Evolution of river pollutions under the influence of local hydro-climatic changes - the example of the Bienne River (Jura Mountain, France)

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Research problem

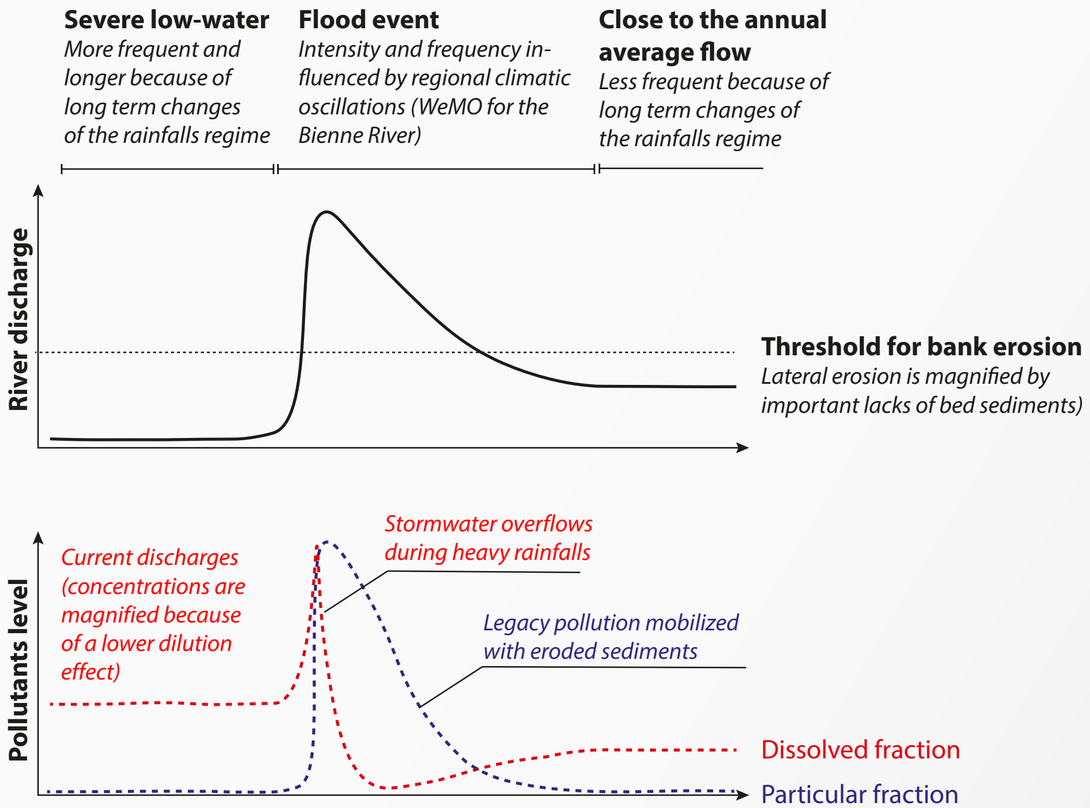
Despite an important decrease of pollutants discharges since the 1990s, the Bienne river has been regularly affected by massive fish mortality over the 2012-2019 period, in relation with pollutions (metals and organic pollutants). In order to understand this phenomenon, this study introduces a transdisciplinary approach allowing to :
- (i) analyse spatial and temporal evolutions of pollutions in the Bienne River,
- (ii) evaluate potential ecotoxicological impacts associated,
- (iii) identify interactions with local hydro-climatic changes.

Methods

Metallic and organic pollutants were analysed over 6 stations set up along the Bienne River :
- in archived sediments coming from river banks and in a sedimentary core dated with a ^{137}Cs profil,
- in suspended matter collected with vertical traps during flood events,
- in the dissolved fraction of water with passive samplers exposed at different steps of the hydrological cycle and completed with samples during flood events.

Geochemical data were compared with ecotoxicological values in order to evaluate the potential impact of pollution levels. In addition, pluriannual hydrological evolutions were analysed with the recording of daily flows at the gauging stations of the Bienne River over the 1971-2019 period. In order to link the river hydrological analysis with the modification of the rainfall regim, due notably to the global climate change, satellite-based precipitation data (IMERG product) have been analyzed over the watershed for the 2000-2019 period.

