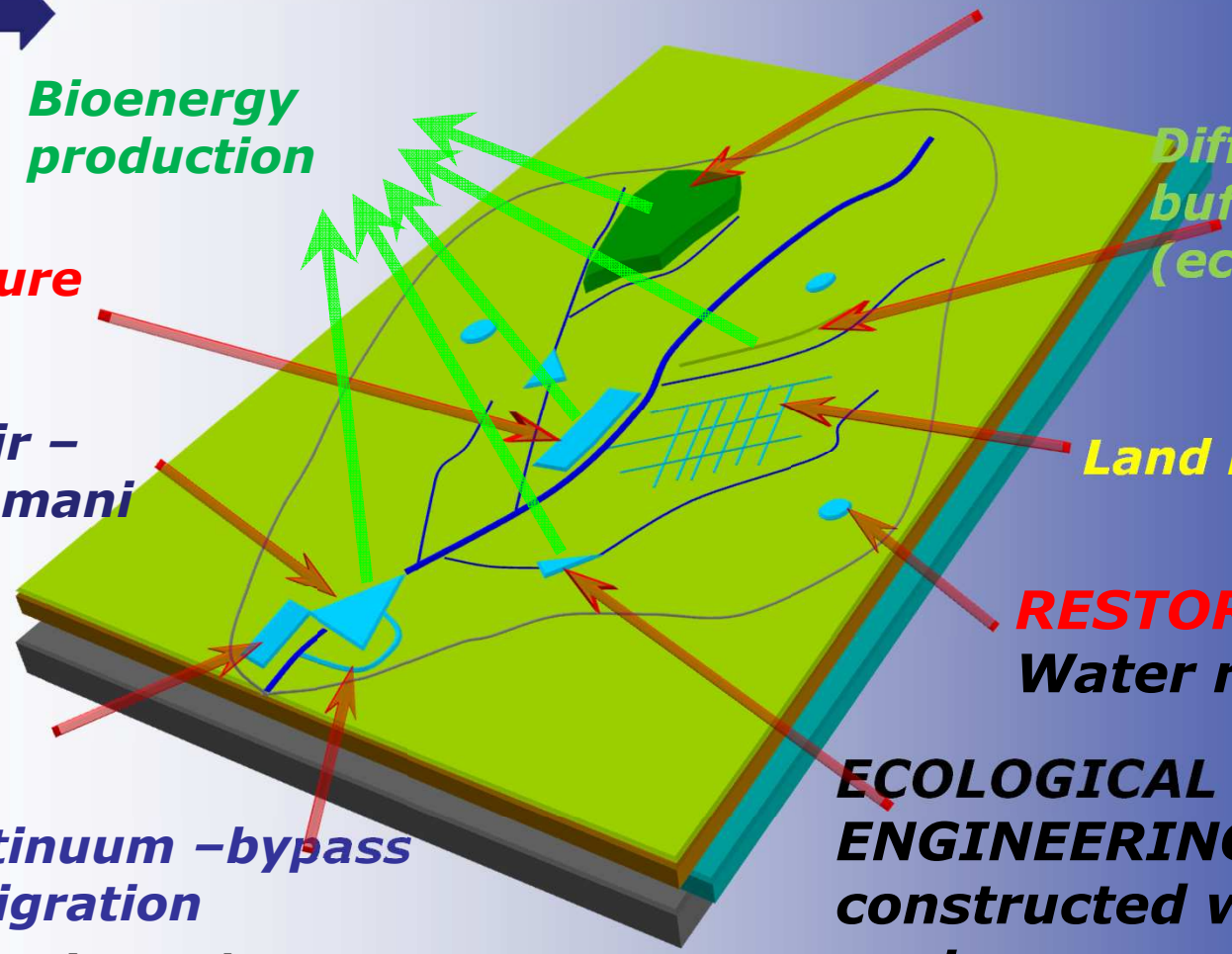
Ecological engineering principle

Using biota to control hydrological processes and vice versa, using hydrology to regulate biota dynamics

H *REGULATION* ***B***

Dual regulation

CONSERVATION



Bioenergy production

Diffuse pollution buffer stripes (ecotones)

