Title:

Disentangling the effects of multiple stressors on urban stream ecosystems: the constraint approach

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Abstract:

A critical factor for the better comprehension of urban stream environments and for decision-making in restoration programs is the individuation of which factors set limits to biological community development. Urban stream ecosystems suffer from the severe effects of multiple stressors, affecting 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 commonly used 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 analyzed over 220 samples of macroinvertebrate assemblages and environmental variables coming from a ten-year long survey in the urban streams of the conurbation of Milan, Italy. We used quantile regression to disentangle the effects of alterations on several biological and ecological metrics, such as taxonomical, functional, diversity and richness attributes of communities. They generally presented a scatter distribution along stressor gradients, due to the presence of the other 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 (figure 1).

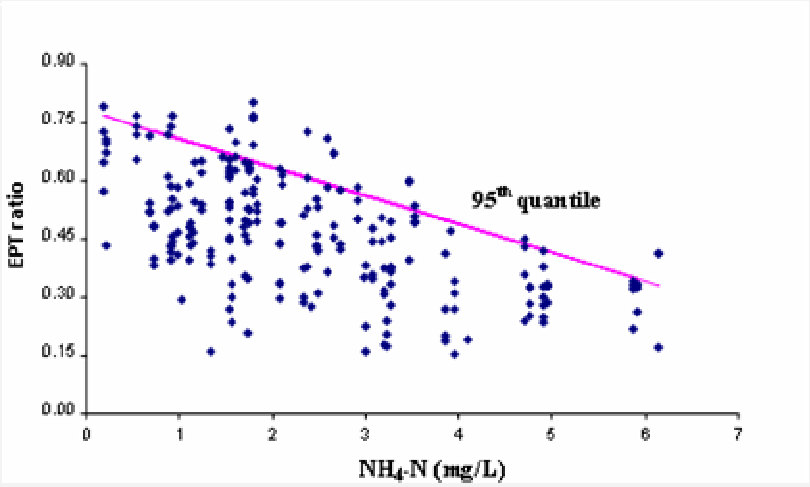

Figure 1 – 95th quantile regression relationship between ammonia nitrogen and the ratio of Ephemeroptera, Plecoptera, Trichoptera to total organisms in samples.

An acceptability threshold has been proposed for every evaluated biological metric, on the basis of the quantile regressions correlating the limiting action of each stressor to the biological response.