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

Pascal Breil

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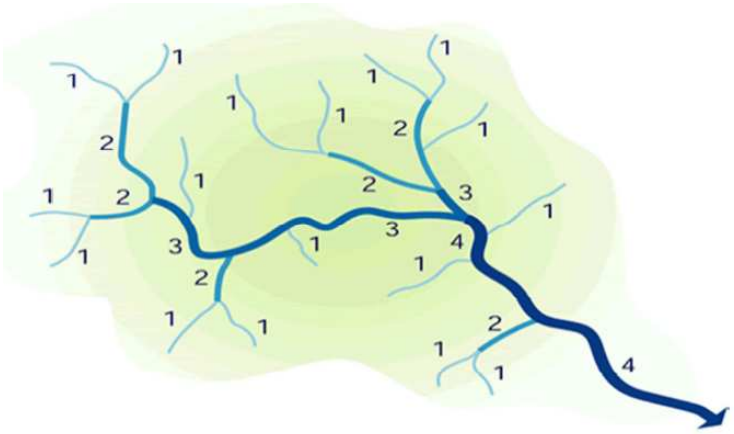
What are headwaters ?



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

- 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

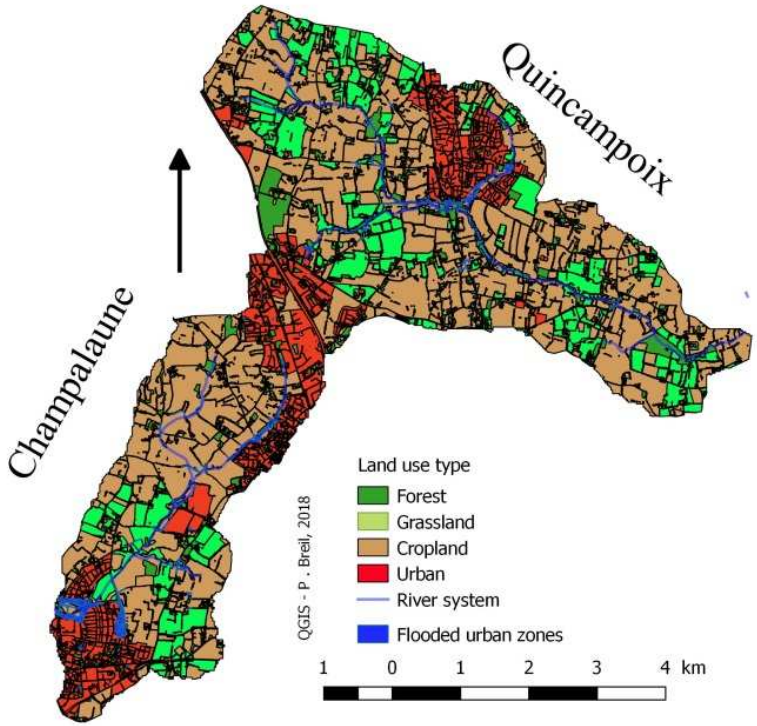
Fertilizers

Straigthening

Enlargement

erosion

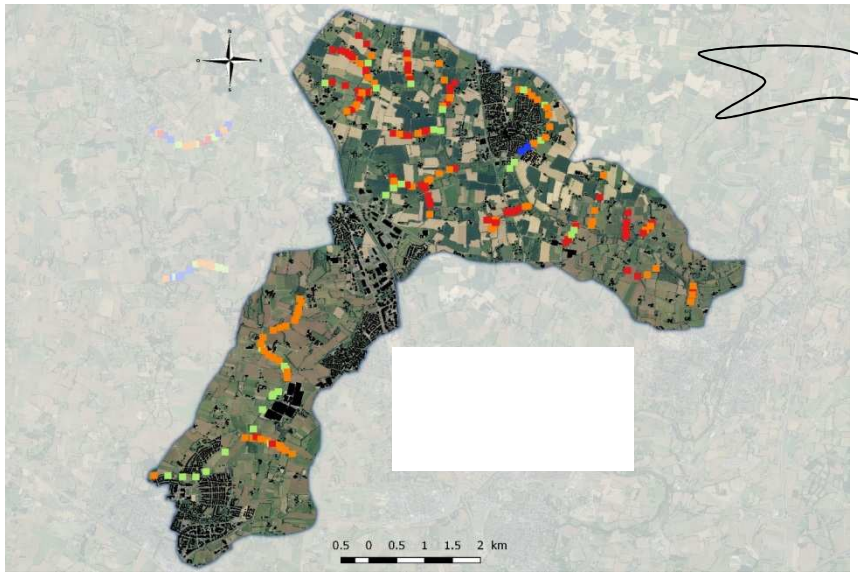
clogging



