Modeling how varying data quality affects the ability to detect trends in environmental time series

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ABSTRACT

Detection of changes in ecosystem characteristics is a principal tool for identifying and understanding the effects of anthropogenic activities on the condition and functioning of ecosystems. It is widely known that temporal trends can be blurred by the imprecision of the data. When detected, trends support the assessment of the future development of ecosystems under the present and predicted environmental scenarios. Further, trend detection can potentially provide tools for policy makers when shaping the environmental policy. Research program managers are aware of the difficulties surrounding representative sampling and therefore enforce strict sampling protocols. Standardized sampling can be so effective that the initially much smaller uncertainty in the instrumental analysis becomes substantial. Despite instrumental improvements and the introduction of quality control and quality assurance systems, instrumental analyses are still prone to many uncertainties. The aim of this study is to quantify the time required to detect linear trends in the chemical composition of ecosystem components, given a certain quality of the applied analytical method.

In this study, we present a novel technique and theoretical computations based on weighted linear regression models for the detection of trends in single and combined indices. The theory is clarified with examples from the International Co-operative Programme on Assessment and Monitoring of Air Pollution on Forests (ICP Forests). The results show that, when sampling protocols largely reduce the variability of representative sampling, poor quality of the instrumental analysis blurs the data such that environmental monitoring or long-term ecological research programs can lose the ability to detect trends by causing up to three decades long delay in detecting changes. We can thus conclude that high quality of the instrumental analysis is a prerequisite for a sensitive monitoring program.

Full version of this paper has been accepted for publication [1]. The work has been done together with Sebastiaan Luyssaert and Ivan A. Janssens from University of Antwerp, Pasi Rautio from the Finnish Forest Research Institute, and Jaakko Hollmén from Helsinki University of Technology.

References

[1] M. Sulkava, S. Luyssaert, P. Rautio, I.A. Janssens, and J. Hollmén. Modeling the effects of varying data quality on trend detection in environmental monitoring. *Ecological Informatics*, accepted for publication, 2007.