Identification of the sources of pollution in the Rhône

Identification des sources de pollution du Rhône

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RÉSUMÉ

Ce projet s'est intéressé à identifier et localiser les sources de micropolluants mesurés dans le Rhône et ses affluents. Nous avons réalisé une première étude sur trois substances que sont : l'aminométhylphosphonique (AMPA), le zinc et les matières en suspension (MES). L'utilisation de l'outil économétrique permet de modéliser, les liens de causalité et de corrélation existants entre la concentration de polluants et les différents facteurs socio-économiques. Les résultats de ces estimations apportent une première conclusion sur les facteurs prédominants pour chaque polluant. Ce travail propose donc un outil d'aide à la décision pour les pouvoirs publics, leur permettant d'avoir des actions plus ciblées pour réduire la pollution à la source. Il s'inscrit également dans une démarche d'enrichissement des connaissances pour préciser les hypothèses scientifiques. Ce travail est pluridisciplinaire et propose une étude complète des enjeux liés à l'identification des sources dans les eaux douces.

ABSTRACT

This project focused on identifying and locating the sources of micropollutants measured in the Rhône and its tributaries. We carried out a first study on three substances: AminoMethylPhosphonic acid (AMPA), zinc and suspended solids (SS). The use of the econometric tool makes it possible to model the causal and/or correlation links existing between the concentration of pollutants and the various socio-economic factors. The results of these estimates provide a first conclusion on the predominant factors for each pollutant. This work therefore offers a decision support tool for public authorities, allowing them to take more targeted actions to reduce pollution at source. It is also part of a process of enriching knowledge to clarify scientific hypotheses. This work is multidisciplinary and offers a comprehensive study of the issues related to the identification of sources in freshwater.

Keywords

Data analysis, ecology, econometrics, aquatic pollution, public policy

1 INTRODUCTION

The multiplicity of sources of micropollutants poses "... *a problem when there is pollution. It is not easy to determine the exact origin and one is reduced to formulating hypotheses* "(N. Chèvre and S. Erkman, 2011, p. 33). This finding challenges us because it shows that it is difficult to establish a causal link between the source responsible for the pollution and the concentration measured in the rivers. However, we know that "*nearly 70% of rivers are affected by pressures due to human activities*" (AERMC, 2020, p.12). It then becomes essential to estimate, as precisely as possible, all the pressures of anthropogenic origin that harm aquatic ecosystems. The main objective of this study is to quantify and locate the sources of pollution in the Rhône in order to allow researchers to specify the hypotheses they make and the public authorities to carry out more targeted actions to reduce pollution at the source. The methodology used is econometric, the application of which to data of this type is unusual. The water data comes from the RMC Water Agency, which, since the 1980s, has recorded the concentrations of various polluting substances present in the Rhône and its tributaries. Data of a socio-economic nature come mainly from INSEE.

2 METHOD

This work uses an econometric tool to test hypotheses on the basis of observational data. This makes it possible to estimate models constructed in the form of an equation, where the variables represent concentrations and economic and social quantities, in our case, between anthropogenic and natural sources and the concentration of pollutant measured in water. Our model uses panel data which allows us to study variations in individual and temporal dimensions. Each data will therefore represent the characteristic of a measuring station i at a time t (year). This double information is very useful in econometrics since it makes it possible to establish causality more easily than if information were only available in one dimension; in particular, in the case where it can be assumed that unobserved characteristics of the stations i remain constant over time.

Moreover, the construction of an econometric model requires identifying the scientific hypotheses that one wishes to test concerning the sources of pollution. Once this work is done, it is necessary to look for qualitative or quantitative variables, in the form of data, which allow these hypotheses to be tested. For each substance, we obtain a number of different explanatory variables, depending on the initial assumptions, which will allow us to specify the model equation.

Generically, the model used throughout the study will be as follows:

$$Rs_{it} = \alpha_{0,i} + \sum_{k=1}^{K} b_k x_{kit} + \varepsilon_{it}, i = 1, \dots, N \; et \; t = 1, \dots, T$$

Equation 1 : Individual (Fixed) Effects Model

Econometric estimation of this equation makes it possible to estimate the expected concentration of a substance (Rs_{it}) according to the different explanatory variables represented by x_{kit}. The econometric estimate of b_k indicates the effect of a marginal change of x_{kit} on Rs_{it}.

