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

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# 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?*





# What is Ecohydrology?

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# IHP's Eighth Phase



# 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 **Water**, **Biodiversity**, **Ecosystem Services** for society, **Resilience** to climatic changes and **Cultural dimension** (WBSRC), all in order to achieve sustainability in both ecosystems and human population

# 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 be based on **trans-disciplinary approaches** recognizing **cultural and time dependent dimensions** of human wellbeing.



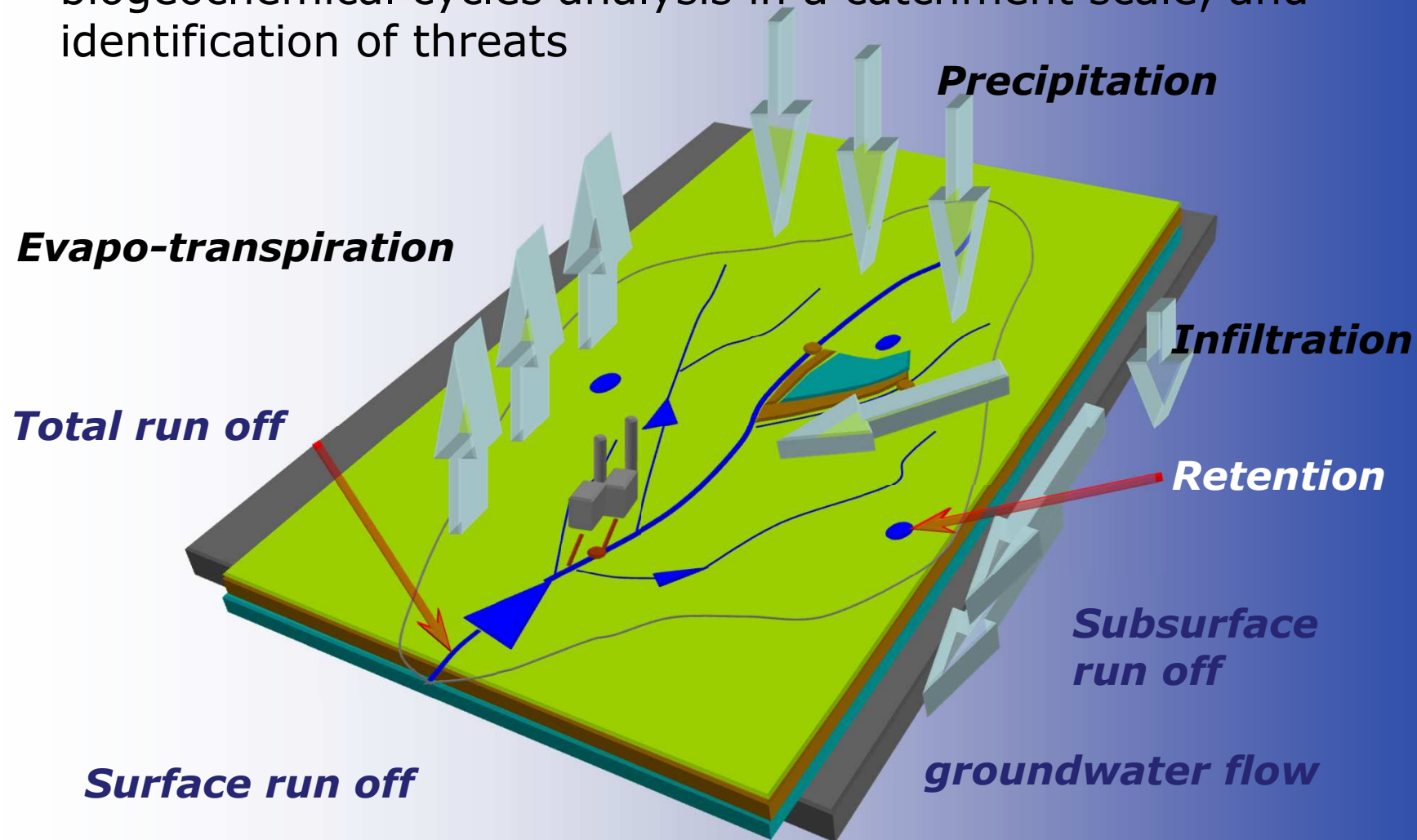
United Nations  
Educational, Scientific and  
Cultural Organization



International  
Hydrological  
Programme

## ***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

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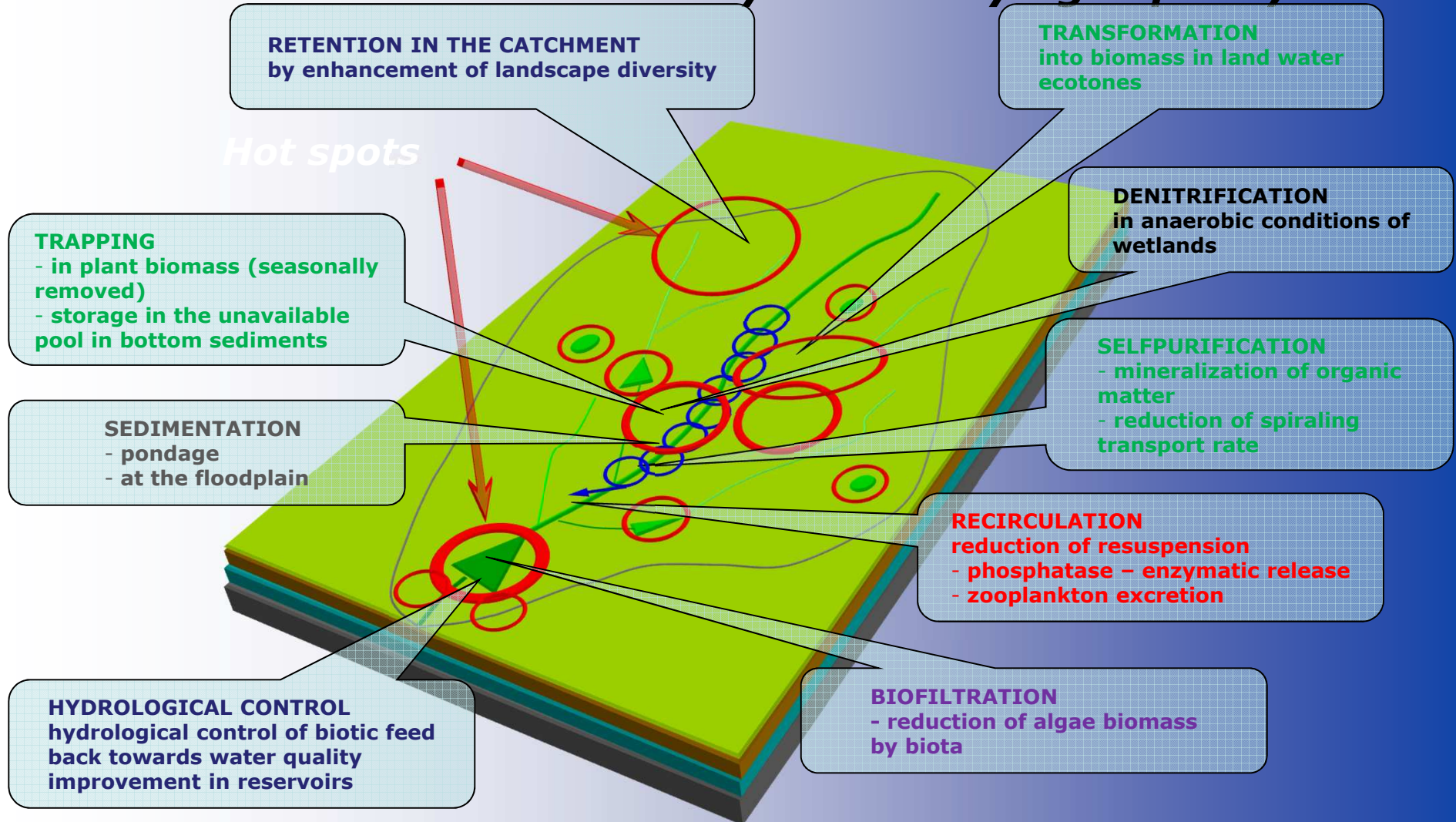
**kb2**

