



SOIL SCIENCE SOCIETY OF BOSNIA AND HERZEGOVINA  
UDRUŽENJE ZA PROUČAVANJE ZEMLJIŠTA/TLA U BOSNI I HERCEGOVINI

## **Book of Abstracts**

PROTECTION OF SOIL AS A FACTOR OF SUSTAINABLE DEVELOPMENT  
OF RURAL AREAS AND IMPROVEMENT OF ENVIRONMENT

November 23rd – 25th 2015 Mostar

## **Zbornik apstrakata**

ZAŠTITA ZEMLJIŠTA KAO FAKTORA ODRŽIVOG RAZVOJA  
RURALNIH PODRUČJA I UNAPRJEĐIVANJA ŽIVOTNE SREDINE

23-25. novembar/studenj 2015. Mostar



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International  
Year of Soils



Sarajevo, 2015.



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**9TH CONGRESS PROTECTION OF SOIL AS A FACTOR  
OF SUSTAINABLE DEVELOPMENT OF RURAL AREAS  
AND IMPROVEMENT OF ENVIRONMENT**

(November 23<sup>rd</sup> – 25<sup>th</sup> 2015, Mostar)

**9. KONGRES ZAŠTITA ZEMLJIŠTA KAO FAKTORA  
ODRŽIVOG RAZVOJA RURALNIH PODRUČJA I  
UNAPRJEĐIVANJA ŽIVOTNE SREDINE**

(23 – 25. novembar 2015, Mostar)

Book of Abstracts

*Zbornik apstrakata*

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Sarajevo, 2015.



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## PREDGOVOR



Zemljište je nosilac brojnih funkcija neophodnih za život na Zemlji. Osigurava hranu, biomasu, sirovine, staništa i rezerve gena, skladišti, filtrira i izmjenjuje hranjive materije, ugljik i vodu. Zemljište je složen i kompleksan medij podlozan procesima degradacije i prijetnjama koje u kratkom vremenskom periodu mogu ozbiljno ugroziti i onesposobiti njegove funkcije. Posljedice se očituju kroz smanjenje plodnosti tla, što se odražava dalje na biološku raznolikost, kvalitet zraka i vode, te klimatske promjene.

Globalno se sve više prepoznaje da je zemljište ključan prirodni resurs, a zaštita zemljišta jedno od ključnih pitanja zaštite životne sredine. Zaštita tla obuhvata očuvanje zdravlja i funkcija tla, sprječavanje njegovog oštećenja, praćenje stanja i promjena kvaliteta tla, te saniranje i obnavljanje oštećenih tala i lokacija. Onečišćenje i oštećenje tla ima najdirektniji uticaj na okoliš, a utvrđivanje prihvatljivih graničnih vrijednosti kvaliteta tla provodi se na osnovu posebnih propisa. Obzirom da je tlo neobnovljivo dobro mora se koristiti održivo u očuvanje njegovih funkcija, pri čemu se nepovoljni efekti na tlo moraju izbjegavati u najvećoj mogućoj mjeri.

U Bosni i Hercegovini, ali i na području šireg regiona, zemljište kao prirodni i privredni resurs ne prepoznaje se na pravilan način. Oštećenja i gubici plodnog (poljoprivrednog) zemljišta tokom tranzicijskog period u posljednjih dvadeset godina poprimaju sve veće razmjere. Politika zaštite i korištenja zemljišta koja se vodi na nacionalnom nivou nije u skladu ni sa evropskim, ali ni sa globalnim nivoom potreba i zabrinutosti za ovaj, jedan od najvažnijih prirodnih resursa. Očigledno je da je na našim prostorima zlatno doba poljoprivrede prošlo. S tim u vezi, sve je veća bojazan da će se zajedno s poljoprivrednom naukom zapustiti i nauka o zemljištu/tlu. Međutim, u mnogim publikacijama koje se bave održivim razvojem i opstankom civilizacije na Zemlji dokazuje se upravo suprotno, obzirom da veliki dio čovječanstva još uvijek gladauje i zbog toga što tlo ima širi društveno-ekonomski i ekološki značaj. Pedolozi se moraju baviti svim tim problemima i pokušati da ih riješe zajedno sa povezanim, drugim naučnim područjima na koja se inače oslanjaju. Nauka o zemljištu u BiH, ali i u širem regionu, dugo se veoma uspješno razvijala što pokazuju održani, veoma značajni naučni skupovi i objavljeni radovi u prethodnom periodu.

Istraživanja i naučno-istraživački rad u našim uslovima vezan je uglavnom za visokoobrazovni sistem koji se u BiH, ali i u regionu nalazi u dubokoj krizi.

Sve je veći broj novootvorenih javnih i privatnih univerziteta, i na njima poljoprivrednih i šumarskih fakulteta, odnosno studija ekologije, na kojima su istraživanja na vrlo niskom nivou, posebno iz oblasti zemljišta. Stanje poljoprivrede, šumarstva kao sektora je, također, veoma složeno, a funkcije tla u ekosistemu se još uvijek nedovoljno prepoznaju. Ulaganja u poljoprivredu i naučno-istraživački rad su veoma niska. U vezi s tim istraživanja u oblasti zemljišta su, također, veoma mala.

IX Kongres Udruženja za proučavanje zemljišta/tla u Bosni i Hercegovini u Mostaru predstavlja šansu da se prezentira stanje kvaliteta tla, procijeni ozbiljnost prijetnji kojima su tla izložena, te da se razmijene informacije o aktivnostima na zaštiti tla u zemljama Evropske unije i nekim susjednim zemljama. Pedologija i znanje vezano za zemljište imaju u ovoj regiji dugu istoriju.

Naučna zajednica u regionu treba imati koristi od saradnje. Stoga je veoma važno imati na umu da događaji ovakvog tipa treba da predstavljaju priliku za mlade istraživače i šansu da se okupe, inspirišu i međusobno djeluju sa drugim institucijama, uz mogućnost prekograničnih istraživanja i zajedničkih, ako ne i holističkih, aktivnosti na zaštiti tala u regiji. Rad naučnika u oblasti tla postaje sve značajniji.

Ovaj Kongres je, također, organizovan kako bi se podigla svijest javnosti, a tlo predstavilo kao važno i temeljno, kao nešto što ne zaslužuje pažnju samo stručnjaka, već prije svega svih političara i onih koji donose odluke. S obzirom na ovakav previd ili neprepoznavanje u široj javnosti, naša je obaveza da djelujemo u pravcu postizanja zajedničkog cilja: zaštite i očuvanja kvaliteta tla u cilju prosperiteta ove i budućih generacija.

Obzirom da je kalendarska 2015. godina proglašena je od strane UN-a *Svjetskom godinom zemljišta/tla*, a 05. decembar *Svjetskim danom zemljišta/tla*, koji će se obilježavati svake godine, ovaj IX Kongres Udruženja za proučavanje zemljišta/tla u Bosni i Hercegovini, koji organiziramo po prvi put od sticanja nezavisnost 1992. godine, je doprinos našeg Udruženja i zajednice obilježavanju *Svjetske godine zemljišta/tla*.

Prof. dr. Hamid Čustović  
*Predsjednik Udruženja za proučavanje zemljišta/tla  
u Bosni i Hercegovini*



## FOREWORD



Soil has numerous functions that are indispensable for life on Earth. It provides food, biomass, raw materials, habitats and gene pools; it stores, filters and exchanges nutrients, carbon and water. Soil is a complex medium susceptible to degradation processes and vulnerable to threats that can seriously jeopardize and disable its functions in a very short period of time. The consequences may manifest through the loss of soil fertility which is further reflected on biodiversity, quality of air and water and climate change.

Globally, soil has been increasingly recognized as an essential natural resource and soil protection as one of the key environmental issues. Soil protection includes the preservation of health and functions of soil, prevention of its damage, monitoring of the soil quality condition and changes as well as remediation and restoration of damaged soils and sites. Pollution and damage of soil have the most direct impact on the environment, and determination of acceptable limiting values of soil quality is made based on specific regulations. Given that soil is a non-renewable resource it has to be used in a sustainable way and its functions have to be preserved while the adverse impacts on soil must be avoided to the maximum extent.

In Bosnia and Herzegovina, but also in the wider region, soil as a natural and economic resource is not properly recognized. Damage and loss of fertile (agricultural) land during the transitional period in the past two decades are becoming an increasingly huge problem. The land use and protection policy that is implemented at the national level is not in compliance with European or global level of requirements for and concerns about this natural resource. It is obvious that the golden age of agriculture in this region is over. In this regard, there is an ever growing concern that along with agriculture the soil science will get abandoned as well. However, many publications dealing with sustainable development and survival of civilization on Earth prove exactly the opposite - a large part of humanity is still affected by hunger and the soil has a broader socio-economic and environmental significance. Pedologists have to address all these issues and try to resolve them in connection with other associated scientific areas they normally rely on. The soil science in BiH as well as in the wider region has been successfully developed for a long time which is evident in a number of very significant scientific conferences and published papers.

Studies and scientific and research work in our conditions is mainly related to the higher- educational system which is in a serious crisis not only in BiH but in the entire region.

There is an increasing number of newly established public and private universities with agricultural and forestry faculties or environmental studies where the research activities are at a very low level, especially in the area of soil sciences. The current condition of agriculture and forestry as sectors is also very complex and soil functions within the ecosystem are still insufficiently recognized. Investments in agriculture and scientific and research work are very low. Consequently, the research in the area of soil is also very small.

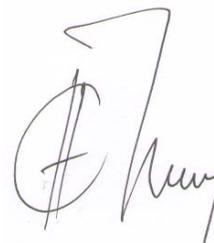
The 9<sup>th</sup> Congress of the Soil Science Society of Bosnia and Herzegovina in Mostar is a chance to present the status of soil quality, to review the severity of threats the soil is exposed to and exchange the information on soil protection activities in the European Union and some neighbouring states. Pedology and soil related knowledge has a rich history in this area.

The scientific community in the region should benefit from cooperation. It is that for important to keep in mind that events as this one should represent a prospect for young researches and a chance to gather, inspire and interact with other institutions with prospects of cross border research and joined if not holistic region soil protection activities. The work of soil scientists is becoming significantly important.

This Congress is also organized to raise the public awareness and to present soil as an important and fundamental and something what deserves not only scientific but above all attention of politicians and decision makers. Thus being overlooked or not recognized enough in wide public, it is our obligation to act in the direction of the common goal: to protect and maintain soil qualities for the prosperity of recent and future generations.

Since the *United Nations* have designated 2015 as the *International Year of Soils* and December 5<sup>th</sup> as the *World Soil Day*, which will be observed every year, this 9<sup>th</sup> Congress of the Soil Science Society of Bosnia and Herzegovina, which we are organizing for the first time since gaining the independence in 1992, is an effort of our Society and community to contribute this initiative.

prof. dr. Hamid Čustović  
*President of the Soil Science Society of Bosnia and Herzegovina*



**The 9<sup>th</sup> Congress of the Soil Science Society of Bosnia and Herzegovina**  
**9. Kongres Udruženja za proučavanje zemljišta/tla u Bosni i Hercegovini**  
**November 23<sup>rd</sup> – 25<sup>th</sup> 2015 Mostar**  
**Mostar, od 23. do 25. 11. 2015.**

**SCIENTIFIC PROGRAM/Naučni-znanstveni program**

**Monday, November 23<sup>rd</sup>/Ponedjeljak, 23. 11. 2015.**

9 <sup>00</sup> -10 <sup>00</sup>	Registration/registracija	
10 <sup>00</sup> -10 <sup>30</sup>	<b>Opening of the Congress/Svečano otvorenje:</b> prof. dr. Hamid Čustović <i>President of the Soil Science Society of B&amp;H</i> prof. dr. Nevenko Herceg <i>Prime Minister of The Herzegovina-Neretva Canton</i> prof. dr. Danijela Petrović <i>Dean of the Faculty of Agriculture and Food Technology, Mostar</i> dr. Luca Montanarella, <i>EU JRC</i>	
10 <sup>30</sup> -13 <sup>30</sup>	Introductory lectures/uvodna izlaganja	Pg./str.
	<b>Chaired by</b> prof. dr. Hamid Čustović, <i>Faculty of Agriculture and Food Science, Sarajevo</i> & prof. dr. Ivica Kisić, <i>Faculty of Agriculture, Zagreb</i>	
10 <sup>30</sup> -11 <sup>00</sup>	<b>Winfried E.H. Blum</b> European Land Quality as a Foundation for the Sustainable Intensification of Agriculture/ <i>Kvaliteta evropskog zemljišta kao temelj održivog intenziviranja poljoprivrede</i>	24/25
11 <sup>00</sup> -11 <sup>30</sup>	<b>Luca Montanarella</b> Soils Within The Post-2015 Sustainable Development Agenda/ <i>Tla u okviru Post-2015 agende za održivi razvoj</i>	26/27
11 <sup>30</sup> -12 <sup>00</sup>	<b>Kust German • Andreeva Olga</b> Possibilities to Use The “Land Degradation Neutrality” Approach for Sustainable Land Management Measuring and Monitoring/ <i>Mogućnosti korištenja pristupa „neutralnosti degradacije zemljišta” u održivom mjerenju i praćenju upravljanja zemljištem</i>	30/31
12 <sup>20</sup> -17 <sup>20</sup>	Oral presentations/usmene prezentacije	Pg./str.
	<b>Chaired by</b> prof. dr. Radica Ćorić, <i>Faculty of Agriculture and Food Technology, Mostar</i> & prof. dr. Marija Romić, <i>Faculty of Agriculture, Zagreb</i>	
12 <sup>20</sup> -12 <sup>40</sup>	<b>Bishal Sitaula</b> Climate Change Adaptation and Mitigation by Transformative Approach in Reducing Fluxes of SoilGreenhouse Gases to Atmosphere/ <i>Adaptacija i ubzavanje klimatskih promjena transformativnim pristupima smanjenja fluksa stakleničkih gasova između tla i atmosfere</i>	32/33
12 <sup>40</sup> -13 <sup>00</sup>	<b>Zoran Knežević</b> Land consolidation as a factor of development of agriculture and land management/ <i>Komasacija zemljišta kao faktor razvoja poljoprivrede i upravljanja prostorom</i>	34/35
13 <sup>00</sup> -13 <sup>20</sup>	<b>Hamid Čustović • Melisa Ljuša</b> Adapting, Adaptation Capacities and Soil Susceptibility on Climate Changes in Sub-Mediterranean Parts of Bosnia and Herzegovina/ <i>Adaptacija, adaptivni kapacitet i osjetljivost tala na klimatske promjene u submediteranskom području Bosne i Hercegovine</i>	36/37
13 <sup>20</sup> -13 <sup>40</sup>	<b>Ferdo Bašić • Nevenko Herceg • Ana Šljivić</b> Specifics Of Soils Of Agricultural Systems In Catchment Area Of The River Neretva/ <i>Posebnosti tala u agroekosustavima porječja Neretve</i>	38/39

<i>15<sup>00</sup>-17<sup>20</sup></i>	<b>Oral presentations/usmene prezentacije</b>	Pg/str.
	<i>Chaired by</i> prof. dr. Maja Manojlović, <i>Faculty of Agriculture, Novi Sad</i>	
<i>15<sup>00</sup>-15<sup>20</sup></i>	<b>Ivica Kisić • Jurišić Aleksandra • Bogunović Igor</b> Impact Of Fire On The Chemical Characteristics Of The Soil/ <i>Utjecaj požara na promjene kemijskih značajki tla</i>	42/43
<i>15<sup>20</sup>-15<sup>40</sup></i>	<b>Radica Ćorić • Matko Bogunović, Stjepan Husnjak, Hamid Ćustović,</b> Paulina Šaravanja, Elma Sefo, Viktor Lasić, Nikolina Kajić, Stanko Ivanković Multi-Purpose Evaluation of Agricultural Land in The Federation of Bosnia and Hercegovina/ <i>Višenamjensko vrednovanje poljoprivrednog zemljišta u Federaciji Bosne i Hercegovine</i>	44/45
<i>15<sup>40</sup>-16<sup>00</sup></i>	<b>Helena Bakić • Monika Zovko, Nada Maurović, Marija Romić</b> Urban Gardening: Managing Soil Quality and Preventing Contamination Risks/ <i>Urbano vrtlarstvo: upravljanje kvalitetom tla i sprečavanje rizika od onečišćenja</i> <i>Chaired by</i> prof. dr. Mihajlo Marković, <i>Faculty of Agriculture, Banja Luka</i>	46/47
<i>16<sup>20</sup>-16<sup>40</sup></i>	<b>Monika Zovko • Davor Romić, Marija Romić, Helena Bakić, Marina Bubalo</b> Soil Salinity Risk Assessment in The Lowland Neretva River Valley/ <i>Procjena rizika zaslanjivanja tla u nizinskom području doline Neretve</i>	48/49
<i>16<sup>40</sup>-17<sup>00</sup></i>	<b>Matjaž Čater</b> Does Thinning Affect the Soil Respiration in Silver Fir, Beech and Spruce Predominating Adult Forest Stands? <i>Da li prorjeđivanje negativno utječe na disanje tla u sastojinama u kojima dominiraju odrasla jela, bukva i smreka?</i>	50/51
<i>17<sup>00</sup>-17<sup>20</sup></i>	Aleksander Marinšek • <b>Emira Hukić, Mitja Ferlan, Milan Kobal, Daniel Žlindra, Hamid Ćustović, Primož Simončič</b> Soils and Carbon Content at Research Objects in Fir-Beech Forests on Calcareous Bedrocks of The Dinaric Mountain Chain: A Case Study From Slovenia and Bosnia/ <i>Tlo i sadržaj ugljika na istraživačkim objektima šuma bukve i jele na karbonatnom supstratu dinarskih planina: Studija slučaja iz Slovenije i Bosne</i>	52/53

Tuesday, November 24<sup>th</sup>/Utorak, 24. 11. 2015.

