Publisher
ECOLOGICAL MOVEMENT OF NOVI SAD
21000 Novi Sad, Vojvodjanskih brigada 17/I
Phone: (+381 21)529 096
(+381 21) 420 175
E-mail: ekopokretns@gmail.com
www.ekopokret.org.rs
Academician Kastori Rudolf, President
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Layout and Formatting
Ljubica Aleksić

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2017

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THE ECOLOGICAL MOVEMENT OF THE CITY OF NOVI SAD: AN IMPORTANT DECISION OF ITS PROGRAMME COUNCIL

Since 1995, the Ecological Movement of the City of Novi Sad organizes „Eco-Conference® on Environmental Protection of Urban and Suburban Areas", with international participation.

Ten biennial conferences have been held so far (in 1995, 1997, 1999, 2001, 2003, 2005, 2007, 2009, 2011, 2013. and 2015.). Their programs included the following environmental topics:

Session 1: Environmental spheres: a) air, b) water, c) soil, d) biosphere
Session 2: Technical and technological aspects of environmental protection
Session 3: Sociological, health, cultural, educational and recreational aspects of environmental protection
Session 4: Economic aspects of environmental protection
Session 5: Legal aspects of environmental protection
Session 6: Ecological system projecting (informatics and computer applications in the field of integrated protection)
Session 7: Sustainable development of urban and suburban settlements–ecological aspects

Conference participants have commended the scientific and organizational levels of the conferences. Conference evaluations have indicated that some aspects are missing in the conference program. In addition, since a team of conference organizers was completed, each even year between the conferences started to be viewed as an unnecessary lag in activity.

Eco-Conference® on Safe Food

With the above deliberations in mind, a decision was made that the Ecological Movement of the City of Novi Sad should embark on another project - the organization of Eco-Conferences® on Safe Food. These Conferences were planned to take place in each even year. Preparations for the first Eco-Conferences® on safe food started after the successful completion of the Eco-Conference® `99.

So far four Eco-Conferences® have been held (in 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014. and 2016.) focusing this general theme.

Theme of the Eco-Conference®

By organizing the Eco-Conference® on Safe Food, the organizer wishes to cover all factors that affect the quality of human living. Exchange of opinions and practical experiences should help in identifying and resolving the various problems associated with the production of safe food.

Since 2007 Eco-Conference gained patronship from UNESCO and became purely scientific Conference.

Objectives of the Eco-Conference®

- To acquaint participants with current problems in the production of safe food.
- To make realistic assessments of the causes of ecological imbalance in the conventional agricultural production and the impact of various pollution sources on the current agricultural production.
- Based on an exchange of opinions and available research data, to make long-term strategic programs of developing an industrialized, controlled, integral, alternative and sustainable agriculture capable of supplying sufficient quantities of quality food, free of negative side effects on human health and the environment.

Basic Topics of the Eco- Conference®

Basic topics should cover all relevant aspects of the production of safe food.

When defining the basic topics, the intention was itemize the segments of the production of safe food as well as the related factors that may affect or that already have already been identified as detrimental for food safety and quality.

The topics include ecological factors of safe food production, correct choice of seed (genetic) material, status and preparation of soil as the basic substrate for the production of food and feed, use of fertilizers and pesticides in integrated plant protection, use of biologicals, food processing technology, economic aspects, marketing and packaging of safe food.

To paraphrase, the envisaged topics cover the production of safe food on the whole, individual aspects of the production and their mutual relations, and impact on food quality and safety.

Sessions of the Eco- Conference®

1. Climate and production of safe food.
2. Soil and water as the basis of agricultural production.
3. Genetics, genetic resources, breeding and genetic engineering in the function of producing safe food.
4. Fertilizers and fertilization practice in the function of producing safe food.
5. Integrated pest management and use of biologicals.
6. Agricultural production in view of sustainable development
7. Production of field and vegetable crops.
8. Production of fruits and grapes.
9. Livestock husbandry form the aspect of safe food production.
10. Processing of agricultural products in the framework of safe food production.
11. Economic aspects and marketing as segments of the production of safe food.
12. Food storage, transportation and packaging.
13. Nutritional food value and quality nutrition.
14. Legal aspects of protecting brand names of safe food.
15. Ecological models and software in production of safe food.

