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Freshwater mussels' valve movement response as early-warning system of river's ecosystem conditions

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Global warming has lead concerns about more frequent high intensity rainfall events and increasing river floods. Changes in the river hydrodynamics affect the biological communities which are controlled by the interplay between physical-chemical and hydraulic processes. **Thus, there is increasing interest in identifying the impact of the hydrodynamic stresses, also determined by climate change, on the aquatic environment** and, consequently, on the interactions between flow and organisms (Lopez and Vaughn, 2021). **To this aim, it is fundamental to use remote sensors to constantly monitor the** responses of animals to environmental changes. Among these sensors, bio-indicators have been increasingly used to monitor water quality conditions. Some species, called as "ecosystem engineers", are especially important in studying the effects of climate changes in rivers (Butler and Sawyer, 2012). The present study considers freshwater mussels which meet the criteria to be considered as typical "ecosystem engineers" and can be considered as sensitive biosensors of environmental disturbance (among others Gerhardt et al. 2006). Monitoring freshwater mussels' opening and closing valves activities (i.e., valvometric technique) over time has been used to evaluate the behavior of the bivalves in reaction to their environmental exposure. The application of the valvometric technique is not recent and has been mainly applied to analyze the impact of chemical stressors on freshwater mussels. Recent experimental results obtained by the research group of the present work (Modesto et al., 2023; Termini et al., 2023), in sand-bed laboratory flumes with different FMs' populations, have suggested that the mussels' behavioural response could be also used as a tool for an early warning system of flow variations in rivers, also in the presence of sediment transport. The present work reports the results both of an experimental investigation conducted in a laboratory flume to analyze the influence of the substrate composition on the freshwater mussels' response and of an in-situ test conducted in a selected reach of the Paglia river (Italy) to verify the FMs' response in non-controlled environment. In both cases the FMs' valvometry data were collected in real-time by using Hall sensors technology. The FMs' behavioural response was examined in terms of valves' opening/closure frequency and amplitude. The obtained results have confirmed that FMs' behavioural response can be used as BEWS for identifying the impacts of hydrodynamic changes in rivers.

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