Environmental Impact of Heavy Metals Presence in the Fan and Shkumbin Rivers

Conference Paper · January 2010

CITATIONS
6

READS
341

2 authors:

Uran Abazi
Agricultural University of Tirana, Koder-Kamez, Tirana, Albania
33 PUBLICATIONS **77** CITATIONS
SEE PROFILE

Astrit Balliu
Agricultural University of Tirana
121 PUBLICATIONS **1,204** CITATIONS
SEE PROFILE

Environmental Impact of Heavy Metals Presence in the Fan and Shkumbin Rivers

Uran ABAZI, Balliu ASTRIT

Agricultural University of Tirana, Faculty of Agriculture and Environment, Tirana, Albania.
(e-mail: uranabazi@yahoo.it)

Abstract

The aim of this study was the detection of heavy metals presence due to industrial discharges, in Fan and Shkumbin river of northern and central part of Albania and the estimation of their negative effects on crop performance because of irrigation use. The heavy metal detection was done, based on USEPA methodology (1991), at Soil Research Institute in Tirana. The data found were compared with KSSH (2001) thresholds and water quality estimation was done, accordingly. The content of heavy metals in Fan and Shkumbin river's waters was found to be very high, because of industrial discharges in both them. There is a very high content of Cr, Cu, Pb and Ni, respectively 30.1, 1.2, 3.0 and 2.2 mg L^{-1}. A less important presence was also found for Mn, Zn and Fe (respectively, 0.5, 0.48, and 1.7 mgL^{-1}). Though less compared with Fan river, the presence of heavy metals was high at Shkumbin river's water, also. The highest amount of Cu founded was 0.6 mgL^{-1}, while the rest of elements were respectively; Cr 0.7 mgL^{-1}, Ni 0.29 mgL^{-1}, Mn 0.21 mgL^{-1}, Pb 0.12 mgL^{-1}, Fe 0.07 mgL^{-1} and Zn 0.025 mgL^{-1}. The long use of heavy metals contaminated water and soil alkaline pH has favored the precipitation of Cr, Cu, Pb, Fe, Ni and Mn into arable land, which has negatively influenced to the environmental pollution and has increased the potential threats for the human population health. The risks should be reduced, whether by the appropriate agronomic interventions the soil pH would remain alkaline.

Key words: heavy metals, contaminated water, environment pollution

Introduction

The quality of irrigation water is important for the good performance of irrigated crops and soil preservation. Soil contamination from heavy metals is becoming critical due to intensive use of contaminated irrigation water (Tamariz, 1996; Mendez et al., 1997). This problem is mostly evident at the agricultural soils near to mines and big cities, at which the amount of residual waters is continuously becoming larger. Generally speaking the amount of heavy metals in the river waters are not important excluding specific cases where industrial facilities discharge theirs processing residues into the river's water (Mendez at al., 1997). Though the possibility to affect the human health is limited because of soil barriers which handicap the heavy metals entrance into the plants (Barbafieri et al., 1996), plants and water living organisms may be negatively affected, even by small concentration of heavy metals. While small amounts would not cause the immediate death of small water living organisms they will endorse serious physiological and metabolically disorders like; histological and morphological changes of organism's tissues, growth retardation, biochemical changes affecting enzymatic activity and reproduction cycle, etc. The goal of this study was the detection of heavy metals presence in the Fan and Shkumbin rivers in Albania and the evaluation of potential negative effects on the environment pollution and plant productivity due to theirs water use for irrigation purposes.

Material and methods

The research was conducted during the year 2006 by Soil Research Institute of Tirana, Albania. The country is located in the Balkan Peninsula, between 39^0 38' and 42^0 39' N latitude, and 19^0 16' and 21^0 40' E longitude.

Proceedings. 43rd Croatian and 3rd International Symposium on Agriculture. Opatija. Croatia (111-114)