Attempts will be made to make the above conference program permanent. In this way will the conference become recognizable in form, topics and quality, which should help it find its place among similar conferences on organized elsewhere in the world.

By alternately organizing conferences on environmental protection of urban and suburban areas in odd years and conferences on safe food in even years, the Ecological Movement of the City of Novi Sad is completing its contribution to a higher quality of living of the population. Already in the 19th century, Novi Sad was a regional center of social progress and broad-mindedness. Today, owing first of all to its being a university center, Novi Sad is in the vanguard of ecological thought in this part of Europe.

It is our duty to work on the furtherance of the ecological programs of action and, by doing so, to make our contribution to the protection of the natural environment and spiritual heritage with the ultimate goal of helping the population attain e higher level of consciousness and a higher quality of living.

Director of the Ecological Movement
of Novi Sad
Nikola Aleksic

INTRODUCTION

Recognizing the importance and specificity of environmental problems of cities and suburban areas, and the fact that about half the world's population lives in cities, Ecological Movement of Novi Sad in its activities included the environmental problems of the settlements. In this context, in 1995, the first scientific conference dedicated to the above mentioned problems,was organized. This was the first scientific ECO-conference in our country dedicated to all aspects of environmental problems of cities and suburbs. This conference has become traditional and has grown into an international scientific conference. It is held every second year and this year's is 12th in a row.

Environmental problems of cities and suburban areas are partially specific since a large concentration of people in a relatively small space poses many problems, not only environmental but also other nature (air pollution, noise, water supply, municipal solid and liquid waste, social issues, etc.). Environmental problems of cities and suburban areas can not be separated from degradation of the biosphere as a whole, as they are an integral part of it, so that in the future should pay more attention to the problems relating to the role of cities in the pollution of the atmosphere on a global scale and measures for its reduction. In the future energy consumption should be reducedwith better thermal insulation of buildings, energy needs of the settlements to be providedfrom renewable energy sources, consumption of drinking water to be replaced by using technical waterwhere possible, reduce municipal waste with separation and recycling, purify waste waters, in order to protect the health of the population strictly implement a ban on smoking in public premises and places, using means of transport that less pollute the air, increase green spacesin the settlements, reduce the amounts of dust particles and harmful gases in the air, noise etc. All this will contribute to the reduction of environmental pollution and globally biosphere and thus to a higher quality of life of the urban population.

Climate change, the greenhouse effect and in that respect warming of our planet is the biggest environmental problem of our time. It is also not only a greater environmentalbut also economical, migrational, social and political problem on a global scales. Cities and suburban areas, directly and indirectly significantly contribute to this problem. Cities produce about three-quarters of carbon dioxide emissions. In order to reduce carbon dioxide emissions, there are suggestions of numerous international and national institutions that are mainly only under partial implementation. Thus, in order to mitigate this problem, the EU proposes and predicts a reduction in carbon dioxide emissions, increasing the share of renewable energy consumption and energy efficiency of all by 20%. A big step forward in limiting the rise in global temperature on our planet represents the Paris Agreement which was adopted in 2015, and entered into force the following year, after the ratification of the EU, ie. almost of 200 countries. This agreement predicts a significant reduction in fossil fuel use and thus carbon dioxide emissions and gives priority to the use of renewable energy. The largest emitters of carbon dioxide are populated China and the United States. US withdrawal from the mentioned agreement will significantly diminish the sense of the Paris Agreement. In addition, it should be noted that there are also opinions that the warming of the planet is not the result of various human activities, but it's a cyclical phenomenon on our planet, which opponents to restrict emissions of carbon dioxide often use as an argument in opposition to the mentioned agreement.

