RESEARCH ARTICLE **(Open Access)**

Heavy metals in agricultural soils of Albania and the need for national soil quality standards

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Abstract

Soil contamination by heavy metals is a direct threat to the environment and human health. A DAAD-supported research project in 2016 produced the first comprehensive database in Albania for nine heavy metals such as Cd, Cr, Cu, Ni, Pb, Zn, As, Co and Hg in topsoil with a total of 278 soil samples collected from the main soil types, parent materials of soil formation and current land use categories. This unique database provides a national overview of soil metal concentrations. After testing the database for its suitability for determining the background values, the latter were calculated for six metals as the antilog of the median of the ln-transformed metal concentration (on aqua regia basis). Background values for agricultural soils were as follows (mg/kg): Cd 0.24, Cr 131.63, Cu 41.26, Ni 287.15, Pb 19.11, Zn 81.80. These values for Ni, Cr and Cu were higher than the international guidelines used for comparison, with the exception of the EU Directive 86/278/EEC for Cr and Cu. The study indicated that a small number of soil samples had higher heavy metal concentrations than these background values, suggesting contamination from anthropogenic sources. The obtained background values can be used to complete the picture of metal concentrations in European agricultural soils. They can also be used as reference values for Albanian environmental legislation. The study should continue to complete the existing database and to determine the maximum allowable and intervention values for heavy metal concentrations in agricultural and other soils.

Keywords: Heavy metal, background concentration, land use, natural log transformation, soil parent material

1. Introduction

Food security depends as much on the quantity of soil resources as on their quality. In general, this critical function has been ignored, while land suitable for food production is declining. Soil pollution by heavy metals is a direct threat to human health and the environment. Sources of pollution can be geogenic and anthropogenic. Among the latter, the use of water contaminated with metals for irrigation, the application of composts and phosphate fertilizers, etc. can be singled out. Pollution including risk to food belongs to Indicator 5 of soil health or soil quality.

Healthy soils are at the heart of the European Green Deal. Assessment of heavy metal levels in agricultural soils is the basis for soil pollution assessment and land use control. The quality of the soil in relation to the level of heavy metals that contaminate the food chain should be one of the criteria for classifying the capability and suitability of the soil. According to Veerman et al. (2020), cited by Bouma and Veerman (2022), 60–70% of soils in Europe are unhealthy, due to physical, chemical and biological degradation. The lack of data for the countries of the Western Balkans

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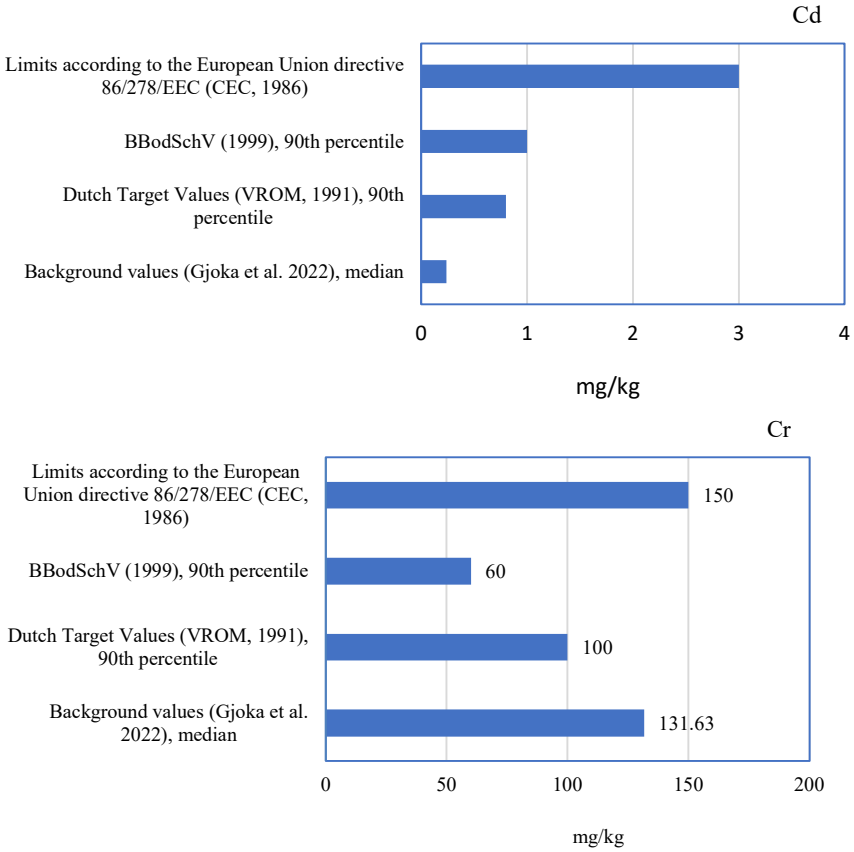
makes it very difficult to assess the degree of contamination of agricultural soils with heavy metals (Zdruli et al. 2022). Although soil pollution is a real threat in Albania, national criteria or standards for its assessment are missing. Until now, the assessment of metal contamination of the soil has been done using international guidelines. Previous studies have revealed the background values of heavy metals at the local level (Gjoka et al. 2022, Kasa et al. 2014, Gjoka et al. 2011), while this study aims to determine the background concentrations of 9 heavy metals such as Cd, Cr, Cu, Ni, Pb, Zn, As, Co and Hg in Albanian agricultural soils, which can be used to complete the picture of metal concentrations in European agricultural soils and for the development of guidelines for national environmental legislation. Both for the European Union (EU) and for Albania, healthy soils are a necessity.