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

Aquaculture

Reservoir – Hydrobiomanipulation

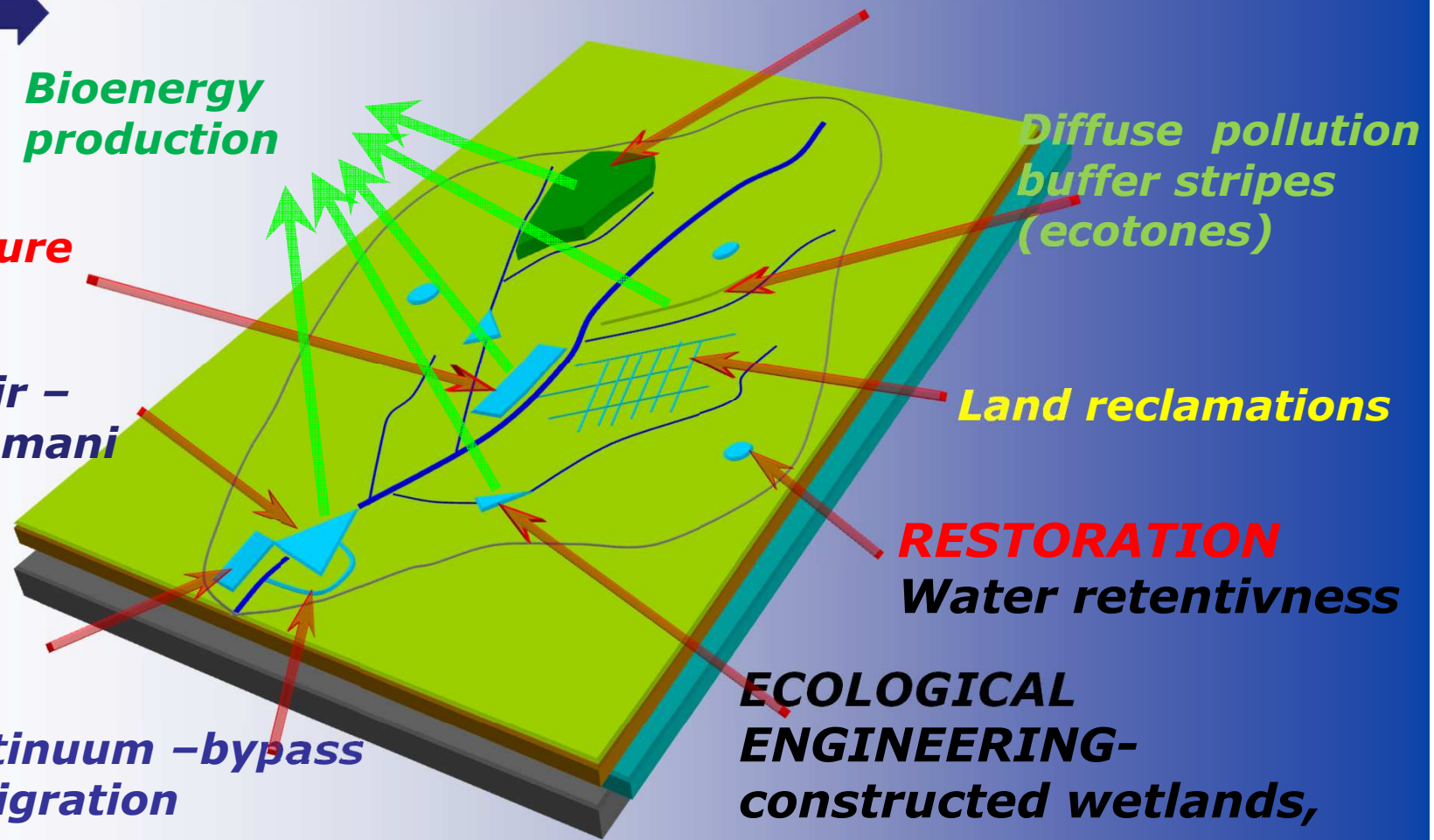
Diffuse pollution buffer stripes (ecotones)

