Context-dependency for multiple stressors assessment in freshwater ecosystems

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In spite of their great ecological, economic and cultural importance, freshwater ecosystems are one of the most degraded ecosystems in the world affected by a wide array of stressors. Around 60% of surface water bodies are failing good ecological status. Several regulations have been developed (e.g. Water Framework Directive (WFD) (2000/60/EC) in Europe) to protect and enhance the status of water resources. Environmental legislation follows a reactive rather than proactive behaviour resulting in end-of-pipe measures. Further, it sets limits for individual stressors while, at least 40% of European waters are subject to multiple stressors. Further, it does not consider physical, chemical and biological characteristics of receiving ecosystems. Similarly, most results from scientific works addressing multi stressors effects cannot be extrapolated to other fluvial ecosystems if not embedded in a conceptual framework which accounts for each site's characteristics.

DPSIR (Driver-Pressure-State-Impact-Response) model is an analytical framework amended by the European Environment Agency (EEA) under the WFD. Although DPSIR framework has been used in a large number of studies there are still some gaps which hurdle its usefulness. DPSIR do not separate the term "stressor" as an explicit term but it instead incorporates stressor variables in the "state" term which often promotes confusion among managers and scientists. Through an extensive literature review and synthesis, here we propose a multi stressor approach based on a DPSSIR framework (Driver-Pressure-State-Stressor-Impact-Response). One considering the State and the Stressor categories in the model.

Main points of our work are that State characterization must include both hydrological and chemical characteristics (usually included in previous studies) but also morphological (mostly forgotten although they play a key role in receiving system's response linked to spatial heterogeneity and ecological habitats –include hyporheic and floodplains-riparian areas-) and biological characteristics. State should account also for seasonal dynamics which modulate the windows of ecological opportunity. To assess the impact, it is necessary to address stressors interaction and cascading effects throughout the food web, since impact varies among receptor organisms. In this assessment it must be taken into account the natural thresholds (range) to which the receiving system is used to (State); the set point of the receiving system before –temporal/spatial- the action of the stressor (State) and the magnitude of the stressor (degree of

change – stressor -).

With the use of this new conceptual framework, DPSSIR aims to serve as a basis for both stakeholders to establish a new regulatory framework as well as for scientists when designing an experiment to study pressures and impacts in aquatic ecosystems considering the characteristics of the receiving environment, the interaction between stressors (also context-dependent) and the transfer along the food web. Not based merely on setting limits from laboratory studies with a specific organism. It aims to prevent the degradation of aquatic ecosystems and improve the ecological status of aquatic ecosystems.