Aquaculture

Reservoir – Hydrobiomani pulation

Land reclamations

RESTORATION

Water retentivness

ECOLOGICAL ENGINEERING- constructed wetlands, ecotones

River continuum –bypass for fish migration

Sediment release/use system

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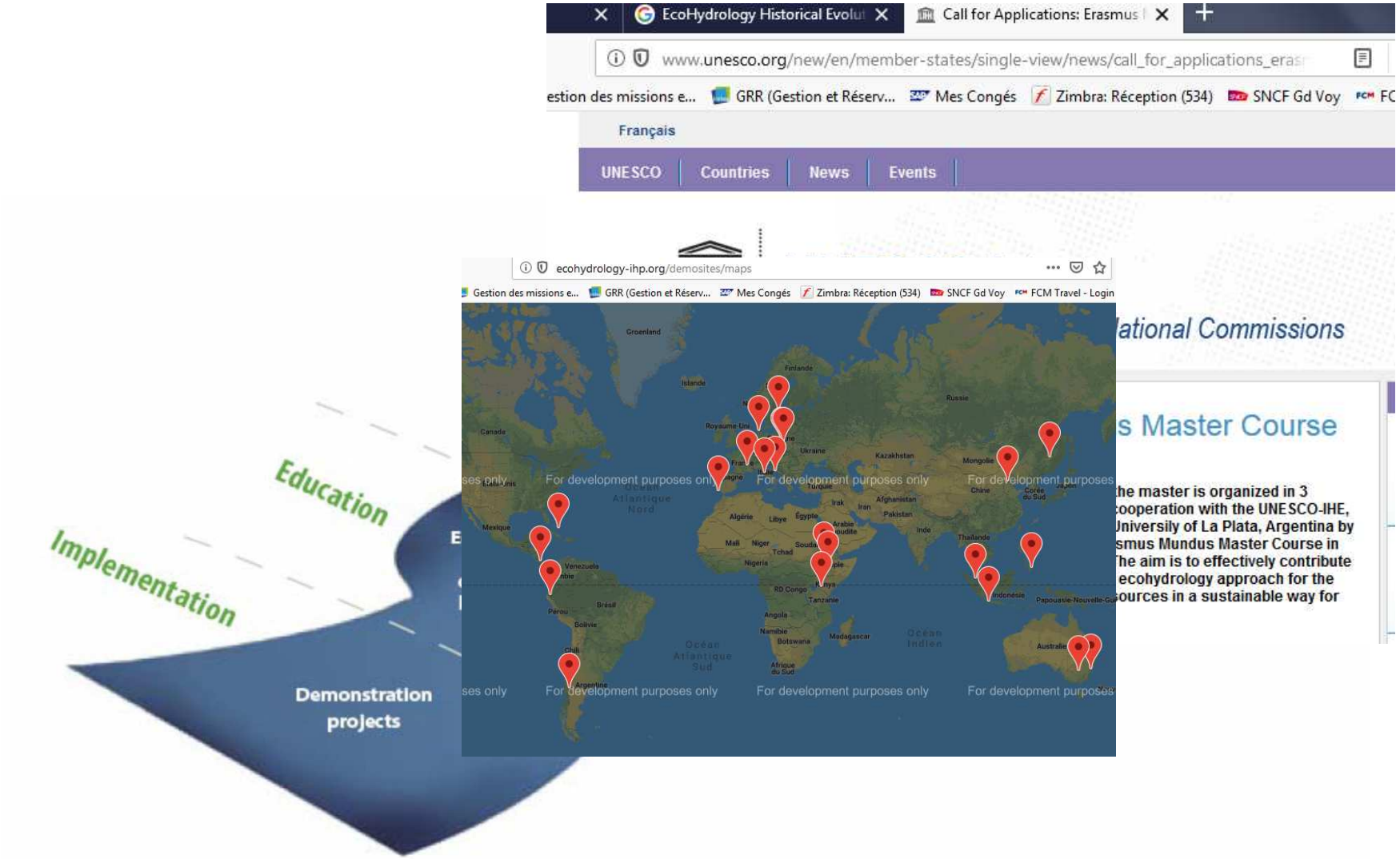
Ecohydrology Action Areas

ecohydrology programme



Application of ecohydrology

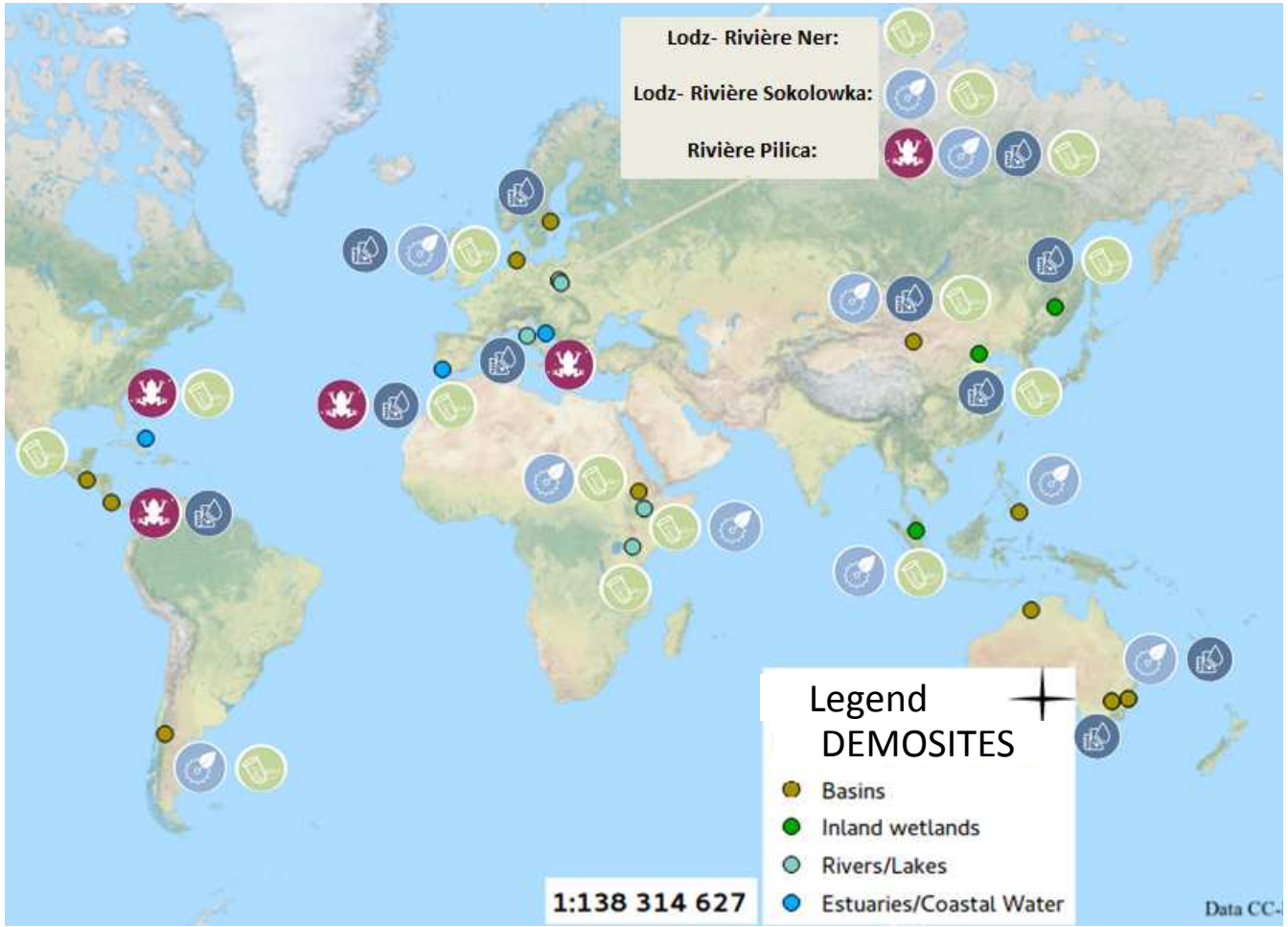
Four ecohydrology engineering solutions:

