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Limiting factors for macroinvertebrate assemblages in impaired streams: the quantile regression approach

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It is known that river ecosystems are strongly influenced by water quality (and so by anthropogenic alterations in general) and that large-scale pressures may even be limiting. The individuation of which factors set limits to biological community development and their respective values is of great interest for river managers and essential to effectively manage and restore degraded rivers. Urban stream ecosystems are affected by multiple stressors, influencing water quality, flow and habitat availability. In these conditions it is usually hard to assess causal relationships among specific stressors and responses of biological communities using the most common statistical tools. Usually, hypotheses about the central response of organisms to environmental gradients are tested, although the effects of other stressors may also influence such response and decrease the fit of the model, which may even become uninformative. In this perspective, quantile regression enables the various stressors to be considered as "constraints" to the distribution of biological communities, without compromising the model causal relationship.

In our study we analysed over 220 samples of macroinvertebrate assemblages and environmental variables coming from the ten-year long institutional survey conducted by ARPA Lombardia in the urban streams of the conurbation of Milan, Italy. We used quantile regression to analyse the effects of alterations on several biological and ecological metrics, such as taxonomical, functional, diversity and richness attributes of communities. These metrics generally presented a scatter distribution along stressor gradients, due to the presence of many sources of variation. Using quantile regression, the role of many pollutants (mostly due to sewage and wastewater treatment plant discharges) and of hydromorphological alterations was defined as a constraint to the biotic distribution.