Graphical abstract



Main results

River bank sediments

- High pollution levels in archived sediments for Bi, Cu, Pb, Sn, Zn and PAH
- Pollution reaches maximum dowstream Morez for metals and St Claude for PAH
- Historical metal industries and wood/coal combustions are the main sources

Sediment core

- General decrease of pollution levels since the late 1970s
- Reactivation of old pollution sources during the 2010s (same geochemical signal than in the 1960-1970s)
- Evidence of the influence of polluted banks erosion (same geochemical signal than in polluted banks)

Water monitoring

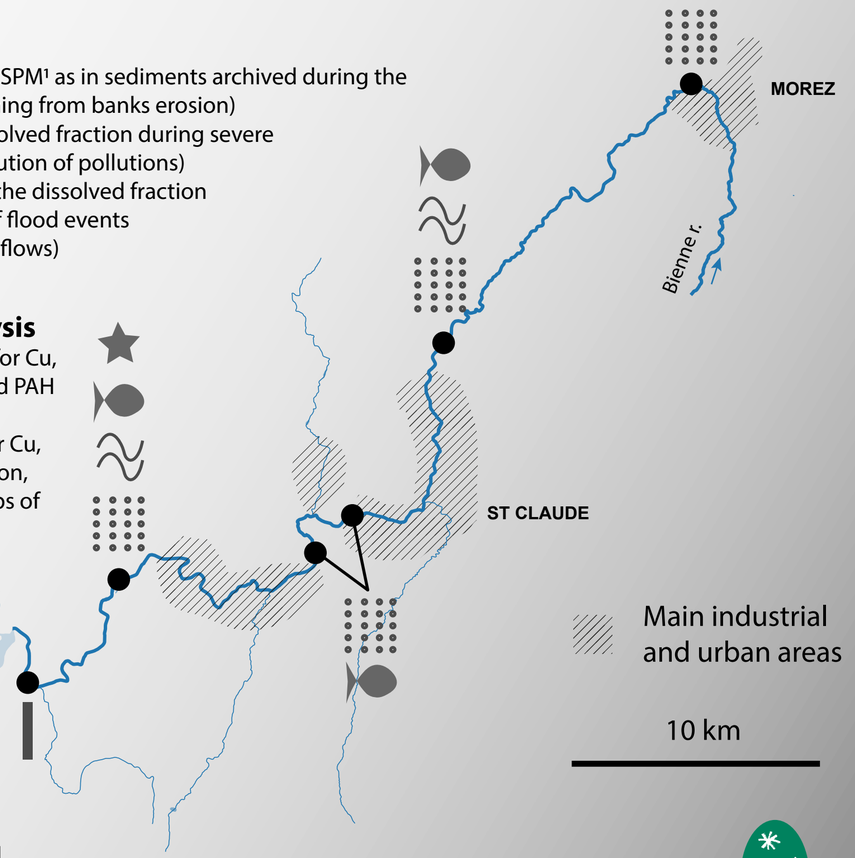
- Same geochemical signal in SPM[1] as in sediments archived during the 2010s (legacy pollutions coming from banks erosion)
- High metal levels in the dissolved fraction during severe low-water conditions (low dilution of pollutions)
- Pulse of metal pollutions in the dissolved fraction during the increasing steps of flood events (influence of stormwater overflows)

Ecotoxicological analysis

- Sediment pollutions > SEL[2] for Cu, Pb, Sn downstream Morez and PAH downstream St Claude
- Water pollutions > NOEC[3] for Cu, Pb and Zn during banks erosion, low-water and increasing steps of flood events

Hydro-climatic survey

- Annual average flow influenced by the WeMO[4]
- High average flows over the 2012-2019 period
- Increasing trend for the frequency and duration of low-water since 1971
- Rainfall timeseries shows an augmentation of the dry spell duration, especially since 2014



1 - Suspended Matter ; 2 - Severe Effect Level ;
3 - No-Observed Effect Level ; 4 - Western Mediterranean Oscillation

Anthropo-crisis

Parc naturel régional du Haut-Jura