Ecological Movement with its activities including scientific conferences is not able to directly solve specific environmental problems of cities and suburbs, but its indirect contribution can be significant because: it draws the attention of the general public and competent authorities to the existing environmental problems in our cities and to proposes solutions to overcome them, to encourage an interdisciplinary approach for solving environmental problems in this aspect, which by nature are often very complex, to promote the sustainable development of settlements and to increase environmental awareness of the population, to contribute to research and draw attention to certain technological solutions and encourage the adoption of legal regulations in the field of environmental protection of cities and suburban areas, with the aim of improving the quality of life of the population.

Proceeding from the above, the program and of this scientific conference is designed so, that preferably includes all significant environmental issues of cities and suburban areas: land, water, air, biosphere, medical, economic, legal and social aspects, sustainable development, information systems, design of environmental system, raising environmental awareness and others.

In the belief that this international scientific conference will contribute to solving the environmental problems of the settlements, andthat Conference Proceedings will enrich our scientific and technical heritage in the environmental protection field, Ecological Movement of Novi Sad thanks to the co-organizers and individuals who contributed to the organization and holding of this scientific meeting. Special thanks belong to participants of the meeting that contributed with their scientific papers to the updating of the environmental problems of the settlements, pointed to possible solutions of the problems and thus contributed to the improvement in quality of life of inhabitants in cities and suburbs.

R. Kastori

My newtelephone number is: 021/485-3487

Prof. Dr. Rudolf Kastori
Foreign Member of the Hungarian Academy of Sciences
Full Member of the VANU and JINA

[1] **Maja Poznanović Spahić, [2]Sanja Sakan ,[3] Dragan Manojlović, [1]PavleTančić, [2]Sandra Škrivanj, [1] Jovan Kovačević[4], Zoran Nikić**
[1]Geological Survey of Serbia, Belgrade
[2]ICTM, Chemistry Center, University of Belgrade
[3]Faculty of Chemistry, University of Belgrade
[4]Faculty of forestry, University of Belgrade

CHROMIUM, NICKEL AND COBALT IN SOILS OF SREM AND CENTRAL BANAT (VOJVODINA)

Abstract

This paper reports the concentration and sources of chromium, nickel, and cobalt in soil samples from the Srem and Central Banat (Vojvodina, Serbia). Different methods were applied to identify the sources of elements and to classify them as geogenic or anthropogenic (modified Tessier sequential extraction, statistical methods, and XRPD). The data obtained indicated that elements content were higher in soils of Srem, due to the influence of the geological matrix and influence of industrial facilities.

Keywords: *chromium, nickel, cobalt, soil, Vojvodina*

INTRODUCTION

Increasing concentrations of chromium, cobalt and nickel detected in soils of Balkan and Serbia can be explained by distribution pattern and presence of the parent rocks (ultramafic, mafic) (Albanese et al 2015) which define geochemical background in this area, while anthropogenic activities particularly increase that values in some areas. Sources of anthropogenic pollution of these elements can be different industrial processes. Thus, the cement- arrived dust becomes a source of contamination of Cr and Ni in the air and soil (Banat et al, 2005), leather factory and tannery which mostly used salts of chromium, can be the source of Ni and Co as well (Tariq et al, 2005).