FAUNATECHNOLOGY

PHYTOTECHNOLOGY

HYDROLOGICAL FLOW

ECOHYDROLOGICAL INFRASTRUCTURE



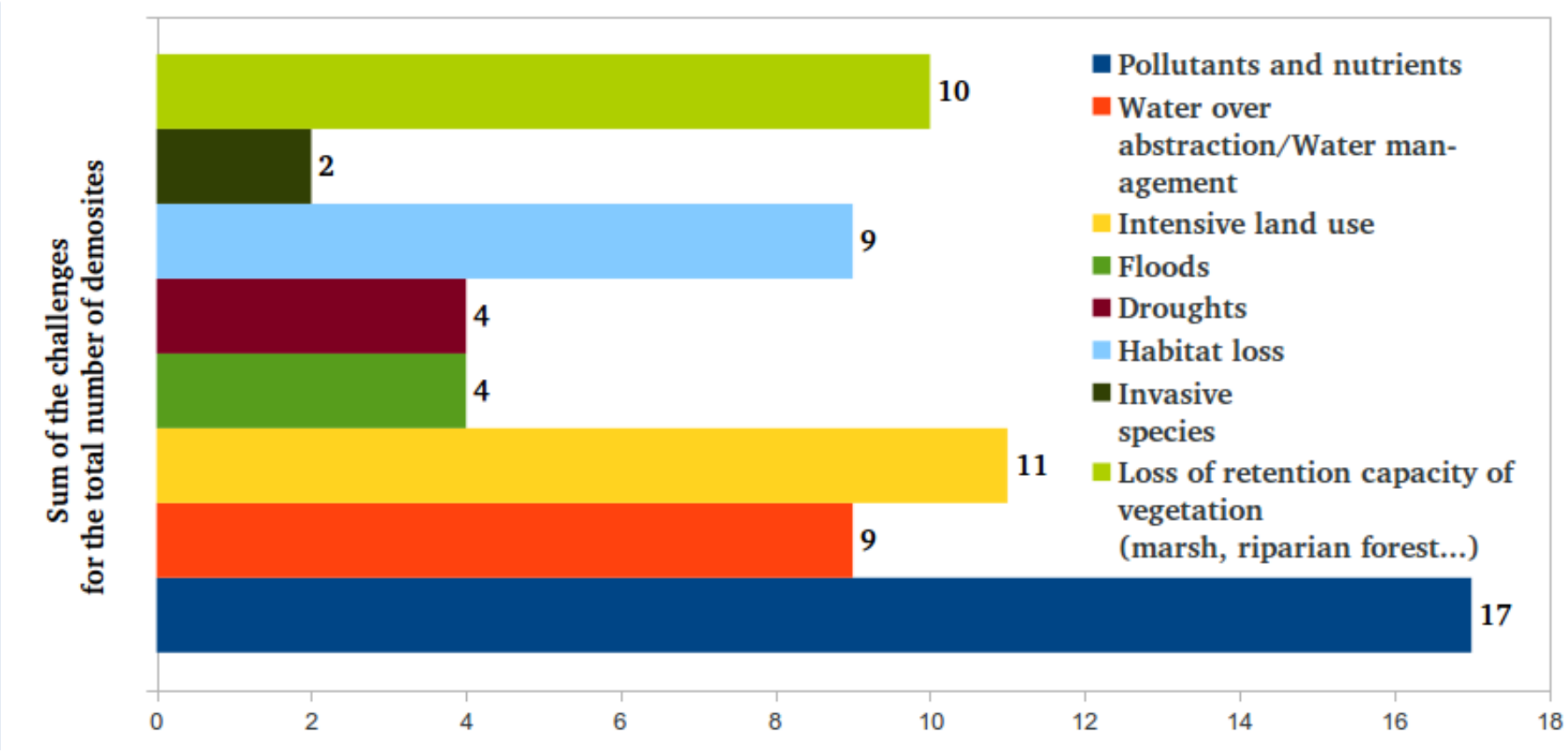
65% of the demosites are using the **phytotechnologies** as EH solution.