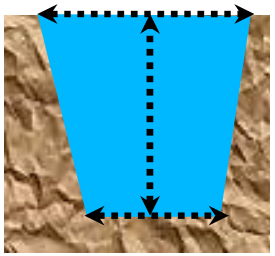
1/ Analyze the degradation level of connected lands and river channel, considering “baseline conditions”.

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

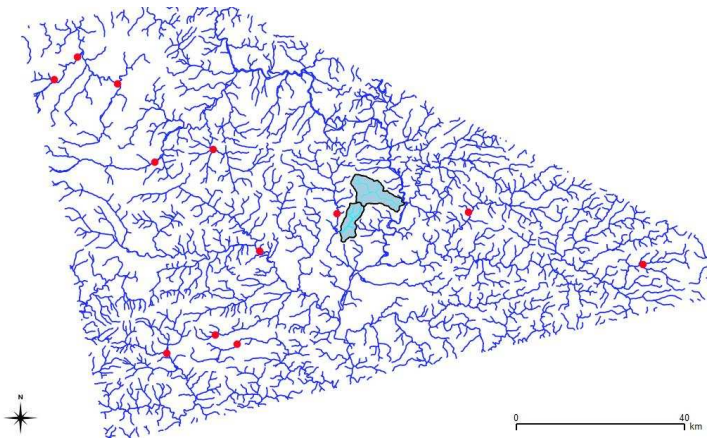
Bottom channel width

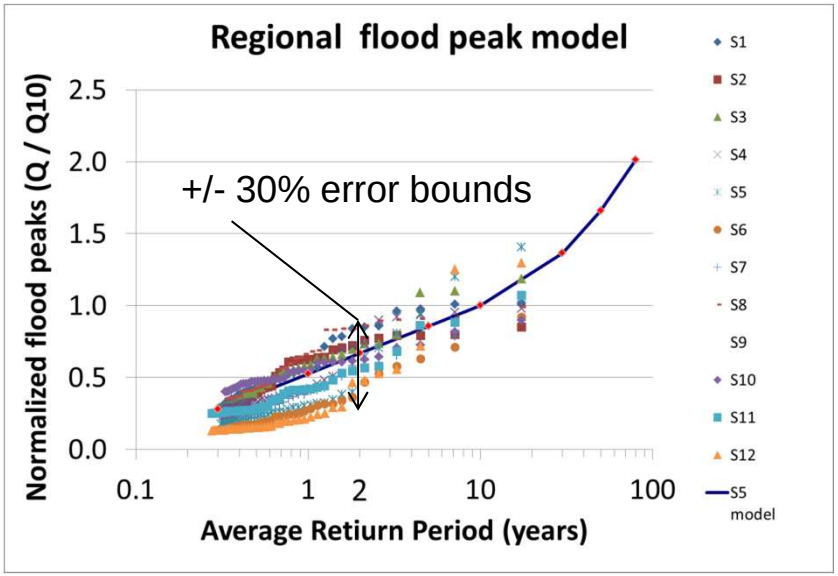
Mean local bottom gradient

Roughness coef.

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

Building of a regional hydrological model….