Also, these elements can be released in metal processing factories (Panagopoulos et al, 2015) and through fly ash after fossil fuels combustion (coal) (Sarkar et al, 2006) used in some industrial processes. In fertilizers which have been used in Serbia, is detected presence of Cr and Ni, particularly Cr in the organic-composts and phosphate fertilizers (Zeremski-Škorić et al, 2010), and cobalt is more present in manure (Nagajyoti et al 2010). Many authors studied heavy metals concentrations in agricultural and nonagricultural soils of Vojvodina and detected higher nickel content (of lithological origin) (Ninkov, et al 2012; Brankov et al, 2006). In some parts less terraces of Srem, higher values of Ni and Cr, above the maximum allowed concentrations (MAC) in top soils presented as anthropogenic, but in bottom soil as natural (Jakšić et al, 2012). Ni was found as slightly mobile in alluvial-delluvial soil of Srem and in South Bačka (Dozet et al, 2011, Maksimović et al 2012). The distribution of cobalt concentrations is uniform in agricultural and nonagricultural soils of Banat and below MAC (Brankov et al, 2006). This paper presents the value of total and bioavailable content of these elements in the area of Srem and Central Banat. Main goal of this work was to assess the distribution of studied elements and to identify the sources of elements, as well as to classify them as geogenic or anthropogenic.

METHODS AND INVESTIGATED AREA

Investigated area in Srem included 8 towns and different industrial objects: 1.Šimanovci - samples labeled as S1-S5 (metal cutting and boiler factory-S1, printing shop-S2, S3, pesticide factory-S4,S5);2. Pećinci, S6-S8 (sugar factory); 3.Stara Pazova-samples S6-S14 (salt processing plant-S9, printing shop-S10,solid metal waste - S11, metal processing plant (abandoned) S11-S14); 4.Inđija- S15-S20 (tobacco factory-S15, S16, paint and varnish factory and battery factory-S17, S18, pet food industry and metal factory- S19;sample S20 islocated between these factories); 5. Ruma-S21- S26 (leather industry S21, S22 and tire factory S23- S26); 6.Sremska Mitrovica- samples S27-S32 (wood, cellulose and paper factory S27, S28; S29 is placed further, in urban area and sugar mill plant S30-S32); 7.Šid samples S33-S4 1(paint and varnish factory S33-S35, insulation material factory S36, S37 and S38 between this factory and oil mill plant, S41, print shop- S39, S40); 8. Beočin –samples S42-S45 (cement factory). In Central Banat, the samples were collected in the area surface 20x20 km, from agricultural and nonagricultural soils, and include five municipalities: Zrenjanin, Novi Bečej, Sečanj, Žitište and Nova Crnja. The sample labeled with SB13 was taken from non-agricultural soil in industrial zone Bagljaš –Elemir nearby Zrenjanin.

Soil samples from Srem were collected in October 2010 at 45 localities around the industrial objects and 23 samples (SB1-SB23) from C. Banat in June 2012 and 2013. The samples were collected with stainless steel shovels on two depths: 10-30 cm and 30-50 cm or 0-10 cm and 10-50 cm depending on type of soils-agricultural or grazing/nonagricultural. Sampling methodology defined in the GEMAS project (Geological Mapping of Agricultural and Grazing Soils). Also, 7 boreholes were drilled

(0.2m - 6m) in southwestern Srem, the area of oak wood, located far away a potential sources of pollution. For the purpose of the research mean values Cr, Ni, and Co of shallow depth samples (0.2 m) is taken into consideration as a reference -B1 (Table 1)

In order to determine distribution – geochemical affinity of metals and their bioavailability, modified Tessier sequential extraction (Sakan et al, 2011) were used. This extraction includes five phases: F1-exchangeable (1MNH_4CH_3COO); F2-metal bound to carbonate sand easily reducible species (0.01MHCl and 0.1M $NH_2OH \cdot HCl$); F3-metal bound to moderately reducible phases or Fe-oxides fraction (0.2M $H_2C_2O_4$ and 0.2M $(NH_4)_2C_2O_4$); F4-organic matter and sulfides (30% H_2O_2 adjusted to pH 2 with HNO_3/ followed by extraction with 3.2M$CH_3COO(NH_4)$; F5-Residual fraction (6MHCl).

Determination concentrations of Cr, Co, and Ni were performed by ICP/AES– (inductively coupled plasma atomic emission spectrometry-iCAP-6500 Duo,Thermo Scientific, UK). The organic matter determined by Kotzmann method.

