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XIV ENVIRONMENTAL PROTECTION OF URBAN AND SUBURBAN SETTLEMENTS

PROCEEDINGS

NOVI SAD, SERBIA

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ECOLOGICAL MOVEMENT OF NOVI SAD

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Original Scientific paper

RECOGNIZED VALUES OF THE CONTENT OF HAZARDOUS AND HARMFUL SUBSTANCES IN THE SOIL FROM THE ANGLE OF SCIENCE AND LEGISLATION

Abstract

Based on the role that soil has for life on Earth, preservation of soil as a resource for future generations is highly positioned environmental priority of the international community. Assessing the soil use risk is a very important fact for assessing its quality, but also for obtaining healthy food. National legislation defines criteria that are binding as tools for assessing soil use risk and it varies between countries. Science has recognized that due to the influence of many factors on the mobility of hazardous and harmful substances, it is necessary to use modeling to obtain logarithms that would be used in machine learning and artificial intelligence, which should be applied in legislation.

Key words: *soil, hazardous and harmful substances, legislation, modelovanje*

INTRODUCTION

The importance of soil as the basis of life on Earth, and its primar role in meeting human needs through the production of food, biomass, fiber and other products, as well as ensuring the provision of basic ecosystem services was discussed in the Revised World Soil Charter (FAO, 2015). The role that soil has for life on Earth makes soil resources more and more susceptible to the pressure of human activities, and according to the authors of the Charter, only careful soil management, which is the basis of sustainable agriculture, can regulate climate and preserve ecosystem and biodiversity. Since soil is the basis of almost all ecosystem functions, which we know does not have an adequate replacement, it is justifiably seen as an immeasurable good of all humanity, which we have inherited to use and preserve for future generations. Through the processes of pedogenesis, its formation is slow, but with various types of degradation and changes in the way of use, it is damaged and destroyed quickly, ie in some cases it is lost permanently.

The problem of soil use and conservation should be approached systematically and in a planned manner, at all levels (local, regional and global) in order to achieve, in addition to the quality of services and products it produces, maximum utilization with the highest possible cost-effectiveness. This is feasible by promoting the basic environmental principles and goals of sustainable development (Grujić, 2020). It was necessary to define global strategies to meet long-term goals, as well as an international legal framework for their implementation. At the local level, it was necessary to enact laws, regulations and ordinances concerning the quality and monitoring of soil that are in line with global strategies while respecting the principles set out above.

The aim of this paper is to review and compare the existing European legislation and the laws of the Republic of Serbia (RS) related to soil as a resource for obtaining healthy food products. Current scientific conclusions that have been applied in legal regulations will also be listed, as well as the results of researches that have an impact on obtaining safe food.

METHODES AND MATERIALS

Documents adopted by relevant international bodies, publications and scientific papers, as well as laws in force in the RS, relating to soil as a resource, were reviewed for the purposes of this paper.

RESULTS AND DISCUSSION

Legislation in Europe

The international community began to see the dimensions of the problem and recognized the importance of protecting and preserving soil as a resource in the middle of the 20th century. As early as 1972, in the "European Soil Charter" (Committee of Ministers of the Council of Europe), it was adopted that Governments and competent institutions must plan and manage soil resources, which meant rational use o soil reasources that would increase or at least maintain its production capacity to ensure long-term soil conservation. The authors pointed out that the legislation needed to plan the distribution of soil for different purposes through regional and national development plans, control of soil use techniques that can cause deterioration or pollution of the environment, protection of soil from natural factors and human activities and restauration if necessary.

Monitoring the qualitative and quantitative content of hazardous and harmful substances (HHS) in the soil and their translocation into the food chain is one of the main challenges of science in the process of obtaining safe food and preserving the environment. It is well known that HHSs can enter the soil in different ways and from different sources, and the negative consequences of their accumulation, in addition to the toxic effect on cultivated plant species and reduced productivity, increase the risk to human and animal health by entering the food chain. The GSP Voluntary Guidelines for Sustainable Soil Management (2017 FAO) encourage governments to establish and implement regulations that limit the accumulation of HHS below established levels in order to protect human health and well-being and facilitate the remediation of contaminated soil that exceeds these levels, and also regulations which would regulate that contaminated soil is not used for the production of food for humans and animals.

