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Detecting trend on ecological river status – how to deal with short incomplete bioindicator time series? Methodological and operational issues

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The Water Framework Directive (WFD) (EEC 2000) requires achievement of (ecological and chemical) "good status" for the conservation or restoration of water bodies in the short and medium term. Managers expect tools to enable them to (1) identify differences between the status of a given water body and the reference status, as well as its potential for resilience, (2) define and prioritize restoration actions and (3) assess changes due to actions undertaken. Among the various parameters analyzed in river monitoring networks, bioindicators provide very informative data: they may be able to integrate many changes in catchment conditions over time. However bioindicators datasets are often short, irregular, and non-normally distributed, as well as being positively skewed in most cases. Analyzing time variations in such series is tricky for water managers and is still a real methodological challenge for scientists. It requires the adaptation of classical tools. In this study, we selected a two-step framework combining various kinds of tools: parametric tests, non-parametric statistical tests and graphical analysis. The statistical tests were the following: Spearman rho test, Mann-Kendall test and linear regression. The efficiency and the complementarity of these three tests were analyzed through a simulation study that reproduces the conditions associated with bioindicators time series. Subsequently, the methodology was applied on real IBGN (French macroinvertebrate bioindicators) series taken on the Saône catchment (30000km2) in France. IBGN is based on the abundance and the selective sensitivity of river benthic invertebrates to stressors such as flow, dissolved substances, temperature, light, pH, turbidity, etc. Between 1988 and 2010, 2572 IBGN values were built from samplings collected on 812 sites, at various time steps, on the Saône River and its tributaries. 721 of 812 stations (89%) contain at most 5 values over the 22 years of observation. Among the data, 582 IBGN coupled values were considered (i.d. two IBGN measurements taken at the same site during the same year): no seasonal patterns were detected in this sub-sample. Then, the study focused on the remaining 71 IBGN series that contained at least 10 values. We observed the major influence of extreme values in stationary series with small series, which significantly affects the shape of the graph. Most of the outliers are due to the 2003 drought. Some of these series might not be classified as stationary series due to the presence of either a step trend or a linear trend in IBGN values after the disturbance. Finally, we were able to classify all the IBGN time series: out of 71 series studied, 26 series were classified as non-stationary (25 positive trends and one negative trend) and 45 as stationary. Series from sampling on rivers located in the same hydroecoregion seem to have the same behaviour whereas stationary and non-stationary stations both contain all classes of river size. From a methodological point of view, combining different statistical tests and graphical analysis is a relevant alternative when striving to improve trend detection, which is a key issue in water quality assessment. In our case, it was possible to propose a way to summarise series in order to analysing links between water quality indicators and land use stressors. One of next challenges is to test the approach on new bioindicators.