48% -> hydrological flow

43% -> ecohydrological infrastructure

22% -> faunatechnology

Major issues addressed by the demonstration sites



The three main threats are the excessive presence of pollutants and nutrients, intensive land use and loss of retention capacity of vegetation.

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Web platform: an interactive network

(collaboration with CIH, Itaipu', Brazil)

- The web-platform is the interactive environment that will enhance the dissemination of the ecohydrological concept within different targets, from scientists to general public and to Member States
- ecohydrology-ihp.org

Apply to the EH network

- Application to become a UNESCO EH Demonstration site will be done through the web platform and "demo cards" will be constructed through an **automatic user friendly process**.

Ecohydrology Demonstration sites

Ecohydrology Web Platform
Operational since 2016
ecohydrology-ihp.org

ECOHYDROLOGY DEMONSTRATION SITES			
Region	**Site**	**Country**	**Downloads Count**
Latin America & Caribbean	CATACOCHA-PALTAS	Ecuador	173
	VICTORIA POND WETLAND	Bahamas	248
	SAN MARTÍN DE LOS ANDES - NEUQUÉN	Argentina	261
	RANA-ICE STUDY	Costa Rica	273
Africa	NAIVASHA BASIN	Kenya	380
	ASELLA CITY	Ethiopia	285
	RIBB WATERSHED & LAKE TANA SHORE		801
Asia-Pacific	PUTRAJAYA LAKE AND WETLAND	Malaysia	296
	DAVAO CITY	Philippines	324
	SAGULING RESERVOIR	Indonesia	150
	METROPOLITAN BEIJING	China	239
	SANJIANG PLAIN		327
	MURRAY-DARLING BASIN	Australia	276
	WESTERN SYDNEY		312
Europe	TRASIMENO LAKE	Italy	251
	CONSTRUCTED POROUS RIFFLE	France	38
	KAŠTELA BAY	Croatia	267
	GUADIANA ESTUARY	Portugal	287
	NORRSTRÖM DRAINAGE BASIN	Sweden	313
	KIELSTAU CATCHMENT	Germany	462
	NER RIVER	Poland	269
	SOKOLOWKA RIVER		443
	PILICA RIVER CATCHMENT		270
	September 2018	**TOTAL**	**6,945**

Dissemination Material

- Ecohydrology as an integrative science from molecular to basin scale (2016).
- Historical Evolution, advancements and implementation activities

Now available in English, Spanish and Chinese

unesdoc.unesco.org/images/0026/002657/265736s.pdf

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What are headwaters?

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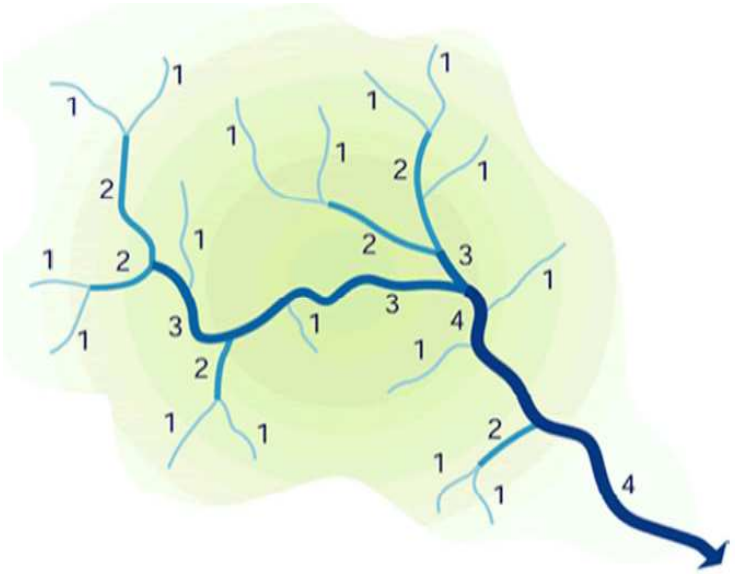
What are headwaters ?



Strahler classification (EPA, 2009)

- Natural drains of order 1-2, from less than 1 meter to 2-3 m in width
- Watershed from hectares to some sq km.
- Easy to disturb by mechanical means
- Almost never gauged while……

they can represent 60 to 90% of a hydrographic network length!