The scientific community contributed to the state legislative bodies and institutions in creating draft laws and bylaws regarding the definition of protection of humans and animals from negative environmental impacts by participating in the working groups of relevant ministries. Harmonization of legal regulations and scientific knowledge cannot be synchronized due to the accelerated productivity of today's scientific research and the resulting knowledge and conclusions, since the adoption of legal acts requires compliance with legal procedures that are long and complex.

The list of recognized HHS varies depending on the country and organization. A parameter that is recognized as an indicator of the impact of a chemical compound is its concentration in the soil. Depending on the country, it is defined as: maximum permitted quantities, permitted concentrations, preventive values, trigger values, target values, reference values, regulatory values, warning values, remediation values, intervention values, precautionary value, action level, proposed limit values, threshold values, values as guidelines, lower guideline, upper guideline, proposed limit, limit values, purification levels, precautionary levels, permissible concentrations. In most countries, the values of these parameters are fixed in national legislation and are expressed as total (pseudo-total) concentrations. Many authors believe that total concentrations are not relevant indicators of soil quality and human health risks (Lamb et al., 2009; Smolders et al., 2009), as bioavailable concentrations are those that the plant and soil biome adopt, and they are significantly lower of the total and they are influenced by many soil properties and processes that take place in the soil (Robinson et al., 2005; Carrillo-Gonzalez et al., 2006; Lončarić et al., 2012; Violante et al., 2010; Legrand et al., 2005).

Some European countries have introduced variable values for these parameters in their legislation, and their concentration has been adjusted in relation to certain soil characteristics that differ between countries. Belgium, the Netherlands and RS have variable values of the content of HHS depending on the content of soil organic matter (SOM) and clay, and Slovakia depending on the texture class of the soil and pH value. In Poland, the values are defined depending on the electrical conductivity of the saturated soil and the depth of the soil for which it is determined. In Great Britain, SOM and pH have an influence on the value of HHS. In the Czech Republic and Lithuania, values are determined by the texture class of the soil, while in Germany, in addition to the texture class, the influence of SOM is also included.

Recognized soil characteristics adopted by legal regulations are taken from the results of scientific research dealing with bioavailability, mobility and translocation of HHS in soil. However, according to many authors (Carrillo-Gonzalez et al., 2006;

Ivezić et al., 2012; Anagu et al., 2009; Imoto and Iasutaka, 2020; Hu et al., 2020; Zhang et al., 2020; Martine et al., 2020; Baize et al., 2009; Sarkar et al., 2017), number of physicochemical parameters have the influence on bioavailability of trace elements (TE), including the content of clay fraction, organic matter (total SOM and / or water-soluble DOM), cation exchange capacity (CEC), total, DTPA, EDTA soluble and water-soluble forms of TEs, iron / manganese / aluminum oxide, pH, texture class, liquid-solidity ratio for TE and chemical properties of TEs.

These facts indicate that in addition to SOM and clay (Radovanović et al., 2015; Pivić et al., 2020), it is necessary to include all known factors that affect the mobility of HHS and to model the bioavailability of HHS in order to assess the risk of soil use (Dinić et al., 2019; Maksimović et al., 2021). Based on bioavailability, it is possible to make a risk assessment, predict transport, destiny and potential impact on the environment. Through synergy of agricultural practice, science and computer technologies with the help of machine learning and artificial intelligence (AI), highly predictive mathematical models based on patterns and structures hidden in large and high-dimensional data sets (Nakamura et al., 2017) can be formed and used for risk assessment.

Some legislations additionally define values based on extraction techniques for analysis (Czech Republic and Austria), route or method of introduction of hazardous and harmful substances, direct contact, through the food chain, groundwater (Germany) and soil uses as a factor influencing the recognized values, in addition to the physicochemical characteristics of the soil. The basic purpose based classification is whether the soil is used in agricultural production or for other purposes. In most European this classification is clearly defined and and HHS values are set accordingly. In Belgium categories are natural, agricultural, recreational, special, settlement and industrial areas, while in the Czech Republic there is a category of generalized area, in Italy inhabited/public areas and industrial/commercial, while in Germany they are divided into children's playgrounds, parks and recreational areas , inhabited and industrial areas. In France and Sweden, areas are divided on the basis of sensitivity of use, in Spain into categories of human health and environmental protection and in Poland into three groups which include various uses.