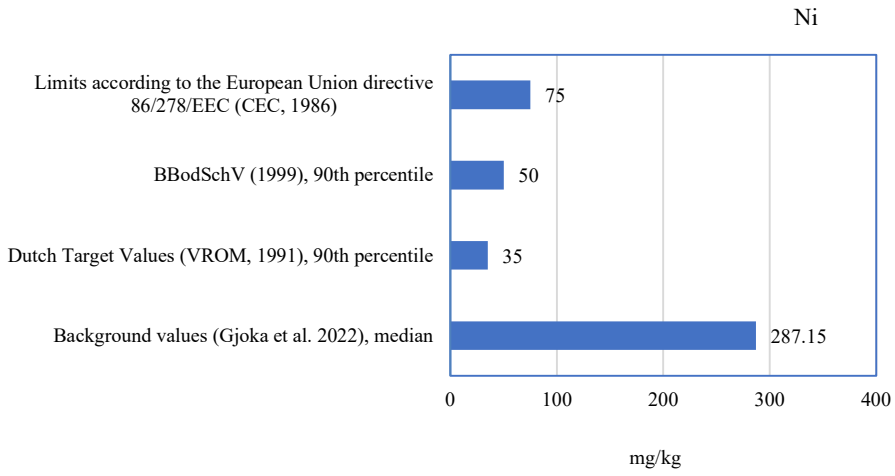
2. Materials and Methods

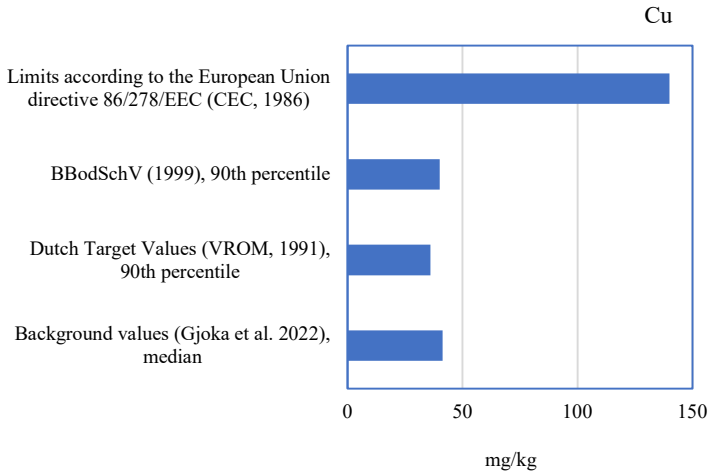
To fulfill the purpose of this study, a three-stage methodology was implemented. Phase 1, gathering data on heavy metals in soil from different sources such as scientific papers, research reports and doctoral theses. Phase 2, data preparation including removal of values below the level of detection, conversion of analytical results to common units (mg/kg), reconciliation of data (on an aqua regia basis) with respect to analytical procedures using the equations of regression, thematic stratification of the database according to parent soil-forming material, land use and soil type, normalization of the database (test for normality) using the Shapiro and Wilk test and the natural log transformation (ln). Phase 3, statistical analysis for the identification and removal of extreme values using the box-plot method and the determination of background values respectively as the antilog of the median concentrations using SPSS 20.0. The minimum number of samples taken for this study is > 10. The methodology used in this study is explained in detail by Gjoka et al. (2022).