Land reclamations

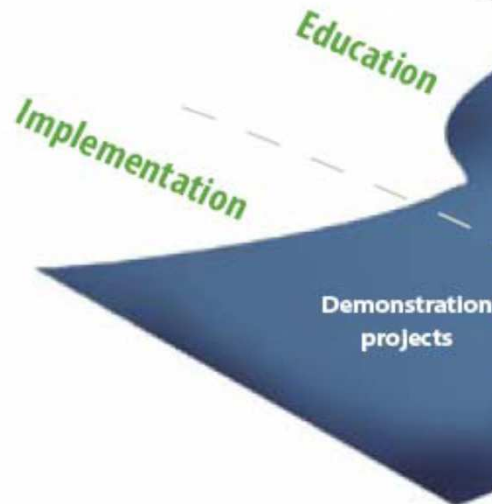
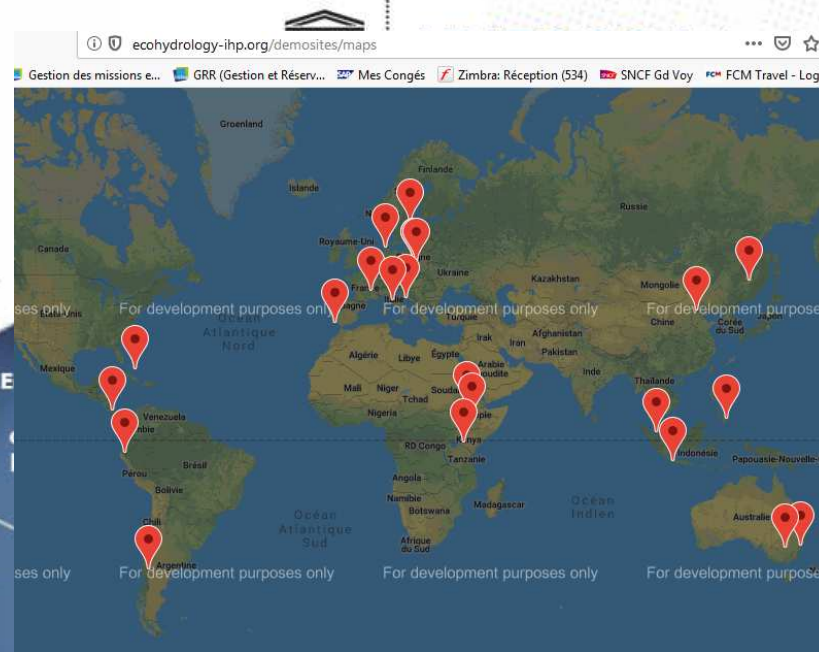
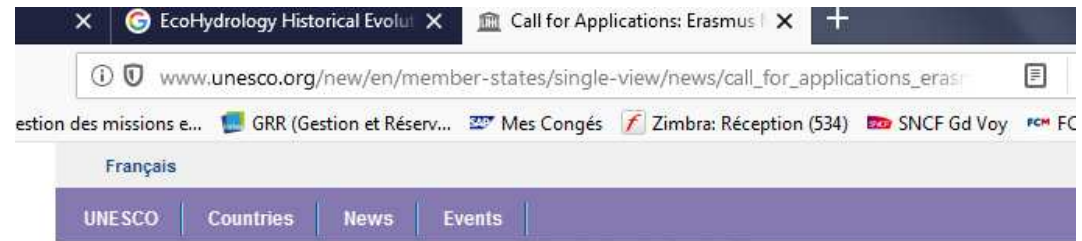
RESTORATION  
Water retentivness

River continuum –bypass for fish migration  
Sediment release/use system

ECOLOGICAL ENGINEERING-constructed wetlands, ecotones



# Ecohydrology Action Areas





## Four ecohydrology engineering solutions:

FAUNATECHNOLOGY



PHYTOTECHNOLOGY



HYDROLOGICAL FLOW



ECOHYDROLOGICAL  
INFRASTRUCTURE



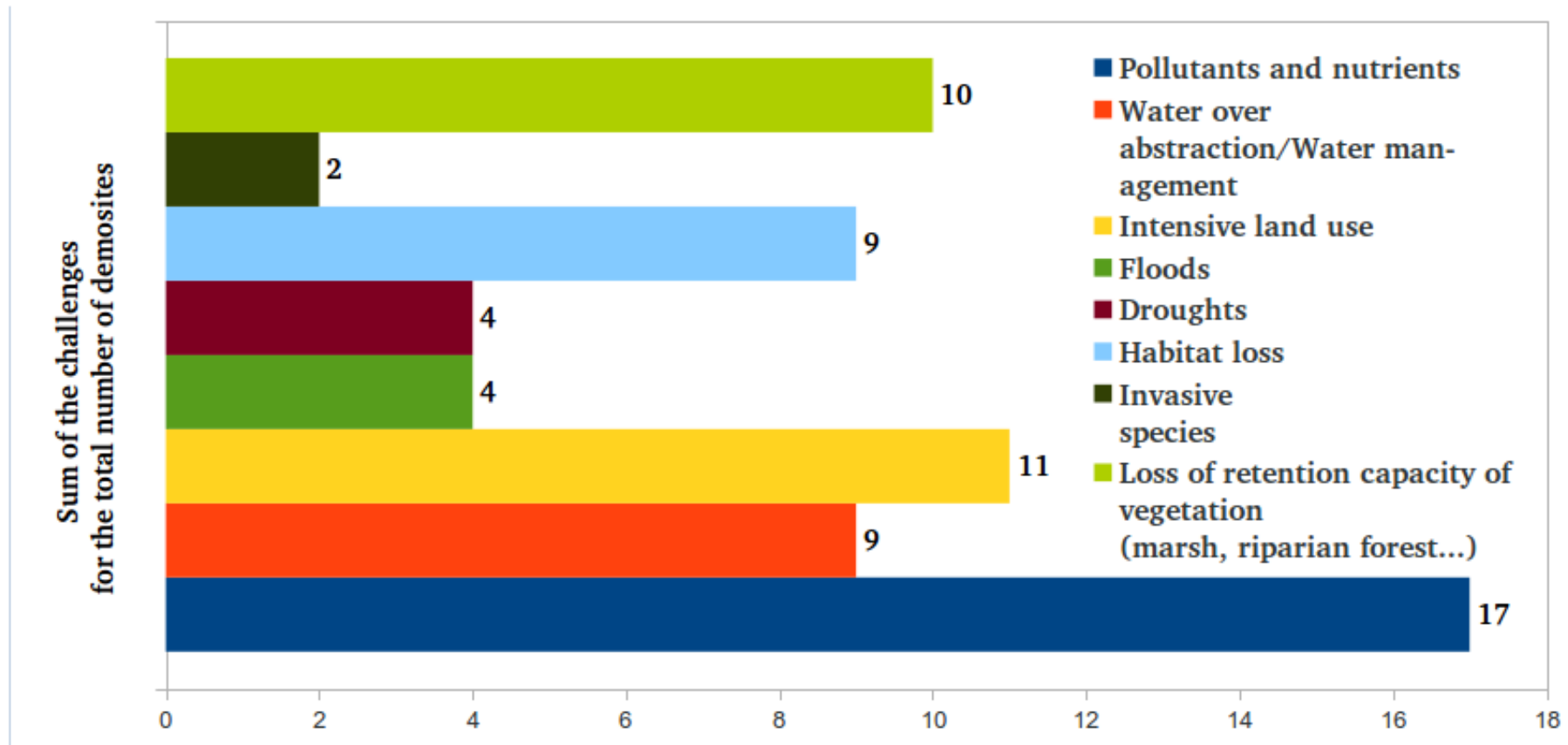
**65%** of the demosites are using the **phytotechnologies** as EH solution.