<b>8<sup>30</sup>-9<sup>00</sup></b>		<b>Registration/registracija</b>	
<i>Chaired by</i> prof. dr. Davor Romić, <i>Faculty of Agriculture, Zagreb</i>			
9 <sup>00</sup> -9 <sup>20</sup>	<b>Nenad Malić • Zorica Golić • Mihajlo Marković</b>	Changes in The Adsorption Complex of Rekultisol Underneath The Seeded Grasslands/ <i>Promjene u adsorptivnom kompleksu rekultisola pod sijanim travnjacima</i>	54/55
9 <sup>20</sup> -9 <sup>40</sup>	<b>Mirza Tvica</b>	The State of Soil Organic Matter in Different Physical Fractions Depend on Land Use Type/ <i>Stanje organske materije tla u različitim fizičkim frakcijama zavisno od načina korištenja zemljišta</i>	56/57
9 <sup>40</sup> -10 <sup>00</sup>	<b>Zorica Golić • Nenad Malić • Mihajlo Marković</b>	Microbiological Properties of Rekultisol Under The Different Cultures at “Stanari” Coal Mine/ <i>Mikrobiološka svojstva rekultisola pod različitim kulturama u rudniku “Stanari”</i>	58/59
10 <sup>00</sup> -10 <sup>20</sup>	<b>Fatima Muhamedagić • Mirsad Veladžić, Željka Zgorelec, Silva Žužul, Jasmina Rinkovac</b>	Comparison of Alluvial Soils of Different Land Use in The Area of The National Park „Una“ With Special Emphasis on the Distribution of Cd, Ni and As/ <i>Komparacija aluvijalnog tla različitog načina korištenja na području Nacionalnog parka „Una“ s posebnim akcentom na distribuciju Cd, Ni i As</i>	60/61
<i>Chaired by</i> prof. dr. Zdenko Lončarić <i>Faculty of Agriculture, Osijek</i>			
10 <sup>40</sup> -11 <sup>00</sup>	<b>Mihajlo Marković</b>	Implementation of the UNCCD in Bosnia and Herzegovina/ <i>Implementacija UNCCD u Bosni i Hercegovini</i>	62/63
11 <sup>00</sup> -11 <sup>20</sup>	<b>Mihajlo Marković • Melisa Ljuša</b>	Needs and Initiation Method of Sustainable Land Management in Bosnia and Herzegovina/ <i>Potreba i način uvođenja održivog upravljanja zemljištem u Bosni i Hercegovini</i>	64/65
11 <sup>20</sup> -11 <sup>40</sup>	<b>Marija Misilo • Melisa Ljuša</b>	Changes in Land Cover and Land Use in the Karst Area of Bosnia and Herzegovina/ <i>Promjene zemljišnog pokrova i korištenja zemljišta na krškom području Bosne i Hercegovine</i>	66/67
11 <sup>40</sup> -12 <sup>00</sup>	<b>Adrijana Filipović • Irena Vujević, Stanko Ivanković, Radica Ćorić, Dragan Jurković, Višnja Vasilj</b>	Influence of Soil Chemical Properties on Relationship of Some Metals Ion in Soil and Plant/ <i>Utjecaj kemijskih svojstava tla na odnos između nekih metala u tlu i biljci</i>	68/69
<b>12<sup>00</sup>-13<sup>30</sup></b>		<b>Poster presentation session &amp; coffee/poster prezentacije uz kafu</b>	
<b>15<sup>00</sup>-15<sup>10</sup></b>		<b>Review of poster session presented by</b> Jovana Draganić, (Crna Gora/Montenegro), Fatima Muhamedagić, (B&H), Zorica Golić (B&H), Mirza Tvica (B&H)	
<b>Oral presentations/usmene prezentacije</b>			<b>Pg/str.</b>
<i>Chaired by</i> mr. Esad Bukalo, <i>Federal institute for agropedology, Sarajevo</i> , mr. Afrim Sharku, NIRAS, Prishtina, Kosovo			
15 <sup>10</sup> -15 <sup>30</sup>	<b>Esad Bukalo • Šefika Rahmani, Habiba Lugonić, Damir Behlulović, Marina Mitrović</b>	Assessment of Agroecological Land Suitability for Raspberry Production in The Federation of Bosnia and Herzegovina/ <i>Ocjena agroekološke pogodnosti zemljišta za uzgoj maline u Federaciji Bosne i Hercegovine</i>	70/71
15 <sup>30</sup> -15 <sup>50</sup>	<b>Melisa Ljuša • Hamid Čustović, Alina Omanović</b>	Land Capability Study and Map in Function of Land Protection, Spatial Planning and Agro-Ecological Zoning/ <i>Studija i karta upotrebne</i>	72/73

15<sup>50</sup>-16<sup>10</sup> *vrijednosti zemljišta u funkciji njegove zaštite, prostornog planiranja i agro-ekološkog zoniranja*  
**Afrim Sharku • Marianna Posfai, Valon Gërmizaj, Fatbardh Sallaku** 74/75  
 The agricultural land suitability and agroecological zoning as the main factors for rural spatial planning in Kosovo/ *Pogodnost poljoprivrednog zemljišta i agro-ekološko zoniranje kao glavni faktori prostornog uređenja ruralnih područja na Kosovu*

**Wednesday, November 25<sup>th</sup>/Srijeda, 25. 11.**

9<sup>00</sup> - **FIELD TRIP/Naučno/znanstveno-stručna ekskurzija**  
 Area of visit: West Herzegovina, Čitluk and Ljubuški/*Područje posjete: zapadna Hercegovina, Čitluk i Ljubuški*  
**Departure from Hotel Mostar/Polazak ispred hotela Mostar**

**Thursday, November 26<sup>th</sup>/Četvrtak, 26. 11.**

**Departure/odlazak**

## POSTER PRESENTATION SESSION/POSTER PREZENTACIJE

**PS1 (Pg/str. 86/87):** Maja ARAPOVIĆ, Perica KAPETANOVIĆ, Marko MARJANOVIĆ, Radica ĆORIĆ, Paulina ŠARAVANJA

*POTENTIALITY OF AGRICULTURAL LAND IN HERCEGOVINA-NERETVA COUNTY FOR CULTIVATION OF SOME FRUIT SPECIES/ POGODNOST POLJOPRIVREDNOG ZEMLJIŠTA HERCEGOVAČKO-NERETVANSKE ŽUPANIJE ZA UZGOJ NEKIH VOĆNIH VRSTA*

**PS2 (Pg/str. 88/89):** Senada ČENGIĆ-DŽOMBA, Velid ZILKIĆ, Emir DŽOMBA, Dženan HADŽIĆ

*WHOLE FARM NITROGEN BALANCE ON BROILER FARMS IN CENTRAL BOSNIA REGION/ BILANS AZOTA NA FARMAMA ZA TOV PILIČA NA PODRUČJU ZENIČKO-DOBOJSKOG KANTONA*

**PS3 (Pg/str. 90/91):** Jovana DRAGANIĆ, Morteza BEHZADFAR, Marx Leandro Naves SILVA, Junior Cesar AVANZI, Ivica KISIĆ, Velibor SPALEVIĆ

*SOIL LOSS ESTIMATION USING THE IntErO MODEL IN THE S1-2 WATERSHED OF THE SHIRINDAREH RIVER BASIN, IRAN/ PROCJENA GUBITKA TLA PRIMJENOM IntErO MODELA U SLIVU S1-2 SHIRINDAREH PORJEČJA, IRAN*

**PS4 (Pg/str. 92/93):** Jovana DRAGANIĆ, Bojana DROBNJAK, Jovana CAMPAR, Biljana BULAJIĆ, Vanja ZAJOVIĆ, Morteza BEHZADFAR, Velibor SPALEVIĆ

*CALCULATION OF SEDIMENT YIELD USING THE IntErO MODEL IN THE S1-3 WATERSHED OF THE SHIRINDAREH RIVER BASIN, IRAN/ IZRAČUNAVANJE PRINOSA SEDIMENTA, PRIMJENOM IntErO MODELA U SLIVU S1-3 SHIRINDAREH PORJEČJA, IRAN*

**PS5 (Pg/str. 94/95):** Mirha ĐIKIĆ, Emir DŽOMBA, Drena GADŽO, Teofil GAVRIĆ, Jasmin GRAHIĆ, Dženan HADŽIĆ, Bal Ram SINGH

*RELATIONS BETWEEN SOIL CHEMICAL PROPERTIES AND CADMIUM CONTENT IN GREEN MASS OF SILAGE MAIZE/ ODNOS IZMEĐU HEMIJSKIH OSOBINA TLA I SADRŽAJA KADMIJA U ZELENOJ MASI SILAŽNOG KUKURUZA*

**PS6 (Pg/str. 96/97):** Mirsad IČANOVIĆ, Mirza TVICA

*INFLUENCE OF THE ANTHROPOGENIZATION ON THE SOIL PROPERTIES DEVELOPED ON SILICATE SUBSTRATES IN THE WESTERN PART OF BOSNIA AND HERZEGOVINA/ UTICAJ ANTROPOGENIZACIJE NA SVOJSTVA ZEMLJIŠTA RAZVIJENA NA SILIKATNIM SUPSTRATIMA PODRUČJA ZAPADNE BOSNE*

**PS7 (Pg/str. 98/99):** Krunoslav KARALIĆ, Zdenko LONČARIĆ, Domagoj RASTIJA, Vladimir IVEZIĆ, Brigita POPOVIĆ, Meri ENGLER, Darko KEROVEC, Vladimir ZEBEC

*THE TOTAL AND AVAILABLE CONCENTRATIONS OF MICRONUTRIENTS IN SOILS ON FARMS OF EASTERN CROATIA/ UKUPNE I RASPOLOŽIVE KONCENTRACIJE MIKROELEMENTA U TLIMA POLJOPRIVREDNIH GOSPODARSTAVA ISTOČNE HRVATSKE*

**PS8 (Pg/str. 100/101):** Mirko KNEŽEVIĆ, Ljubomir ŽIVOTIĆ, Dijana ĐUROVIĆ, Boban MUGOŠA, Ana TOPALOVIĆ

*SWISS CHARD YIELD RESPONSE TO VARIOUS FERTILIZATION RATES AT SOIL WITH DIFFERENT AMOUNTS OF CALCIUM CARBONATE/ UTICAJ RAZLIČITIH DOZA ĐUBRIVA NA PRINOS BLITVE GAJENE NA ZEMLJIŠTIMA SA RAZLIČITIM SADRŽAJEM KALCIJUM KARBONATA*

**PS9 (Pg/str. 102/103):** Abdelkader LARIBI, Nabila SAIDANI

*DISTRIBUTION AND CONTAMINATION ASSESSMENT OF HEAVY METALS IN AGRICULTURAL SOILS AROUND THE MEFTAH CEMENT PLANT, ALGERIA/ PROCJENA DISTRIBUCIJE I ZAGADENOSTI POLJOPRIVREDNIH TALA TEŠKIM METALIMA U OKOLINI TVORNICI CEMENTA „MEFTAH“ U ALŽIRU*

- PS10 (Pg/str. 104/105):** Marina LAVRIĆ, Radica ĆORIĆ  
*INTERNATIONAL YEAR OF SOILS (IYS) 2015/2015 MEĐUNARODNA GODINA TLA*
- PS11 (Pg/str. 106/107):** Ivana LOBOJA, Radica ĆORIĆ, Mirjana MILIČEVIĆ  
*ANALYSIS OF RELIEF AND PEDOLOGICAL CHARACTERISTICS IN WEST HERZEGOVINA CANTON OF FEDERATION OF BOSNIA AND HERZEGOVINA/ ANALIZA RELJEFA I PEĐOLOŠKOG POKROVA NA PODRUČJU ŽUPANIJE ZAPADNOHERCEGOVAČKE U FEDERACIJI BOSNE I HERCEGOVINE*
- PS12 (Pg/str. 108/109):** Zdenko LONČARIĆ, Vladimir IVEZIĆ, Brigita POPOVIĆ, Krunoslav KARALIĆ, Meri ENGLER, Darko KEROVEC, Zoran SEMIALJAC  
*TOTAL AND PLANT AVAILABLE TOXIC TRACE ELEMENTS (Cd, Cr, Co AND Pb) AT FARMS OF EASTERN CROATIA/ UKUPNE I RASPOLOŽIVE FRAKCIJE TOKSIČNIH TEŠKIH METALA (Cd, Cr, Co I Pb) NA POLJOPRIVREDNIM GOSPODARSTVIMA ISTOČNE HRVATSKE*
- PS13 (Pg/str. 110/111):** Maja MANOJLOVIĆ, Massimo ANGELONE, Giovanna ARMIENTO, Ranko ČABILOVSKI, Vladimir ĆIRIĆ, Maria Rita MONTEREALI, Cinzia CROVATO, Maurizio DE CASSAN, Paolo MASSANISSO, Dragana VIDOJEVIĆ  
*PRELIMINARY DATA ON PGES (PLATINUM GROUP ELEMENTS) AND REE (RARE EARTH ELEMENTS) IN URBAN SOILS IN NOVI SAD (SERBIA) IN RELATION TO CAR CATALYTIC CONVERTERS EMISSION/ PRELIMINARNI PODACI O PGE (PLATINSKA GRUPA ELEMENATA) I REE (RIJETKI ZEMLJIŠNI ELEMENTI) U URBANIM TLIMA NOVOG SADA (SRBIJA) U ODNOSU NA EMISIJU AUTOMOBILSKIH KATALITIČKIH KONVERTERA*
- PS14 (Pg/str. 112/113):** Andrea MARIĆ, Elma SEFO, Radica ĆORIĆ  
*SUITABILITY OF AGRICULTURAL LAND FOR THE CULTIVATION OF CABBAGE IN THE AREA OF HERZEGOVINA-NERETVA COUNTY/ POGODNOST POLJOPRIVREDNOG ZEMLJIŠTA ZA UZGOJ KUPUSA NA PODRUČJU HERCEGOVAČKO-NERETVANSKE ŽUPANIJE*
- PS15 (Pg/str. 114/115):** Siniša MITRIĆ, Mihajlo MARKOVIĆ, Mladen BABIĆ, Milan ŠIPKA, Dušica PEŠEVIĆ, Duško DRAGIČEVIĆ  
*RISK ASSESSMENT OF LEACHING HERBICIDES IN GROUNDWATER/ PROCJENA RIZIKA OD ISPIRANJA HERBICIDA U PODZEMNE VODE*
- PS16 (Pg/str. 116/117):** Siniša MITRIĆ, Vaskrsija JANJIĆ  
*MOBILITY OF IMAZETHAPYR IN DEPENDING ON THE CHARACTERISTICS OF THE SOIL/ MOBILNOST IMAZETAPIRA U ZAVISNOSTI OD KARAKTERISTIKA ZEMLJIŠTA*
- PS17 (Pg/str. 118/119):** Volodumur MOROZOV, Kateruna DUDCHENKO, Oleksiu MOROZOV, Petro LAZER, Volodumur KORNBERGER  
*EFFECT OF IRRIGATION DRAINAGE-DISCHARGE WATER OF RICE IRRIGATION SYSTEMS ON DARK CHESTNUT SOILS OF SOUTH OF UKRAINE/ UTICAJ NAVODNJAVANJA TAMNIH KESTENJASTIH TALA U JUŽNOJ UKRAJINI DRENAŽNOM/ISPUSNOM VODOM IZ SISTEMA ZA NAVODNJAVANJE RIŽE*
- PS18 (Pg/str. 120/121):** Alina OMANOVIĆ  
*EDUCATION ON WORLD REFERENCE BASE FOR SOIL RESOURCES (WRB) - EXAMPLE OF GOOD PRACTICE/ EDUKACIJA O SVJETSKOJ REFERENTNOJ OSNOVI ZA TLO (WRB) - PRIMJER DOBRE PRAKSE*
- PS19 (Pg/str. 122/123):** Muzafera RAMOVIĆ, Edina LATINOVIĆ, Mirza SEMIĆ, Amira SOLAK, Marijana TOMIĆ, Enisa NEZIREVIĆ-NIZIĆ  
*COMPARISONS OF HEAVY METALS IN TWO TIME PERIODS IN THE MUNICIPALITY OF ZENICA/ POREĐENJE SADRŽAJA TEŠKIH METALA U DVA VREMENSKA PERIODA NA PODRUČJU OPŠTINE ZENICA*

**PS20 (Pg/str. 124/125):** Nura REŠIDOVIĆ, Helena FILIPOVIĆ, Alema MRKOVIĆ, Amra SEMIĆ, Ahmedin SALČINOVIĆ

*CONTAMINATION WITH HEAVY METALS AND PAHs IN SOILS OF CANTON SARAJEVO IN PERIOD 2009-2015/ ZAGAĐENOST TEŠKIM METALIMA I PAH-OVIMA U TLIMA KANTONA SARAJEVO U PERIODU 2009-2015. GODINE*

**PS21 (Pg/str. 126/127):** Nijaz SULJIĆ, Drena GADŽO, Nedžad KARIĆ, Mirha ĐIKIĆ  
*DISTRIBUTION OF JERUSALEM ARTICHOKE (HELIANTHUS TUBEROSUS L.) IN THE CANTON OF SARAJEVO/ RASPROSTRANJENOST ČIČOKE (Helianthus tuberosus L.) NA PODRUČJU KANTONA SARAJEVO*

**PS22 (Pg/str. 128/129):** Mohamed TERT

*WATER-LOGGING OF SOIL IS A TWO-EDGED SEASONAL PHENOMENON: COMBINED PHYSICAL-TECHNICAL SOLUTIONS/ VODOLEŽINE KAO DVOSJEKLA SEZONSKA POJAVA: KOMBINIRANA FIZIČKO-TEHNIČKA RJEŠENJA*

**PS23 (Pg/str. 130/131):** Dragana VIDOJEVIĆ, Maja MANOJLOVIĆ, Aca ĐORĐEVIĆ, Branislava DIMIĆ

*SOIL ORGANIC CARBON STOCKS IN AGRICULTURAL SOILS IN THE REPUBLIC OF SERBIA/ REZERVA ORGANSKOG UGLJENIKA U POLJOPRIVREDNOM ZEMLJIŠTU REPUBLIKE SRBIJE*

**PS24 (Pg/str. 132/133):** Aleksander MARINŠEK, Primož SIMONČIČ, Daniel ŽLINDRA  
*SOILS OF LJUBLJANA MUNICIPAL FOREST*



# **INTRODUCTORY LECTURES**

## ***UVODNA IZLAGANJA***

# EUROPEAN LAND QUALITY AS A FOUNDATION FOR THE SUSTAINABLE INTENSIFICATION OF AGRICULTURE

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## Abstract

The quality of land and soil is one of the most important parameters for agricultural production. However, agricultural land use causes physical, chemical and biological impacts, reaching from mechanical soil management like tillage and harvesting to the application of organic and inorganic fertilizers, pesticides and others. In Europe we perform agriculture on thousands of different sites and soils for example with different depths, texture, mineralogical and chemical composition, organic matter content, in different topographic positions, which all react most differently on agricultural soil management. Under these conditions we are since centuries intensifying agricultural production in Europe and have reached worldwide a top position in productivity. The question is now: whether we can still increase agricultural production further and if biomass production can be considered as the only target of agriculture or if we need further goods and services provided by soils and land, such as rain water filtration and production of clean and drinkable groundwater or the maintenance of biodiversity at a maximum level, especially in view of the fact, that agriculture produces mainly monocultures, which are ecologically unstable and can only be maintained by protective human interference. When using soil for intensive agricultural production, all the above mentioned additional functions of soil and land can only be used under the condition that soils have enough resilience for levelling out environmentally negative impacts such as for example erosion, compaction, contamination, which endanger drinking water resources and biodiversity. At the same time soils and sites must perform in such a way that an optimal agricultural biomass production is guaranteed. In view of all these aspects of sustainable land use we developed a soil and land evaluation scheme for Europe, based on the assumption, that the best soils show the highest resilience and have the best productive performance at the same time. In a first approximation we analysed 61% of all arable land in 25 countries of the European Union based on actually available information on physical and chemical soil characteristics and their geographical, including topographical distribution. By scoring 6 main soil and land parameters such as soil organic carbon, clay and silt content, soil depth, pH, cation exchange capacity and topography, we found out, that 43% of the soils are not suitable for sustainable intensification and 12% only with restrictions. Moreover, 4% of the productive surface should be extensified because of environmental reasons and only on 41% of the arable land surface sustainable intensification can be recommended.

For more detailed information see [www.risefoundation.eu/images/pdf/si\\_2014](http://www.risefoundation.eu/images/pdf/si_2014)

**Key words:** *agriculture, land, sustainable intensification*

# KVALITETA EVROPSKOG ZEMLJIŠTA KAO TEMELJ ODRŽIVOG INTENZIVIRANJA POLJOPRIVREDE

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## Sažetak

Kvalitet zemljišnog prostora i tla jedan je od najbitnijih parametara za poljoprivrednu proizvodnju. Međutim, način korištenja poljoprivrednog zemljišta uzrokuje fizičke, hemijske i biološke uticaje, počevši od mehaničkog upravljanja tlom poput obrade tla i žetve, pa do primjene organskih i anorganskih gnojiva, pesticida itd. U Evropi se poljoprivreda odvija na hiljadama različitih mjesta i tala koja imaju različitu dubinu, teksturu, mineraloški i hemijski sastav, sadržaj organske tvari, koja se nalaze na različitim topografskim lokacijama i od kojih svako reaguje na upravljanje poljoprivrednim tlom na najrazličitiji način. U ovakvim uslovima mi već vijekovima intenziviramo poljoprivrednu proizvodnju u Evropi i postigli smo najveću produktivnost u cijelom svijetu. Postavlja se pitanje: „Da li možemo i dalje povećavati poljoprivrednu proizvodnju i da li se proizvodnja biomase može smatrati jedinim ciljem poljoprivrede?” ili „Da li nam trebaju drugi proizvodi i usluge koje obezbjeđuju tla i zemljište, kao što su filtriranje kišnice i proizvodnja čiste i pitke podzemne vode ili održavanje biološke raznolikosti na maksimalnoj razini, naročito s obzirom na činjenicu da poljoprivreda proizvodi uglavnom monokulture koje su ekološki nestabilne i koje se mogu održavati jedino zaštitničkim uplitanjem čovjeka?”. Kada se tlo koristi za intenzivnu poljoprivrednu proizvodnju, sve gore navedene dodatne funkcije tla i zemljišta mogu se ostvariti samo pod uvjetom da tlo ima dovoljno otpornosti kako bi izbalansiralo negativne okolišne efekte kao što su erozija, zbijanje i onečišćenje, koji ugrožavaju resurse pitke vode i biološku raznolikost. U isto vrijeme, tla i lokacije moraju se ponašati na način koji garantira optimalnu proizvodnju poljoprivredne biomase. S obzirom na sve ove aspekte održivog korištenja zemljišta, razvili smo program ocjenjivanja zemljišta za Evropu, koji se temelji na pretpostavci da najbolja tla istovremeno pokazuju najveću otpornost i imaju najbolje produktivne performance. U prvoj aproksimaciji analizirali smo 61% ukupnih obradivih površina u 25 zemalja Evropske unije, na osnovu stvarno dostupnih informacija o fizičkim i hemijskim karakteristikama tala i njihovoj geografskoj i topografskoj rasprostranjenosti. Bodovanjem 6 glavnih parametara tla i zemljišta kao što je organski ugljik tla, sadržaj gline i mulja, dubina tla, pH, kapacitet izmjene kationa i topografija, otkrili smo da 43% tala nije pogodno za održivo intenziviranje, a 12% jeste ali samo uz ograničenja. Osim toga, 4% produktivne površine treba ekstenzivirati zbog ekoloških razloga, dok se održivo intenziviranje može preporučiti samo za 41% obradivih površina.