EcoHydrological role of headwaters : related Ecosystem Services

- Headwaters can have permanent or seasonal or intermittent flow regimes
- Often connected to upstream wetlands
  - *Contribute biodiversity dissemination*
  - *Ensure low flow regulation*
  - *Provide a variety of physical-chemical processes (oxic – anoxic)*
  - *Fed downstream systems with minerals and organic matter*
  - *Limit water temperature fluctuation*
  - *Dissipate hydraulic energy……*

- Economical impact of headwater degradation *:*
  - *Increasing cost of remediation efforts for downstream rivers belonging to EU referenced water masses (EWFD)*
  - *Increasing cost of flooding damages for near downstream urbanized riversides*

How and Why headwaters are so degraded ?

Cropland

Urbanization

Straigthening

Pesticides

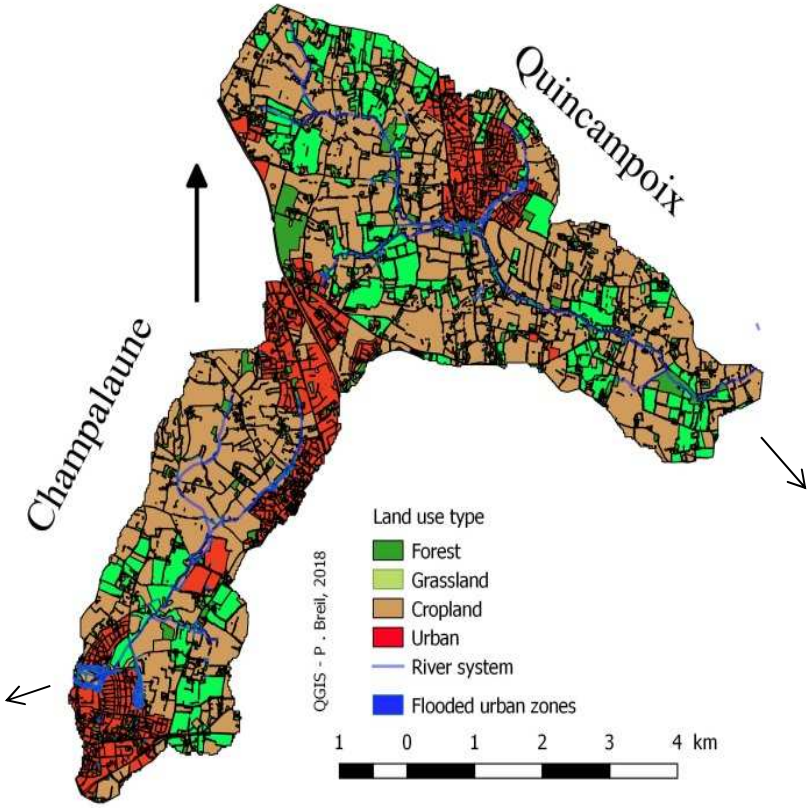
Fertilizers

Enlargement

erosion

clogging

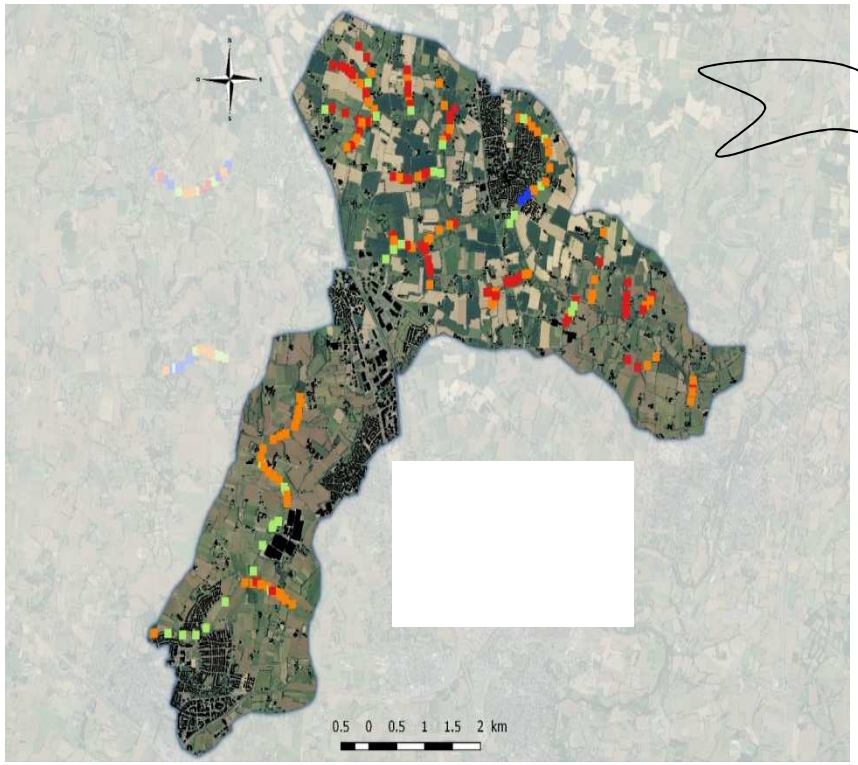
Study area



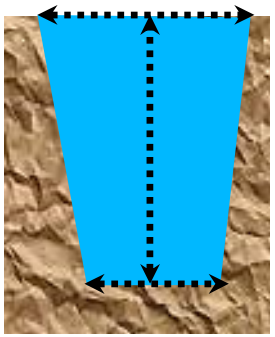
1/ Analyze the degradation level of connected lands and river channel, considering “baseline conditions”.

