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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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In application of the EU Water Framework Directive, many actions have been undertaken in order to reduce pollution levels in river systems. However, for certain catchments, the resilience process is not occurring as expected. In the Bienne River basin, metals discharge has plummeted since the 1990s, following the implementation of a better industrial waste management, as well as an important industrial restructuring. Nevertheless, this river has been regularly affected by massive fish mortality over the 2012-2019 period. This phenomenon, never identified before, is becoming recurrent. Organic tissues sampled in dead fish contained high concentrations of metals in association with other toxics. In this context, this study introduces a transdisciplinary approach in order 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. Metallic and organic pollutants were analysed over different stations and at multi-temporal scales, associating sedimentary archives, suspended matters and passive water samplers. These analyses highlight the impact on the river quality of both current and legacy pollutions, particularly during prolonged low-water periods and high discharge events. Ecotoxicological analyses emphasize a severe risk level in the case of polluted sediments remobilization, especially because of heavy metals and PAH contamination. Geochemical evidence of such remobilization events has been recorded over the last decade in a sedimentary core sampled in the downstream part of the Bienne River. Hydrological data recorded in the Bienne River gauging stations since 1971 attests of an important year-to-year variability, although changes in the river discharge distribution are ongoing. Data has shown a higher frequency of both the lowest and the highest outflows over the 2012-2019 period compared to the rest of the hydrological recording. Hydro-climatic variables coming from in-situ measurements and satellite data (GPM-IMERG6) has also shown significant modifications in the rainfall regime over this period, especially in the augmentation of dry spells and heavy rainfall episodes. Those modifications agree well with the discharge change observations. This study brings out knock-on impacts of combined geochemical, ecotoxicological and hydro-sedimentary issues on the fate of aquatic ecosystems, especially under the influence of local hydro-climatic changes and their implications on hydrological regimes. Those results aim at reducing uncertainties concerning the evolution of the river quality by highlighting such a tipping point for environmental conditions. In addition, such a

study helps us to grasp the complexity of local stakes regarding the multiple interests of a wide range of stakeholders and policy makers involved on the field.