TheX-ray powder diffraction (XRPD) of the soil fraction above 0.063mm studies were performed by automatically diffractometer for powder “PHILIPS”, model PW-1710. Identification of the present mineral compared with the literature data (www.icdd.com)

Descriptive statistics, Wilcoxon Signed-Rank test, Student′s paired t-test, correlations (Pearson′s coefficients) were performed by demo version of NCSS statistical software. (www.ncss.com).

THE RESULTS AND DISSCUSSION

XRD analyses of fraction above 0.063 mm showed mineralogical composition: the most dominant mineral is quartz as a primal mineral (with exception of the sample S41, where is dominant calcite), feldspar and clay minerals type illite, sericite, chlorite and montmorillonite. In Banat soils clays are more dominant than feldspars. Carbonates - calcite and dolomite are present in different concentration range and not in all samples. In some samples of Srem in bottom soil samples, carbonates are more dominant than feldspar or clays. Amphiboles and hematite are detected in soils as well, but much more in soils of Srem than in soils of C. Banat. The mean values of organic matter (humus %) of 4.71% and 4.85%, both depths in Srem and 6.02 и 4.75% in C. Banat, can classify them into chernozems.

The results of Cr, Ni, and Co concentrations as mean, maximum, minimum standard deviations (st.dev.), and coefficient of variation (CV) in two depths of soils in Srem and C. Banat, as well as referent values (B1), mean and concentration range of the elements in chernozems (Kabata Pendias, 2011) are given in Table 1.

High coefficients of variation of heavy metal, indicate great concentration variability, i.e. greater heterogeneity of the samples, which in the case of Ni and Cr is more notable in the top soil of Srem, than in the soils of Banat, and also in the case of nickel in the bottom soils in Banat. Using the Student’s paired t-test ($\alpha = 005$), it was found that there is statistically significant difference between the values of Cr, Ni in soils of Srem and C. Banat– higher values are in the soil of Srem.

Table 1.Descriptive statistic of Cr, Ni, Co in both depths of soils and referent values (mg/kg)(Kabata&Pendias, 2012)*

Element	Cr		Ni		Co	
Locality	Srem	S.Banat	Srem	S.Banat	Srem	S.Banat
Mean	49.3	31.7	51.6	29.2	10.8	9.69
St. dev	39.1	6.99	40.4	8.25	3.99	2.64
Median	36.8	29.4	39.9	28.4	9.97	9.49
Min	21.1	21.3	23.5	20.3	5.31	5.56
Max	247	44.2	230	51.0	24.1	16.7
CV%	**79.25**	22.07	**78.35**	28.25	36.97	27.28
Mean	44.8	31.3	49.7	34.5	10.13	10.2
St dev	29.1	8.03	44.8	27.6	3.55	3.28
Median	36.9	25.7	36.4	23.8	9.45	9.50
Min	20.1	20.2	21.7	11.4	5.44	5.67
Max	152	45.9	273	145	20.2	20.3
CV%	**64.88**	25.70	**90.17**	**80.04**	35.05	32.23
B1	40.0		37.2		12.5	
*range	11-195		6-61		0.5-50	

Taking into a consideration Pearson's coefficients (p≥0.80), it has been found there is a significant correlation between Cr and Ni (0.88) in top soils of Srem; Ni and Cr (0.93), Co and Cr (0.81) in bottom soils. Cr, Ni, Co, and Mg have association in minerals such as chlorite and serpentinite, and here chlorite, may be one of the natural sources of studied elements, which is the same conclusion as well as Giuseppe et al (2014). In C. Banat soils, the significant correlation between these elements at given level is missing.

Wilcoxon's test indicates only higher values of Ni in the top soils than in bottom soils in Srem. As the opposite, in the Banat elements are uniformly distributed in both depths.