2/ Look for opportunities to recover part of the lost ecosystem services using the spatial distribution of their potential.

Hydrogeomorphic study of 192 river sections



Collection of numerous geomorphic features..



Bank full flow width

Bank full height

Bottom
channel width

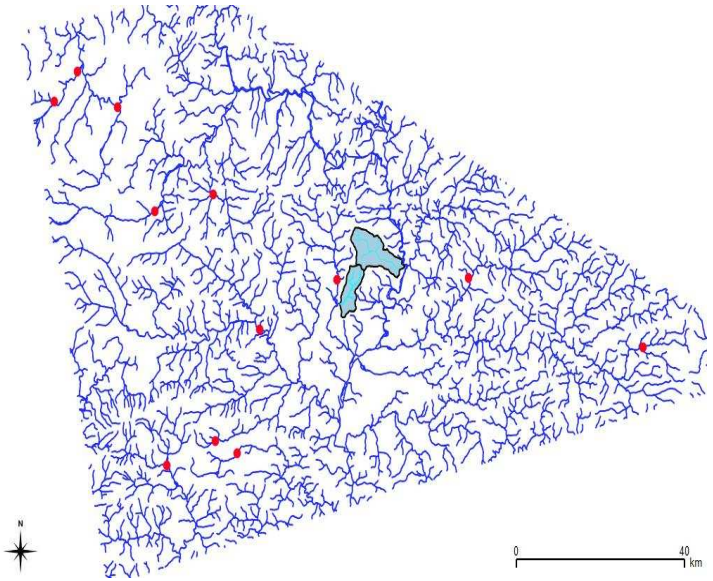
Mean local bottom gradient

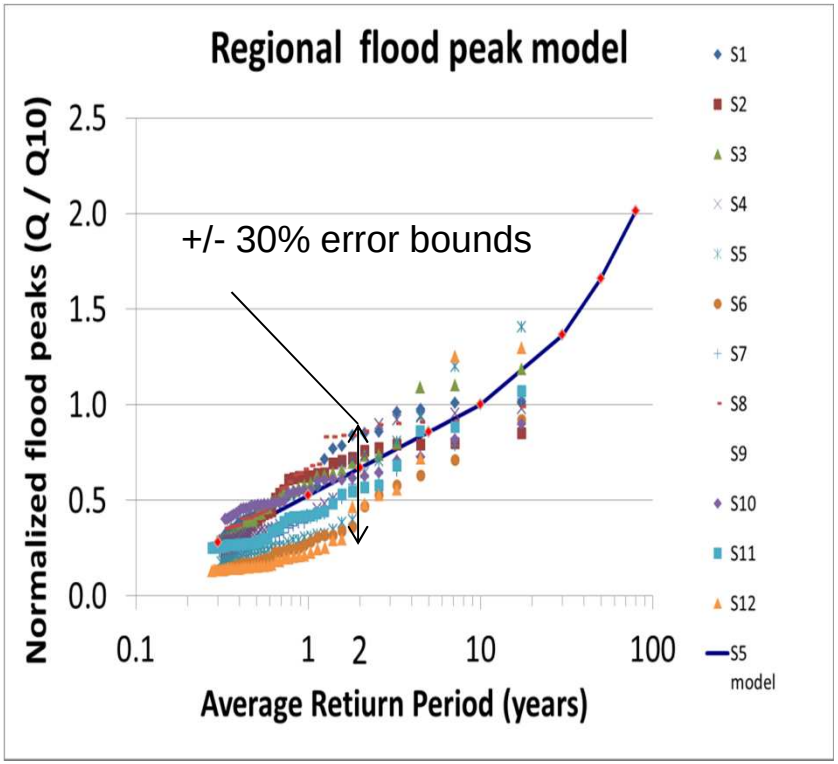
Roughness coef.

Manning-Strickler eq.

$$BFF = K^* Rh^{(2/3)} S^{(1/2)}$$ with an error of +/- 30% on S

Building of a regional hydrological model….

