HEAVY METALS IN SOILS AND MOSSES OF PIEDMONT AND AOSTA VALLEY (ITALY): A MULTIVARIATE AND GIS APPROACH

[1]Gramatica, P., [1]Giani, E., [1]Papa, E., [2]Cenci, R. M., [2]Jones, R. J. A. and [3]Preatoni, D.

[1] QSAR and Environmental Chemistry Research Unit, University of Insubria, Varese (Italy) - [2] Institute for Environment and Sustainability, Joint Research Centre, Ispra (Italy) - [3] Biocoenosis Analysis and Management Unit, University of Insubria, Varese (Italy)

Web: http://dipbsf.uninsubria.it/qsar/ e-mail: paola.gramatica@uninsubria.it

EUROPEAN COMMISSION Joint Research Centre

ABSTRACT

A biomonitoring survey involving the moss Hypnum cupressiforme was carried out throughout territories of Aosta Valley and Piedmont to evaluate the atmospheric deposition of the elements Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Ti, V and Zn. The concentrations of the same elements were also assessed in soil samples taken from under the moss. The concentrations of heavy metals in mosses have permitted the evaluation of the rates of deposition of the elements studied. The combined approach using soils and mosses has discriminated, by the enrichment factor (on Al basis), the anthropogenic from pedological/geological sources. For instance, the fallout of elements Ni at Cogne and Bi, Cd, Mo, Pb and Tl at Col du Joux in Aosta Valley and Pb at Marene (CN) in Piedmont were found to be predominantly anthropogenic in origin. Moss and soil concentrations were investigated using Principal Components Analysis (PCA). This multivariate analysis permitted visual representation of the co-distribution of metals in the mosses and soil, and to evaluate site similarities. The results are also presented in map form using the kriging approach integrated in the Geographic Information System (GIS).

INTRODUCTION

The emergency created by environmental pollution, caused by human activities (both industrial and domestic), means that tools are needed to determine the quality and quantity of pollutants in the environment. Recording system are necessary to identify appropriate strategies of reduction of pollutants emitted and to verify, afterwards, the effectiveness or the inadequacy of measures taken. Technological research has provided and improved instrument systems to record air, soil, water and biota pollution. Since these instruments are often characterized by high cost just few of them are usually applied; moreover being these techniques projected to record only certain substances, they are unable to detect the presence of new pollutants. In order to complete the information given by the technical instruments there is a spreading use of living organisms to detect the presence of pollutants and to determine their effect on live communities.

MATERIALS & METHODS

Data: Soil and mosses samples were collected in 41 sites in Piedmont and in 20 sites in Aosta Valley.

The methodology adopted for the samples analysis was applied according to the A.N.P.A. method [1]. The heavy metals Cd, Co, Cr, Cu, Mn, Ni, Pb, Ti, V, Zn and Hg were investigated.

Principal Components Analysis (PCA): linear combinations of the input variables (metal concentration in this case) to new uncorrelated variables, called principal components, which account for the variance in the data. The first PC explains the main part of the variance of the original data set.

Geostatistical Methods and Mapping: each data set was transformed in logarithmic units. The heavy metal levels were shown on contour maps using the coordinates of sampling sites. Maps were obtained using an universal kriging interpolator [2].

RESULTS

Principal Components Analysis (PCA) of metal concentrations in Aosta Valley and Piedmont mosses and soils was performed in order to have a multivariate view and a graphic representation of the overall metal distribution in mosses and soils in the studied sites (Fig.1-2) identifying the most polluted zones. The normalization of the concentration values of heavy metals in soils and mosses, considering Al as the conservative element, allows the discrimination between anthropogenic and natural heavy metals' sources using the following formula: Enrichment Factor (EF)= [(X moss/Al moss)/(X soil/Al soil)]

EF≥10: heavy metal concentrations observed in moss could be originated by anthropogenic activity and/or natural events such as volcanic eruptions and large forest fires.

EF<10: heavy metal concentrations observed in moss are related to their concentration in soil and/or substrate (natural sources);

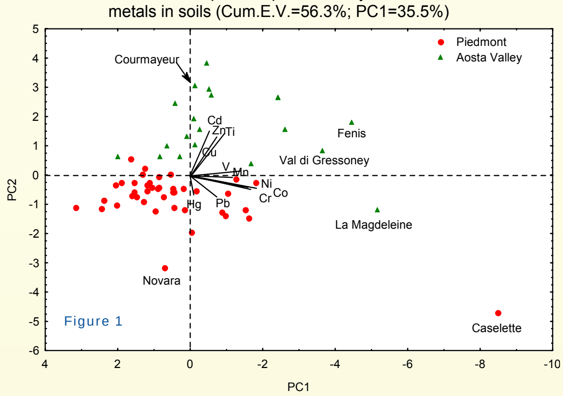

Figure 1

The PCA of metal concentrations in Aosta Valley and Piedmont soils (Figure 1) highlights the sites with higher metal concentration on the right (Caselette in particular). Similar PCA on mosses (Figure 2) and the combined EF analysis allow the identification of the sites polluted by specific metals of anthropogenic origin.

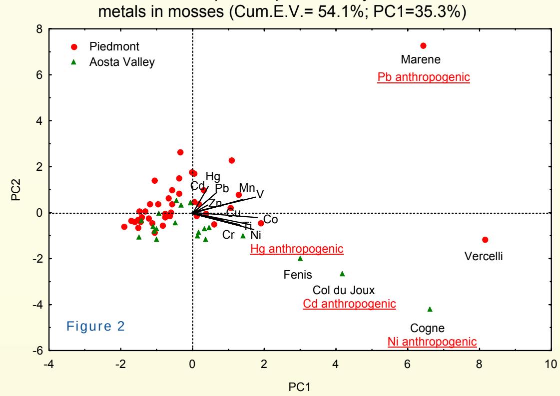

Figure 2

The **GIS approach** was adopted to distinguish the sites characterized by high concentration of Cd, Cu, Hg, Ni Pb and Zn in Piedmont and in Aosta Valley. Some results are presented in the form of coloured maps reported.

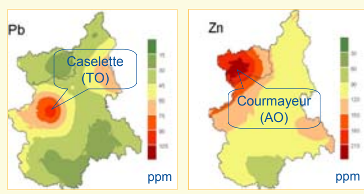

Figure 3 - Pb and Zn in soils

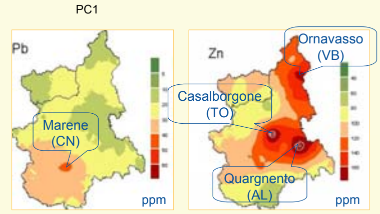

Figure 4 - Pb and Zn in mosses

CONCLUSIONS

- Mosses are good indicators of atmospheric pollution by heavy metals useful for the monitoring at a regional scale, for the estimation of the actual contamination or of the temporal changes in contamination.
- PCA performed on heavy metals concentrations measured in Piedmont and Aosta Valley sites, identified the most polluted sites and the similarity in pollution typology.
- GIS mapping is useful for immediate visualization of metal distribution and contamination level in a region.

REFERENCES

[1] R.M. Cenci. 1999. Agenzia Nazionale per la Protezione dell'Ambiente. Biomonitoraggio della qualità dell'aria sul territorio nazionale. Serie Atti 2/1999. 241-263;

[2] P.A. Burrough e R.A. McDonnell. (1998). Oxford. pp. 333.