Detaljnije informacije potražite na [www.risefoundation.eu/images/pdf/si\\_2014](http://www.risefoundation.eu/images/pdf/si_2014)

**Ključne riječi:** *poljoprivreda, zemljište, održivo intenziviranje*

## SOILS WITHIN THE POST-2015 SUSTAINABLE DEVELOPMENT AGENDA

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### Abstract

Soils are a limited natural resource that can be renewed only over very long time spans. Therefore it is of crucial importance that this resource has been included within the sustainable development agenda adopted at the UN General Assembly in September 2015. The proposed Sustainable Development Goals (SDGs) include explicitly soils in three goals related to food security, human health and terrestrial ecosystems. But soils are as well implicitly relevant in several other goals addressing water resources, climate change and biodiversity. Strategies for achieving sustainable development will therefore certainly include a relevant component addressing the sustainable management of soil resources. The recent activities of the Intergovernmental Technical Panel on Soils (ITPS) have initiated the process that will lead to the adoption of Voluntary Guidelines for Sustainable Soil Management that can greatly support the achievement of the proposed SDGs by 2030.

**Key words:** *soils, political advocacy, sustainable development goals, UNCCD, UNCBD, UNFCCC*

## TLA U OKVIRU POST-2015 AGENDE ZA ODRŽIVI RAZVOJ

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### Sažetak

Tla predstavljaju ograničen prirodni resurs koji se može obnoviti samo tokom dugog vremenskog razdoblja. Stoga je izuzetno važno da je ovaj resurs uvršten u agendu za održivi razvoj, usvojenu na Generalnoj skupštini UN-a u septembru 2015. Predloženi ciljevi održivog razvoja (Sustainable Development Goals - SDG) eksplicitno uključuju tla u tri cilja koji se odnose na sigurnost hrane, zdravlje ljudi i kopnene ekosisteme. Međutim, tla su i implicitno uključena u nekoliko drugih ciljeva koji se bave vodnim resursima, klimatskim promjenama i biološkom raznolikošću. Strategije za postizanje održivog razvoja će stoga sigurno obuhvatiti i relevantnu komponentu koja se bavi održivim upravljanjem zemljišnim resursima. Nedavne aktivnosti Međuvladinog stručnog panela za tla (Intergovernmental Technical Panel on Soils - ITPS) pokrenule su proces koji će dovesti do usvajanja dobrovoljnih smjernica za održivo upravljanje tlom (Voluntary Guidelines for Sustainable Soil Management) koje uveliko mogu podržati ostvarivanje predloženih ciljeva održivog razvoja do 2030. godine.

**Ključne riječi:** *tla, političko zagovaranje, ciljevi održivog razvoja, UNCCD, UNCBD, UNFCCC*

**SOIL RELATED REASONS AND CONSEQUENCES OF EXTREME  
HYDROLOGICAL SITUATIONS  
(FLOODS, WATERLOGGING – DROUGHTS)**

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**Abstract**

The most important elements of sustainable development in the Carpathian Basin are the rational use and conservation of soil and water resources, maintaining their favourable „quality” and desirable multifunctionality. These are the main factors of multipurpose biomass production and environment protection: may help to prevent, eliminate or reduce extreme moisture situations (floods, waterlogging vs. droughts), unfavourable soil degradation processes limiting soil fertility/productivity, and their harmful economical/ecological/environmental/social consequences.

**Keywords:** *soil moisture regime, water storage, waterlogging hazard, drought sensitivity, soil moisture control*

**RAZLOZI I POSLJEDICE EKSTREMNIH  
HIDROLOŠKIH SITUACIJA  
(POPLAVE, VODOLEŽINE – SUŠA) KOJI SE ODNOSU NA TLO**

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**Sažetak**

Najvažniji elementi održivog razvoja u Karpatskoj dolini su racionalno korištenje i čuvanje zemljišnih i vodnih resursa, održavanje njihovog povoljnog „kvaliteta” i poželjne multifunkcionalnosti. To su glavni faktori proizvodnje višenamjenske biomase i zaštite okoliša koji mogu doprinijeti sprječavanju, otklanjanju ili smanjivanju ekstremnih situacija uzrokovanih vlagom (poplave, vodoležine naspram suše), nepovoljnih procesa degradacije tla koji ograničavaju plodnost/produktivnost tla, kao i njihovih štetnih ekonomskih/ekoloških/socijalnih posljedica.

**Ključne riječi:** *režim vlažnosti tla, čuvanje vode, opasnost od vodoležina, osjetljivost na sušu, kontrola vlažnosti tla*

# POSSIBILITIES TO USE THE „LAND DEGRADATION NEUTRALITY” APPROACH FOR SUSTAINABLE LAND MANAGEMENT MEASURING AND MONITORING

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## Abstract

Key messages of the paper include the following: (i) Land Degradation Neutrality (LDN) is a new paradigm reflecting the cross-linked aspirations and demands of land-related sustainable development goals; (ii) LDN is politically sounding and attractive, it has a good background to be economically evaluated; (iii) LDN is a part of „Land-based approach” and might be considered as an operational platform for overlapping issues of 3 Rio conventions; (iv) LDN state can serve as a SLM target and overall criteria at different levels (local, subnational, national); (v) Spatial and temporal changes in land cover are measurable by indicators of land quality balance; (vi) LDN is not equally measured and is a site-specific (national-specific) matter, although global indicators of land quality can be considered as common platform for coordination; (vii) LDN concept needs advanced scientific development.

**Key words:** *Land Degradation Neutrality, Sustainable Land Management, Climate Change Adaptation*

# MOGUĆNOSTI KORIŠTENJA PRISTUPA „NEUTRALNOSTI DEGRADACIJE ZEMLJIŠTA” U ODRŽIVOM MJERENJU I PRAĆENJU UPRAVLJANJA ZEMLJIŠTEM

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## Sažetak

Ključne poruke ovog rada su sljedeće: (i) neutralnost degradacije zemljišta (Land Degradation Neutrality - LDN) je nova paradigma koja odražava unakrsno povezane težnje i potrebe ciljeva održivog razvoja vezano za zemljište; (ii) LDN je politički zvučna i privlačna, ima dobru osnovu da bude ekonomski vrednovana; (iii) LDN je dio „pristupa zasnovanog na zemljištu” i mogla bi se smatrati operativnom platformom za pitanja tri Rio konvencije koja se preklapaju; (iv) stanje LDN može služiti kao cilj održivog upravljanja zemljištem i kao ukupni kriterij na različitim razinama (lokalna, podnacionalna, nacionalna); (v) prostorne i vremenske promjene u zemljišnom pokrovu mogu se mjeriti pomoću pokazatelja ravnoteže kvalitete zemljišta; (vi) LDN se ne mjeri jednako, jer je specifična za svaki lokalitet (državu), mada se globalni pokazatelji kvalitete zemljišta mogu smatrati zajedničkom platformom za koordinaciju; (vii) konceptu LDN potreban je napredni naučni razvoj.

**Ključne riječi:** *neutralnost degradacije zemljišta, održivo upravljanje zemljištem, prilagodba klimatskim promjenama*

# CLIMATE CHANGE ADAPTATION AND MITIGATION BY TRANSFORMATIVE APPROACH IN REDUCING FLUXES OF SOIL GREENHOUSE GASES TO ATMOSPHERE

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Climate change is a hyper-complex problem. Dramatic changes in land use have taken place in many parts of Europe, Asia and the world, as a result of economic growth. Forestlands are converted into agricultural land and are intensified for food production. Hence, the ongoing and unsustainable intensification of cropping systems will result in increased emissions of mainly N<sub>2</sub>O and CH<sub>4</sub>. The increasing trend is N input to agroecosystem with large N losses could be dark side of agricultural intensification. We have conducted a research on N<sub>2</sub>O and CH<sub>4</sub> in different land uses mainly from Europe and Asia. The study conducted in intensified agricultural land showed significantly higher N<sub>2</sub>O emission compared to traditional agricultural system. Similarly N<sub>2</sub>O emissions were high in upland and grazing land as compared to emissions from forestland and lowland. Similarly CH<sub>4</sub> sink was highest in forestland and CH<sub>4</sub> emission was highest in periodically flooded lowland area. The field emissions carried out in rice field with SRI techniques, showed a reduced CH<sub>4</sub> and N<sub>2</sub>O emissions in SRI compared to non-SRI rice fields. Likewise, emission study on biochar applied agricultural lands in Nepal indicated a lower N<sub>2</sub>O emission in the field where biochar was applied. A similar study was conducted in heavily grazed forest in India, which showed reduced net CH<sub>4</sub> uptake rate and hence increases the net global warming potential of forest soil. These early studies in Nepal and India provide useful data to illustrate magnitude and mechanism of the problem. However due to the urgency of emerging climate crises, incremental change in technology may not address the ecological problem at their source. There is a need for transformative change in our consumption behavior, lifestyle that are linked to demand for choices of food that has an important implication for N fluxes and climate change. After the entire climate change is a multi-dimensional problem, including more than just social or environmental issues. To understand this, one must first identify the linkages between environmental problems rooted in human greed and manifested in various forms such as biodiversity losses, climate change and land degradation. To address these problems, we propose to link these with human desires and how they can be balanced using noetic science of personal and social transformation.

**Key words:** *climate change, soil, greenhouse gases, adoption, mitigation*

# ADAPTACIJA I UBŽAVANJE KLIMATSKIH PROMJENA TRANSFORMATIVNIM PRISTUPIMA SMANJENJA FLUKSA STAKLENIČKIH GASOVA IZMEĐU TLA I ATMOSFERE

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Klimatske promjene predstavljaju hiperkompleksan problem. Izražene promjene u načinu korištenja zemljišta u mnogim dijelovima Europe, Azije i svijeta vezane su uz ekonomski rast. Šumsko zemljište je pretvoreno u poljoprivredno i na njima je intenzivirana proizvodnja hrane. Nadalje, trenutno neodrživa intenzifikacija ratarske proizvodnje će rezultirati u povećanoj emisiji, pretežno N<sub>2</sub>O i CH<sub>4</sub>. Povećanje trenda unosa N u agroekosisteme i veliki gubitci N bi mogli biti “tamna strana” intenzifikacije poljoprivrede. Naša istraživanja fluksa N<sub>2</sub>O i CH<sub>4</sub> u različitim sistemima korištenja zemljišta su provedena pretežno u Europi i Aziji. Ove studije pokazuju da zemljište na kome je intenzificirana poljoprivreda imaju značajno veću emisiju N<sub>2</sub>O u poređenju sa tradicionalnim poljoprivrednim sistemima. Slično, emisije N<sub>2</sub>O su bile više u visokim područjima i pašnjacima, u odnosu na niska područja i šumsko zemljište. Tako je ponor CH<sub>4</sub> bio najveći u šumskim tlima i emisija CH<sub>4</sub> najveća u periodično plavljenim niskim područjima. Emisije mjerene u poljskim uslovima u rižinim poljima gdje se primjenjuju SRI tehnike, ukazuju na reducirane vrijednosti NO<sub>2</sub> i CH<sub>4</sub> u odnosu na ne-SRI rižina polja. Također, studije na poljoprivrednim zemljištima na kojima se unosi ugljen u Nepal upućuju na manju emisiju N<sub>2</sub>O u odnosu na površine gdje nije apliciran ugljen. Slična studija je provedena u jako pašarenim tlima u Indiji, gdje je konstatovana redukcija neto CH<sub>4</sub> usvajanja i uvećan neto potencijal globalnog zatopljenja šumskih tala. Ove rane studije iz Nepala i Indije pružaju korisne podatke koji ilustruju jačinu i mehanizam problema. No međutim, shodno hitnosti rastuće klimatske krize, povećanje promjena u tehnologiji možda neće dati odgovor na niz ekoloških problema, na njihovom izvorištu. Postoji potreba za transformativnim promjenama u našem potrošačkom ponašanju i stilu života koje su povezane sa zahtjevima izbora hrane koja značajno utiče na fluks N i klimatske promjene. Napokon, klimatske promjene su multidimenzionalan problem koji uključuje više od samo socijalnih i okolišnih problema. Da bi ovo razumjeli, potrebno je najprije identificirati veze između problema u okolišu, a koji su zakorijenjeni u ljudskoj pohlepi i manifestiraju se u različitim oblicima gubitka biodiverziteta, klimatskim promjenama i degradaciji zemljišta. Odgovor na ova pitanja predlažemo kroz povezivanje ljudskih želja i njihovim balansiranjem sa spoznajnom naukom lične i društvene transformacije.

**Key words:** *klimatske promjene, tlo, staklenički gasovi, adaptacija, mitigacija*

# LAND CONSOLIDATION AS A FACTOR OF AGRICULTURAL DEVELOPMENT AND LAND MANAGEMENT

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## Abstract

Land consolidation is the most complex measure of land regulation. Land consolidation is carried out to improve living and working conditions of people who live in that area. It is a very important instrument of rural development. Basic characteristics of land ownership in Serbia are: small farms, high fragmentation and dispersion of land parcels, dysfunctional road network, lack of drainage systems and irrigation, partially solved problems in regulation of rivers, difficult land access for modern mechanization, difficult implementation of agromeliorative measures, unresolved property ownership, uncompleted restitution, outdated real estate registers, inadequate attention to environmental protection, land abandonment and others. Land consolidation is one of the most important measures to solve the above mentioned and other land policy issues. It is a measure of a complex spatial regulation to achieve a stable and competitive food production, secure transport of people and goods, environmental protection and better living conditions in the consolidated area. Unlike the land consolidation which was carried out 30-60 years ago in former Yugoslavia and earlier before that in Europe, when the primary objective was to improve agricultural production, land consolidation carried out today aims to improve living and work conditions beside the improvement of agricultural production. Land consolidation in European Union is conducted mainly for environmental reasons and infrastructure works. The land consolidation strategy for Serbia was made in 2005 in collaboration with FAO through the pilot project. It served as a starting point for a new regulation that allowed the beginning of the new land consolidation activities. From 2007 until today, consolidations were completed on more than 25,000 hectares, and intensive work is still carried out on more than 61,000 hectares. In addition, the documentation was prepared and administrative procedure initiated for the process of land consolidation on additional 130,000 hectares. In the last three years, through the „Efficient land management“ project funded by the EU, the Governments of Germany and Serbia are implementing consolidation in seven pilot municipalities in Southeast Serbia. For successful consolidation, it is necessary to fulfill a series of conditions of which the most important are the interest of landowners and the need for land consolidation, legal framework, administrative capacity and to provide funding for land consolidation.

**Key words:** *land consolidation, rural development, agricultural production, pilot project*

# KOMASACIJA ZEMLJIŠTA KAO FAKTOR RAZVOJA POLJOPRIVREDE I UPRAVLJANJA PROSTOROM

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## Sažetak

Komasacija je najsloženija mera uređenja zemljišta. Komasaacija se sprovodi radi poboljšanja uslova života i rada ljudi koji žive u tom području. Ona predstavlja veoma važan instrument ruralnog razvoja. Osnovne karakteristike zemljišnog poseda u Srbiji su: mali posed, velika usitnjenost i razbacanost parcela, nefunkcionalna putna mreža, nedostatak sistema za odvodnjavanje i navodnjavanje, delimično rešeni problemi regulacija reka, otežan pristup savremenoj mehanizaciji do parcela, otežano sprovođenje agromeliorativnih mera, nerešeni imovinsko-pravni odnosi, nezavršena restitucija, neažurnost evidencije o nepokretnostima, nedovoljna briga o zaštiti životne sredine, napuštanje zemljišta i dr. Za rešavanje navedenih i drugih problema iz zemljišne politike jedno od najznačajnijih mesta pripada komasaciji kao meri kompleksnog uređenja prostora kojom se postiže stabilnija i konkurentnija proizvodnja hrane, bezbedniji transport ljudi i roba, zaštita životne sredine i bolji uslovi života u komasiranom području. Za razliku od komasacija koje su se sprovodile pre više od 30-60 godina u ex Jugoslaviji, a pre više od pola veka, odnosno jednog veka u Evropi kada je osnovni cilj komasacije bio unapređenje poljoprivredne proizvodnje, sada se komasacija sprovodi radi poboljšanja uslova života i rada, što znači da se ona sprovodi i radi unapređenja poljoprivredne proizvodnje, ali i radi unapređenja zaštite životne sredine i unapređenja drugih aktivnosti i poslova koji će omogućiti bolje uslove ljudima koji žive u tom području, dok se u Evropskoj uniji uglavnom sprovodi zbog zaštite životne sredine i infrastrukturnih radova. U Srbiji je 2005. godine kroz pilot projekat u saradnji sa fao urađena „strategija uređenja zemljišta“. Nakon toga je doneta nova regulativa koja je omogućila početak „novih“ komasacija. Od 2007. godine do danas završene su komasacije na više od 25.000 hektara, a intenzivno se radi na još nešto više od 61.000 hektara. Takođe, pripremljena je dokumentacija i započeta administrativna procedura za postupak komasacije na još 130.000 hektara. U poslednje tri godine kroz projekat „Efikasno upravljanje zemljištem“ koji finansira Evropska unija, nemačka Vlada i Vlada Republike Srbije, sprovodimo komasaciju u sedam pilot opština na području jugoistočne Srbije. Za uspešnu komasaciju neophodno je ispuniti niz uslova od kojih su najvažniji: zainteresovanost vlasnika zemljišta i potreba za komasacijom, pravni okvir, administrativni kapacitet i obezbeđena sredstva za komasaciju.

**Ključne riječi:** komasacija zemljišta, ruralni razvoj, poljoprivredna proizvodnja, pilot projekat

# ADAPTATION, ADAPTIVE CAPACITY AND VULNERABILITY OF SOIL TO CLIMATE CHANGE IN SUBMEDITERRANIAN REGION OF BOSNIA AND HERZEGOVINA

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## Abstract

Contemporary approach to the roles of soil has been defined by the International Conference held in Maastricht (1999) under the auspices of FAO and the Government of the Netherlands as the concept entitled „The Multi-Functional Character of Agriculture and Land-MFCAL”. The MFCAL concept is based on the fact that land has a multi-functional character and role in the production of food and timber; it also plays environmental, social and spatial roles as well as a role in shaping the landscape: it is a source of raw materials and energy and is used for recreational and tourism purposes. The value of the landscape in karst region of Bosnia and Herzegovina (BiH) is the foundation of its existence and the key role in its appearance and formation is played by geomorphology and the soil. Through history the man has created a „cultural landscape” which is completely adapted to the natural conditions. He further enriches the space and makes it more appealing. Soils in BiH karst are extremely heterogenous and form a real pedological mosaic. Found on the Mesozoic sediments of limestone and dolomite of the Middle and Upper Jurassic and Early and Late Cretaceous are Bare rocks (barren land), Rocky grounds (Lithosol), Limestone-dolomite Black soil (Calcomelanosol) and Brown soil on limestone and dolomite (Calcocambisol). If cherts are present in the limestone their influence is reflected in the acidification of soil which as a result have lower pH values, smaller adsorption capacity and the occurrence of acidophilus vegetation. A specificity of these rocks is the screes that are transported down the hillside mixed. A series may occur on them in which, if shale materials are contained, Rendzina appears as a calcareous soil. In addition to the above mentioned limestone and dolomite, there are marly limestones of Jurassic and Cretaceous age and Quaternary sediments on which Alluvial soils (Fluvisol) developed as well as the soils of karst fields which are sometimes very porous and skeletal and sometimes heavy and clayey on impermeable substrate (hydromorphic soils). The paper will provide an overview of characteristic soil types in the Sub-Mediterranean region of BiH taking into account a range of properties that make them sensitive and vulnerable within the ecosystem. These should include a lack of water on the surface and large fluctuations in the amount of water during the rainy and dry seasons and whimsicality of climate in general, which has a huge impact on the state of biodiversity and human lives in this region.