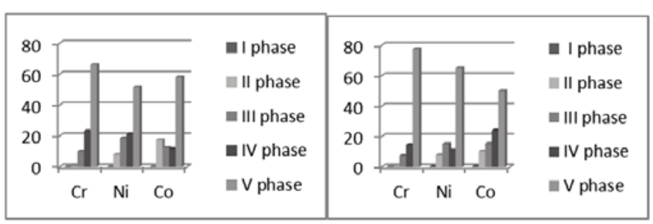

Figure 1.*The distribution of Cr, Ni , Co between phases(%)in soils of a) Srem, b)C. Banat*

The diagrams (Figure 1) depict the distribution of the three elements between phases (geochemical affinity in %) obtained by sequential extraction methods in the investigated area.

Chromium in soils of Srem and C. Banat is distributed according to geochemical affinity between F5>F4>F3 (both depths). Cr as lithophile element changes Al and Fe and thus can be in the silicate minerals clays- chlorite, amphibole, garnet, biotite, pyroxene (Albanese et al, 2015), as well as Fe minerals, such as hematite. Approximately 0.20 mg/kg is present in F2 phase , but in exchangeable phase (F1) presence of this element is not detected. Furthermore, in Banat soils there is no existence both in F1 and F2, so low level of mobility/ bioavailability means low possibility of entering into the food chain in these areas. In addition, it suggests it′s lithological origin. The concentration values of chromium in the investigated area are both above and below the referent value (B1) but within the range of values characteristic in chernozems (Table 1). The maximum value is observed in the samples S21 (the only value higher than given range in chernozems) taken nearby the leather factory (top soil) and locality S 43 (bottom soil), taken 400 m away from the cement factory in urban area of Beočin town (141 mg/kg in top soil). Higher values are registered in the sample S22, placed 250 m away from leather factory top soil (130 mg/kg) and S12 (bottom soil), nearby metal processing factory (146 mg/kg). All samples were taken from nonagricultural soils so there is no influence of agrochemicals application, but the industrial activity in leather factory , cement factory and the metal processing factory as well as combustion of fossil fuel in industrial processes can contribute to the total content of chromium. In C. Banat, the highest concentration is detected in sample of nonagricultural soil (SB13), with dominant presence of chromium in residual phase. The minimum values obtained in agricultural and nonagricultural soil samples (SB18 and SB21), which suggests the lithological origin and the absence of contamination due to agricultural activities.

Nickel in the soil in Srem has the same geochemical affinity as chromium (Figure 1a) and suggests the lithological origin and geochemical similarity**.** The Sakan et al.(2010) in sediments of the Tisa river had the same conclusion. In soils of C. Banat, nickel is mostly concentrate in residual phase (F5) (both depths) and further in decreasing order: F3>F4>F2>F1. Generally, nickel in soils can be found in limonite and Fe-silicate minerals (Hawks&Webb, 1968) and such distribution, amongst the other, may be the result of decomposition of crystalline forms minerals - Fe and the silicate minerals (F5) to less crystalline forms (F3). The mean value of nickel content in the mobile phases (F1 + F2) in soils of Srem is 4.12 mg/kg and in C. Banat 2.30 mg/kg, which indicates a relatively low content of available nickel and suggests it′s lithological origin. Dozet et al (2011) also found a low value of easily available nickel (1.48 mg/kg) in alluvial-delluvial soils of Srem. Range of nickel concentrations indicates existence values both above and below the reference (B1) in Srem, and out of the range given for chernozem (Table 1) are values: the maximum value - registered in both depths of the soil sampled 400 m away from the cement factory in an urban area Beočin (S43) and nearby the factory S42 (106 and 82.1 mg/kg), than in the sample labeled as S22 in top soil (167 mg/kg) and S21 (158 and 148 mg/kg), nearby the leather factory in urban area of Ruma town. Also, notable is value of 165 mg/kg in the subsurface of locality S 12. All localities mentioned above present nonagricultural soils. As in the case of chromium, the cement factory (Beočin), leather factory (Ruma), and metal processing factory (S.Pazova), can contribute to the total content of this metal. In C. Banat the maximum value is recorded in the sample SB1 (non agricultural top soil) and SB3 (agricultural bottom soil), indicating some low impact of agricultural activity to the nickel contents.

