



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

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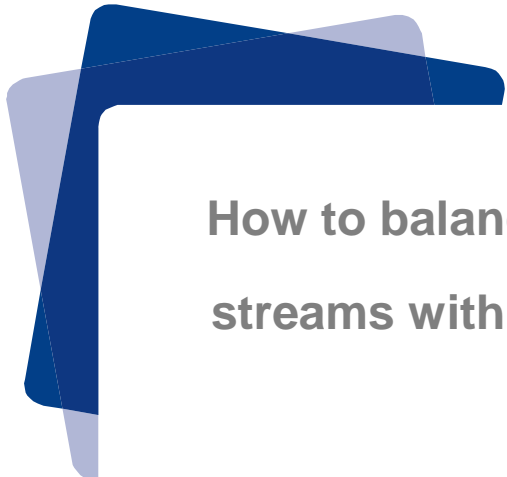
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## How to balance the ecohydrological functioning of headwater streams with their surrounding anthropogenic pressures?

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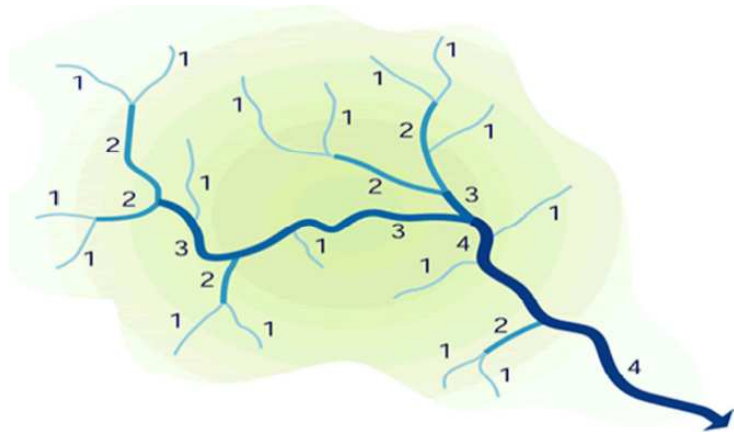
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*8th Global FRIEND-Water Conference -Hydrological Processes and Water Security in a Changing World - November 6-9, 2018 -Beijing, China*

## 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!*

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## *EcoHydrological role of headwaters*