**Key words:** *karst, relief, soil types, biodiversity, sensitivity*

# ADAPTACIJA, ADAPTIVNI KAPACITET I OSJETLJIVOST TALA NA KLIMATSKE PROMJENE U SUBMEDITERANSKOM PODRUČJU BOSNE I HERCEGOVINE

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## Sažetak

Savremen pristup ulogama tla definirala je Međunarodna konferencija u organizaciji FAO i Nizozemske vlade, održana u Maastrichtu (1999. godine), konceptom koji ima naslov „Višenamjensko obilježje poljoprivrede i tla-VOPT“ (Multi-Functional Character of Agriculture and Land-MFCAL). Koncept VOPT-MFCAL polazi od činjenice da tlo ima višenamjenska obilježja i uloge u proizvodnji hrane i drvne mase, ekološku, socijalnu i prostornu ulogu, ulogu u oblikovanju krajolika, kao izvor sirovina i energije, i rekreacijsko-turističku ulogu. Vrijednost krajolika područja krša Bosne i Hercegovine (BiH) temelj je njegova opstanka, a ključnu ulogu u njegovom izgledu i oblikovanju ima geomorfologija terena zajedno sa tlom. Čovjek je kroz historiju stvorio „kulturni krajolik“, potpuno prilagođen prirodnim prilikama. On čak obogaćuje prostor i čini ga još dopadljivijim. Tla BiH krša su izuzetno heterogena i čine pravi pedološki mozaik. Na mezozojskim sedimentima krečnjaka i dolomita srednje i gornje jure, donje i gornje krede, nalazimo Gole stijene (golet), Kamenjar (Litosol), Vapnenačko dolomitne crnice (Kalkomelanosol) i Smeđe tla na vapnencu i dolomitu (Kakokambisol). Ukoliko se u krečnjacima nalaze rožnjaci njihov se utjecaj ogleda na način da vrše zakiseljavanje tla, pa su takva tla niže pH vrijednosti, manjeg kapaciteta adsorpcije, a na njima se javlja acidofilna vegetacija. Posebnost ovih stijena predstavljaju sipari, koji se transportuju niz padinu izmiješani. Na njima se može javiti serija u kojoj se, ako se javljaju primjese laporovitih materijala javlja Rendzina kao karbonatno tlo. Osim gore navedenih krečnjaka i dolomita, javljaju se i Laporoviti krečnjaci jurske i kredne starosti, kao i Kvarterni sedimenti na kojima su se razvila Aluvijalna tla (Fluvisol), kao i tla kraških polja nekad veoma porozna i skeletna, a nekad teška i glinovita na nepropusnoj podlozi (hidromorfna tla). U radu će se dati prikaz karakterističnih tipova tala Submeditranskog područja BiH imajući u vidu čitav niz osobina koje ih čine osjetljivim i ranjivim u ekosistemu. Ovome treba dodati manjak vode na površini i velike oscilacije u količini vode tokom kišnih i sušnih razdoblja, te općenito kapricioznost klime, što ima veoma veliki uticaj na stanje biodiverziteta i život ljudi na ovome području.

**Ključne riječi:** *krš, reljef, tipovi tala, biodiverzitet, osjetljivost*

## SPECIFICS OF SOILS IN AGROECOSYSTEMS OF NERETVA RIVER BASIN

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### Abstract

The diversity of soils in the basin of the Neretva, from sea level to 2,000 meters above sea level, is a key factor of the diversity of agro-ecological conditions of this area, in which we find Anthrosol, very fertile, deep, hydro ameliorated soil, resulting from Fluvisols, Gleysols, and peat Hutovo Blato and the Neretva valley. In the mountain area we find Calcic melanosol and Lithosol on limestone and dolomite, which meets the EU criteria for inclusion in the so-called LFA (less favoured area). Management systems in these conditions ranged from very intensive farming of vegetables and modern fruit plantations in the open field and protected areas (greenhouses), but the low-intensity farming system in a mountainous area. Extensive agriculture, adapted to the natural conditions, and environmentally and socially sustainable, but it is the economic viability questionable. As it cannot cover all the needs of the market, regulation of agricultural soil amelioration projects designed by our scientists believe unquestionable and inevitable direction of development of agriculture basin Neretva. It would be nothing new, but not so! The current climate changes, which obviously are not a temporary phenomenon, looking from the soil in the same vegetation period to quickly and effectively remove the sufficient water, and in dry season to irrigate crops. Therefore, today's generation of decision-makers and users of soil as a natural treasure that represents heritage and or some kind of link to the generations yet to come, it cannot avoid the question as to which soil/land areas and at which to focus investments. Because it is the encroachment on very sensitive and vulnerable karst ecosystems. As for drainage and irrigation near the water source of budget for these purposes is concerned, there is no doubt, in other circumstances, in our opinion, should approach the construction of multi-purpose water reservoir, which will collect excess precipitation of autumn-winter season, to defray the needs of crops for water in the vegetation period. General characteristic of pedosphere of Neretva catchment area that are permeable soil and harmful substances (nitrates, heavy metals and other pollutants) emitted into the soil, quickly coming to the water, through which are distributed all over the area. Therefore, sustainable land management is the only way.

**Key words:** *Neretva river basin, soil in the agro ecosystem, karst*

## POSEBNOSTI TALA U AGROEKOSUSTAVIMA PORJEČJA NERETVE

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### Sažetak

Raznolikost tala porječja Neretve, od razine mora do 2.000 m.n.m., ključni je čimbenik raznolikosti agroekoloških uvjeta toga prostora, u kojemu nalazimo antropogena, vrlo plodna, duboka, hidromeliorirana tla, nastala iz hidromorfni fluvijativnih i glejnih, zatresećenih tala i treseta Hutova blata i doline Neretve, a plitke vapnenačko-dolomitne crnice i kamenjare u planinskom području, koje ispunjava kriterije EU za svrstavanje u tzv. POP (područja ograničene pogodnosti) ili LFA (manje povoljna područja). Sustavi gospodarenja u tim uvjetima kreću se u rasponu od vrlo intenzivnog uzgoja povrća i suvremenih plantaža voća na otvorenom i zaštićenim prostorima (staklenici i plastenici), do sustava gospodarenja niskog intenziteta (*low intensity farming system*) u planinskom području. Ekstenzivna poljoprivreda, prilagođena prirodnim uvjetima, najmanje je agresivna, a okolišno je i socijalno održiva, ali joj je ekonomska opstojnost upitna. Kako ona ne može namiriti sve potrebe tržišta, uređenje poljoprivrednih tala melioracijskim zahvatima koje su osmislili naši znanstvenici smatramo neupitnim i neizbježnim smjerom razvitka poljoprivrede porječja Neretve. Reklo bi se ništa nova, ali nije tako! Naime, aktualne promjene klime, koje očito nisu privremena pojava, traže od tla da u istoj vegetacijskoj godini može brzo i djelotvorno odstraniti suvišnu vodu, a u sušnom razdoblju namiriti nedostatak navodnjavanjem. Zbog toga današnji naraštaj donositelja razvojnih odluka i korisnika tla-zemljišta, kao prirodnog blaga koje predstavlja baštinu i nekovrsnu poveznicu s naraštajima koji tek dolaze, ne može zaobići odgovor na pitanje kako, na koja područja i kojom dinamikom usmjeriti investicije u te zahvate. Jer, radi se o zadiranju u vrlo osjetljive i ranjive ekosustave krša. Što se odvodnje i navodnjavanja u blizini izvora vode povoljnih za te svrhe tiče, nema dvojbi, a u drugim uvjetima, prema našem mišljenju, valja prići izgradnji višenamjenskih vodnih akumulacija, koje će skupljati višak vode izvan vegetacijskog, za namirenje potreba usjeva i nasada za vodom u vegetacijskom razdoblju. Opće je obilježje pedosfere slivnog područja da su tla propusna te da štetne tvari (nitrati, teški metali i drugi onečišćivači) emitirane u tla, brzo pristizu do vode, putem koje se distribuiraju po cijelom prostoru. Stoga održivo gospodarenje tлом nema alternative.

**Ključne riječi:** *porječje Neretve, tlo u agroekosustavu, krš*



**ORAL PRESENTATIONS**  
***USMENE PREZENTACIJE***

## IMPACT OF FIRE ON THE CHEMICAL CHARACTERISTICS OF THE SOIL

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### Abstract

During the last decade, rapid climatic changes have been occurred and through frequent fires strongly affected agricultural production and landscape in general. Wildfires directly influence on soil physical, chemical and microbial characteristics, and leaves mineral soil less protected which increases erosion risks. In general, wildfire affects soil through its ability to transform soil and ecosystem components and changes in soil chemical properties. In Croatia the greatest danger of fire had Dalmatian region with almost 30,000 fires in the period of 1998–2008. Due to the lack of multiple sources of fresh water, most fires in Dalmatia are extinguished by seawater, which directly affects the soil. During vegetation period in 2012 different soil samples (0-5 cm) were taken depending on: slope, elevation and vegetation characteristics from very healthy shrub lands, not arable, which have been diversely affected by wildfires in recent decade. Samples were taken from burned and from unburned area in order to determine the possible differences. In this paper we analyzed the effects of wildfire on soil chemical properties, soil pH, Total Carbon (TC), Total Nitrogen (TN), Total sulfur (TS), C/N and N/S ratio, and some elements such as plant available phosphorus (P) and potassium (K) collected after wildfires occurred in 2011 and 2012. Also were determined electro conductivity (EC), thirteen cations and anions, and their dependence on seawater used back for fire suppression. The results showed significant statistical differences among burned and control samples for pH, plant available P and K, TC, TN and N/S ratio. Differences between the cations and anions of burned and control samples also exist. Other investigated properties had no clear trend. Such changes, from these fires, in soil properties from fire suppression suggest there has also been change in soil processes. Some differences were found in the sampling points in some investigated factors (TS, TC and TN). These investigated parameters are under the direct influence of the fire intensity on the ground, while the indirect effects (erosion relocation) affect to a greater extent than the locations with smaller fire intensity.

**Key words:** *wildfire, chemical soil properties, Dalmatia*

# UTJECAJ POŽARA NA PROMJENE KEMIJSKIH ZNAČAJKI TLA

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## Sažetak

Tijekom posljednjeg desetljeća, svjedoci smo rapidnih klimatskih promjena. U mediteranskom dijelu Republike Hrvatske navedene klimatske promjene osobito su se manifestirale sve učestalijom pojavom ljetnih požara koji su imali jak utjecaj na uzgoj poljoprivrednog bilja, s jednu stranu, a s drugu stranu na izrazite promjene u krajoliku. Direktna posljedica požara su promjene fizikalnih, kemijskih i mikrobioloških značajki tla, a indirektna posljedica je pojava erozije vjetrom i vodom. U Republici Hrvatskoj najveću opasnost od požara ima Dalmatinska regija s gotovo 30.000 požara u razdoblju od 1998-2008. godine. Odstupanja od navedenoga broja požara ima 2014. godina koja je bila skoro bez požara i kataklizmična 2015. godina s ekstremnom pojavom broja požara. Navedeno je u skladu s vremenskim prilikama tih godina. Zbog nedostatka izvora slatke vode, većina požara u Dalmaciji se gasi morskom vodom, što izravno utječe na kemijske značajke tla. U cilju provjere promjena kemijskih parametara tla u jesen 2012. godine poslije sezone gašenja požara na opožarenim površinama poluotoka Pelješac i otoka Korčula, te neposrednom okolišu koji nije bio zahvaćen požarom uzeti su uzorci tla s dubine 0-5 cm, ovisno o nagibu, nadmorskoj visini i načinu korištenja tla (poljoprivreda ili šumarstvo). U ovom radu iznose se rezultati istraživanja vezani uz promjene narednih kemijskih parametara tla: reakcija tla, ukupni ugljik (TC), ukupni dušik (TN), ukupni sumpor (TS), C/N i N/S omjer, kao i promjene biljci pristupačnoga fosfora i kalija. Također je određena elektrovodljivost tla, te promjene sadržaja trinaest kationa i aniona. Rezultati su pokazali značajne statističke razlike između opožarenih površina i kontrolnih uzoraka za reakciju tla, biljci pristupačna hranjiva, TC, TN i N/S omjer. Razlike između istraživanih kationa i aniona, također, su utvrđene. Promjene svih navedenih parametara direktno su ovisne o izraženosti požara. Na onim površinama gdje su bili izraženiji požari koji su dulje trajali, utvrđene promjene istraživanih kemijskih parametara bile su izraženije. Vrijedi i obrat. Sve navedeno ukazuje da je najefikasnija metoda u cilju sprečavanja pojave požara a samim time i nepoželjnih promjena kemijskih parametara u tlu preventivno provođenje agrotehničkih zahvata odmah u jesen godine kada su se požari pojavili odnosno u rano proljeće naredne godine prije sezone požara. Na žalost, na problem požara se odmah zaboravi s krajem ljetne sezone, a sjetimo ih se ponovno s njihovom pojavom narednog ljeta.

**Ključne riječi:** *požari, kemijske promjene u tlu, Dalmacija*

## MULTI-PURPOSE EVALUATION OF AGRICULTURAL LAND IN THE FEDERATION OF BOSNIA AND HERZEGOVINA

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### Abstract

Multi-purpose land evaluation is process of assessing the quality and value of the land in the service planning and land management, and is the fundamental basis for the development and optimum use of space in general. The subject of the study was evaluation of multi-purpose benefits land for agricultural use was made according to the Regulations on the uniform methodology for the classification of agricultural land in the class include („Official Gazette of BiH”, No. 43/11), based on the FAO assessment criteria include land (FAO, 1976; Brinkman and Smyth, 1973). Based on the results of research conducted is a database, and map benefits for individual activities (gardening, farming, fruit growing, viticulture and grassland) and are determined by the priority agricultural economic programs, and is made of the same name dedicated map (1: 200000), which shows the distribution 36 recommended agricultural and economic programs in the Federation. Area inventory of recommended agricultural economic programs, it was found that the area of agricultural land, the Federation occupies the largest area agricultural economic program livestock breeding and 429,685.4 ha or 40.45% of the agricultural land of the Federation. For the representation of the following agricultural economic programs fruit growing, livestock breeding 123,996.4 hectares or 11.67%; then fruit growing, gardening (vegetable growing), farming with an area of 89,384.7 ha (8.41%); programs and livestock breeding, fruit growing, gardening (vegetable growing) is occupying 66,562 ha or 6.26% and livestock breeding, gardening (vegetable growing), farming with an area 62,136.3 ha (5.85%). Other agricultural economic programs individually occupy a surface area of less than 4%. We believe that the information obtained through this project contribute to the overall development of agriculture in the Federation of Bosnia and Herzegovina, especially in terms of creating a proper and clear concept as part of keeping the land policy.

**Key words:** *evaluation of land, maps benefits, agricultural economic programs*

## VIŠENAMJENSKO VREDNOVANJE POLJOPRIVREDNOG ZEMLJIŠTA U FEDERACIJI BOSNE I HERCEGOVINE

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### Sažetak

Višenamjensko vrednovanje zemljišta proces je procjene kvalitete i vrijednosti zemljišta u službi planiranja i gospodarenja zemljištem, a predstavlja temeljnu podlogu za razvoj i optimalno korištenje prostora općenito. U okviru ovog rada izvršena je procjena višenamjenske pogodnosti zemljišta za korištenje u poljoprivredi prema Pravilniku o jedinstvenoj metodologiji za razvrstavanje poljoprivrednog zemljišta u klase pogodnosti („Službene novine FBiH“, broj 43/11), koji se temelji na FAO kriterijima procjene pogodnosti zemljišta (FAO, 1976; Brinkman i Smyth, 1973). Temeljem rezultata istraživanja izrađena je baza podataka, te karte pogodnosti po pojedinim djelatnostima (povrćarstvo, ratarstvo, voćarstvo, vinogradarstvo i travnjaštvo) i određeni su prioritetni poljoprivredno gospodarski programi, a izrađena je i istoimena namjenska karta (M 1:200.000) kojom je prikazana distribucija 36 preporučenih poljoprivredno gospodarskih programa na području Federacije BiH. Inventarizacijom površina preporučenih poljoprivredno gospodarskih programa, utvrđeno je da na području poljoprivrednog zemljišta Federacije BiH najveću površinu zauzima poljoprivredno gospodarski program Stočarstvo i to 429.685,4 ha, odnosno 40,45% poljoprivrednog zemljišta Federacije BiH. Po zastupljenosti slijede poljoprivredno gospodarski programi Voćarstvo, Stočarstvo koji zauzimaju 123.996,4 ha ili 11,67%; zatim Voćarstvo, Povrćarstvo, Ratarstvo s površinom od 89.384,7 ha (8,41%); te programi Stočarstvo, Voćarstvo, Povrćarstvo koji zauzimaju 66.562 ha ili 6,26% i Stočarstvo, Povrćarstvo, Ratarstvo s površinom 62.136,3 ha (5,85%). Ostali poljoprivredno gospodarski programi pojedinačno zauzimaju površinu manju od 4%. Vjerujemo kako će podatci dobiveni kroz ovaj projekt pridonijeti ukupnom razvoju poljoprivrede na području Federacije Bosne i Hercegovine, posebice na planu stvaranja ispravnih i jasnih koncepcija u sklopu vođenja zemljišne politike.

**Ključne riječi:** *vrednovanje zemljišta, karte pogodnosti, poljoprivredno gospodarski programi*

## URBAN GARDENING: MANAGING SOIL QUALITY AND PREVENTING CONTAMINATION RISKS

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### Abstract

Municipalities throughout Croatia are turning to urban agriculture and gardening as a reasonable option to increase their access to healthy, nutritious, and low-cost agri-products. Community gardens provide many benefits, including healthier lifestyles by increasing activity levels, providing fresh produce, growing community pride, and nurturing social interactions and cooperation among people. However, it is important to timely identify risks that the use of soil in the urban area can carry on. City of Zagreb has recognized the importance of urban gardening and since 2013 has started with the establishment of urban gardens, which are all involved in the current monitoring program. The main objectives of this study are: (i) to identify location of urban gardens considering land use history, proximity to roads and their frequency, proximity to industry and waste landfills, and (2) to determine the effective depth of a soil, physical-chemical characteristics and trace element content of soil. The study includes 9 locations of urban gardens in Zagreb. Most of these gardens are formed on abandoned land located on the periphery and in newer neighbourhoods. Only one garden is located on the land that has been used for agriculture for decades. Depending on the total area of the garden, topsoil samples (0-30 cm) were taken as 2 or 4 composited soil samples made up of 5 sub-samples. In this way, it is collected a total of 22 soil samples. Main soil physical-chemical characteristics (pH, CaCO<sub>3</sub>, OC, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, nitrogen-nitrate (NO<sub>3</sub>-N) and nitrogen-ammonia (NH<sub>4</sub>-N)) were determined along with the element contents (Cd, Cu, Cr, Hg, K, Ni, P, Pb i Zn) after aqua regia extraction. A GIS geospatial database was compiled: the observation sites were spatially referenced using GPS and the resulting data were stored in different GIS layers. Furthermore, the resulting data were examined through uni- and multivariate statistical analyses. Although the largest concentration range, expressed as coefficient of variation, are observed for Cu (55.4%), Hg (50.9%), P (43.9%) and Cr (41.3%), the trace metal contents do not exceed threshold value established by the Croatian government regulation. Moreover, the results indicate that soil fertility varies considerably at the garden level, as well as at the parcel level within a garden. Such marked differences in soil fertility are due to a combination of inherent and agricultural practices.

**Key words:** *urban gardening, contamination risks, soil quality, monitoring program*

# URBANO VRTLARSTVO: UPRAVLJANJE KVALITETOM TLA I SPRJEČAVANJE RIZIKA OD ONEČIŠĆENJA

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## Sažetak

Općine u cijeloj Hrvatskoj se okreću urbanoj poljoprivredi i vrtlarstvu kao prihvatljivoj mogućnosti da povećaju pristup zdravim, hranjivim i jeftinim poljoprivrednim proizvodima. Društveni vrtovi pružaju mnoge pogodnosti, uključujući zdraviji način života povećanjem nivoa aktivnosti, daju svježe proizvode, doprinose ponosu zajednice, te njeguju društvene interakcije i saradnju među ljudima. Međutim, važno je pravovremeno utvrditi rizike koje donosi korištenje zemljišta u urbanom području. Grad Zagreb je prepoznao važnost urbanog vrtlarstva i od 2013-e godine započeo je sa formiranjem urbanih vrtova, koji su svi uključeni u aktualni program praćenja. Glavni ciljevi ovog istraživanja su: (i) identificirati lokaciju urbanih vrtova s obzirom na historijat korištenja tog zemljišta, blizinu saobraćajnica i intenzitet prometa, blizinu industrijskih objekata i odlagališta otpada, i (2) utvrditi efektivnu dubinu tla, fizičko-hemijske karakteristike i sadržaj elemenata u tragovima u tlu. Studija obuhvata devet lokacija urbanih vrtova u Zagrebu. Većina ovih vrtova formirana je na napuštenom zemljištu koje se nalazi na periferiji i u novijim četvrtima. Samo jedan vrt se nalazi na zemljištu koje se desetljećima koristi za poljoprivredu. Ovisno o ukupnoj površini vrta, uzorci gornjeg sloja tla (0-30 cm) uzeti su kao 2 ili 4 složena uzorka sastavljena od 5 poduzoraka. Na ovaj način prikupljeno je ukupno 22 uzorka tla. Glavne fizičko-hemijske karakteristike (pH, CaCO<sub>3</sub>, OC, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O, NO<sub>3</sub>-N i NH<sub>4</sub>-N) određene su zajedno sa sadržajem elemenata (Cd, Cu, Cr, Hg, K, Ni, P, Pb i Zn) nakon ekstrakcije zlatotopkom. Sastavljena je GIS geo-prostorna baza podataka: praćene lokacije su prostorno referirane pomoću GPS-a, a dobiveni podaci pohranjeni u različitim slojevima GIS-a. Nadalje, dobiveni podaci su ispitani pomoću statističkih analiza sa jednom ili više varijabli. Iako je najveći raspon koncentracije, izražen kao koeficijent varijacije, primijećen kod Cu (55,4%), Hg (50,9%), P (43,9%) i Cr (41,3%), sadržaj metala u tragovima nije prelazio graničnu vrijednost utvrđenu državnim popisom Hrvatske. Osim toga, rezultati pokazuju da plodnost tla značajno varira ne samo na nivou vrta, već i na nivou parcele u sklopu vrta. Ovako izražene razlike u plodnosti tla uzrokovane su kombinacijom inherentnih i poljoprivrednih praksi.