Cobalt in the sample soils of Srem is distributed between the phases (Figure 1) in order: F5>F2>F3> F4> F1. Such non-selective distribution between phases and depths suggest it′s heterogeneity, since Co is siderophile, chalcophile and lithophile and in nature appeared along with nickel and iron, but can be found in carbonates as well (Baralkiewicz&Siepak,1999). In the investigated soils of Srem most probably, Co is bounded in carbonate minerals (not genetically) as a consequence of decomposition other minerals. This is obviously different from the distribution of Co in C. Banat soils, where it is similar to the distribution of chromium, and suggests a common origin. The mean values of the most mobile phases (F1+F2) of 1.82 and 0.95 mg/kg in Srem and Banat respectively, indicate a low mobility level and bioavailability. Cobalt content values in soils of Srem are above and below the reference value in the whole researched area and within the range of values in chernozems. The maximum value was observed in the samples S42, with dominate mineral calcite and the highest percentage is distributed between the residual and the carbonate phase. In bottom soil, maximum value is registered in sample S12. Regardless to the fact that distribution between the phases is the same in all samples of Srem soils and a maximum is placed in the area of presence of igneous rocks (S 42-Beočin, Fruška gora), it can be concluded that here exists eventually low contribution of presence cement factories and metal processing factory. The other potential sources do not have significant impact. In C.Banat, the maximum value (Table 1) is registered in the surface sample SB16, taken from and subsurface sample SB-21 (agricultural soil), with dominant concentration bound in the organic matter, and the minimum in samples of grazing soil (SB1 and S23), which may suggest the minor contribution due to usage of manure regardless the values of Co (Table1).

CONCLUSION

According to the obtained results, we can conclude that there is a difference in the content of Cr, Ni, between investigated soils of C. Banat and Srem and they are higher in soils of Srem, due to both the influence of the geological matrix, especially in Beočin town (which suggest good correlation between the elements) ,which in the area of the Ravni Srem originates from Fruška Gora mt., and the presence of industrial facilities: cement factory Beočin, leather factory Ruma and metal processing factory (S. Pazova). Furthermore, the highest percentage of Ni, Co, Cr is in the residual phase (iron minerals, and aluminosilicates), while the values in the mobile – bioavailable forms are low, confirming dominate lithological origin. Agricultural activities have the minimal or no impact on the content of Cr, Ni, and Co in the investigated area of Srem and C. Banat.