- 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



Pesticides

Straightening



Fertilizers

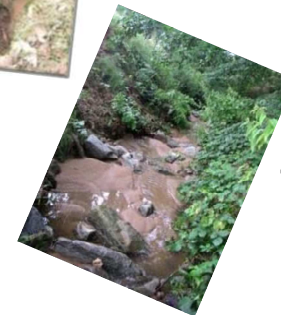
Enlargement

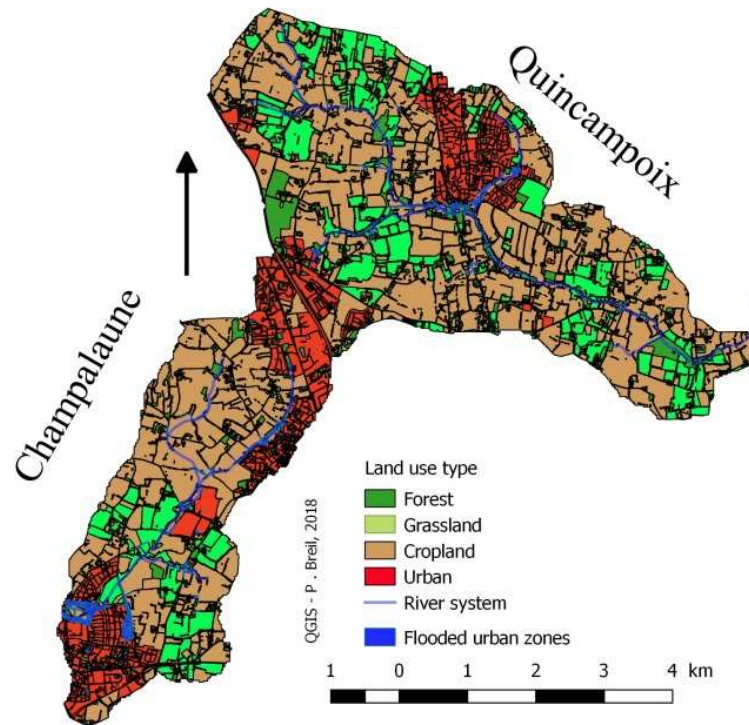


erosion



clogging



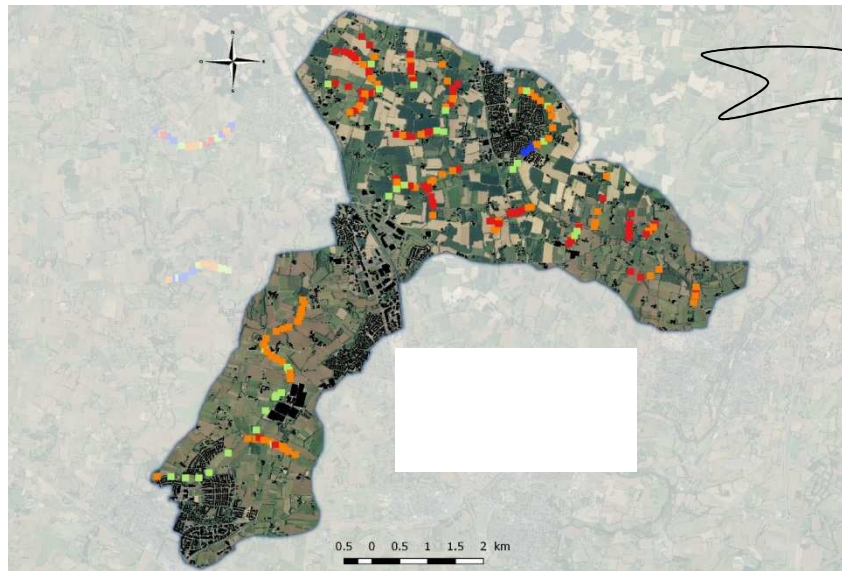


1/ Analyze the degradation level of connected lands and river channel, considering “baseline conditions”.

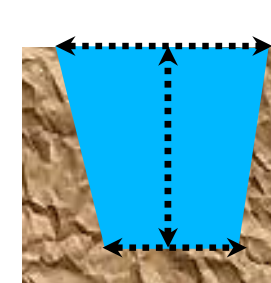
2/ Look for opportunities to recover part of the lost ecosystem services using the spatial distribution of their potential.



# Hydrogeomorphic study of 192 river sections



Collection of numerous geomorphic features..



Bank full flow width

Bank full height

Bottom  
channel width

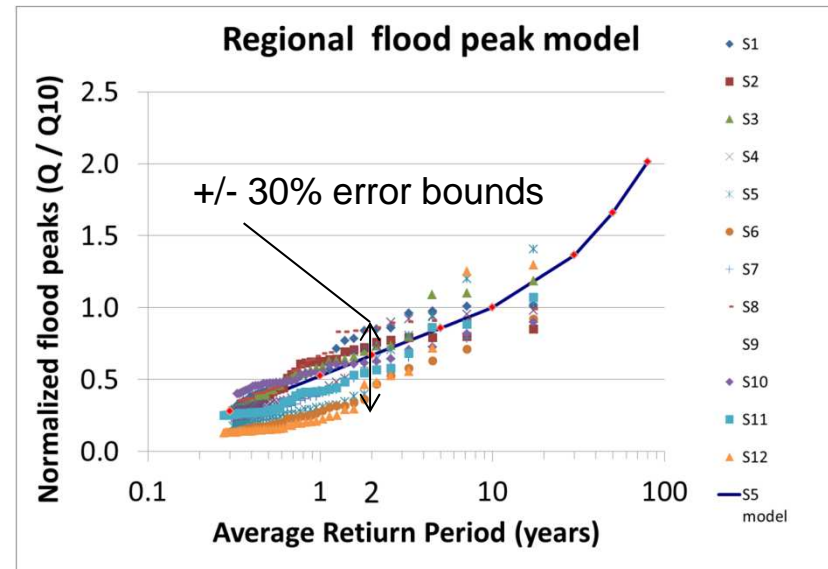
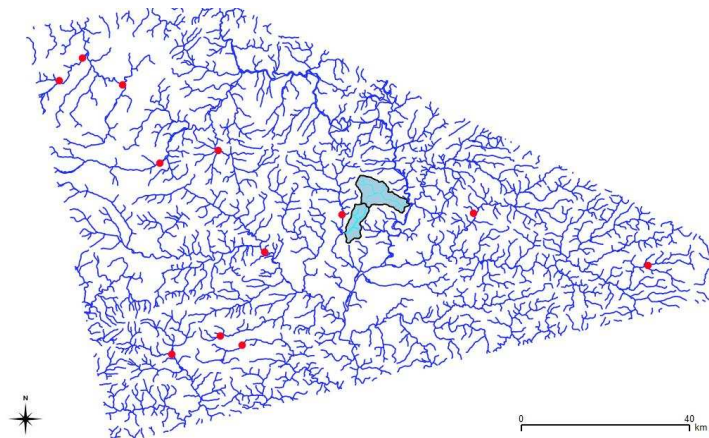
Mean local bottom gradient

Roughness coef.