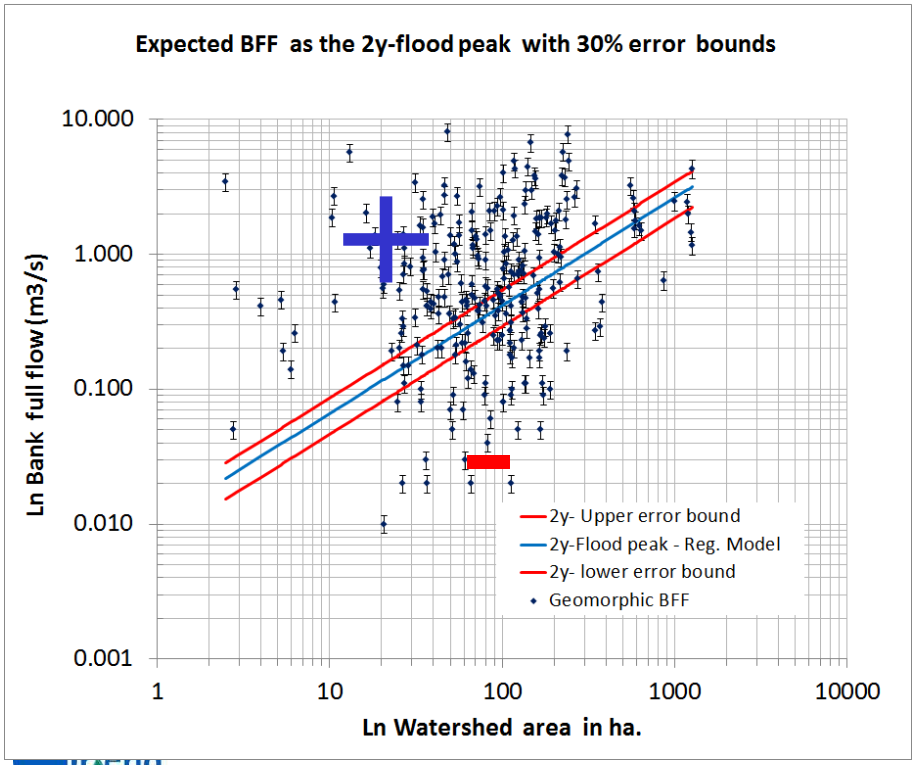


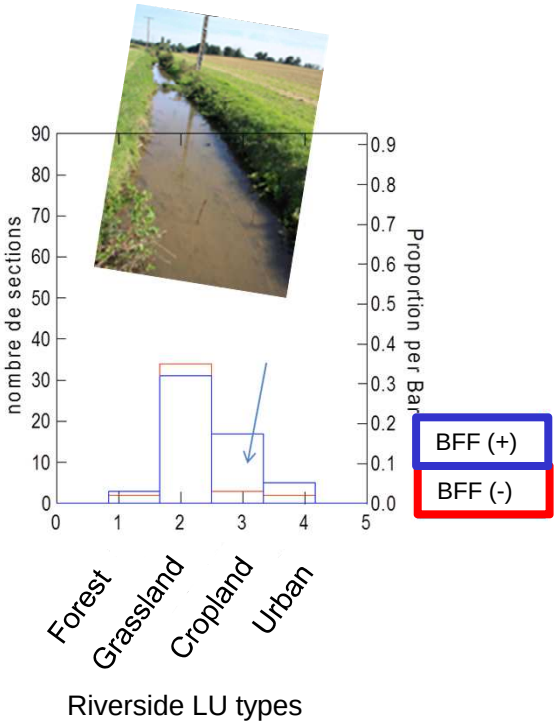


** 2y- FP = baseline cond.*

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

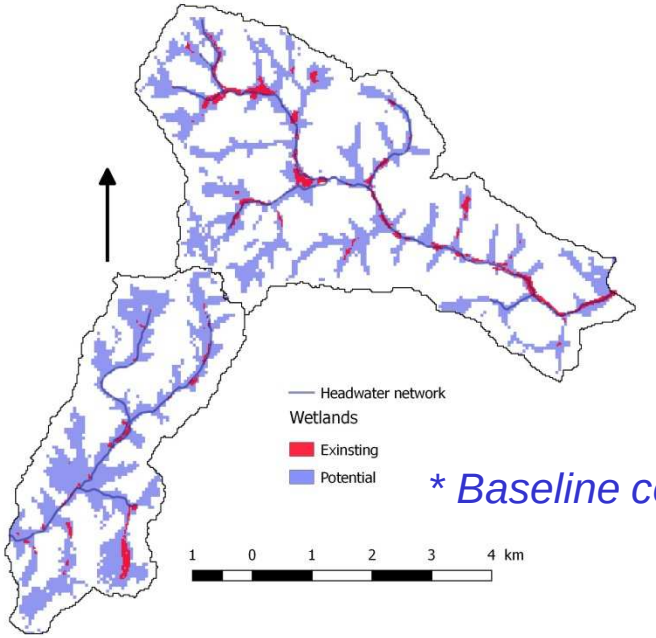
Bank full flow & expected return period range



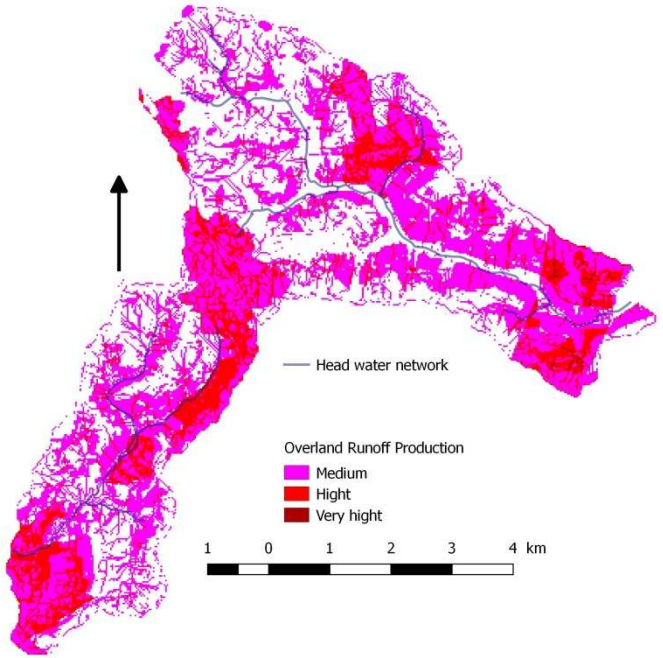


Riverside LU types