**Ključne riječi:** *urbano vrtlarstvo, rizik od onečišćenja, kvalitet tla, program praćenja*

## SOIL SALINITY RISK ASSESSMENT IN THE LOWLAND NERETVA RIVER VALLEY

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### Abstract

Soil salinization caused by natural or human-induced processes is a worldwide environmental hazard impacting more than 100 countries. In Europe this problem is most pronounced in the Mediterranean basin region including the coastal region of Croatia where seawater intrudes through porous media into calcareous aquifers and salinizes both ground and surface water. This is especially evident in the Neretva River Valley, important agricultural region for citrus and leafy vegetable production which is becoming more affected by periodical or occasional soil and water salinization. The research was carried out in floodplain of the Neretva River Valley in the Mediterranean part of Croatia (43°00

'N, 17°30' E)

agricultural land. The topsoil samples were taken using regular rectangular grid with a 500-m distance between the points, and from boreholes with a 1,000-m distance between the points. A probabilistic approach, based on multivariate geostatistics was used to model the spatial variation of soil salinization risk at the landscape scale and to delineate the areas at high risk. The method requires indicator coding, which transforms measured data values into a binary variable according to critical thresholds. These latter were set to: 2 dS m<sup>-1</sup> for EC<sub>e</sub> and 350 mg l<sup>-1</sup> for C<sup>1-</sup> to determine the probability of exceeding these critical values. Factorial kriging was also applied to identify one regionalized factor that summarizes the effects of the selected variables on soil salinization. Maps of each soil indicator and regionalized factor were produced to show the areas at risk of salinization. The results are valuable for planning the management of salinity. The result considering land resources surveys showed that the degree of salinisation is strongly related to characteristics of the soils and their location in the catchments area. Salinity of soils within the root zone can be highly variable and in order to estimate the risk of salinisation it is important to examine soil salinity as a function of depth.

**Key words:** *soil salinity, risk assessment, soil degradation, soil quality, mapping*

## PROCJENA RIZIKA ZASLANJIVANJA TLA U NIZINSKOM PODRUČJU DOLINE NERETVE

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### Sažetak

Zaslanjivanje tla uzrokovano prirodnim ili antropogenim procesima predstavlja svjetsku ekološku opasnost koja pogađa više od 100 zemalja. U Europi je ovaj problem najizraženiji u regiji Mediterana, uključujući obalni pojas Hrvatske u kojem morska voda kroz poroze medije prodire u krečnjački akvifer i zaslanjuje kako podzemne, tako i površinske vode. To je naročito vidljivo u dolini rijeke Neretve, važnoj poljoprivrednoj regiji za uzgoj citrusa i lisnatog povrća, koja je sve više pogođena periodičnim ili povremenim zaslanjivanjem tla i vode. Istraživanje je provedeno u plavnoj ravnici doline Neretve u mediteranskom dijelu Hrvatske (43°00' S, 17°30' E) koja pokriva 5.200 ha gornjeg sloja tla uzeti su pomoću pravilne pravougaone mreže s razmakom od 500 m između tačaka, i iz bušotina sa razmakom od 1.000 m između tačaka. Probabilistički pristup koji se temelji na multivarijantnoj statistici, korišten je za modeliranje prostorne varijacije rizika od zaslanjivanja tla u razmjeri krajolika, kao i za razgraničenje područja sa visokim rizikom. Ova metoda zahtijeva kodiranje indikatora, koje pretvara izmjerene vrijednosti u binarne varijable u skladu s kritičnim pragovima. Ovi drugi su bili podešeni na: 2 dS m<sup>-1</sup> za EC<sub>e</sub> i 350 mg l<sup>-1</sup> za C<sup>-</sup> kako bismo utvrdili vjerovatnoću prekoračenja ovih kritičnih vrijednosti. Također je korišteno faktorijalno korigovanje za identifikaciju jednog regionaliziranog faktora koji sumira učinke odabranih varijabli na zaslanjivanje tla. Izrađene su mape svih indikatora tla i regionalni faktor kako bi se pokazala područja na kojima postoji rizik od zaslanjivanja. Rezultati su dragocjeni za planiranje upravljanja zaslanjivanjem. Rezultat premjera zemljišnih resursa pokazao je da je stupanj zaslanjenosti usko povezan sa karakteristikama tala i njihovom lokacijom u slivnom području. Salinitet zemljišta u zoni korijena može biti izrazito promjenjiv, tako da je za procjenu rizika od zaslanjivanja veoma važno ispitati salinitet tla u funkciji dubine.

**Ključne riječi:** salinitet tla, procjena rizika, degradacija tla, kvalitet tla, mapiranje

# DOES THINNING AFFECT THE SOIL RESPIRATION IN SILVER FIR, BEECH AND SPRUCE PREDOMINATING ADULT FOREST STANDS?

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## Abstract

CO<sub>2</sub> movement or CO<sub>2</sub> flux out of the soil is the primary function of soil respiration; soil CO<sub>2</sub> flux is a significant component of the total atmospheric carbon balance, a physical process driven primarily by the CO<sub>2</sub> concentration diffusion gradient between the upper soil layers and the atmosphere near the soil surface. In three high karst forest complexes same spatial design was applied to observe the effect of silvicultural treatment-the degree of mature stand removal on soil efflux. In every forest complex nine subplots were established during the time of experiment according to predominating tree species in growing stock of the mature canopy stand-Silver fir, Norway spruce and European beech. In 2012 silvicultural measures with different intensity were applied with 50% and 100% removal of growing stock around the centre of the plot with minimal diameter of two tree heights. The seasonal pattern of CO<sub>2</sub> efflux rates was mostly accountable by changes in soil temperature. Simple exponential functions including temperature alone accounted relatively well for the spatial variability over the investigated forest stands. Spatial heterogeneity in CO<sub>2</sub> efflux rates was clearly reflected in management practice, while higher soil respiration rates. A higher amount of above ground litter associated with high decomposition rates is a good predictor of soil respiration rates. Release rates and recovery period were extreme in beech predominating sites, followed by the silver fir and norway spruce. It is our belief, that more oscillations may be expected in carbon release dynamics in the future, as the number of extreme weather events increases and the withdrawal of silver fir with its poor recruitment may have long term consequences on this high karst high productive sites.

**Key words:** *soil efflux, silviculture, carbon release, beech, silver fir, Norway spruce*

# DA LI PRORJEĐIVANJE NEGATIVNO UTJEČE NA DISANJE TLA U SASTOJINAMA U KOJIMA DOMINIRAJU ODRASLA JELA, BUKVA I SMREKA?

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## Sažetak

Kretanje CO<sub>2</sub> ili fluks CO<sub>2</sub> iz tla je primarna funkcija disanja tla; fluks CO<sub>2</sub> iz tla je značajna komponenta bilansa ukupnog atmosferskog ugljika, fizički proces koji pokreće prvenstveno gradijent difuzije koncentracije CO<sub>2</sub> između gornjih slojeva tla i atmosfere blizu površine tla. Kod tri šumska kompleksa visokog krša primijenjen je isti prostorni dizajn kako bi se promatrao učinak gospodarskog tretmana-stupanj uklanjanja zrele sastojine-na respiraciju tla. Za vrijeme eksperimenta u svakom šumskom kompleksu formirano je devet podoloha u skladu s dominantnom vrstom drveća kod rastućih stabala sastojina sa razvijenom krošnjom-obična jela, norveška smreka i evropska bukva. U 2012. godini primjenjene su gospodarske mjere sa odstranjivanjem 50% i 100% drvene zalihe oko centra parcele u minimalnom prečniku od dvije visine stabla. Za sezonski obrazac stope isticanja CO<sub>2</sub> uglavnom je odgovorna promjena temperature tla. Jednostavne eksponencijalne funkcije, uključujući temperaturu, relativno dobro predstavljaju prostornu varijabilnost nad ispitivanim šumskim sastojinama. Prostorna heterogenost kod brzine isticanja CO<sub>2</sub> jasno se odražava u praksama upravljanja, kada je stopa intenziteta disanja tla viša. Veća količina nadzemnog otpadnog materijala, povezana s visokim stopama razgradnje, dobar je prediktor intenziteta disanja tla. Brzina otpuštanja i period oporavka su bili ekstremni na pretežno bukovim lokacijama, nakon čega slijede obična jela i norveška smreka. Uvjereni smo da se u budućnosti mogu očekivati veće oscilacije u dinamici otpuštanja ugljika, pošto se broj ekstremnih vremenskih prilika povećava, a povlačenje obične jele s njenim slabim popunjavanjem može imati dugoročne posljedice na ova visokoproduktivna staništa visokog karsta.

**Ključne riječi:** *isticanje tla, uzgoj šuma, otpuštanje ugljika, bukva, obična jela, Norveška smreka*

**SOILS AND CARBON CONTENT AT RESEARCH OBJECTS IN  
FIR-BEECH FORESTS ON CALCAREOUS BEDROCKS OF  
THE DINARIC MOUNTAIN CHAIN:  
A CASE STUDY FROM SLOVENIA AND BOSNIA**

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**Abstract**

Large areas of European silver fir-beech forests are characteristic for the Dinaric mountains and represent one of the most important forest ecosystems in the region. Such forests extend in high karst plateaus from the eastern Alps in SE Slovenia to the northern Albania massifs at the altitudes from 700 to 1,200 (1,500) m a.s.l. This is the area with a diverse landscape configuration. The bedrock consists of limestone and occasionally of dolomite limestone and dolomite. There are also various soil conditions, where in a small area, a mosaic of Rendzic Leptosols, Chromic Cambisol and Chromic Luvisols occur. As climate conditions are very favourable for the growth of forests (high rainfall and air humidity), production function of wood is much more emphasized. Very little is known about the long-term effects of forest management and intensity of logging on soil organic matter quality and carbon stocks in the forest soil. As quality of forest soils is associated with the range of stand disturbance due to the intensity of logging, its properties are often used as a criterion in valorisation of sustainability of forest management systems. Therefore, from the aspect of different intensity of logging we studied changes in soil properties as well as changes in C and N stocks in the forest soils. For that purpose we have set up a research objects in silver fir-beech forests, in Slovenia (research plots in Kočevje, Snežnik and Trnovo) and Bosnia and Herzegovina (research plots on Bjelašnica). Preliminary results from Slovenian sites show that the intensity of logging causes a decrease in the total soil organic carbon and nitrogen contents, wider C/N ratio and increases of pH values, with the largest level of alternations in the organic part of the soils. Since adjacent logging operations are applied we are expecting similar results for the Bosnian sites.

**Key words:** *forest management, organic matter, calcareous bedrocks, C stocks*

# TLO I SADRŽAJ UGLJIKA NA ISTRAŽIVAČKIM OBJEKTIMA ŠUMA BUKVE I JELE NA KARBONATNOM SUPSTRATU DINARSKIH PLANINA: STUDIJA SLUČAJA IZ SLOVENIJE I BOSNE

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## Sažetak

Zajednice bukve i jele zauzimaju veliku površinu u planinskom lancu Dinarida i predstavljaju jedne od najvažnijih šumskih ekosistema regije. U visokim karstnim područjima, staništa ovih šuma se pružaju u rasponu od 700 do 1.200 (1.500) m nadmorske visine, od istočnih Alpa u Sloveniji do sjevernih Dinarida Albanije. Područje se karakteriše izuzetnim geomorfološkim diverzitetom. Krečnjaci, dolomitizirani krečnjaci i dolomiti predstavljaju najzastupljenije tipove stijena, koje kao osnovno obilježje prati izražena raznolikost tala na malom prostoru. Tla se pojavljuju u mozaičnoj konstelaciji Kalkomelanosola (Leptosol), karbonatnih Kalkomelanosola (Rendzic Leptosol), Kalkokambisola (Chromic Cambisol) i Luvisola (Chromic Luvisol). Pogodni uslovi za rast šumske vegetacije (velike prosječne količine padavina i vlažnost zraka) su vezani uz naglašenu proizvodno-ekonomsku funkciju ovih šuma. Međutim, dugoročne posljedice sistema upravljanja koji se primjenjuje i intenziteta sječe drveta su nedovoljno poznate kada je u pitanju organska materija tla (kvalitet i sadržaj organskog ugljika (C)) kao glavni element proizvodnosti tla. S obzirom na povezanost organske materije sa intenzitetom poremećaja staništa u toku sječe, ova karakteristika tla se vrlo često koristi kao kriterij za ocjenu održivosti sistema gospodarenja. Studija, s tim u vezi ima zadatak da analizira promjene svojstava tla među kojima zalihe C i azota (N) u tlu u odnosu na različit intenzitet sječe. Odabrani istraživački objekti su smješteni u pojasu šuma bukve i jele u Sloveniji (Kočevje, Snežnik i Trnovo) i Bosni i Hercegovini (Bjelašnica). Preliminarni rezultati analiza iz Slovenije upućuju na to da je intenzitet sječe povezan sa smanjenjem zalihe ukupnog organskog C u tlu, širim CN odnosom i većim pH vrijednostima, što je posebno izraženo u organskom horizontu. S obzirom na primjenu jednake šumskogospodarske prakse, podaci u ovome radu će odgovoriti na pitanje da li se slični rezultati mogu očekivati na istraživačkom objektu u Bosni.

**Ključne riječi:** *gospodarenje šumama, humus, zalihe C, plodnost*

## CHANGES IN THE ADSORPTION COMPLEX OF REKULTISOL UNDERNEATH THE SEEDED GRASSLANDS

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### Abstract

The research were conducted on Deposol and Recultisol in lignite mine Stanari. The main task of the formed grasslands is to improve the mechanical, chemical and biological properties of the Deposol in the reclamation process. The fertility of Stanari Deposol is extremely low in comparison to the natural soil. Grassland seeding through direct type of reclamation was conducted in 2008, 2011 and 2012 year. The conducted researches include the changes in the adsorption complex in the surface layer of the treated Deposol in the reclamation process. Laboratory analysis of this technogenic soil were carried out before the reclamation and sowing started, and then in the process of reclamation at the end of 2012. Adsorption capacity and saturation degree of alkali cations in Recultisol were increased. Proper selection of the agromeliorative and other measures is required in the reclamation process. Well based seeding grasslands contribute to the creation of quality Recultisol.

**Key words:** *soil-Recultisol, reclamation, chemical properties, Stanari*

## PROMJENE U ADSORPTIVNOM KOMPLEKSU REKULTISOLA POD SIJANIM TRAVNJACIMA

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### Sažetak

Istraživanja su obavljena na Deposolima i Rekultisolima u rudniku lignita Stanari. Zadatak formiranih travnjaka je poboljšanje mehaničkih, hemijskih i bioloških osobina deposola u procesu biološke rekultivacije. Plodnost stanarskih Deposola je izuzetno niska u odnosu na prirodna zemljišta. Zasnivanje travnjaka u tipu direktne rekultivacije je vršeno tokom 2008., 2011. i 2012. godine. Provedena istraživanja obuhvataju nastale promjene adsorptivnog kompleksa u površinskom sloju tehnogenog zemljišta u procesu rekultivacije. Laboratorijske analize su vršene prije početka rekultivacije, a potom u procesu rekultivacije, na kraju 2012. godine. Utvrđeno je povećanje sposobnosti adsorpcije i stepen zasićenosti baznim katjonima u Rekultisolima. U procesu rekultivacije je potreban pravilan izbor agromeliorativnih i drugih mjera. Dobro zasnovani sijani travnjaci doprinose stvaranju kvalitetnog Rekultisola.

**Ključne riječi:** *zemljište-Rekultisol, rekultivacija, hemijska svojstva, Stanari*

# THE STATE OF SOIL ORGANIC MATTER IN DIFFERENT PHYSICAL FRACTIONS DEPEND ON LAND USE TYPE

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## Abstract

Known fact is that arable soils compared with correspondent native soils differ in the state of soil organic matter (SOM) and that agricultural practices halved content of soil organic carbon in last decades. Further, soil structure or aggregation mediates many biological and chemical processes in soil and influence on protecting of SOM. The objectives of this paper is to analyze how the different land use (forest, grassland and arable soil) affects on quality and quantity of SOM in different physical fraction. In particular, it is important to determine what pool (physically separated fraction) of SOM is most sensitive on cultivation and what pool is more resistant to mineralization. The research is carried out on two soil types with different texture, Pseudogley and Terra Rossa, in condition of different climate and soil management. Two groups of SOM analysis are singled out: 1) quantify SOC and N storage, and  $\delta^{13}\text{C}$  by horizons; and 2) quantify the SOC and N in the following physically separated fractions of SOM: a) coarse and fine particulated organic matter (POM) density  $<1,8 \text{ gcm}^{-3}$ ; b) occluded POM in stable microaggregates 53-250  $\mu\text{m}$ ; and c) SOM in small microaggregates  $<53 \mu\text{m}$ .

**Key words:** *soil organic matter, physical fractions, type of land use*

# STANJE ORGANSKE MATERIJE TLA U RAZLIČITIM FIZIČKIM FRAKCIJAMA ZAVISNO OD NAČINA KORIŠTENJA ZEMLJIŠTA

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## Sažetak

Poznato je da se većina obradivih tala u poređenju sa odgovarajućim prirodnim tlima razlikuje u stanju organske materije tla (OMT), kao i da je primjena savremene agrotehnike prepolovila sadržaj organskog karbona u nekoliko posljednjih desetljeća. Nadalje, struktura tla ili agregacija posreduju u mnogim biološkim i hemijskim procesima i tako utiču na očuvanje organske materije u tlu. Cilj ovog rada je analizirati kako način korištenja zemljišta (šuma, livada i oranica) utiče na kvantitet i kvalitet organske materije u njenim različitim fizičkim frakcijama. Posebno je važno odrediti koji su to oblici (fizičke frakcije) OMT osjetljivije na kultivaciju, a koje frakcije su zaštićenije od mineralizacije. Istraživanja su vršena na tlima različite teksture-pseudogleju i crvenici, u uslovima različite klime i načina upravljanja tлом. Rađene su dvije grupe analiza organske materije tla: 1) kvantificiranje organskog C i N, te  $\delta^{13}\text{C}$  po horizontima; 2) kvantificiranje C i N u sljedećim fizički izdvojenim frakcijama OMT: a) krupne i sitne čestice slobodne/nevezane OMT specifične gustine  $<1,8 \text{ g/cm}^3$ ; b) OMT zatvorena u stabilnim mikroagregatima od 53-250  $\mu\text{m}$ ; c) OMT vezana u malim mikroagregatima  $<53 \mu\text{m}$ .

**Ključne riječi:** *organska materija tla, fizičke frakcije, način korištenja zemljišta*

# MICROBIOLOGICAL PROPERTIES OF RECVTISOL UNDER THE DIFFERENT CULTURES AT STANARI COAL MINE

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## Abstract

This paper studied the number of physiological and systematic groups of microorganisms in Recultisol under the different cultures at Stanari coal mine, and in variants of Recultisol where mineral fertilization and calcification were applied and in variants of Recultisol where only mineral fertilization were applied. The trial was set in the field conditions at the location of the internal part of overburden deposition site, near open pit Raskovac which is the part of Stanari coal mine. Mineral fertilizers were used as starter fertilizer and supplementary nutrition in the amount of 100-140 kg/ha of N and 40-60 kg/ha P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and calcification was completed by adding 4 t/ha CaCO<sub>3</sub>. Microbiological analysis of the Recultisol determined the total number of bacteria, Azotobacter sp., ammonifiers, oligonitrophyls, actinomycetes and fungi. The aim of the research is to determine the effect of mineral fertilizers and calcification on the number of microorganisms in the Recultisol under small grains, potatoes and grass-clover mixture. The total bacterial count, oligonitrophyls, sporogenic ammonifiers, Azotobacter sp. and actinomycetes was higher in recultisol under all of the tested cultures in the variant fertilizers + CaCO<sub>3</sub> comparing to the variant without CaCO<sub>3</sub>, while the number of ammonifiers and fungi in Recultisol under all of the tested cultures was higher in the variant without CaCO<sub>3</sub> in relation to the variant mineral fertilizers + CaCO<sub>3</sub>. In Recultisol under grass-clover mixture, higher total bacterial, oligonitrophyls and fungi count was recorded in both tested variants, in relation to their number in Recultisol under potatoes and small grains. The number of actinomycetes was higher in Recultisol under potato in both variants, in relation to the number of actinomycetes in Recultisol under small grains and grass clover mixture. In Recultisol under small grains in variant mineral fertilizers + CaCO<sub>3</sub> number of ammonifiers was the lowest (182 x 10<sup>4</sup>g<sup>-1</sup> absolutely dry soil), while the highest number of ammonifiers was recorded in Recultisol under grass and clover in the variant without CaCO<sub>3</sub> (1778 x 10<sup>4</sup>g<sup>-1</sup> absolutely dry soil). Azotobacter sp. count was lowest in Recultisol under grass clover variant without CaCO<sub>3</sub> (68 x 10<sup>2</sup>g<sup>-1</sup> absolutely dry soil), while the highest Azotobacter sp. count was recorded in recultisol under small grains in the variant with fertilizers + CaCO<sub>3</sub> (123 x 10<sup>2</sup>g<sup>-1</sup> absolutely dry soil).