48% -> hydrological flow

43% -> ecohydrological infrastructure

22% -> faunatechnology

# Major issues addressed by the demonstration sites

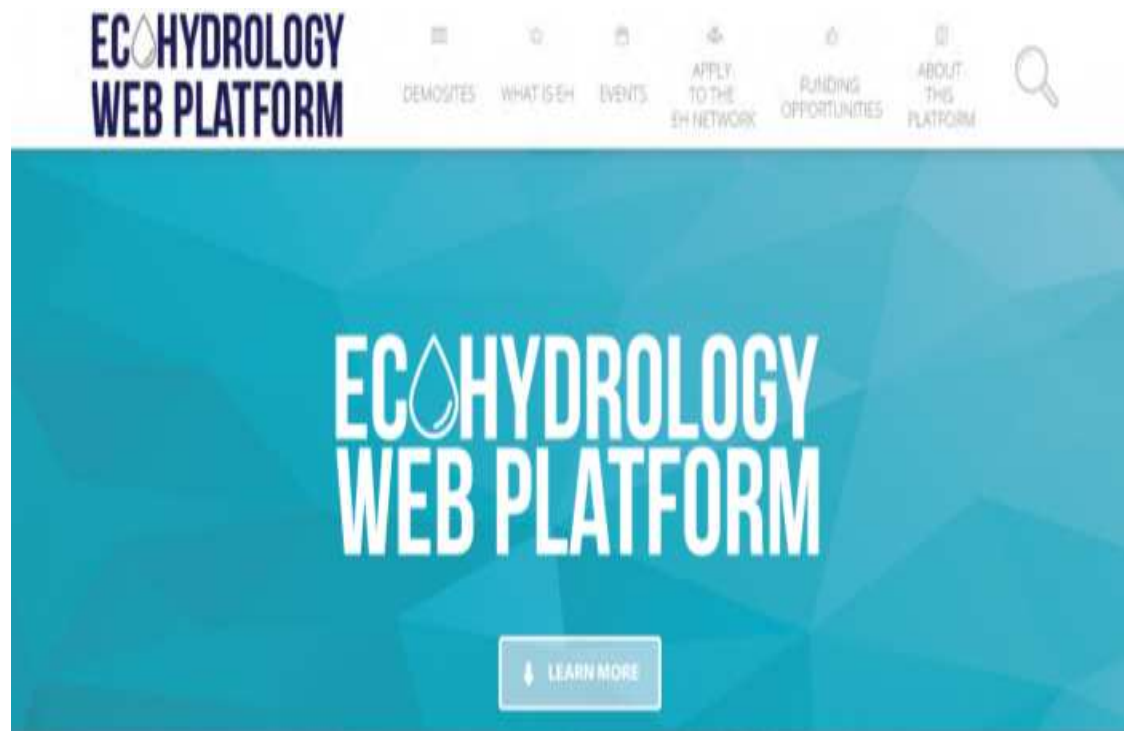


The three main threats are the excessive presence of pollutants and nutrients, intensive land use and loss of retention capacity of vegetation.

# 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](http://ecohydrology-ihp.org)



# Apply to the EH network

## APPLY TO THE EH NETWORK

If you have a long-term engagement with a solution-oriented project that applies a ecohydrological implementation principle, you are welcome to postulate to the Ecohydrology Network. The main benefit of being part of the network is the visibility that the project can get, deploying to a wider audience: more people can know the project. Every year UNESCO-IHP and specifically the Ecohydrology Programme reach several seminars and related events around the world disseminating the Ecohydrology concept and the demonstration sites information. Additional, an intangible good reputation is acquired by projects inside of the network, an additional value regarding funds solicitation.

Application to become a UNESCO Ecohydrology Demonstration site will be done through a two-step on line questionnaire, "demonstration cards" will be constructed through an automatic user friendly process.

First step: provide a main description of the demonstration site that will be submitted to the Scientific Advisory Committee.

Second step: If accepted, you'll have access to the EH Technical Form, a second and more detailed questionnaire (8 sections).

Know more by clicking on the link below:



## MINIMUM CRITERIA FOR THE ESTABLISHMENT OF NEW ECOHYDROLOGY DEMONSTRATION SITES

Demonstration site should aim at enhancement of ecological and sustainability status in the catchment in four dimensions: water quality and/or quantity, biodiversity, ecosystem services and resilience (WBSR). Since the core of Ecohydrology is the analysis (understanding of processes) and regulation ("dual regulation") of water-biota interplay, the proposed demonstration sites should be able to demonstrate to what extent it considers/expands the existing knowledge and understanding of this interplay, and the methods to achieve this goal.

There are three key objectives to establish new ecohydrology demonstration sites:

- Synthesize knowledge gaps for addressing ecohydrological issues related to critical water ecosystems, including those in arid and semiarid zones, coastal areas and estuaries, and urbanized areas;
- Showcase how better knowledge of the interrelationships between the hydrological cycle, livelihoods and ecosystems can contribute to more cost-effective and environmental-friendly water management;
- Demonstrate systems solutions and technology transfer opportunities through North-South and South-South linkages in order to harmonize the ecosystem potential with societal needs.

The Ecohydrology concept should operate in demonstration sites on three levels:

- INFORMATION (monitoring, collecting of empirical data, defining interactions and hydrology-biota-society feedbacks);
- KNOWLEDGE (defining patterns and dynamics, describing and explaining processes, understanding water-biota interplay);
- WISDOM (ability to formulate policy, principles for action, problem solving by system solutions, stakeholders involvement, education, implementation).