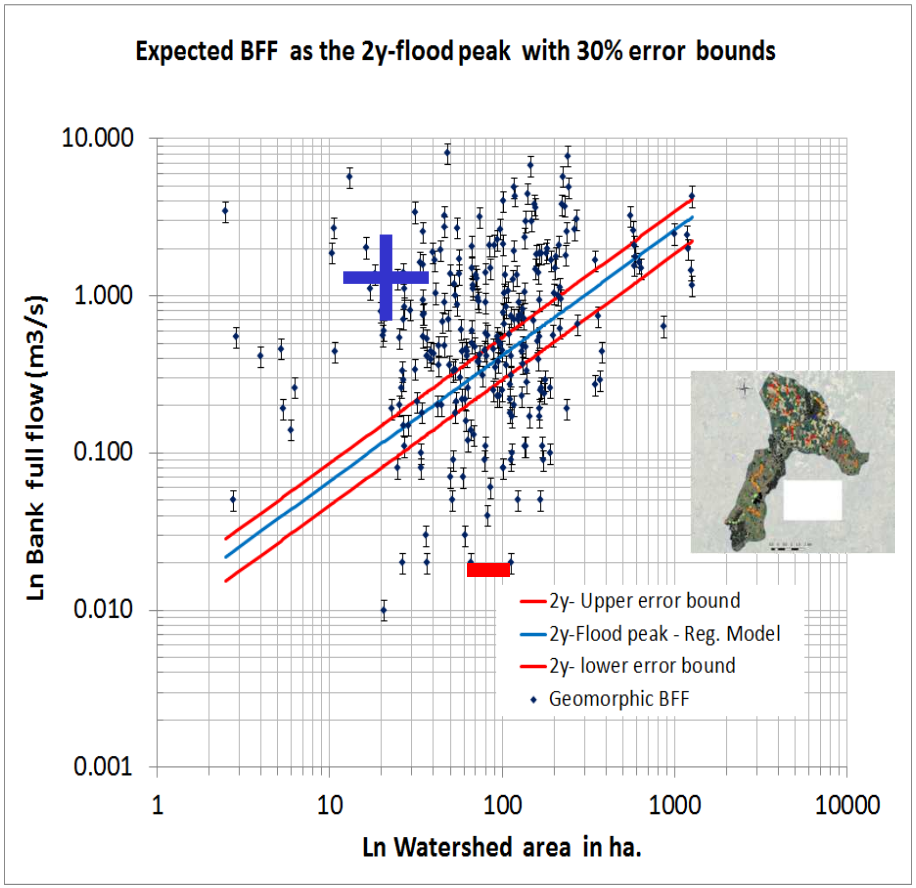


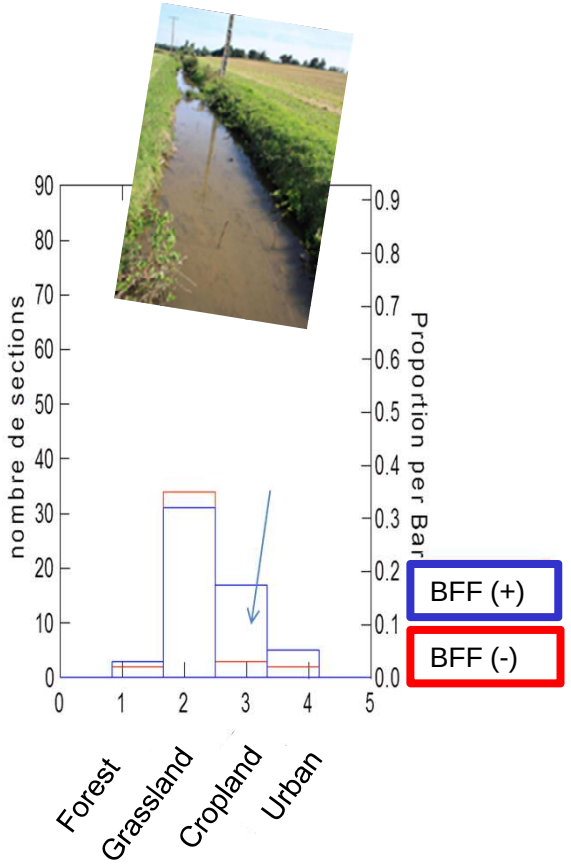


** 2y- FP = baseline cond.*

12 gauges stations, common period of 13 years, near present conditions, 9.3 to 468 km2

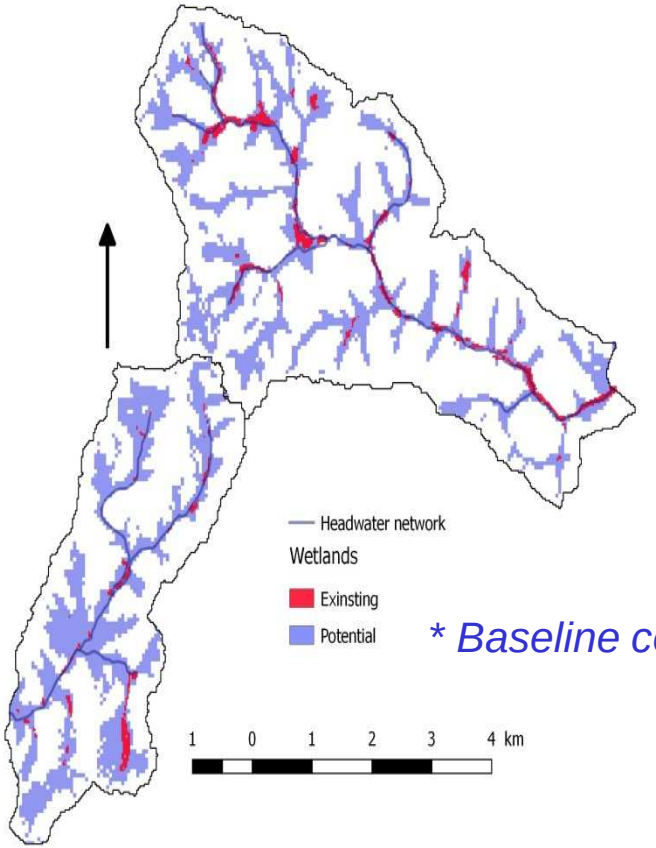
Bank full flow & expected return period range