Finally, it should be noted that for each measuring station, it was necessary to select the municipalities emitting pollution. Indeed, this is diffused in the rivers, and it is necessary to geolocate the data of the explanatory variables in the municipalities which are potentially at the origin of this pollution.

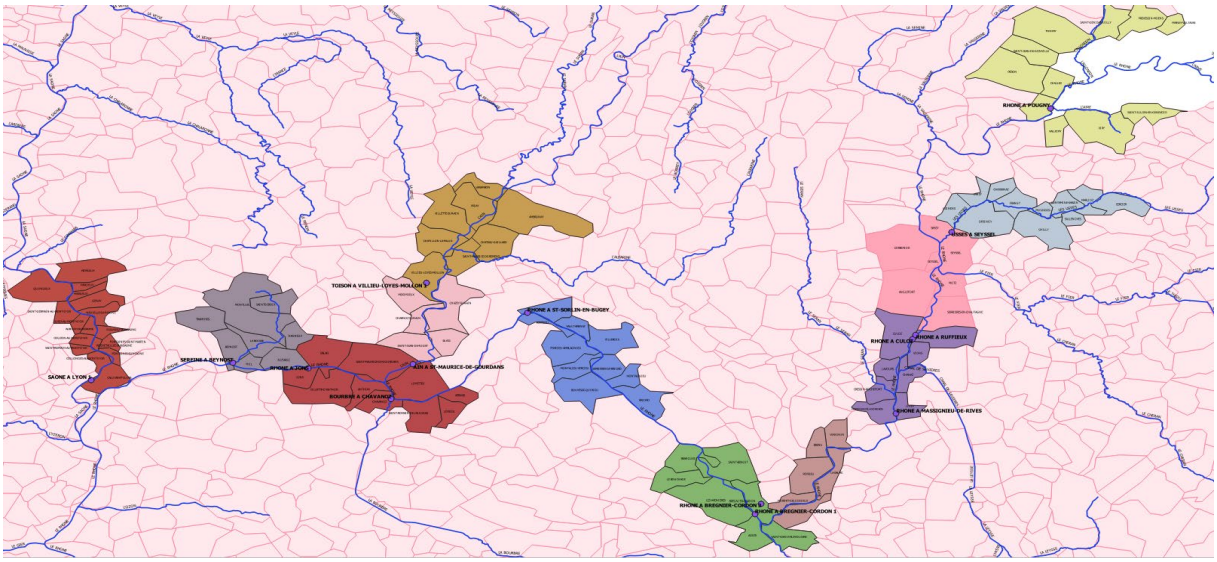

Figure 1 : Location of measuring stations and selected municipalities

3 RESULTS AND DISCUSSION

We obtain statistically significant results for each of the three substances studied. For each pollutant, we estimated several models based on various samples. Samples vary in number of stations and number of years. We detail the main results for each substance.

AMPA	Zinc	SS
Rising prices for pesticides and fungicides lead to lower concentrations of AMPA and zinc, respectively.		The increase in precipitation leads to an increase in SS concentrations.
The establishment of standards, which govern the use of glyphosate and zinc, makes it possible to reduce the concentration of AMPA and zinc, respectively.		
The increase in precipitation leads to a decrease in the concentration of AMPA. This result invalidates our initial hypothesis and shows that rainwater will mainly have a dilution action on the pollutants studied.	The increase in population leads to a decrease in the concentration of zinc and SS. This result invalidates the hypothesis according to which domestic waste is the main responsible for the presence of zinc and SS at measuring stations.	

Tableau 1 : Résultats économétriques pour chaque substance

4 CONCLUSIONS

The use of the econometric tool makes it possible to identify the socio-economic and natural factors potentially at the origin of the pollution. This innovative method offers complementary results to current scientific studies. It can also be transposed to any other polluting substance in waterways as long as the data used are reliable and controlled. Finally, this study remains a first in the field of econometric analysis. It therefore needs to be completed and improved, in particular by working with other pollutants, in order to best respond to the questions of scientists and political decision-makers concerning the sources of aquatic pollution.

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