Total surface area of the country is 28748 square km, and out of this area, only 16.2% is less than 100 m above see level. It is very mountainous, with many varied landscapes including bare rock. According to Hydro meteorological Institute of Tirana (1988), Albania is subdivided in four climatic zones. The flat zone, which is mostly the coastal area, has relatively dry and hot summers with mean temperature of 26 ^{0}C. Winters are cool and wet with mean temperatures in December and January of 11.8 ^{0}C and 9.8 ^{0}C. Average annual rainfall of this zone is 900-1400 mm, and more than 80% occurs during the rainy season from October to March. The central and northern part of the coastal area is wetter, especially in Shkodra where rainfall measures about 2000 mm per year. The hilly area stretching from north to south and located on the eastern side of the coastal zone is divided into three parts: northern, central and southern sub-zones. Hills reach an altitude of 300 to 500 m and have similar climate characteristics of the flat zone. The sub-mountainous zone is comprised of highland plains in the south (plain of Korca) and river valleys in Peshkopi, Kukes, Tropoje and Puke. The altitude is about 800 m and the mean temperatures are 3-4 ^{0}C lower than the coastal plain and have frequent frost. The mountainous zone which covers all lands above 800 m has a continental climate. Annual precipitation is 1000-1800 mm, and Northern Albanian Alps exceeds 2000 mm. Maximum summer temperatures are always below 25 ^{0}C, while minimum temperatures can be as low as -25 ^{0}C.

The study was focused on river Fan (Mirdita area) and Shkumbin (Elbasani area). Both rivers are important irrigation water sources for the country. There are 1800 ha of agricultural land irrigated by Fan river and close to 28000 ha irrigated from Shkumbin river. The second one has also a larger catchment's area of about 2444 square km, against of 1075 square km of Fan river. The water samples were collected weekly during the period June 15 – August 30 at the specific points were water was channeled for irrigation use. The procedure of sample collection was done according to USEPA procedure (2001). The water samples were analyzed according Atomic Absorber Spectrophotometry method (AAS), at the Soil Research Institute laboratory. Cr, Pb, Ni, Fe, Cu, Mn and Zn were chemically identified and their respective amounts were calculated. Each of them was compared with defined thresholds of Albanian state standards catalogue (KSSH, 2001).

Results and discussion

There were found heavy metals at both rivers; Fan and Shkumbin. The range of heavy metals found at the Fan river was at the following order; Cr>Pb>Ni>Fe>Cu>Mn>Zn. Talking about accepted thresholds, a very high amount, exceeding Albanian state standards was found for Cu, 1.2 mgL^{-1}. The amount of Cu founded at Shkumbin river was less that of Fan river, 0.6 mgL^{-1}, but still, it was above the standard limits.

Really high amounts, 30 mgL^{-1}, were found for Cr in the Fan river's water, which were much higher of that founded by Tamariz, 1996, in the residual waters used for irrigation purposes. Meantime, the amount of Cr founded in Shkumbin river was much less, 0.95 mgL^{-1}. Both cases the highest amounts of Cr were found at the end of irrigation period. Compared with Shkumbin, Fan river has resulted with higher amounts of Fe, too. The highest amount was 1.7 mg L^{-1}, while there was found much less in Shkumbin river, equal to an average of 0.07 mg L^{-1}. Meanwhile, both rivers has resulted with small amounts for Zn. 0.41 mg L^{-1} for Fan and 0.025 mg L^{-1} for Shkumbin were both inside the accepted levels of Albanian standards.

Mn content were found up to 0.56 mgL^{-1} in Fan river, at the end of irrigation season, while it was much less in Shkumbin river, 0.12 mgL^{-1}. Fan river has resulted highly contaminated with Pb, also. The amount founded there was beyond the accepted thresholds and accounted for 3.1 mg L^{-1}, while it was only 0.7 mgL^{-1} in Shkumbin river.

Due to high amounts of heavy metals founded in Fan, according to NIVA's classification (Bratli, 2000), can be classified as heavy polluted (class III) and Shkumbin river as slightly polluted (class I). Both cases this is a consequence of industrial discharges into the river's water. The high amount of heavy metals founded during this survey and the presence of other elements founded in lower concentration (MMPU, 2006), will lead to theirs gradual accumulation in to agricultural land through irrigation cycles. This will negatively influence to the soil and subsurface water pollution, and will increase the risk of plant contamination. This potential risk is very much eminent at the agricultural areas nearby this rivers, where is a predominance of heavy clay soils, at which the accumulation of heavy metals is favored by their colloidal fractions. At the area irrigated by Fan and Shkumbin river's water is also, a distinctive predominance of alkaline soils (Lushaj, et al., 2002). Because of that, a low mobility of heavy metals is expected, which will affect the accumulation of heavy metals into the soil and consequently reduce their availability to the plants.

The high content of Cu, Pb, Cr and Ni in Fan river, up to the toxic level, will make it a serious threat for soil and subsurface water and a considerable potential risk for plant contamination. Considering an annual amount of 5000 cubic meter of irrigation water per ha, an amount of up to 5,8 kg Cu, 1,5 kg Pb, 14,7 kg Cr and 10,4 kg Ni is assumed to be accumulated per each ha of irrigated land, each irrigation season. Under the same conditions, less amounts, respectively 2,3 kg Cu, 0,6 kg Pb, 3,5 kg Cr and 1,5 kg Ni, per year are accumulated in to the soils irrigated by Shkumbin river.