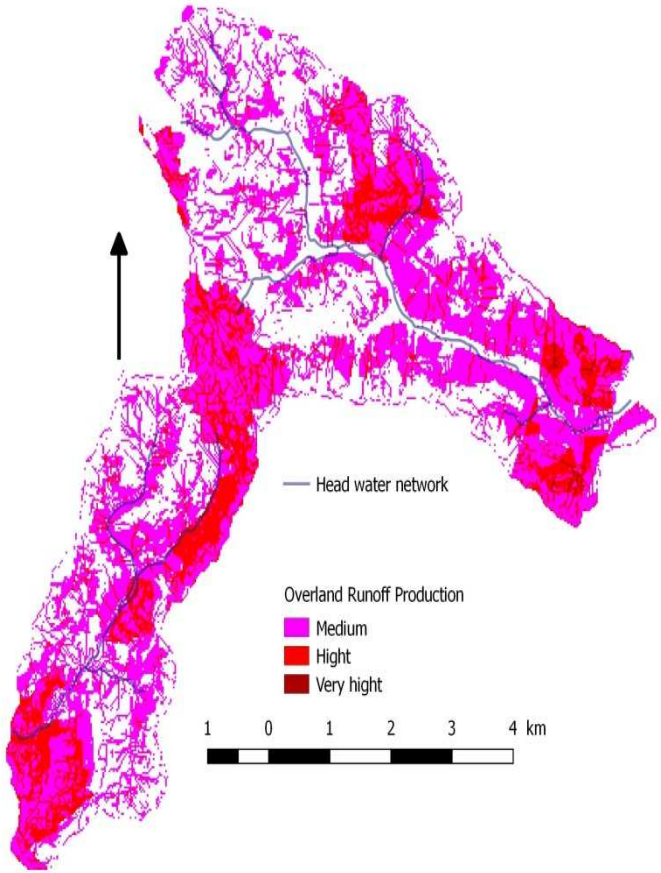


Riverside LandUse types

Headwater connected lands – opportunities?



** Baseline condition*



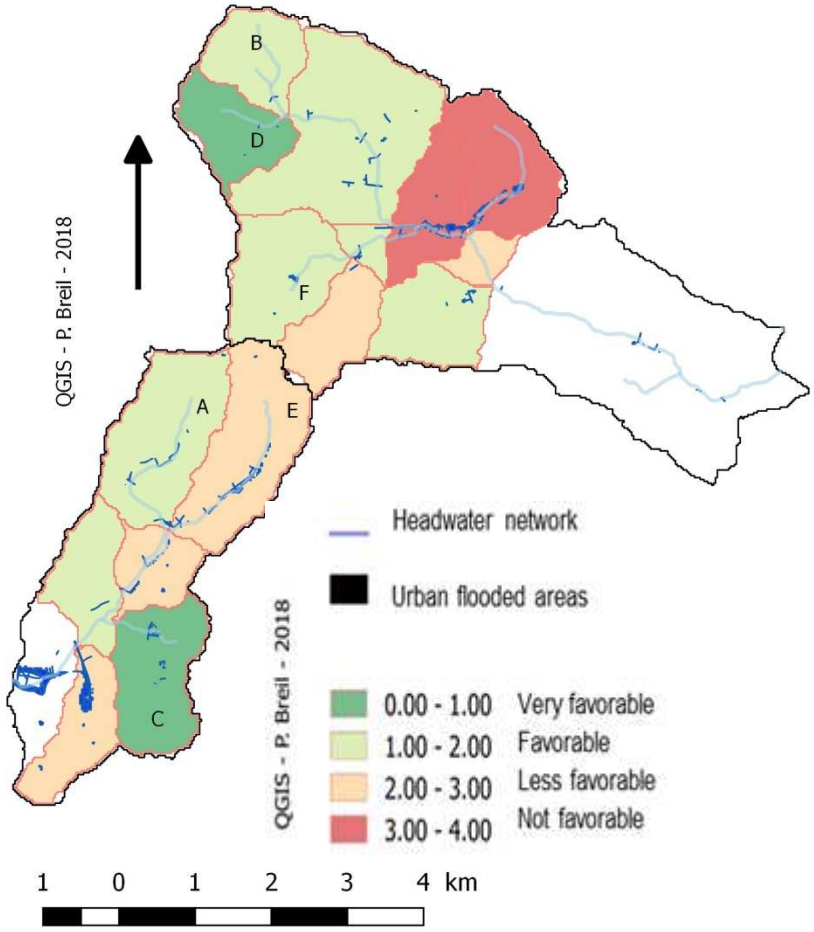
Applying EcoHydrology Principles

Overland Runoff Interception efficiency :

-> Ratio of

Intense runoff production area
to
Potential wetland area

in headwater sub-watersheds



Headwater degradation induces flooding and low quality water in downstream.

The EcoHydrological restoration of related ESs requires :

- *The definition of baseline conditions (regional flood peak model; potential wetlands)*
- *Understanding of water flow pathways*
- *Spatial analysis of opportunities in connected lands*
- *Develop channel restoration a/o eco-engineering*

Ecohidrología es un concepto de la UNESCO para la gestión integrada del agua

Muchas gracias por su atencion

¿ Preguntas ?