REFERENCES

1. Albanese S., Segedhi M., Lima A. : *GEMAS: Cobalt, Cr, Ni Cu distribution in agricultural and grazing land soil of Europe*, Journal of geochemical exploration, 154, 81-93, 2015
2. Banat K.M., Howari F.M., Al-Hamad A.A.: *Heavy metals in urban soils of central Jordan: Should be worry about their environmental risks?*, Environmental research 97, 258-273, 2005
3. Baralkiewicz D., Siepak J.: *Cr, Ni, Co in environmental samples and existing legal norms*, Polish Journal of environmental studies, 8 (4), 201-208, 1999
4. Brankov M, Ubavić M., Sekulić P., Vasin J.: *Trace elements and heavy metal contents of agricultural and nonagricultural soils in the region of Banat,* Proceedings 42, 169-177, Institute of field and vegetable crops, Novi Sad, 2006
5. Cai L., Xu Z., Ren M. *Source identification of eight hazardous heavy metals in agricultural soils of Huizhou, Guangdong province, China*, Ecotoxicology and environmental safety 78, 2-8, 2012
6. Dozet D., Nešić Lj., Belić M.,Bogdanović D., Ninkov J., Zeremski T., Dozet D., Banjac B. : *Origin and content of Ni in alluvial-delluvial soils of Srem, Serbia*, Field and vegetable crops research 48, 369-374 ,2011
7. Giuseppe D., Vittori Antisari L., Ferronato C.: *New insighst on mobility and bioavailability of heavy metals in soils of the Padanian alluvial plain (Ferrara Province, (northern Italy)*,Chemie der erde 74, 615-623, 2014.
8. Hawkes H.E, Web J.S.:,*Geochemistry in mineral exploration*, Harper and row publishers, New York and Evanson,1962
9. Jakšić S., Sekulović P., Vasin J.: *Content of Heavy Metals in gleyic chernozem of Srem loess terrace under Alfalfa*, Field and vegetable crops research 49(2), 189-194, 2012
10. Kabata Pendias A.: *Trace elements in soils and plants,* 4th edition, CRC press, Taylor and Francis Group, LLC,2011
11. Maksimović L., Milošević N., Nešić Lj, Zeremski T., Vasin J., Ninkov J., Grahovac N.: *Soil contamination in South Bačka Region of Serbia with dangerous and harmful substances*, Field and vegetable crops research 49(2) 220-228, 2012
12. Tariq S.R. Shah M.H., Shaheen N., Khalique A., Manzoor S., Jaffar M.: *Multivariate analysis of selected metals in tannery effluents and related soil*, Journal of hazardous materials A122, 17-2., 2005
13. Nagajyoti P.C., Lee K.D., Sreekanth T.V.M.: *Heavy metal occurrence and toxicity for plants a review,* Environmental chemical letters, 8, 199-216,

14. Ninkov J., Zeremski-Škorić T., Sekulić P., Vasin J., Milić S., Paprić Đ.: *Heavy metals in vineyard soils of Vojvodina province*, Field and vegetable crops research 47(1), 273-279, 2010
15. Sakan S., Đorđević D., Manojlović D.: *Trace element as tracers of environmental pollution in the canal sediments (alluvial formation of the Danube river, Serbia)*, Environmental monitoring assessment 167, 219-233, 2010
16. Sarkar A., Rano R., Udaybhanu G., Basu A.K. *A comprehensive characterization of fly ash from thermal power plant in Eastern India,* Fuel Processing Technology 87, 259-277, 2006
17. Zeremski-Škorić T, Ninkov J., Sekulić P., Milić S., Vasin J., Dozet D., Jakšić S.: *Heavy metal content in some fertilizers used in Serbia*, Field and vegetable crops research 47(1), 281-287 ,2015

[1] Маја Познановић Спахић, [3]Сања Сакан,[2] Драган Манојловић, [1]Павле Танчић, [2]Сања Шкривањ, [1]Јован Ковачевић [4]Зоран Никић

[1] Геолошки завод Србије

[2] Хемијски факултет Универзитета у Београду

[3]Институт за хемију, технологију и металургију, хемијски одсек

[4]Шумарски факултет Универзитета у Београду

ХРОМ, НИКЛ, КОБАЛТ У ЗЕМЉИШТУ СРЕМА И СРЕДЊЕГ БАНАТА (ВОЈВОДИНА)

Апстракт

У овом раду представљене су концентрације и потенцијални извори хрома, никла и кобалта у земљишту Срема и Средњег Баната (Војводина, Србија). Применом различитих метода: модификоване Tessier-ове методе секвенцијалне екстракције, статистичких метода, и методе рентгенске дифракције праха, идентификовани су извори елемената и дефинисано на одређеним локацијама да ли су они антропогени или природни.

Резултати су указали да су вредности хрома и никла више у земљишту Срема, због утицаја како геолошког матрикса, тако и присутних индустријских објеката.

Keywords: *хром, никл, кобалт, земљиште, Војводина*