- 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](http://ecohydrology-ihp.org)



E COHYDROLOGY DE MONSTRATION SITES			
Region	Site	Country	Downloads Count
Latin America & Caribbean	CATACOCCHA-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
	A SELLA 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
<b>September 2018</b>		<b>TOTAL</b>	<b>6,945</b>



# Dissemination Material



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

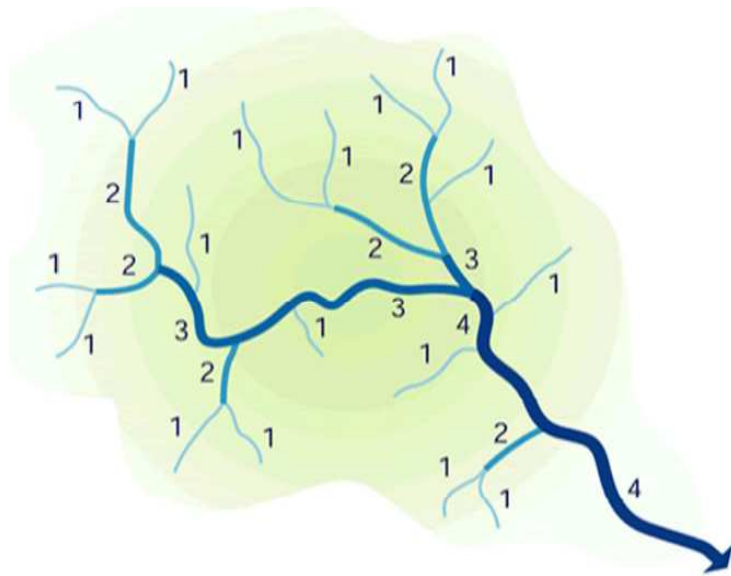
*Now available in English, Spanish and Chinese*

[unesdoc.unesco.org/images/0026/002657/265736s.pdf](https://unesdoc.unesco.org/images/0026/002657/265736s.pdf)

# 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 ?

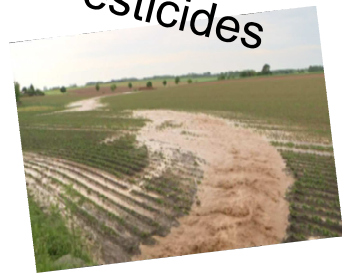


Cropland



Straightening

Urbanization



Pesticides

Fertilizers



Enlargement



erosion

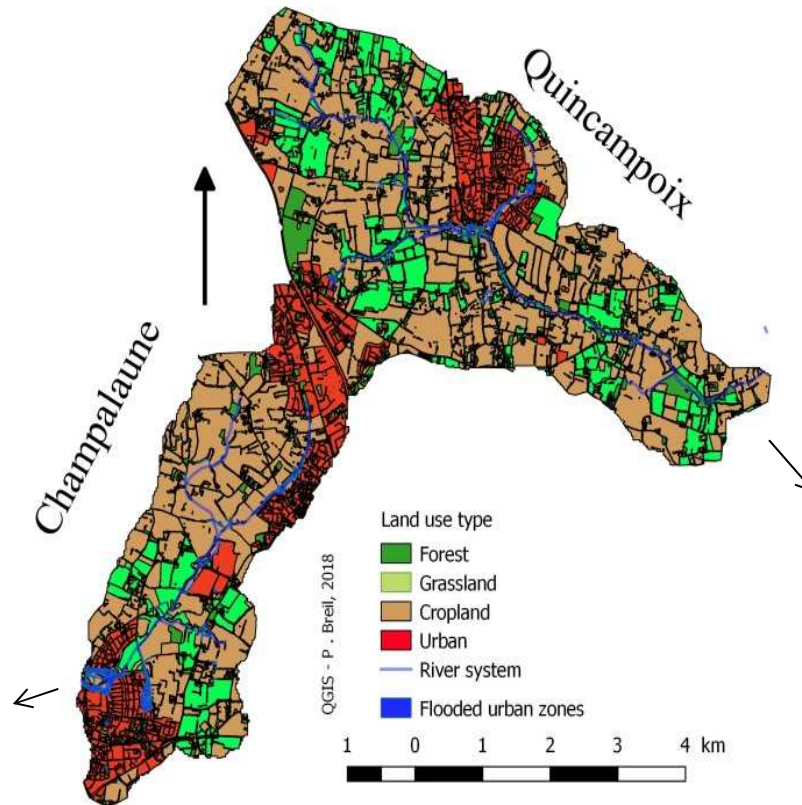


clogging





*Study area*

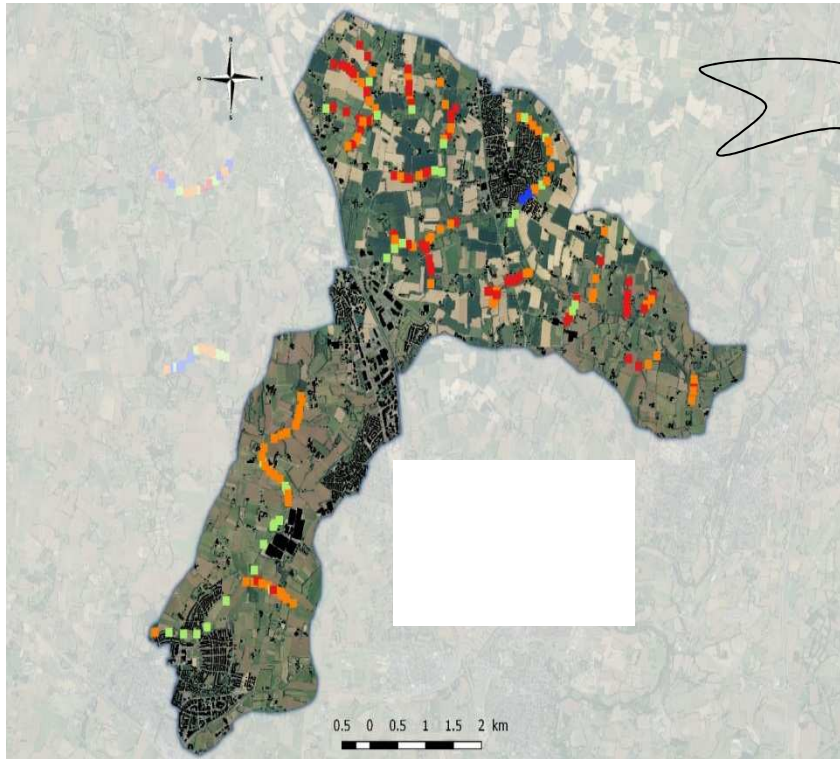


1/ Analyze the degradation level of connected lands and river channel, considering “baseline conditions”.

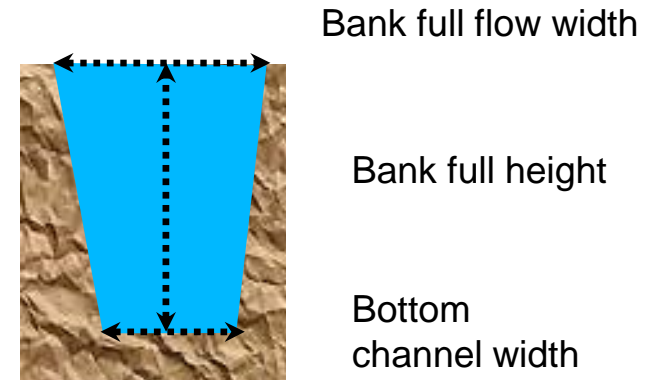
2/ Look for opportunities to recover part of the lost ecosystem services using the spatial distribution of their potential.