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

## Building of a regional hydrological model....



\* 2y- FP = baseline cond.

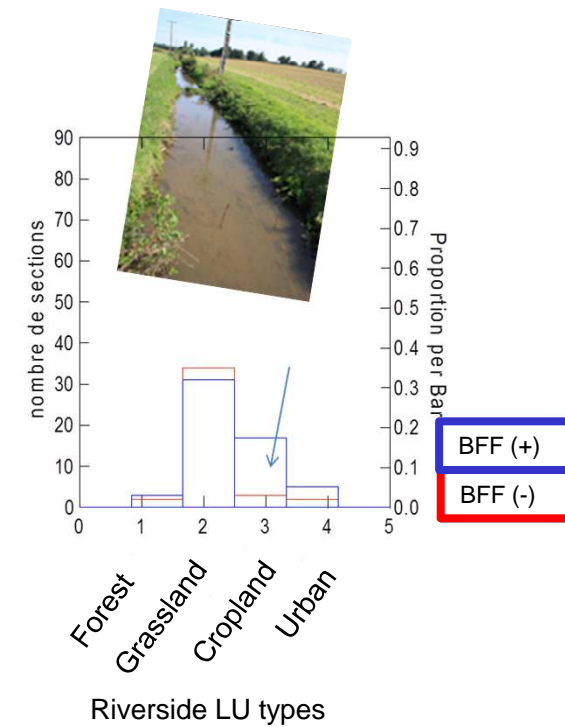
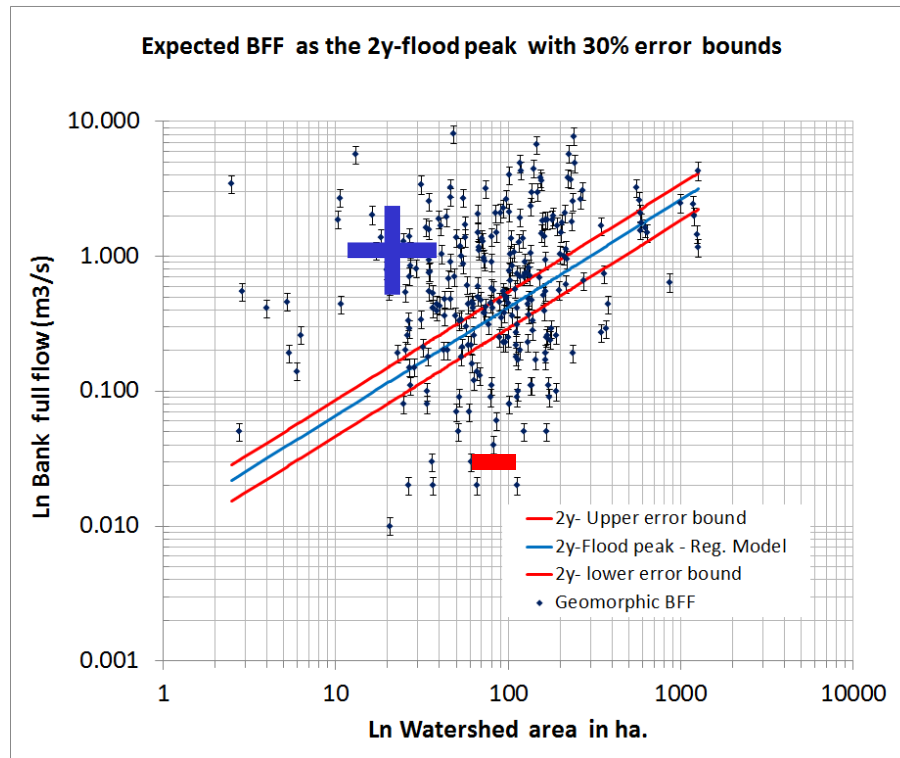


12 gauges stations, common period of 13 years, near present conditions, 9.3 to 468 km<sup>2</sup>