The above information indicates that the interpretation of the obtained results is not a simple process. In many cases, it is not possible to determine whether the soil on the examined locality meets the set criteria according to the valid national legislation only on the basis of the value of the required parameter. It is necessary to have additional information about the site and other physical and chemical characteristics of the soil, in order to conclude whether the criteria defined by law have been met.

The results defined by national legislation are not comparable between countries in most cases due to differences in the basis of their production, which is why there are significant differences between the allowable values for the amount of HHS in the soil. Thus, in some localities, the allowed quantities will be in accordance with the defined values according to the legal regulations of the state on whose territory the soil is located, and at the same time the same quantities would indicate significant pollution within the legal framework of another state.

According to Belgian legislation, the permitted value of As in agricultural soil is 45 mg/kg. This value can be higher or lower after correction depending on the SOM content and the clay fraction. If this value of As concentration in soil were interpreted on the basis of Austrian legislation, the conclusion would be that the value of As is close to intervention-value, and significantly exceeds the Trigger-Value. In Italy, this is close to the value allowed for soils in industrial area. In most other European countries, according to the legal regulations, the permitted values for As are less than or equal to 30 mg/kg. Some countries allow higher concentrations of As for industrial areas (Poland 100 mg/kg, Germany 140 mg/kg while Belgium allows as much as 300 mg/kg). Belgian legislation stands out with values for the permitted quantities of HHS, which are significantly higher than most European norms. The countries that have perhaps the least tolerance for the content of HHS in their legislation are Denmark and Finland. Permitted amounts of Hg in soil are best example of a wide range of values in European legislation. Allowed values are 0.1 mg/kg inorganic Hg (Denmark), 0.15 mg/kg Hg (Slovakia), 0.3 mg/kg Hg (Netherlands), 0.5 mg/kg Hg in (Finland), 0.6 mg/kg Hg (Czech Republic), 2 mg/kg Hg (Austria) and 10 mg/kg (Belgium), which is 100 times higher than the value recognized in Denmark. In RS, according to the valid acts, the maximum allowed amount is 2 mg/kg (agricultural soils) and the maximum limit value is 0.3 mg/kg (all soils).

The activities of the Dutch National Institute for Public Health and the Environment (RIVM) are a real example of cooperation between the scientific community and the legislator, as cooperation between the state administration and scientific institutions through the implementation of many projects that include health, nutrition, health care, disaster management, nature and the environment (https://www.rivm.nl/en). From 1978 until today, 25,860 scientific papers and 8229 Reports have been published, which have had a significant impact on local and world legislation. The values for parameters that can be dangerous and harmful to humans and the environment are periodically revised once defined, and ongoing researches define new parameters that are subsequently introduced into legislation. Thanks to the research of mobility of organic and inorganic pollutants, their translocation from soil to plant and values derived from the natural background, formulas for correcting limit and remediation values depending on the content of organic matter and clay fraction were obtained:

$$(SW, IW)b=(SW, IW)sb \times [\{A+(Bx\%\ clay)+(Cx\%\ SOM)\}/\{(A+(Bx25)+(Cx10)\}] \quad (1)$$

(SW, IW)b – corrected maximum limit or remediation value for a certain soil;
(SW, IW)sb – maximum limit or remediation value from the table% clay – measured percentage of clay in a certain soil (particle size < 2 μm);
% SOM – measured percentage of SOM in a certain soil;
A, B, C – constants depending on the type of metal

$$(SW, IW)b = (SW, IW)sb \times \%\ SOM/10 \quad (2)$$

(SW, IW)b – corrected maximum limit or remediation value for a certain soil;
(SW, IW)sb – maximum limit or remediation value for standard soil;
% SOM – measured percentage of SOM in a particular soil.

In addition to the Dutch Institute, a good example of cooperation between science and legislators can be illustrated by the activities of the UK Environment Agency (https://www.gov.uk/government/organisations/environment-agency). Their scientific reports (eg SC050021 / arsenic SGV. SCHO0409BPVY-EP – Soil Guideline Values for arsenic in soil: SGV technical note. Supersedes: Soil Guideline Values for arsenic contamination (EA, 2002 indicate that it is necessary to take into account the human daily intake of HHS from the environment per kilogram of a person. These calculations take into account the intake from air, water, food and soil.