# Hydrogeomorphic study of 192 river sections



Collection of numerous geomorphic features..



Mean local bottom gradient

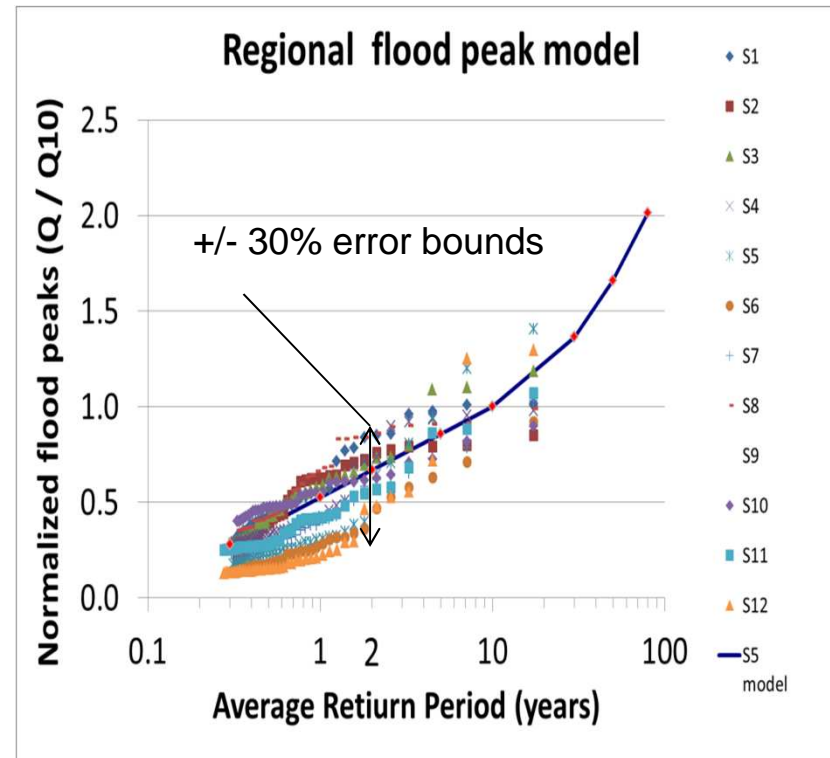
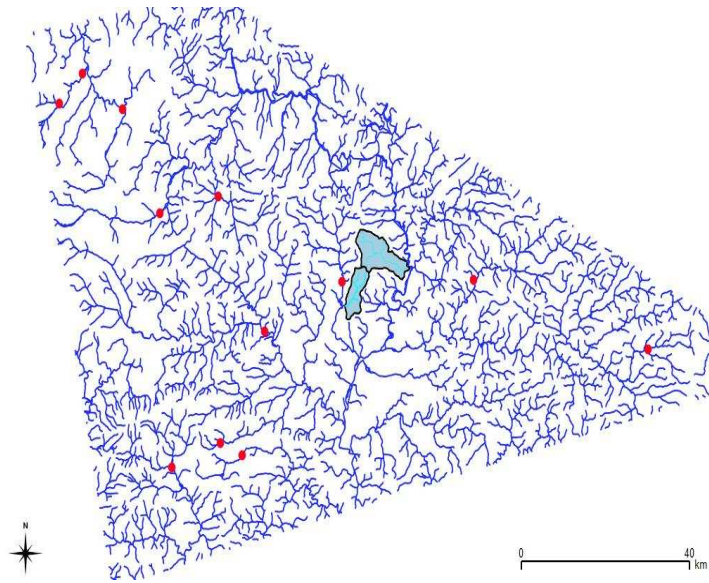
Roughness coef.

*Manning-Strickler eq.*

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



# Building of a regional hydrological model....



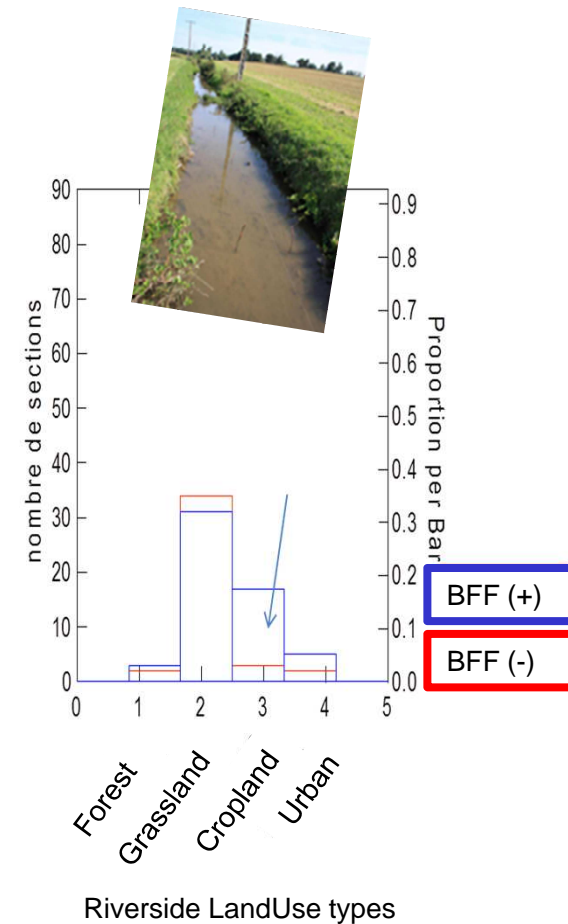
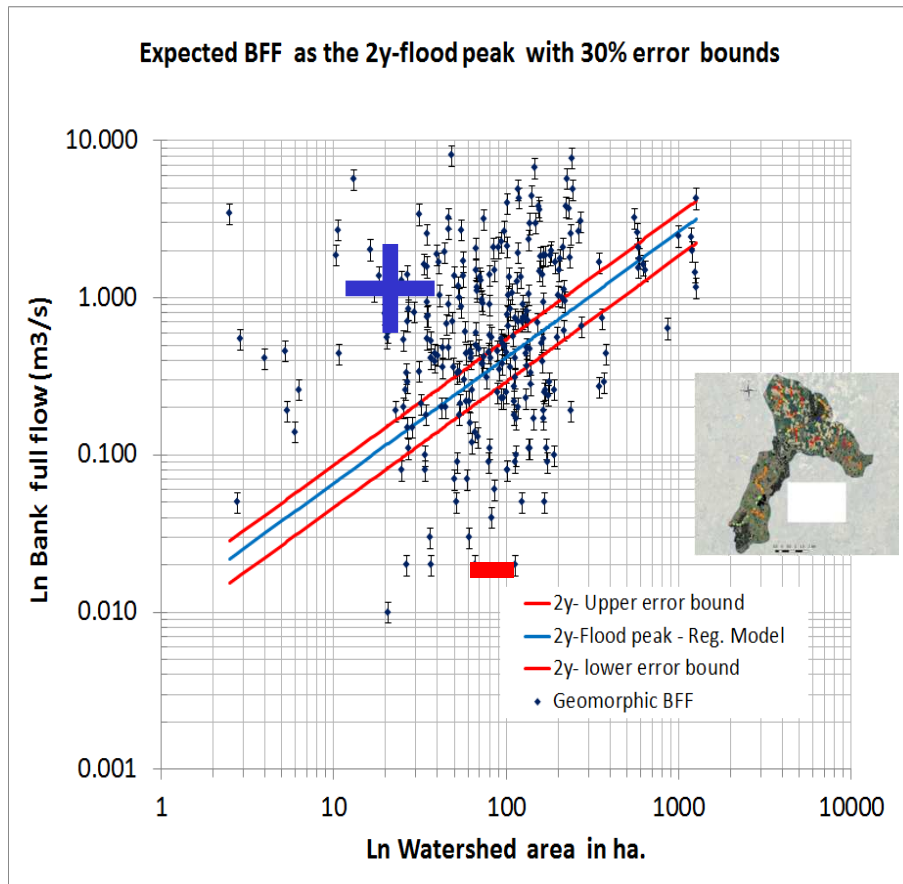
\* 2y- FP = baseline cond.