**Key words:** *Recultisol, microbiological properties, mineral fertilizers, calcification*

# MIKROBIOLOŠKA SVOJSTVA REKULTISOLA POD RAZLIČITIM KULTURAMA U RUDNIKU STANARI

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## Sažetak

U ovom radu ispitivana je brojnost pojedinih fizioloških i sistematskih grupa mikroorganizama u Rekultisolu pod različitim kulturama u rudniku Stanari, i to u varijantama Rekultisola gdje je primjenjena fertilizacija mineralnim đubrivom i kalcifikacija, i u varijantama Rekultisola gdje je primjenjena samo fertilizacija mineralnim đubrivom. Ogled je postavljen u poljskim uslovima na lokalitetu unutrašnjeg odlagališta otkrivke sa površinskog kopa Raškovac, Stanari. Mineralna đubriva su primijenjena startno i kroz prihranu u količini od 100-140 kg/ha N i 40-60 kg/ha P<sub>2</sub>O<sub>5</sub> i K<sub>2</sub>O, a kalcifikacija je izvršena dodavanjem 4 t/ha CaCO<sub>3</sub>. Mikrobiološkom analizom ispitivanog Rekultisola određen je ukupan broj bakterija, broj Azotobacter sp., amonifikatora, oligonitrofila, aktinomiceta i gljiva. Cilj istraživanja je da se utvrdi djelovanje mineralnih đubriva i kalcifikacije na brojnost mikroorganizama u Rekultisolu pod strnim žitima, krompirom i travno-djetelinskom smjesom. Ukupan broj bakterija, broj oligonitrofila, sporogenih amonifikatora, Azotobacter sp. i aktinomiceta je veći u Rekultisolu pod svim ispitivanim kulturama u varijanti mineralna đubriva + CaCO<sub>3</sub> u odnosu na varijantu bez CaCO<sub>3</sub>, dok je broj amonifikatora i gljiva u rekultisolu pod svim ispitivanim kulturama veći u varijanti bez CaCO<sub>3</sub> u odnosu na varijantu mineralna đubriva +CaCO<sub>3</sub>. U Rekultisolu pod travno-djetelinskom smjesom zabilježen je veći ukupan broj bakterija, broj oligonitrofila i gljiva u obje ispitivane varijante, u odnosu na njihovu brojnost u rekultisolu pod krompirom i strnim žitima. Brojnost aktinomiceta je veća u Rekultisolu pod krompirom u obje ispitivane varijante u odnosu na brojnost aktinomiceta u Rekultisolu pod strnim žitima i travno-djetelinskom smjesom. U Rekultisolu pod strnim žitima u varijanti mineralna đubriva + CaCO<sub>3</sub> brojnost amonifikatora je najmanja (182 x 10<sup>4</sup>/ g apsolutno suvog zemljišta), dok je u najveća brojnost amonifikatora zabilježena u Rekultisolu pod travno-djetelinskom smjesom u varijanti bez CaCO<sub>3</sub> (1778 x 10<sup>4</sup>/g apsolutno suvog zemljišta). Brojnost Azotobacter sp. je najmanja u Rekultisolu pod travno-djetelinskom smjesom u varijanti bez CaCO<sub>3</sub> (68 x 10<sup>2</sup>/g apsolutno suvog zemljišta), a najveća brojnost Azotobacter sp. je zabilježena u Rekultisolu pod strnim žitima u varijanti mineralna đubriva +CaCO<sub>3</sub> (123 x 10<sup>2</sup>/g apsolutno suvog zemljišta).

**Ključne riječi:** *Rekultisol, mikrobiološka svojstva, mineralna đubriva, kalcifikacija*

## COMPARISON OF ALLUVIAL SOILS OF DIFFERENT LAND USE IN THE AREA OF THE NATIONAL PARK „UNA“ WITH SPECIAL EMPHASIS ON THE DISTRIBUTION OF Cd, Ni AND As

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### Abstract

The paper presented results of a comparison of alluvial soils of different land use at two different sites within the National Park „Una“. The sites were related to a natural meadow (BUK) and artificial meadow (KLISA). The main objective of the research, in addition to the physical and chemical parameters of soil quality, was to determine the distribution of the total content of cadmium (Cd), nickel (Ni) and arsenic (As). The total content of these elements were observed in composite samples at two depths of 0-10 cm and 0-20 cm and horizons profile. Their total content was measured by atomic adsorption spectrometry-AAS. The results were statistically analyzed using Kruskal-Walisovog test at the significance level of  $p \leq 0.05$  using correlation coefficient  $\chi^2$ . The results showed a single legality of the distribution of Cd, Ni and As in samples of soil profile, while the average soil samples showed unique legality of the distribution of observed elements.

**Key words:** *alluvial soil, distribution, cadmium, nickel, arsenic*

# KOMPARACIJA ALUVIJALNOG TLA RAZLIČITOG NAČINA KORIŠTENJA NA PODRUČJU NACIONALNOG PARKA „UNA“ S POSEBNIM AKCENTOM NA DISTRIBUCIJU Cd, Ni i As

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## Sažetak

U radu su predstavljeni rezultati komparacije aluvijalnog tla različitog načina korištenja na dva različita lokaliteta unutar nacionalnog parka „Una“. Lokaliteti su se odnosili na prirodnu livadu (BUK) i vještačku livadu (KLISA). Osnovni cilj istraživanja, pored fizičko-hemijskih parametara kvaliteta tla, bio je da se utvrdi distribucija ukupnog sadržaja kadmija (Cd), nikla (Ni) i arsena (As). Ukupan sadržaj ovih elemenata praćen je kod prosječnih uzoraka na dvije dubine 0-10 cm i 0-20 cm i po horizontima profila. Njihov ukupni sadržaj izmjeren je metodom atomske adsorpcione spektrofotometrije-AAS. Dobiveni rezultati su obrađeni statistički pomoću Kruskal-Walisovog testa na nivou značajnosti  $p \leq 0,05$  korištenjem korelacionog koeficijenta  $\chi^2$ . Rezultati istraživanja su pokazali jedinstvenu zakonitost u distribuciji Cd, Ni i As kod uzoraka iz profila tla, dok kod prosječnih uzoraka tla nisu pokazali jedinstvenu zakonitost u distribuciji posmatranih elemenata.

**Ključne riječi:** *aluvijalno tlo, distribucija, kadmij, nikal, arsen*

# IMPLEMENTATION OF THE UNCCD IN BOSNIA AND HERZEGOVINA

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## Abstract

The UN Convention to Combat Desertification (UNCCD) is one of three UN Rio Conventions, together with UN Convention on Climate Change (UNFCCC) and the Convention on Biological Diversity (UNCBD). Bosnia and Herzegovina (B&H) has ratified this Convention on August 26, 2002 and became fully effective as of November 24, 2002. Initially, B&H was a member of two regional annexes, Annex IV (in the countries of the northern Mediterranean) and Annex V (countries of Central and Eastern Europe), and since 2009 B&H belongs only to Annex V. From 2002 to 2006 the function of the focal point was held by Prof. Dr. Hamid Čustović, and since 2006 this function is performed by Prof. Dr. Mihajlo Marković, while Prof. Čustović is the correspondent for Science and Technology. Prof. Marković was the Vice President of the Bureau Committee of Science and Technology (CST) from 2009 to 2011, and Prof. Čustović held the post from 2013 to 2015. It is important to point out that at the last, twelfth Conference (UNCCD COP12) held in Ankara, October 12-23, 2015, which was attended by around 6,000 participants, Prof. Čustović was elected president of the Committee for Science and Technology for the next two years (CST13 Chair). As part of fulfilling the obligations our country has towards the UNCCD Convention, prepared is an action plan to combat land degradation and mitigation of the consequences of the drought (AP) in B&H during 2014 and 2015. The creation of the AP is funded by the Global Environment Fund (GEF), while the implementation went through UNEP, with the support from the Ministry of Foreign Trade and Economic Relations of Bosnia and Herzegovina, and the Ministry of agriculture, Forestry and Water Management of Republika Srpska, which is the also the focal ministry for the UNCCD Convention. Future steps in the implementation of the National Action Plan (NAP for B&H) will follow after the adoption of this document and the action plan (AP) by the entity governments and the Council of Ministers. They relate to the realization of strategic and operational objectives identified in the AP with the goal to combat land degradation and the consequences of the drought. In addition, it is necessary that B&H in the future aspires to keep the level of land degradation on the so-called zero-level, meaning that further processes of land degradation and its rehabilitation balance out. Particular attention must be paid to the monitoring and reporting system to the UN and other relevant international institutions.

**Key words:** *UNCCD, BIH, history, Focal point, CST, NAP (Action Plan)*

## IMPLEMENTACIJA UNCCD U BOSNI I HERCEGOVINI

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### Sažetak

Konvencija UN za borbu protiv dezertifikacije (UNCCD) je jedna od tri Rio UN konvencije, uz UN konvencije o klimatskim promjenama (UNFCCC) i konvenciju o biodiverzitetu (UNCBD). Bosna i Hercegovina (BiH) je pristupila ovoj konvenciji 26.08.2002. godine, a u punopravno članstvo primljena je 24.11.2002. godine. U početku BiH je bila članica dva regionalna aneksa, Aneksu IV (u zemljama sjevernog Mediterana) i Aneksu V (Budući koraci na implementaciji Nacionalnog akcionog zemlje centralne i istočne Evrope), a od 2009. godine BiH pripada samo Aneksu V. Od 2002 do 2006 funkciju fokal pointa je obavljao prof. dr. Hamid Čustović, a od 2006. godine do danas tu funkciju obavlja prof. dr. Mihajlo Marković, dok je prof. Čustović korespondent za nauku i tehnologiju. Prof. Marković je od 2009-2011. godine bio podpredsjednik Biroa komiteta za nauku i tehnologiju (CST), a prof. Čustović je tu funkciju obavljao od 2013-2015. godine. Na posljednjoj, dvanaestoj konferenciji (UNCCD COP12), održanoj u Ankari, u periodu 12-23. oktobar 2015. godine, u čijem radu je učestvovalo oko 6.000 učesnika, prof. Čustovića je izabran za predsjednika Komiteta za nauku i tehnologiju u naredne dvije godine (CST13 Chair). U okviru ispunjavanja obaveza naše zemlje prema UNCCD konvenciji, pripremljen je Akcioni program za borbu protiv degradacije zemljišta i ublažavanje posljedica suše (AP) u BiH tokom 2014. i 2015. godine. Izrada AP-a je finansirana od strane Globalnog fonda za životnu sredinu (GEF), a implementacija je išla preko UNEP-a, uz podršku Ministarstva spoljne trgovine i ekonomskih odnosa Bosne i Hercegovine i Ministarstva poljoprivrede, šumarstva i vodoprivrede Republike Srpske, koje je ujedno fokalno ministarstva za UNCCD konvenciju. Naredni koraci u implementaciji NAP-a za BiH uslijedit će nakon usvajanja ovog dokumenta i Akcionog plana (AP) od strane entitetskih vlada i Savjeta ministara BiH. Oni se odnose na realizaciju strateških i operativnih ciljeva, identifikovanih u AP-u, u cilju suzbijanja degradacije zemljišta i posljedica suše. Pri tome u budućnosti treba u BiH težiti da se degradacija zemljišta zadrži na tzv. nultom nivou, odnosno da se dalji procesi degradacije zemljišta i njegove rehabilitacije izbalansiraju. Posebnu pažnju treba obratiti na monitoring i sistem izvještavanja prema UN i drugim relevantnim međunarodnim institucijama.

**Ključne riječi:** *UNCCD, istorijat, fokalna tačka, CST, NAP (Akcioni plan)*

# NEEDS AND INITIATION METHOD OF SUSTAINABLE LAND MANAGEMENT IN BOSNIA AND HERZEGOVINA

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## Abstract

The paper aims to present needs and the method of initiation of sustainable land management in Bosnia and Herzegovina (B&H). According to estimates, 47.8% of agricultural land in B&H is affected by certain form of degradation that is constantly increasing. Water erosion and landslides are most frequent causes as well as droughts and floods. Significant drivers of land degradation are migration of population, urbanization and climate change. Sustainable land management is crucial for minimizing land degradation, rehabilitating degraded areas, ensuring the optimal use of land resources and provisioning of ecosystem services for the benefit of present and future generations. It is a key for the conservation and sustainable use of soil, water and biodiversity, for adapting to and mitigating climate change and contributing to food safety, nutrition and sustainable livelihoods. In B&H will soon begin implementation of the FAO-GEF project „Decision support for mainstreaming and scaling out sustainable land management”, which will be implemented in both entities of B&H, over the next few years, at all levels, from local to regional and on entity levels. The basic principles of sustainable land management will be imposed by the project, based on the best practices.

**Key words:** *land, degradation, sustainable management, BiH*

# POTREBA I NAČIN UVOĐENJA ODRŽIVOG UPRAVLJANJA ZEMLJIŠTEM U BOSNI I HERCEGOVINI

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## Sažetak

Rad ima za cilj da prikaže potrebu i način uvođenja održivog upravljanja zemljištem u Bosni i Hercegovini (BiH). Prema procjenama, 47,8% poljoprivrednog zemljišta u BiH pogođeno je nekim oblikom degradacije koja je u stalnom porastu. Erozija vodom i klizišta su najčešće prisutni uzroci, ali i suša i poplave. Značajni pokretači degradacije zemljišta su i migracije stanovništva, urbanizacija i klimatske promjene. Održivo upravljanje zemljištem je od ključne važnosti za minimiziranje degradacije zemljišta, sanaciju degradiranih područja, osiguranje optimalnog korišćenja zemljišnih resursa i pružanje usluga ekosistema za dobrobit sadašnjih i budućih generacija. To je ključ za očuvanje i održivo korištenje tla, vode i biološke raznovrsnosti, za prilagođavanje i ublažavanje klimatskih promjena i doprinosi sigurnosti hrane, ishrane i održivog života. U BiH uskoro počinje implementacija FAO-GEF projekta „Decision support for mainstreaming and scalling out sustainable land management“, kojim će se u oba entiteta BiH, tokom nekoliko narednih godina, na svim nivoima od lokalnih, preko regionalnih i entitetskih, uvesti osnovni principi održivog upravljanja zemljištem, zasnovani na najboljim praksama.

**Ključne riječi:** *zemljište, degradacija, održivo upravljanje, BiH*

## CHANGES IN LAND COVER AND LAND USE IN THE KARST AREA OF BOSNIA AND HERZEGOVINA

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### Abstract

Natural characteristics of karst areas (lack of water on the surface, scarce soil and vegetation) are rather specific and because of them they are often viewed as unsuitable for human habitation. They are often described as inhospitable and passive areas, and Aley (1992) states that karst areas in America are correlated with areas of rural poverty. A large part of Bosnia and Herzegovina consists of karst areas (karstland extending northwest-southeast) which on average are quite sparsely populated. The scarcity of nature, and especially of soil functions in terms of agriculture, as well as the previous period of industrial development caused depopulation which became particularly apparent after the recent war. This contributed to the fact that in some karst areas population has been drastically reduced, in some places by more than 60%, which affects the condition of land cover and land use as well as change in functions of soil in the ecosystem. Given the fact that the soil formation process on karst terrain is very slow (these are mainly shallow and skeletal soils) and in view of the importance of soil and its multi-functionality, this paper is aimed at analyzing the extent and nature of changes which occurred in land cover and in land use in this part of BiH, namely at analyzing the causes and effects. In order to be able to make such analysis, we used land cover databases, aerial photographs as well as orthophoto maps of the terrain.

**Key words:** *land cover, land use, karst area, Bosnia and Herzegovina*

# PROMJENE ZEMLJIŠNOG POKROVA I KORIŠTENJA ZEMLJIŠTA NA KRŠKOM PODRUČJU BOSNE I HERCEGOVINE

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## Sažetak

Područja krša specifična su po svojim prirodnim karakteristikama (nedostatak vode na površini, oskudno tlo i vegetacija), te se često smatraju teškim za život čovjeka. Nerijetko se opisuju kao negostoljubiva i pasivna područja, a Aley (1992) navodi da se u Americi krška područja podudaraju s područjima ruralnog siromaštva. Veliki dio Bosne i Hercegovine čine krška područja (područje krša se proteže od SZ prema JI) i u prosjeku su to dosta rijetko naseljena područja. Škrtost prirode, osobito funkcija tla u pogledu poljoprivrede, kao i razdoblje industrijskog razvoja izazvali su depopulaciju koja je postala naročito vidljiva nakon nedavnog rata. To je pridonijelo činjenici da je u nekim krškim područjima broj stanovnika drastično smanjen, u nekim mjestima više od 60%, što utječe na stanje zemljišnog pokrova i način korištenja zemljišta, ali i na promjene funkcija tla u ekosustavu. S obzirom na činjenicu da je brzina formiranja tla na krškim terenima vrlo spor proces (uglavnom su to plitka i skeletna tla) i s obzirom na značenje tla i njegovu multifunkcionalnost, željelo se utvrditi kolike i kakve promjene su se dogodile u zemljišnom pokrovu i korištenju zemljišta ovog dijela BiH, te analizirati uzroke i posljedice. Za analizu su korišteni podaci o zemljišnom pokrovu, satelitski snimci kao i ortofoto karte terena.

**Ključne riječi:** *zemljišni pokrov, korištenje zemljišta, krško područje, Bosna i Hercegovina*

## INFLUENCE OF SOIL CHEMICAL PROPERTIES ON RELATIONSHIP OF SOME METALS ION IN SOIL AND PLANT

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### Abstract

The concentration and form of Se in soil is governed by many chemical and physical properties of soil as pH, redox, Fe ions and soil composition. Selenate, Se(VI), is the predominant form of selenium in calcareous soils and selenite, Se(IV), is the predominant form in acid soil. The paper studied the influence of chemical soil properties I selenium fertilization rate applied on ions status of selenium and ferum in soil and plant material, as well as specific adsorption, translocation, distribution and accumulation of these ions in two different corn hybrids. The aim of this study was to examine whether there is a genetic specificity of selected corn hybrids in terms of accumulation of selenium in above ground mass of maize and to determine the effect on the yield of maize, and possibly define the factors as chemical soil properties which influence on selenium and ferrum ion accumulation in corn. The study was conducted at the farm Vita Vi Višići (Čapljina). The experiment design was a completely randomized design with two hybrids, four different fertilization treatments in four replications. The experimental area was implemented standard agricultural management practices of preparation, tillage, fertilization, application of protective agents. The basic fertilization of NPK fertilizers, sowing fertilization KAN and urea fertilization infection, and other variants of fertilization involving applications with selenium were conducted. Hybrid NP Pako is selected in order to achieve a high return, and M34 hybrid doing quality yield. The test results and their statistical analysis revealed no significant difference in the yield of hybrids, as well as their impact on the yield of fertilization, although there are small fluctuations. Also accumulation of selenium in corn between fertilization treatments, as well as compared with the control, showed no significant difference. Also hybrids were not significantly different in the accumulation of selenium. The highest yield was achieved hybrid M34 Pioneer of 41.1 t/ha in the third fertilization treatment NaSeO<sub>4</sub> 20g/ha, and the highest content of selenium in the plant was found in hybrid NP PAKO than 0,065 mg Se/kg of dry matter of maize in the fourth fertilization treatment (20 Na<sub>2</sub>SeO<sub>4</sub> kg/ha) in a foliar application. Fertilization selenium did not have a limiting effect on the formation of the yield, but the yield was a reflection and other factors, soil properties and climatic conditions this growing season.