Analyzing the available documents, it can be noticed that European countries have different laws and bylaws regarding soil as a resource, and the reasons are numerous. Carlon et al. (2007) analyzed the basics of methods for assessing soil contamination used in EU Member States in a comprehensive study, and based on the review they concluded that there are large differences in the adopted legislation, which are presented above. The authors defined the possible reasons for the differences in five categories. Under the first are geographical and biological differences related to regional (soil pollutants, groundwater depth, precipitation, snow cover, organic matter content, soil texture, proximity to water, evaporation temperature) and physical factors (sensitivity of human receptors as average body weight, life expectancy and sensitivity of environmental receptors such as the presence of vulnerable species). The next category is of socio-cultural character and refers to different social behaviors and soil use. This refers to factors that affect the potential exposure of receptors to soil contaminants, such as the frequency and duration of children's outdoor activities, construction work, gardening and consumption of home-grown vegetables. The regulatory category is linked by legislation (constitutional aspects or complementarity with other existing laws). The political category is related to the prioritization of environmental and economic values regulated by policy makers – the executive and the legislature. The last category, according to the authors of the study, is scientific and it depends on the arguments of competing scientific views.

Legislation in the Republic of Serbia

The legislation of RS covers a large number of aspects of soil conservation as a resource, two laws stand out- a decree and a rulebook in the domain of reviewing the topics covered by this paper. The Law on Soil Protection (Official Gazette of RS 112/2015) regulates soil protection, systematic monitoring of soil condition and quality, remediation measures, remediation, recultivation, inspection supervision and other issues of importance for protection and preservation of soil as a natural resource of national interest. Regulations defined by this law are implemented in all types of soil (in the territory of the Republic of Serbia) as a natural resource, regardless of the form of ownership, its purpose and current use. The main goal of this law is to preserve the surface and function of the soil as well as to prevent or eliminate various harmful changes in the soil that can occur naturally (due to abiotic factors) or human activities.

The Law on Agricultural Soil ("Official Gazette of RS", No. 95/2018) regulates the planning, protection, arrangement and use of agricultural soil (soil used for agricultural production such as fields, gardens, orchards, vineyards, meadows, pastures, fishponds, reeds and wetlands and areas that can be used for agricultural production) supervision over the implementation of this law and other issues of importance for the protection, arrangement and use of agricultural soil.

By-laws such as the Decree on Limit Values of Pollutants, Harmful and Hazardous Substances in Soil ("Official Gazette of RS", No. 30/2018, 64/2019) and the Ordinance on Permitted Quantities of Hazardous and Harmful Substances in Soil and Water for irrigation and methods of their testing ("Official Gazette of RS" No. 23 of March 18, 1994) determine the limit values of pollutants, harmful and dangerous substances in the soil, ie, prescribe the maximum permitted amounts of HHS in soil and water used for irrigation that can damage or change the production capacity (fertility) of agricultural soil and the quality of water used for irrigation. Such pollutants come from discharges from factories, landfills, improper use of mineral fertilizers and plant protection products. The legal predecessor of this act (Decree on the program of systematic monitoring of soil quality, indicators for assessing the risk of soil degradation and methodology for the development of remediation programs, "Official Gazette of RS", No. 88/2010) which introduced the Dutch model into national legislation in Article 1 defines that the limit and remediation values do not refer to agricultural soil. By upgrading the regulation from 2010, Article 1 was reformulated and the part of the text which defines that this regulation does not refer to agricultural soil was removed, which resulted in overlapping of competencies for agricultural soil between two legal acts.

CONSLUSION

Preservation of soil as a resource for future generations has been highly positioned as one of the environmental priorities of the international community in recent years. A large number of scientists and institutions are working on the development of strategies and programs for their implementation. This is a process that is not even close to the end. RS legislation covers a large number of aspects of soil conservation as a resource. It is necessary to ensure the strengthening of legislation in this area, the implementation of existing laws and bylaws, as well as "keep pace" with strategies, guidelines and criteria prescribed by the international scientific community that are changing and evolving rapidly and adopt new regulations in accordance with the above. Current scientific achievements indicate that in the very near future, algorithms for machine learning and artificial intelligence will be used as the main tool in the assessment of soil use risk, which will very certainly be applied in the adoption of legal regulations.