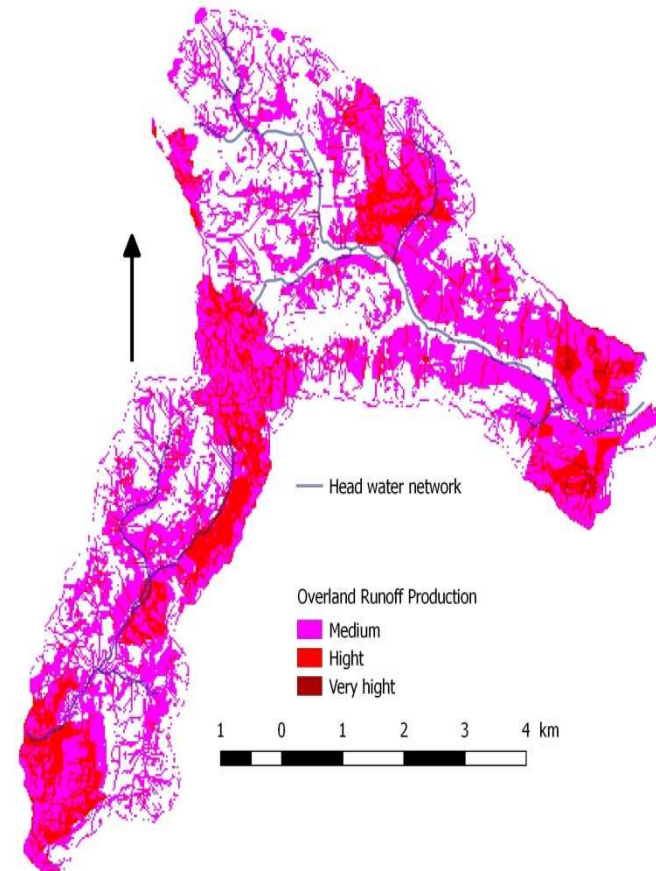
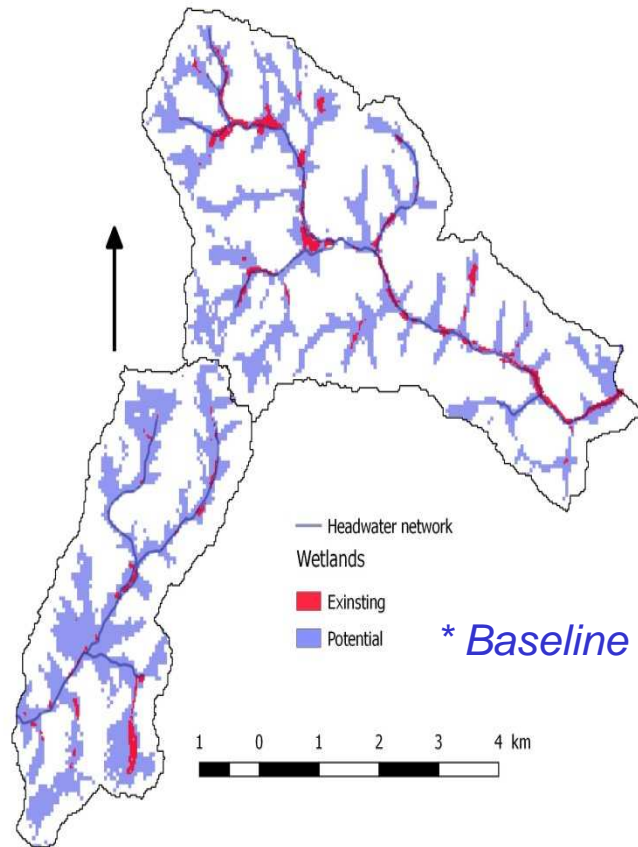
12 gauges stations, common period of 13 years, near present conditions, 9.3 to 468 km<sup>2</sup>