Headwater connected lands – opportunities?



** Baseline condition*



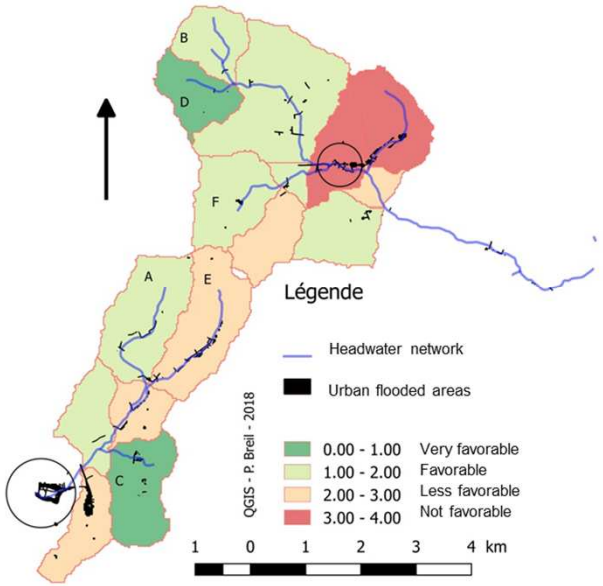
Applying EcoHydrology Principles

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 restoration of related ESs requires :

- *The definition of baseline condtiions (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