REFERENCES

1. Anagu, I.; Ingwersen, J.; Utermann, J.; Streck, T. Estimation of heavy metal sorption in German soils using artificial neuralnetworks. Geoderma 2009, 152, 104–112.
2. Baize, D.; Bellanger, L.; Tomassone, R. Relationships between concentrations of trace metals in wheat grains and soil. Agron.Sustain. Dev. 2009, 29, 297–312.

3. Carlon, C.; D'Alessandro, M.; Swartjes, F. Derivation Methods of Soil Screening Values in Europe: A Review of National Procedure stowards Harmonisation; Scientific and Technical Research Series; Office for Official Publications of the European Communities: Ispra, Italy, 2007.
4. Carrillo-Gonzalez, R.; Simunek, J.; Sebastien, S.; Adriano, D. Mechanisms and pathways of trace element mobility in soils. Adv. Agron. 2006, 91, 111–179.
5. Dinić, Z.; Maksimović, J.; Stanojković-Sebić, A.; Pivić, R. Prediction Models for Bioavailability of Mn, Cu, Zn, Ni and Pb in Soilsof Rep. of Serbia. Agronomy 2019, 9, 856.
6. Hu, B.; Xue, J.; Zhou, Y.; Shao, S.; Fu, Z.; Li, Y.; Chen, S.; Qi, L.; Shi, Z. Modelling bioaccumulation of heavy metals in soil-cropecosystems and identifying its controlling factors using machine learning. Environ. Pollut. 2020, 262, 114308
7. Lamb, D.T.; Ming, H.; Megharaj, M.; Naidu, R. Heavy metal (Cu, Zn, Cd and Pb) partitioning and bioaccessibility in uncontaminatedand long-term contaminated soils. J. Hazard. Mater. 2009, 171, 1150–1158.
8. Lončarić, Z.; Kadar, I.; Jurković, Z.; Kovačević, V.; Popović, B.; Karalić, K. Heavy metals from farm to fork. In Proceedings ofthe 47th Croatian and 7th International Symposium on Agriculture, Opatija, Croatia, 13–17 February 2012; Pospišil, M., Ed.; University of Zagreb, Faculty of Agriculture: Zagreb, Croatia, 2012; pp. 14–23, ISBN 978–953–7878–03–0
9. Legrand, P.; Turmel, M.C.; Sauve, S.; Courchesne, F. Speciation and bioavailability of trace metals (Cd, Cu, Ni, Pb, Zn) in therhizosphere of contaminated soils. In Biogeochemistry of Trace Elements in the Rhizosphere, 1st ed.; Huang, P.M., Gobran, G.R., Eds.; Elsevier: New York, NY, USA, 2005; pp. 261–299.
10. Imoto, Y.; Yasutaka, T. Comparison of the impacts of the experimental parameters and soil properties on the prediction of the soilsorption of Cd and Pb. Geoderma 2020, 376, 114538.
11. Ivezić, V.; Almås, Å.R.; Singh, B.R. Predicting the solubility of Cd, Cu, Pb and Zn in uncontaminated Croatian soils under different land uses by applying established regression models. Geoderma 2012, 170, 89–95.
12. Martíne, I.; Maria, A.; Bernal, P. Environmental Impact of Metals, Metalloids, and Their Toxicity. In Metalloids in Plants: Advancesand Future Prospects, 1st ed.; Deshmukh, R., Tripathi, D.K., Guerriero, G., Eds.; JohnWiley & Sons: Hoboken, NJ, USA, 2020; 451–488.
13. Maksimović J, Pivić R, Stanojković-Sebić A, Jovković M, Jaramaz D, Dinić Z. Influence of Soil Type on the Reliability of the Prediction Model for Bioavailability of Mn, Zn, Pb, Ni and Cu in the Soils of the Republic of Serbia. Agronomy. 2021; 11(1): 141.
14. Nakamura, K.; Yasutaka, T.; Kuwatani, T.; Komai, T. Development of a predictive model for lead, cadmium and fluorine soil–waterpartition coefficients using sparse multiple linear regression analysis. Chemosphere 2017, 186, 501–509.
15. Official Gazette of Republic of Serbia. Rule Book of Allowed Concentrations of Dangerous and Hazardous Materials in Soil and in Waterfor Irrigation and Methods for Analysis; No. 23; Official Gazette of Republic of Serbia: Belgrade, Serbia, 1994.
16. Pivic R., Dinic Z., Maksimovic J., Poštic D., Štrbanovic R., Stanojkovic-Sebic A. Evaluation of trace elements MPCIN Agricultural soil using organic matter and clay content. Zbornik Matice srpske za prirodne nauke 2020, 138: 97–108.
17. Radovanović V., Dinić Z., Maksimović J., Pivić R., Stanojkovic Sebić A, Žarkovic B. Organic matter and clay contents impact on the target and remediation values of As, Ni and Cr in soil in Serbia affected by floods. 7th Symposium Chemistry and Environmental Protection with international participation, in: Palić, Srbija, 09–12. jun, 2015. 158–159.
18. Robinson, B.H.; Bolan, N.S.; Mahimairaja, S.; Clothier, B.E. Solubility, mobility and bioaccumulation of trace elements: Abiotic processes in the rhizosphere. In Trace Elements