Table 1. The content of heavy metals (mgL^{-1}) found in Fan river's water.

Sample	Fe	Mn	Pb	Cr	Cu	Zn	Ni
1	1.13	0.41	2.10	30.1	1.10	0.46	1.98
2	1.34	0.44	2.98	28.5	1.20	0.42	1.97
3	1.23	0.50	2.96	28.0	1.18	0.36	2.24
4	1.45	0.43	2.96	29.8	1.17	0.34	2.20
5	1.67	0.53	2.98	30.0	1.14	0.40	2.00
6	1.70	0.56	3.00	30.1	1.20	0.48	2.20
Average	1.42	0.47	3.1	29.4	1.16	0.41	2.09
Standard	2	2	0.2	2	0.1	0.5	0.005

Table 2. The content of heavy metals (mg L^{-1}) found in Shkumbin river's water.

Sample	Fe	Mn	Pb	Cr	Cu	Zn	Ni
1	0.07	0.08	0.08	0.60	0.4	0.03	0.22
2	0.06	0.06	0.09	0.70	0.4	0.02	0.35
3	0.08	0.07	0.10	0.60	0.5	0.03	0.25
4	0.05	0.04	0.15	0.80	0.4	0.04	0.28
5	0.09	0.90	0.08	0.65	0.5	0.02	0.38
6	0.1	0.12	0.23	0.95	0.6	0.01	0.30
Average	0.07	0.21	0.12	0.7	0.46	0.025	0.29
Standard	2	2	0.2	2	0.1	0.5	0.005

Conclusions

The presence of heavy metals in Fan and Shkumbin is a consequence of mine's and industrial discharges. The amount of Cu, Cr, Pb and Ni was especially high and at the toxic level in Fan river. The content of Mn, Zn and Fe was less important. The amount of these elements founded in Shkumbin river was less and generally speaking is acceptable according to Albanian state standards.

Due to water use for irrigation purposes a gradual soil and subsurface water pollution is expected. This will increase the risk of plant contamination with heavy metals.

The risk of soil pollution, because of contaminated water with heavy metals, can be reduced by maintaining a alkaline pH of irrigated soils.

References

Barbafieri F., Lubrano L., Petruzzeli G., 1996. Characterization of pollution in sites Contaminated by heavy metals: a proposal. Società Chimica Italiana. Annali di Chimica 86, pp 585-594.

Bratli L.J. 2000. Classification of the environmental quality of freshwater in Norway. In: Hydrological and limnological aspects of lake monitoring. Heinonen et al. (Ed.). John Willey& Sant. Ltd.pp.331-343.

Instituti i Hidrometereologjise. 1988. Klima e Shqipersise.

Katalogu i Standarteve Shtetërore Shqiptare, 2001. Botim i Drejtorisë së Përgjithshme të Standarteve, (D.P.S.).

Lushaj SH., Dedaj K., 2002. Final Report of the Soil Science. Institute of Tirana and soil data base 1:50 000 scale for the districts of Kavaja, Lushnja and Peqin of Albania.

MMPU (Ministria e Mjedisit, Pyjeve dhe Administrimit të Ujërave), 2006. Raport vjetor mbi "Gjendjen e Mjedisit në Shqipëri".

Mendez G., A. Flores R., S. Palacios M., 1997. Disponibilidad de Cd, Fe, Mn y Pb en suelos agricolas de Tecamachalco, Edo. De Puebla. Pp. 60. In: Memorias del XXVIII, Congreso Nacional de la Ciencia del Suelo, Villahermosa, Tabasco.

Rodrigues D., 1995. Mendez G., A. Salas C., 1995. Contaminación de los suelos del Ejido Flores Magon, municipio de Atlixo por Fe, Mn, Zn y Pb por el uso de aguas del rio Atoyac, pp. 34. In memorias, XXVI, Congreso Nacional de la Ciencia del Suelo. Cd. Victoria, Tamps.

Tamariz F,. 1996. Contaminación de los suelos agricolas por metales pesados en el municipio de Atlixo, Puebla. Tesis de Mestria en Edafologia. Faculdad de Ciencias, Universidad Nacional Autonoma de México, México.

USEPA, 1991. Methods for Chemical Analysis of Water and Wastes, 2nd ed. Washington, D.C.:U.S. Environmental Protection Agency, 1991.

sa2008_0114