**Key words:** *fertilization selenium, soil properties, accumulation of selenium, corn hybrids, yields*

## UTJECAJ KEMIJSKIH SVOJSTAVA TLA NA ODNOS IZMEĐU NEKIH METALA U TLU I BILJCI

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### Sažetak

Na koncentraciju i formu selena u tlu utječu brojna kemijska i fizička svojstva tla, kao što je pH, redoks potencijal, struktura tla, prisutnost Fe iona i td. Selenat, Se(VI), je dominantna forma selena na karbonatnim tlima, dok je selenit Se(IV), dominantna forma u kiselim tlima. Kroz ovaj rad je istraživana utjecaj kemijskih svojstava tla i primjenjenih gnojidbenih tretmana sa selenom na stanje iona selena i željeza u tlu i biljci, te specifičnost njihovog usvajanja, translokacije, distribucije i akumulacije u dva različita hibrida kukuruza. Cilj rada je bio da se ispita postoji li genetska specifičnost izabranih hibrida kukuruza u pogledu akumulacije selena u nadzemnu masu kukuruza i utvrditi utjecaj na prinos kukuruza, te eventualno definirati faktore, kemijska svojstva tla, koji utječu na akumulaciju selena i željeza u kukuruza. Istraživanje je provedeno na Farmi Vita Vi Višići (Čapljina). Pokus je postavljen po planu potpuno slučajnog rasporeda sa dva hibrida, četiri različita gnojidbena tretmana u četiri ponavljanja. Na pokusnoj površini su provedene standardne agrotehničke mjere od pripreme, obrade tla, gnojidbe, primjene zaštitnih sredstva. Provedena je osnovna gnojidba NPK gnojivima, predstjevena gnojidba KAN-om i prihrana UREE-om, te ostale varijante gnojidbe koje su uključivale aplikacije sa selenom. Hibrid NP Pako je odabran radi ostvarivanja visokog prinosa, a M34 hibrid radi kvalitetnog prinosa. Rezultati pokusa i njihova statistička obrada su pokazali da nema signifikantnih razlika u prinosu hibrida, kao ni utjecaju gnojidbe na njihov prinos, iako male oscilacije postoje. Također, akumulacija selena i željeza u kukuruza između gnojidbenih tretmanima, kao ni u usporedbi sa kontrolom, nije pokazala značajne razlike, a također ni hibridi se nisu značajno razlikovali u njihovoj akumulaciji. Najveći prinos je ostvario hibrid M34 Pioneer od 41,1 t/ha u trećem gnojidbenom tretmanu sa 20g NaSeO<sub>4</sub>/ha, a najveći sadržaj selena u biljci utvrđen je u hibridu NP PAKO od 0,065 mg Se/kg suhe tvari kukuruza u četvrtom gnojidbenom tretmanu (20 kg Na<sub>2</sub>SeO<sub>4</sub>/ha) u folijarnoj aplikaciji. Gnojidba selenom nije imala limitirajući učinak na formiranje visine prinosa, nego je prinos bio odraz kemijskih svojstava tla, kao i klimatskih prilika u ovoj vegetacijskoj sezoni.

**Ključne riječi:** *gnojidba selenom, kemijska svojstva tla, akumulacija selena, hibridi kukuruza, prinos*

# ASSESSMENT OF AGROECOLOGICAL LAND SUITABILITY FOR RASPBERRY PRODUCTION IN THE FEDERATION OF BOSNIA AND HERZEGOVINA

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## Abstract

Different agricultural crops have different requirements for growing in relation to land properties. Raspberry has a capability for adapting to different climate and soil conditions, so it can be grown in hilly mountain area up to altitude of 1,000 m. In our experience, raspberry production grows best in the altitude of 400-800 m. In this paper, for the assessment of land suitability for raspberry production following parameters have been used: soil depth, pH, humus content and texture of soil (source of data: Basic soil map of Bosnia and Herzegovina M1:50.000). Source of data for elevation and delineation of agricultural land is a Spatial Basis of the Federation of BiH Spatial Plan for period 2008-2028. Land suitability map for raspberry production has been prepared based on evaluation of the above mentioned parameters. This map as a final output provides a review of land use possibilities for the raspberry production in the Federation of Bosnia and Herzegovina.

**Key words:** *soil properties, GIS, limiting factors, raspberry*

# OCJENA AGROEKOLOŠKE POGODNOSTI ZEMLJIŠTA ZA UZGOJ MALINE U FEDERACIJI BOSNE I HERCEGOVINE

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## Sažetak

Različite poljoprivredne kulture imaju različite zahtjeve za uzgoj u odnosu na svojstva tla. Malina ima sposobnost prilagođavanja različitim klimatskim i zemljišnim uslovima, pa se može uzgajati i u brdsko planinskim krajevima do 1.000 m nadmorske visine. Naša iskustva pokazuju da intenzivna proizvodnja maline daje najbolje rezultate u područjima od 400 do 800 m nadmorske visine. U radu su za ocjenu agroekološke pogodnosti zemljišta za uzgoj maline pored nadmorske visine, korišteni slijedeći parametri: dubina tla, pH vrijednost, humoznost i tekstura tla (izvor: Osnovna pedološka karta Bosne i Hercegovine M1:50.000). Nadmorska visina i granica poljoprivrednog zemljišta preuzeti su iz Prostorne osnove Prostornog plana Federacije BiH za period 2008-2028. godina. Na osnovu ocjene navedenih parametara, pripremljena je karta pogodnosti za uzgoj maline koja, kao krajnji rezultat, daje ocjenu mogućnosti korištenja zemljišta za proizvodnju maline u Federaciji Bosne i Hercegovine.

**Ključne riječi:** *svojstva tla, GIS, faktori ograničenja, malina*

# LAND CAPABILITY STUDY AND MAP IN FUNCTION OF LAND PROTECTION, SPATIAL PLANNING AND AGRO-ECOLOGICAL ZONING

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## Abstract

Production of food and raw materials is the primary role of land. However, it is used for other purposes as well. Development of a society is followed by ever growing needs for food, raw materials as well as for the construction of residential facilities, infrastructure and the like. That puts this resource in a very bad position within the overall development, in terms of its use for non-agricultural purposes. The main act to consider the value of land from the perspective of various sectors and their needs (urban planning, agriculture etc.), in the Federation of B&H is the Decree on unique methodology for preparation of the spatial planning documents (Gazette of the Federation of B&H, No. 63/04 and No. 50/07), which prescribes the obligation of making the Land capability study as a segment of spatial basis. Land capability study projects are being implemented by the Institute of Soil, Agro chemistry and Melioration (PAM) of the Faculty of Agricultural and Food Sciences University of Sarajevo. Main objectives of these studies are to prepare thematic databases and maps and to explore and analyze land resources of certain municipality by using Geographic Information system and remote sensing source of information (satellite images and ortho-photos). Based on this database, the further objective is to determine the distribution of different land use types, as well as to perform valorization of soil through its quality (bonity) categories and analysis of pedological characteristics of the present soil types. By using defined soil bonity categories, land capability study defines the natural potential of soils in terms of agricultural production and food production, bio production in forestry and defines the zones for various land use types. From the rational land use point of view, it means adequate spatial planning, urban development and environmental protection. This paper aims to present the importance, characteristics as well as use of the Land capability study at the municipality level using municipalities of Tuzla Canton as example.

**Key words:** *land capability, land protection, spatial planning, agro-ecological zoning*

# STUDIJA I KARTA UPOTREBNE VRIJEDNOSTI ZEMLJIŠTA U FUNKCIJI NJEGOVE ZAŠTITE, PROSTORNOG PLANIRANJA I AGRO-EKOLOŠKOG ZONIRANJA

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## Sažetak

Primarna uloga zemljišta je proizvodnja hrane i sirovina, ali zemljište se koristi i za druge namjene. Kako se društvo razvija tako se povećavaju potrebe za hranom, sirovinama, ali i za izgradnjom naselja, infrastrukture i sl. što dovodi do lošeg položaja ovog resursa u sveukupnom razvoju, u kontekstu njegove upotrebe u nepoljoprivredne svrhe. Kako bi se sagledala vrijednost zemljišta sa gledišta različitih sektora i njihovih potreba (urbanizam, poljoprivreda i sl.), Uredbom o jedinstvenoj metodologiji za izradu planskih dokumenata (Sl. novine Federacije BiH, br. 63/04 i br. 50/07) u Federaciji BiH propisana je obaveza izrade Studije upotrebne vrijednosti zemljišta, kao segmenta Prostorne osnove. Projekte izrade Studije upotrebne vrijednosti zemljišta sprovodi Institut za pedologiju, agrohemiju i melioracije (PAM) Poljoprivredno-prehrambenog fakulteta Univerziteta u Sarajevu. Glavni zadatak ove Studije je da pripremi tematske baze i karte, te istraži i analizira prostor neke općine koristeći Geografski informacijski sistem i *remote sensing* izvore informacija (satelitski i ortofoto snimci), te da na bazi istog utvrdi bilanse načina korištenja zemljišnog prostora i izvrši valorizaciju kroz bonitetnu vrijednost, te analizu pedoloških karakteristika tipova tla. Kartom upotrebne vrijednosti zemljišta definišu se prirodne potencijalne vrijednosti zemljišta (bonitetne kategorije) sa aspekta poljoprivredne proizvodnje, odnosno proizvodnje hrane, te bioprodukcije u šumarstvu i zone za različite načine korištenja prostora. Sa stanovišta racionalnog korištenja zemljišta to znači svrsishodno prostorno planiranje, urbanu izgradnju i zaštitu životne sredine. Ovaj rad ima za cilj da prikaže značaj, karakteristike i upotrebnu vrijednost Studije i karte na općinskom nivou, kroz primjere općina Tuzlanskog kantona.

**Ključne riječi:** *upotrebna vrijednost zemljišta, zaštita zemljišta, prostorno planiranje, agro-ekološko zoniranje*

# THE AGRICULTURAL LAND SUITABILITY AND AGROECOLOGICAL ZONING AS THE MAIN FACTORS FOR RURAL SPATIAL PLANNING IN KOSOVO

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## Abstract

According to MAFRD data (2012), Kosovo is characterised as a rural region with approximately 60% of the population living in rural areas with an approximated 35% of the entire labour force involved with farming activities. Therefore, agriculture represents a key strategic sector for employment and economic activity. Compared to the 1990s, agricultural production has increased in the third millennium with a governmental commitment to improve the overall agricultural development. Currently in Kosovo a land categorization system is used, which is based on the soil analysis undertaken fifty years ago and it was primarily used for the visual mapping of land use for land taxation purposes. It was based on the basic principle that a specific land use type is associated with a particular land quality class. Land suitability categorization and the agro-ecological zoning are of basic importance in decision making for justified developments in many policy areas including agriculture and spatial planning. Kosovo has good quality soils, which could be the foundation for a thriving agricultural industry that could sustain a major impact on the country's GDP. However, because of the lack of spatial planning documents related to rural zones, prime agricultural land was used for other purposes and construction that resulted in an immense loss of arable land. This paper is intended to describe the role of the land suitability categorization and the agro-ecological zoning in the rural spatial planning process in Kosovo. The main objective of the proposed paper is to identify the relationship between land suitability categorizations, the agro-ecological zoning and land tenure on rural spatial planning and environmental impact in Kosovo. The paper also aims to ensure widespread awareness among all stakeholders on the prevailing challenges of resource rural spatial planning and on the importance of participatory and interactive intervention process for the rural land sustainable management. A systems approach is used to describe land suitability categorization and agro-ecological zoning in Kosovo, addressing the complex and dynamic nature of the relationships among the subject matter areas.

**Key words:** *land suitability, Agro-ecological zoning, rural spatial planning, Kosovo*

# POGODNOST POLJOPRIVREDNOG ZEMLJIŠTA I AGRO-EKOLOŠKO ZONIRANJE KAO GLAVNI FAKTORI PROSTORNOG UREĐENJA RURALNIH PODRUČJA NA KOSOVU

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## Sažetak

Tlo je važan neobnovljiv resurs od vitalnog značaja za život čovjeka. Ono utječe na biodiverzitet, kvalitet zraka i vode, sigurnosti hrane, kulturno nasljeđe i stanje okoliša. Odgovarajuće naučne informacije su presudne za održivo upravljanje tлом na lokalnom, nacionalnom i regionalnom nivou. Prema podacima MPPRR (2012), Kosovo spada u regije gdje približno 60% stanovništva živi u ruralnom područjima i gdje je približno 35% ukupne radne snage uključeno u poljoprivredne djelatnosti. Dakle, poljoprivreda predstavlja ključni strateški sektor za zapošljavanje i privredu. U odnosu na 1990-e, poljoprivredna proizvodnja je u trećem mileniju porasla zahvaljujući opredijeljenosti vlasti za razvoj ovog sektora. Trenutno se na Kosovu koristi sistem za kategorizaciju zemljišta, zasnovan na analizi tla urađenoj prije pedeset godina, koji se prvenstveno koristio za vizuelno kartografisanje namjene zemljišta radi utvrđivanja poreza. Ovaj sistem temeljio se na osnovnom principu da se određena vrsta namjene zemljišta veže za određenu klasu kvalitete zemljišta. Kategorizacija pogodnosti zemljišta i agro-ekološko zoniranje su od temeljne važnosti u donošenju odluka za opravdana kretanja u mnogim područjima politike, uključujući poljoprivredu i prostorno planiranje. Kosovo ima kvalitetna tla koja bi mogla biti osnov za uspješnu poljoprivrednu industriju koja bi mogla izvršiti veliki uticaj na BDP zemlje. Zbog nedostatka plana prostornog uređenja za ruralna područja, najbolje poljoprivredno zemljište se gubi. Rad ima za cilj da opiše ulogu kategorizacije zemljišta i agro-ekološkog zoniranja u procesu prostornog uređenja ruralnih područja, te da utvrdi odnos između kategorizacije pogodnosti zemljišta, agro-ekološkog zoniranja i zakupa zemljišta na Kosovu. Također, cilj je podizanje svijesti među svim zainteresiranim stranama o preovlađujućim izazovima ruralnog prostornog uređenja, i važnosti participativne i interaktivne intervencije za održivo upravljanje.

**Ključne riječi:** *pogodnost zemljišta, agro-ekološko zoniranje, ruralno prostorno planiranje, Kosovo*

## COPPER CONTENT IN VINEYARD SOILS OF CENTRAL SERBIA CAUSED BY COPPER BASED FUNGICIDES APPLICATION

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### Abstract

Soils where grapevines are grown are especially threatened by copper accumulation due to long-term and intensive application of copper-based pesticides. The aim of this study was general assessment of soil copper contamination in vineyards of central Serbia. The soil samples were taken from individual vineyards, from two depths: 0-30 and 30-60 cm. The total of investigated area was 88 ha. At the same time, at each site, control samples were collected from a nearby forest in order to determine the background concentrations. The pseudototal ( $Cu_T$ ) and available ( $Cu_{EDTA}$ ) copper content were analysed in 196 soil samples in total, 130 of which represented vineyard soils and 66 control samples. The maximum value of copper was 226.2 mg/kg of  $Cu_T$  and 108.4 mg/kg of  $Cu_{EDTA}$ . Comparison of the copper content in vineyards to the background concentrations of control samples clearly confirmed anthropogenic influence. Out of total studied vineyard area (88 ha), 23 ha or 26% had the  $Cu_T$  concentration above the critical level of 60 mg/kg, while 8 ha or 9% of areas had  $Cu_T$  content over the MAC of 100 mg/kg. Anthropogenic influence was also confirmed on the basis of copper bioavailability and copper distribution along the soil profile. Available content of over phytotoxic level of 50 mg/kg was found in 16 ha or 18% of areas. According to the percentage contribution of available to pseudototal  $Cu_{EDTA/T}$ , 30 ha or 34% of areas were above 36%  $Cu_{EDTA/T}$ , which is potentially phytotoxic. The concentration of copper was the highest in the surface layer in the vineyard soil samples. A check of the background Cu levels has shown that the distribution of  $Cu_T$  and  $Cu_{EDTA}$  is uniform throughout the soil profile. Since copper at the surveyed sites is very persistent and accumulates in a short period of time, focus should be placed on the preventive measures of reducing the use of copper-based fungicides to an optimal level.

**Key words:** *copper, soil, vineyards*

# SADRŽAJ BAKRA U ZEMLJIŠTIMA VINOGRADA UŽE SRBIJE KAO POSLEDICA PRIMENE FUNGICIDA NA BAZI BAKRA

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## Sažetak

Zemljišta na kojima se gaji vinova loza su posebno ugrožena akumulacijom bakra usled dugotrajne i intenzivne primene pesticida na bazi bakra. Cilj ovog rada je globalna procena zagađenja zemljišta bakrom u vinogradima uže Srbije. Uzorci zemljišta su uzimani od individualnih proizvođača, sa dve dubine: 0-30 i 30-60 cm. Ukupna analizirana površina je iznosila 88 ha. U isto vreme, za svaki lokalitet, uzeti su uzorci kontrole iz obližnjih šuma u cilju određivanja prirodnih-fonskih koncentracija. Pseudokupni ( $Cu_T$ ) i pristupačni ( $Cu_{EDTA}$ ) sadržaj bakra je određen u ukupno 196 uzoraka zemljišta, od toga 130 uzoraka predstavlja zemljište vinograda, a 66 uzoraka predstavlja kontrole. Maksimalna vredost bakra u istraživanju iznosi 226,2 mg/kg za  $Cu_T$  i 108,4 mg/kg za  $Cu_{EDTA}$ . Poređenjem sadržaja bakra u zemljištu vinograda sa relevantnim kontrolama, jasno je potvrđen antropogeni uticaj. Od ukupne posmatrane površine pod vinogradima koja je iznosila 88 ha, čak 23 ha ili 26% analiziranih površina ima sadržaj  $Cu_T$  iznad kritičnog nivoa od 60 mg/kg. 8 ha ili 9% površina ima  $Cu_T$  sadržaj preko MDK od 100 mg/kg. Antropogeni uticaj je, takođe, potvrđen na osnovu pristupačnosti bakra i distribucije bakra kroz zemljišni profil. Pristupačni sadržaj bakra preko fitotoksičnog nivoa od 50 mg/kg je zabeležen na 16 ha ili 18% površina. Na osnovu procentualnog udela pristupačnog sadržaja u pseudokupnom  $Cu_{EDTA/T}$ , 30 ha ili 34% površina je iznad 36%  $Cu_{EDTA/T}$ , što se smatra kao potencijalno fitotoksična granica. Koncentracija bakra je najveća u površinskom sloju zemljišta u uzorcima zemljišta iz vinograda. U zemljištima kontrola, koncentracija  $Cu_T$  i  $Cu_{EDTA}$  je potpuno uniformna kroz zemljišni profil. Budući da se bakar u zemljištu zadržava veoma dugo, a akumulira za kratak period, pažnju treba usmeriti ka preventivnim merama racionalizacije primene fungicida na bazi bakra.

**Ključne riječi:** *bakar, zemljište, vinograd*

## STEELMAKING SLAG AS A MEANS FOR CORRECTING SOIL ACIDITY IN AGRICULTURE

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### Abstract

Since the management of waste without disposing has become one of the national priorities, and the quantity of the steelmaking slag from carbon steel production process (EAF slag and LF slag) in Croatia (RH) and Bosnia and Herzegovina (BiH) have a growing trend, intensified researches for the possibilities of reuse of these valuable production residues, still called industrial waste, for use in the different branches of activity are conducted. After finishing studies of slag usability in road construction, the study continued on the usability of the fine fraction (<1 mm) in agriculture with purpose to regulate acid soils. Problem of excessive acidity is limiting factor that largely determines the efficiency of plant cultivation in the acidic agricultural soils in RH and BiH, application of appropriate materials, as a complete resolution of the problem for agricultural soils, is one of the key issue. Together with the most important factors, when choosing a means for the correcting soil acidity in practice, together with the physicochemical characteristics, and its price, is to find cheaper solutions, but also a new way for taking care of these production residues/wastes/by-products. In this work usability of the steel slag as means for the correcting soil acidity in agriculture were investigated. The presented results were obtained by scanning electron microanalysis (SEM), energy dispersion X-ray spectroscopy (EDXRF), X-ray diffraction analysis of X-rays (XRDA), atomic absorption spectrometry (AAS), inductively coupled plasma atomic emission spectroscopy (ICP-AAS) and gamma spectrometry.

**Key words:** *electric arc furnace slag, ladle furnace slag, waste, soil acidity*

## ČELIČNA ŠLJAKA KAO SREDSTVO ZA KOREKCIJU KISELOSTI TLA U POLJOPRIVREDI

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### Sažetak

Budući da je upravljanje otpadom bez odlaganja postalo jednim od nacionalnih prioriteta, te da količina šljake iz procesa proizvodnje ugljičnog čelika (šljaka iz elektrolučnih peći i šljaka iz ljevačkih peći) u Hrvatskoj (RH) i Bosni i Hercegovini (BiH) ima rastući trend, počela su se provoditi intenzivna istraživanja mogućnosti ponovnog korištenja ovih vrijednih ostataka iz proizvodnje, koji se još uvijek nazivaju industrijskim otpadom, u različitim privrednim granama. Nakon završetka ispitivanja upotrebljivosti šljake u cestogradnji, nastavilo se sa ispitivanjem upotrebljivosti fine frakcije (<1 mm) u poljoprivredi s ciljem reguliranja kiselih zemljišta. Problem prekomjerne kiselosti je ograničavajući faktor koji uveliko određuje efikasnost uzgoja biljaka na kiselim poljoprivrednim zemljištima u RH i BiH, primjena odgovarajućih materijala kao cjelovito rješenje problema poljoprivrednih zemljišta, jedno je od ključnih pitanja. Prilikom izbora sredstva za korigovanje kiselosti tla u praksi, uz najvažnije faktore, kao što su fizičko-hemijske osobine i cijena, potrebno je iznaći jeftinija rješenja, ali i nove načine za brigu o ovim proizvodnim ostacima/otpadu/nusproizvodima. U ovom radu ispitivana je upotrebljivost čelične šljake kao sredstva za korigovanje kiselosti tla u poljoprivredi. Prikazani rezultati dobiveni su pomoću skenirajuće elektronske mikroanalize (SEM), spektroskopije energetske disperzije rentgenskih zraka (EDXRF), rentgenske difrakcijske analize X-zraka (XRDA), atomske apsorpcijske spektrometrije (AAS), atomske emisijske spektroskopije sa induktivno spregnutom plazmom (ICP-AAS) i gama spektrometrije.