# Bank full flow & expected return period range



# Headwater connected lands – opportunities?





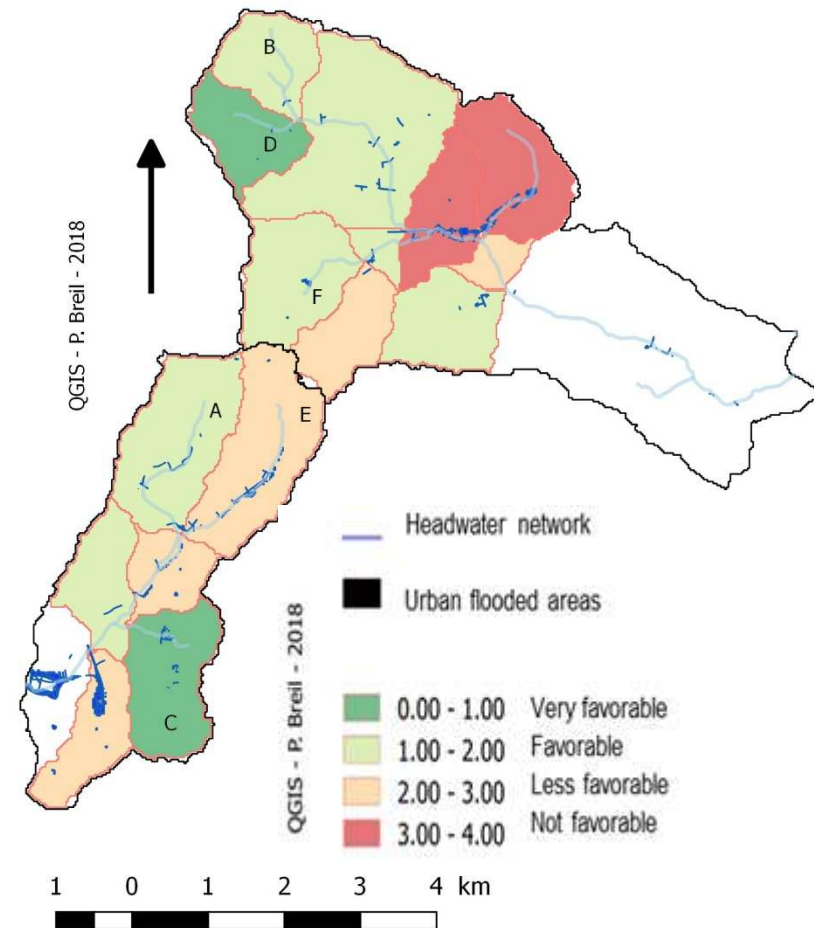
# Applying EcoHydrology Principles

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

UNESCO  
"Construir la paz en la mente de los hombres y de las mujeres"

Inicio » Garantizar el suministro de agua » Hidrología (PHH) » PHH-VIII: Garantizar el suministro de agua

## PHH-VIII: Garantizar el suministro de agua

Respuestas a los desafíos locales, regionales, y mundiales

WATER-RELATED DISASTERS AND HYDROLOGICAL CHANGE  
GROUNDWATER IN A CHANGING ENVIRONMENT  
ADDRESSING WATER SCARCITY AND WATER QUALITY  
WATER AND URBAN SETTLEMENTS OF THE FUTURE  
ECOHYDROLOGICAL ENGINEERING: A KEY TO WATER SECURITY  
EDUCATION, KEY TO WATER SECURITY

WATER SECURITY, ADDRESSING LOCAL, REGIONAL AND GLOBAL CHALLENGES

La situación del agua  
Los desafíos relacionados con el agua están tomando una dimensión global en cuanto a los efectos asociados a la cantidad y la calidad son inadecuados

UNESCO  
"Construir la paz en la mente de los hombres y de las mujeres"

Inicio » Garantizar el suministro de agua » Hidrología (PHH) » Ecohidrología: creación de armonía para un mundo sustentable » Dimensión hidrológica de una cuenca – identificar riesgos potenciales y oportunidades para el desarrollo sustentable

## Dimensión hidrológica de una cuenca – identificar riesgos potenciales y oportunidades para el desarrollo sustentable

La cuantificación e integración de los procesos hidrológicos y biológicos a escala de cuenca se basa en el supuesto de que los factores abióticos son de primera importancia y se vuelven estables y predecibles cuando las interacciones bióticas comienzan a manifestarse. La cuantificación abarca los elementos clave del ciclo hidrológico (precipitación, evapotranspiración), los patrones de los pulsos hidrológicos a lo largo del continuum del río y el monitoreo de las fuentes de contaminación puntuales y no puntuales, erosión y degradación del hábitat. La integración de la información sobre los aportes del ciclo hidrológico y la distribución económica proporcionan un patrón de regulación de procesos dirigidos al uso sustentable de los recursos hídricos y medioambientales. El PHI apoyará iniciativas de investigación y desarrollo de capacidades que tengan por objetivo mejorar nuestro entendimiento de los vínculos internos entre procesos ecohidrológicos a nivel de cuenca, con especial énfasis en la implementación de los sitios de demostración ecohidrológicos de la UNESCO.

**Objetivos Específicos**

- Incrementar el conocimiento base y seguir desarrollando enfoques para la reducción de amenazas como inundaciones y sequías, reivindicando el carácter estocástico de los procesos hidrológicos en cuencas, mediante la armonización de la infraestructura hidrotécnica con la distribución y el manejo de ecosistemas retenedores de agua.
- Apoyar la investigación y el desarrollo de directrices para incorporar la comprensión del pasado en los Planes de Manejo de Cuencas Hidrológicas (p.ej. paleohidrología, patrones de sucesión ecológica, dinámicas espacio-temporales de asentamientos humanos).
- Promover un modelo de desarrollo para reducir los niveles máximos de agua mediante la integración de conocimiento específico de ciencias

UNESCO  
"Construir la paz en la mente de los hombres y de las mujeres"

Inicio » Garantizar el suministro de agua » Hidrología (PHH) » Ecohidrología: creación de armonía para un mundo sustentable » Ecohidrología urbana – purificación de agua de lluvia y retención en el entorno urbano, potencial para mejoramiento de la salud y calidad de vida

## Ecohidrología urbana - purificación de agua de lluvia y retención en el entorno urbano, potencial para mejoramiento de la salud y calidad de vida

Las poblaciones urbanas exigen grandes demandas de recursos y servicios para vivir. Incluyendo agua, lo cual se convierte en una de las mayores causas de la crisis hidrológica mundial. La dinámica de expansión espacial de las ciudades se caracteriza por manchones altamente diversificados "hovedosos" que impactan la sustentabilidad de las ciudades. En consecuencia, la calidad de vida y la salud para el desarrollo de ciudades sustentables, de ahí la necesidad de un nuevo paradigma de manejo holístico de hidrológico, uno de los mayores impactos es el manejo del escurrimiento. Sin embargo, es posible lograr un cambio en la percepción del manejo de agua pluvial mediante la aplicación de mejores prácticas de gestión y, más allá de las prácticas hidrológicas para la retención de agua pluvial y su potabilización. La consideración de mejorar la retención del "verde" del plan espacial de la ciudad resulta en un amigable "paisaje urbano azul-verde", con un consumo de agua reducida, menor contaminación de contaminantes, así como mejoras en la salud humana y en los valores estéticos y culturales.

prácticas para la reducción de los niveles máximos del agua de lluvia urbana mediante el desarrollo de sistemas de retención del agua de lluvia. La planificación urbana sustentable, basada en combinación del diseño urbano sensible hacia el agua, así como las políticas para mejorar la calidad de vida, la economía de los sistemas urbanos y la adaptación a las variaciones...





**Muchas gracias por su atencion**

**¿ Preguntas ?**