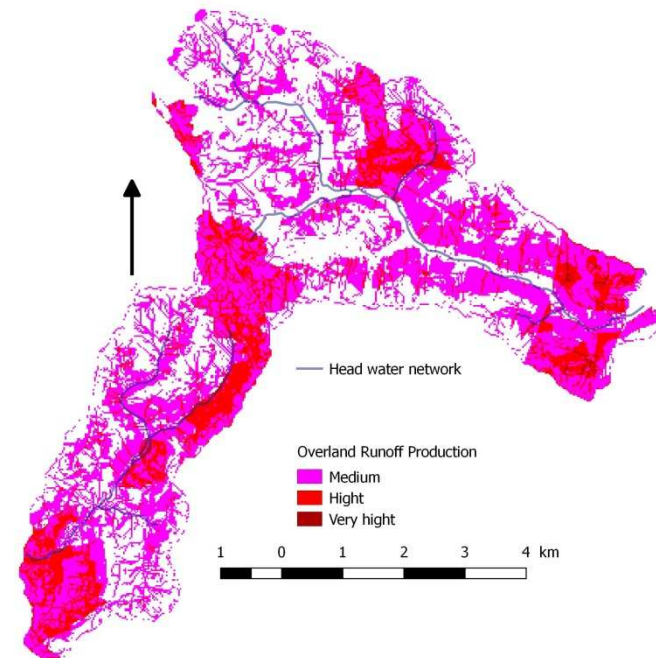
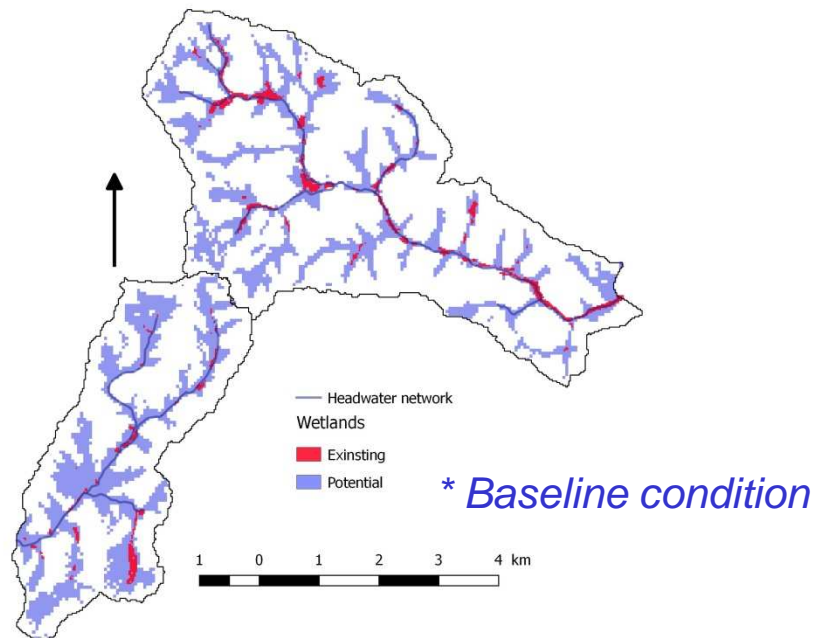
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## Bank full flow & expected return period range



## Headwater connected lands – opportunities?





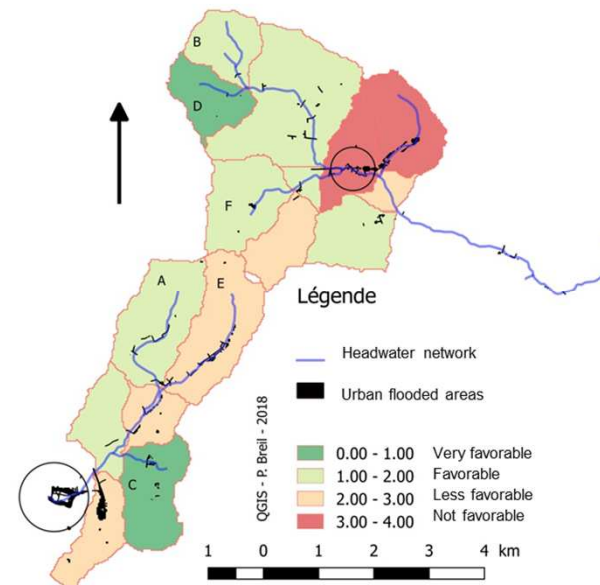
## Applying EcoHydrology Principles

*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 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*





# Thank you for your kind attention

*Next international EH conference: 2020, Faro, Portugal*



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