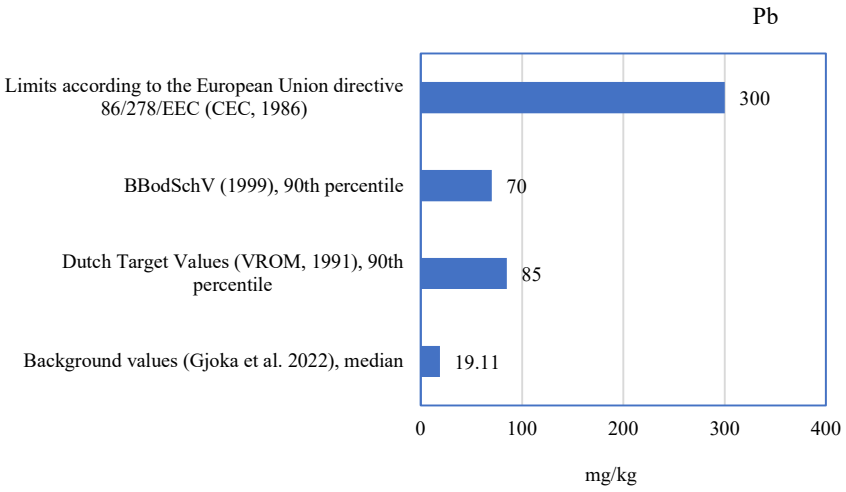
3. Results and discussion

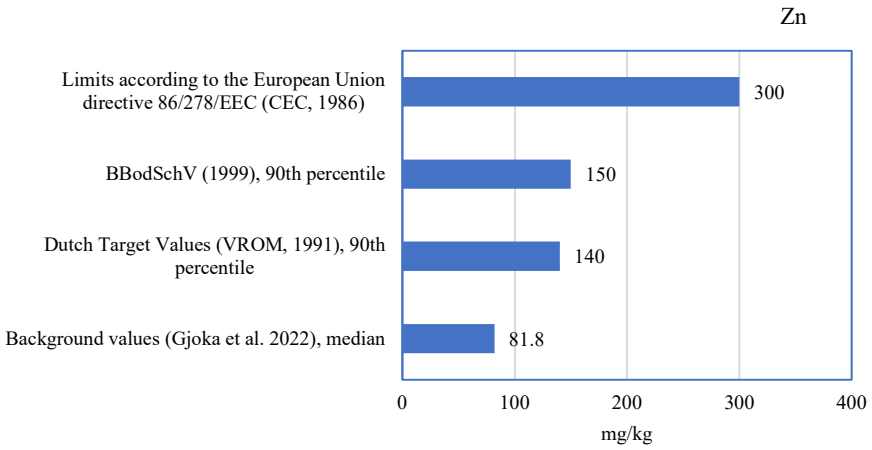
Since the variation in background concentrations of most of the heavy metals considered between parent materials of soil formation was less than or close to 30%, generalized background concentrations of these metals for all Albanian agricultural soils were determined (Figure 1).




Ni
Limits according to the European Union directive 86/278/EEC (CEC, 1986)
75
BBodSchV (1999), 90th percentile
50
Dutch Target Values (VROM, 1991), 90th percentile
35
Background values (Gjoka et al. 2022), median
287.15
0
100
200
300
400
mg/kg


Cu
Limits according to the European Union directive 86/278/EEC (CEC, 1986)
BBodSchV (1999), 90th percentile
Dutch Target Values (VROM, 1991), 90th percentile
Background values (Gjoka et al. 2022), median
0
50
100
150
mg/kg


Pb
Limits according to the European Union directive 86/278/EEC (CEC, 1986)
300
BBodSchV (1999), 90th percentile
70
Dutch Target Values (VROM, 1991), 90th percentile
85
Background values (Gjoka et al. 2022), median
19.11
0
100
200
300
400
mg/kg



These values were as follows (mg/kg): Cd 0.24, Cr 131.63, Cu 41.26, Ni 287.15, Pb 19.11, Zn 81.80. Background values for Ni, Cr and Cu were higher than those of the international guidelines used for comparison, with the exception of the EU Directive 86/278/EEC for Cr and Cu. This proofs the fact that Albanian soils are naturally higher in these heavy metals. The background values of heavy metals Cd, Pb and Zn were lower than those of the international guidelines. Concentrations higher than the respective background values of a small number of soil samples indicate metal contamination of the soil from anthropogenic sources.

4. Conclusion

The proposed background concentrations of 0.24 for Cd, 131.63 for Cr, 41.26 for Cu, 287.15 for Ni, 19.11 for Pb, 81.80 for Zn can be used as reference values for establishing national standards for the assessment of soil contamination with heavy metals. These background values for agricultural soils of Albania can be used to complete the picture of metal concentrations in European agricultural soils.

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