in the Environment: Biogeochemistry, Biotechnology, and Bioremediation, 1st ed.; Prasad, M.N.V., Kenneth, S.S., Naidu, R., Eds.; CRC Press: Boca Raton, FL, USA, 2005; 97–110.
19. Uredba o graničnim vrednostima zagađujućih, štetnih i opasnih materija u zemljištu ("Sl. glasnik RS", br. 30/2018, 64/2019)
20. Sarkar, S.; Sarkar, B.; Basak, B.B.; Mandal, S.; Biswas, B.; Srivastava, P. Soil Mineralogical Perspective on Immobilization/Mobilization of Heavy Metals. In Adaptive Soil Management: From Theory to Practices, 1st ed.; Rakshit, A., Abhilash, P.C.,Singh, H.B., Ghosh, S., Eds.; Springer: Singapore, 2017; pp. 89–102.
21. Smolders, E.; Oorts, K.; Sprang, P.V.; Schoeters, I.; Janssen, C.R.; McGrath, S.P.; McLaughlin, M.J. Toxicity of trace metals in soilas affected by soil type and aging after contamination: Using calibrated bioavailability models to set ecological soil standards. Environ. Toxicol. Chem. 2009, 28, 1633–1642.
22. Violante, A.; Cozzolino, V.; Perelomov, L.; Caporale, A.; Pigna, M. Mobility and bioavailability of heavy metals and metalloids insoil environments. J. Soil. Sci. Plant Nutr. 2010, 10, 268–292.
23. Zhang, H.; Yin, S.; Chen, Y.; Shao, S.;Wu, J.; Fan, M.; Chen, F.; Gao, C. Machine learning-based source identification and spatialprediction of heavy metals in soil in a rapid urbanization area, eastern China. J. Clean. Prod. 2020, 273, 122858.
24. Zakon o zaštiti zemljišta. Službeni glasnik RS, br. 112/2015.
25. Zakon o poljoprivrednom zemljistu ("Sl. glasnik RS", br. 62/2006, 65/2008 dr. zakon, 41/2009, 112/2015, 80/2017, 95/2018 dr. zakon).

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PREPOZNATE VREDNOSTI SADRŽAJA OPASNIH I ŠTETNIH MATERIJA U ZEMLJIŠTU IZ UGLA NAUKE I ZAKONSKE REGULATIVE

Abstrakt

Na osnovu uloge koju zemljište ima za život na Zemlji, visoko pozicioniran ekološki prioritet međunarodne zajednice je očuvanje zemljišta kao resursa za buduće generacije. Procena rizika korišćenja zemljišta je veoma bitna činjenica za ocenjivanje njegovog kvaliteta ali i za dobijanje zdravstveno bezbedne hrane. Nacionalne zakonske regulative definišu kriterijume koji su obavezujući kao alat za procenu rizika korišćenja zemljišta i među državama su različiti. Nauka je prepoznala da zbog uticaja mnogih faktora na mobilnost opasnih i štetnih materija, potrebno je modelovanjem doći do logaritama koji bi se koristili u mašinskom učenju i veštačkoj inteligenciji što bi trebalo primeniti i u zakonskim regulativama.

Key words: *zemljište, opasne i štetne materije, zakonske regulative, modelovanje*