**Ključne riječi:** *šljaka iz elektrolučnih peći, šljaka iz ljevačkih peći, otpad, kiselost tla*

# RESPONSE OF MAIZE (*ZEA MAYS* L.) TO FARMYARD MANURE AND GYPSUM TREATED SALINE SODIC SOILS IN BAILIE DISTRICT, EASTERN ETHIOPIA

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## Abstract

A greenhouse experiment was conducted during October-December, 2012 to evaluate the efficiency of selected treatment combinations of FYM, gypsum and pore volume (PV) of leaching water on growth parameters (number of leaves, plant height, leaf area, fresh and dry biomass) of maize crop. Treatments included the combinations of two rates (0 and 20 t ha<sup>-1</sup>) of FYM, four rates of gypsum (0, 50, 75 and 100% gypsum requirement, GR) and three (1.0, 2.0 and 3.0) PV of leaching water arranged in CRD with three replications. The results indicated that growth parameters of maize showed significant ( $p < 0.05$ ) response to combined application of treatments (FYM, gypsum and PV of water). Maximum growth parameters were observed in the plots that received 20 t FYM ha<sup>-1</sup> + 100% GR + 3.0 PV of water compared to other combinations. Results also indicated that increasing the GR by 25% showed consistent improvement in crop growth parameters across each PV of leaching water. On the other hand, analysis of the post harvest soil revealed that FYM + gypsum sown treatments significantly reduced the soil pH, ECe and SAR over sole application of treatments. However, significantly ( $p < 0.01$ ) higher decrease over the control in pH (7.5%), ECe (23.5%) and SAR (10.0%) were recorded in the combined application of 20 t FYM ha<sup>-1</sup> + 100% GR + 3.0 PV of water. This combination is deemed suitable for improving soil properties to agriculturally permissible limits and for optimal maize crop production. Hence, this combination can be recommended for the production of economically optimal maize crop production in saline sodic soil of Babile low lands.

**Key words:** *biomass, FYM, growth parameters, gypsum requirement*

# REAKCIJA KUKURUZA (*ZEAMAYS L.*) NA STAJSKO GNOJIVO I GIPSOM TRETIRANA ZASLANJENA TLA U OKRUGU BAILIE, ISTOČNA ETIOPIJA

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## Sažetak

U periodu oktobar-decembar 2012. godine proveden je staklenički eksperiment za ocjenu učinkovitosti odabranih kombinacija tretiranja stajnjakom, gipsom i zapremine pora (PV) istisnute vodena parametre rasta (broj listova, visina stabljike, površina lista, svježa i suha biomasa) kukuruznih usjeva. Tretmani su obuhvatili kombinacije dvije stope (0 i 20 t ha<sup>-1</sup>) stajnjaka, četiri stope gipsa (0, 50, 75 i 100% potreba za gipsom, GR) i tri (1,0, 2,0 i 3,0) PV istisnute vode postavljene u potpuno nasumični raspored (CDR) sa tri ponavljanja. Rezultati su pokazali da parametri rasta daju značajnu ( $p < 0,05$ ) reakciju na kombiniranu primjenu tretmana (stajnjak, gips i zapremina pora vode). Maksimalni parametri rasta uočeni su na parcelama koje su tretirane sa 20 t FYM ha<sup>-1</sup> + 100% GR + 3,0 PV vode u poređenju s ostalim kombinacijama. Rezultati su, također, pokazali da povećanje GR za 25% daje konzistentno poboljšanje parametara rasta usjeva za sve PV istisnute vode. S druge strane, analiza tla nakon žetve otkrila je da tretmani stajnjak + gips značajno smanjuju pH, ECe i SAR u odnosu na primjenu samo jednog tretmana. Međutim, značajno ( $p < 0,01$ ) veće smanjenje nad kontrolom pH (7,5%), ECe (23,5%) i SAR (10,0%) zabilježeno je kod kombinirane primjene 20 t FYM ha<sup>-1</sup> + 100% GR + 3,0 PV vode. Ova kombinacija se smatra pogodnom za poboljšavanje osobina tla do poljoprivredno dopuštenih granica, kao i za optimalnu proizvodnju kukuruznih usjeva. Dakle, ova kombinacija se može preporučiti za ekonomski optimalnu proizvodnju kukuruznih usjeva za zaslanjenim tlima ravničarskih predjela Babile.

**Ključne riječi:** *biomasa, stajnjak, parametri rasta, potrebe za gipsom*

## CHARACTERISTICS OF SOILS UNDER CHESTNUT FORESTS (*CASTANEA SATIVA*) IN THE BOSNIA AND HERZEGOVINA

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### Abstract

In the context of gene-environment, studies within and among population-diversity forest of chestnut (*Castanea sativa* Miller) in the different localities of Bosnia and Herzegovina, were carried out and detailed analysis of morphological and physico-chemical properties of the soil. We analyzed the soil at 6 sample plots within researched localities of that are, at the same time, determined by climatic and geological parameters. The climate is humid, the average annual temperature in the range of 9.6 to 10.8 ° C, an average annual rainfall of 848-1449 mm. The geological substrate is a silicate, or it consists mainly of chert, sandstone, shales and slates. According to the classification Škorić et al., (1985), we identified the following types of land: Dystric Cambisol, Eutric Cambisol, Illimerized soil LUVICand Ranker. Active acidity of the analyzed soil types is different. The highest acidity had Ranker (4.22- 4.30 pH) which makes it extremely acidic, and the lowest Eutric Cambisol - from 5.96 to 6.46 pH, which is slightly acidic. Plots contained a lot of humus or compost which reflected on the characteristics of the adsorption complex. The level of base saturation is low and does not exceed 50% in case of Ranker, this value is zero. The share of nitrogen and potassium is good, while the phosphorus is in deficit. The texture is mainly loam, and in Luvisol clay content increases in the deeper part of the profile. Good pedo-ecological conditions for the development of chestnuts provide all types of examined soils except Rankers which is due to the low depth, extreme acidity and very poor adsorption complex the least suitable for this species. Identified pedological characteristics of the analyzed sites under natural forests of chestnuts, despite the fact that they part of environmental attributes of species, are very significant in and multidisciplinary studies of gene-ecological potential *Castanea sativa* as the basis for silviculture and plant breeding.

**Key words:** *Castanea sativa*, soil types, plant breeding

## KARAKTERISTIKE ZEMLJIŠTA KESTENOVIH ŠUMA (*CASTANEA SATIVA*) U BOSNI I HERCEGOVINI

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### Sažetak

U okviru gen-ekoloških proučavanja unutar i među populacionog diverziteta šuma pitomog kestena (*Castanea sativa* Miller) u na različitim lokalitetima Bosne i Hercegovine, obavljene su i detaljne analize morfoloških i fizičko-hemijskih osobina zemljišta. Analizirana su zemljišta na 6 primjernih površina u okviru izdvojenih lokaliteta za koje su istovremeno utvrđeni klimatski i geološki parametri. Klima ima humidan karakter, gdje je prosječna godišnja temperatura u intervalu od 9,6-10,8°C, a prosječna godišnja količina padavina od 848-1.449 mm. Geološka podloga je silikatna, odnosno nju uglavnom čine rožnjak, pješčar, glinci i argilošisti. Prema klasifikaciji Škorić et al., (1985), izdvojeni su sljedeći tipovi zemljišta: Distrični kambisol, Eutrični kambisol, ilimerizirano zemljište i Ranker. Aktivna kiselost analiziranih tipova zemljišta je različita. Najveću kiselost ima Ranker (4,22-4,30 pH jedinica) što ga čini ekstremno kiselim, a najmanju Eutrični kambisol (5,96 - 6,46 pH jedinica) koji je slabo kiseo. Zemljišta su dosta humozna, ali je karakter humusa različit što se odrazilo i na obilježja adsorptivnog kompleksa. Stepenn zasićenosti bazama je nizak i ne prelazi 50%; kod Rankera ova vrijednost je jednaka nuli. Obezbijedenost azotom i kalijumom je dobra, dok je fosfor deficitaran. Tekstura je uglavnom ilovasta, a kod Luvisola sadržaj gline raste u dubljim partijama profila. Dobre pedoekološke uslove za razvoj kestena obezbjeđuju svi tipovi osim Rankera koji je usljed male dubine, ekstremne kiselosti i veoma siromašnog adsorptivnog kompleksa najmanje pogodan za ovu vrstu drveća. Utvrđene pedološke karakteristike na analiziranim lokalitetima prirodnih šumama kestena, pored toga što su prilog ekološkim odlikama vrste, veoma su značajne u i multitisciplinarnim proučavanjima gen-ekološkog potencijala *Castanea sativa* kao osnove budućeg usmerenog gajenja i oplemenjivanja vrste.

**Ključne riječi:** *Castanea sativa*, tipovi zemljišta, oplemenjivanje



**POSTER PRESENTATIONS**

***POSTER PREZENTACIJE***

## POTENTIALITY OF AGRICULTURAL LAND IN HERCEGOVINA-NERETVA COUNTY FOR CULTIVATION OF SOME FRUIT SPECIES

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### Abstract

This paper presents the evaluation of benefits of the agricultural land for the cultivation of cherry, sour cherry, plum and apple in the area of Hercegovina-Neretva County. The evaluation of the land suitability was carried out according to the FAO method (FAO, 1976), according to the agro zone (up to 800 m above sea level) and taking into account the features of the soil, climate and topography and the requirements of these fruit cultures. Results are shown with text and graphics (maps of the agricultural land benefits). Based on the conducted research the existence of significant and valuable land resources for development of fruit cultivation in Hercegovina-Neretva county was established. For the cherry and sour cherry cultivation in the agricultural area of Hercegovina-Neretva county (up to 800 m above sea level) exists 29,682 hectares (28.55%) of suitable land, for the plum cultivation exists 38,952 hectares (37.47%) and for the apple cultivation exists 38,345 hectares (36.89%). In the class structure of the soil for the cherry, sour cherry, plum and apple is the smallest share of the P-1 class benefits. Major proportion of the land P-3 class benefits for growing cherries, apples and cherries and benefits in the soil for growing cherries have less difference between the surfaces of the P-2 and P-3 class suitability. It is significant to point out that most of land has P-2 class suitability for plums cultivation. The main limitations were the slope, the depth of profile, rockiness and stoniness. Temporarily unsuitable land occupied significant area for these fruit species cultivation. Plots of this class can be with adequate, economically justified measures led to a certain class of convenience.

**Key words:** *agricultural land, facility, cherry, sour cherry, climate, relief*

# POGODNOST POLJOPRIVREDNOG ZEMLJIŠTA HERCEGOVAČKO-NERETVANSKE ŽUPANIJE ZA UZGOJ NEKIH VOĆNIH VRSTA

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## Sažetak

U ovom radu je prikazana procjena pogodnosti poljoprivrednog zemljišta za uzgoj trešnje, višnje, šljive i jabuke na području Hercegovačko-neretvanske županije (HNŽ). Procjena pogodnosti zemljišta izvršena je prema FAO metodi (FAO, 1976), po agrozonama (do 800 m nadmorske visine), uvažavajući pored značajki tla, klime i reljefa, i zahtjeve ovih voćnih kultura. Rezultati istraživanja prikazani su tekstualno i grafički (karte pogodnosti). Temeljem provedenih istraživanja utvrđeno je postojanje značajnih i vrijednih zemljišnih resursa za razvoj voćarske proizvodnje na području Hercegovačko-neretvanske županije. Za uzgoj trešnje i višnje na području poljoprivrednog zemljišta HNŽ-a (do 800 m n.v.) nalazi se 29.682 ha (28,55%) pogodnog zemljišta, za uzgoj šljive 38.952 ha (37,47%), a za uzgoj jabuke 38.345 ha (36,89%). U okviru reda pogodnih zemljišta za uzgoj trešnje, višnje, šljive i jabuke, najmanji je udio površina zemljišta P-1 klase pogodnosti. Najveći udio zemljišta P-3 klase pogodnosti je za uzgoj trešnje, višnje i jabuke, s tim da je kod pogodnosti zemljišta za uzgoj višnje nešto manja razlika u površinama između P-2 i P-3 klase pogodnosti. Značajno je istaknuti da je za uzgoj šljive najveći udio zemljišta P-2 klase pogodnosti. Glavna ograničenja zemljišta za uzgoj voćnih vrsta su nagib terena, dubina profila, stjenovitost i kamenitost. Znatne površine zauzimaju i privremeno nepogodna zemljišta za uzgoj spomenutih voćnih vrsta, a koja se mogu adekvatnim, ekonomski opravdanim mjerama dovesti do određene klase (stupnja) pogodnosti.

**Ključne riječi:** *poljoprivredno zemljište, pogodnost, trešnja, višnja, klima, reljef*

## WHOLE FARM NITROGEN BALANCE ON BROILER FARMS IN CENTRAL BOSNIA REGION

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### Abstract

At livestock farms most part of nitrogen arrives as purchased products (fertilizer, animal feed and purchased animals). Within the boundaries of the farm, nitrogen recycles between the livestock and crop components. Finally, nitrogen exit a livestock operation unit preferably as managed outputs (meat, crops and manure) sold off the farm. Difference between the inputs and the managed outputs represents a nitrogen balance that can be an indicator of environmentally sustainable production. Nitrogen (in)balance consider only amount of the nutrient that cross the border of the farm. In ideal conditions the nitrogen input/output ratio should be 1: 1. Some nitrogen exits the farm as losses to the environment (nitrates in groundwater, ammonia volatilized into the atmosphere, and nitrogen into groundwater and surface water). A study was conducted on five small poultry farm in order to determine whole farm nitrogen balance as difference between total nitrogen inputs (one day chickens, litter, animal feed) and outputs (meat, dead animals and manure). Selected farms differ according to capacity (ranging from 5,000 to 40,000 birds), producers of poultry feed, type and length of manure storage as well as other sensible farming practice which could influence on nitrogen balance. Collection of data on all farms is done using a questionnaire. Nitrogen content in all substrates (feed, manure, litter) was determinate by Kjeldahl procedure. The results of the whole farm nitrogen balance with the recommendations of its balancing in order to reduce the negative environmental implications are presented in the paper.

**Key words:** *whole farm nitrogen balance, broiler farms*

## BILANS AZOTA NA FARMAMA ZA TOV PILIĆA NA PODRUČJU ZENIČKO-DOBOJSKOG KANTONA

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### Sažetak

Najveći dio azota importuje se na farme domaćih životinja putem kupljenih đubriva, životinja i hrane za životinje. Na samoj farmi odvija se reciklaža azota između životinja i biljaka kroz stajnjak i uzgoj ratarskih i krmnih kultura. Azot napušta farmu u vidu prodanih životinjskih i biljnih proizvoda i prodanog stajnjaka. Razlika između unijete količine azota na farmu i količine azota koja je iznijeta sa farme predstavlja bilans azota koji može biti indikator ekološki održive proizvodnje. U idealnim uslovima input azota na farmu bi trebao biti izjednačen sa outputom azota, odnosno omjer input/output bi trebao biti 1:1. Na samoj farmi određeni dio azota se gubi u obliku amonijaka u atmosferu, ili u obliku nitrata u podzemnim i površinskim vodama i zemljištu. Istraživanje je provedeno na pet farmi za tov pilića u cilju utvrđivanja bilansa azota kao razlike ukupnih inputa (kupljeni jednodnevni pilići, prostirka i hrana za piliće) i ukupnih outputa (prodani pilići/meso, prodani stajnjak i uginuli pilići). Odabrane farme razlikovale su se po broju pilića (5.000 do 40.000 ptica), hrani za piliće, načinu spremanja i dužini čuvanja stajnjaka, kao i nekim osjetljivijim proizvodnim praksama koje mogu imati uticaj na bilans azota. Podaci o farmama i proizvodnji prikupljeni su putem ankete. Sadržaj azota u hrani za piliće, stajnjaku i prostirci utvrđen je Kjeldahl metodom. U radu je prezentiran ukupan bilans azota na farmama sa preporukama za njegovo poboljšanje u cilju smanjenja negativnog uticaja peradarske proizvodnje na okoliš.

**Ključne riječi:** *bilans azota na farmama, farme brojlera*

## SOIL LOSS ESTIMATION USING THE IntErO MODEL IN THE S1-2 WATERSHED OF THE SHIRINDAREH RIVER BASIN, IRAN

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### Abstract

Soil erosion is one of the main problems of land degradation of agricultural land, especially in the mountainous areas. This negative process is one of the key problems to the environment and water resources in Iran. Using the computer-graphic modelling, we calculated sediment yield and peak discharge of the S1-2 catchment, of the Shirin-Dareh Basin of the Caspian Sea watershed. The area characterized cold winters (the minimum of 24.4°C) and warm, dry summers (the absolute maximum air temperature of 34.6°C; the average annual precipitation of 328 mm). The coefficient of the region's permeability, S1, is calculated on 0.84. The structure of the river basin, according to water permeability, is the following: f0, poor water permeability rocks, 53%; fpp, medium permeable rocks, 41%; fp, very permeable products from rocks: 6%. The most common soil type in the studied area is Inceptisols with Calcic horizon. The river basin is under the mountain pastures (51%) and the rest (49%) is the ground without grass vegetation and plough-lands. The coefficient of the river basin planning is calculated on 0.75. The coefficient of the vegetation cover is calculated on 0.9. We calculated the soil losses from the S1-2 catchment on 20,404 m<sup>3</sup> yr<sup>-1</sup> and the peak discharge on 209 m<sup>3</sup>s<sup>-1</sup> (for the incidence of 100 years). The value of the Z coefficient of 0.917 indicates that the river basin belongs to the second destruction category, where the strength of the erosion process is high. With this study we provided new information about the recent state of the sediment yield of the S1-2 catchment, of the Shirin-Dareh Basin in the North Khorasan province of Iran in formats that can simplify the management in the watersheds, demonstrating the possibility of Soil Loss Estimation using the IntErO Model.

**Key words:** *Soil erosion, IntErO Model, sediment yield, ShirinDareh watershed*

## PROCJENA GUBITKA TLA PRIMJENOM IntErO MODELA U SLIVU S1-2 SHIRINDAREH PORJEČJA, IRAN

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### Sažetak

Erozija tla je jedan od glavnih problema degradacije poljoprivrednog zemljišta, naročito u planinskim krajevima. Ovaj negativni proces jedan je od ključnih problema kad se radi o okolišu i vodnim resursima Irana. Primjenom kompjuterskog grafičkog modeliranja, izračunali smo prinos sedimenta i vršno pražnjenje sliva S1-2 Shirin-Dareh rječnog bazena u sklopu sliva Kaspijskog mora. Ovo područje karakterišu hladne zime (minimalna temperatura od 24,4°C) i topla, suha ljeta (apsolutni maksimum temperature zraka od 34,6°C; prosječna godišnja količina padavina iznosi 328 mm). Koeficijent propusnosti regije, S1, izračunat je na 0,84. Struktura porječja, prema vodopropusnosti, je sljedeća: f0, stijene slabe vodopropusnosti, 53%; fpp stijene srednje vodopropusnosti, 41%; fp vrlo vodopropusni produkti stijena, 6%. Najzastupljeniji tip tla u ispitivanom području su inceptisoli sa kalcijumskim horizonstom. Slivno područje je pod planinskim pašnjacima (51%) a preostali dio (49%) čini zemljište bez travnate vegetacije i oranice. Koeficijent planiranja slivnog područja izračunat je na 0,75. Izračunati koeficijent vegetacijskog pokrivača iznosi 0,9. Izračunali smo gubitke tla iz S1-2 sliva koji iznose 20.404 m<sup>3</sup>yr<sup>-1</sup> i vršno pražnjenje od 209 m<sup>3</sup>s<sup>-1</sup> (za period učestanosti od 100 godina). Visina koeficijenta Z od 0,917 ukazuje na to da slivno područje pripada drugoj kategoriji destrukcije, gdje je snaga erozivnog procesa velika. Ovim istraživanjem dali smo nove informacije o nedavnom stanju prinosa sedimenta sliva S1-2 slivnog područja Shirin-Dareh u iranskoj pokrajini Sjeverni Khorasan u formatima koji mogu pojednostaviti upravljanje u slivovima, te pokazali mogućnost procjene gubitka tla korištenjem IntErO modela.

**Ključne riječi:** *erozija tla, IntErO model, prinos sedimenta, ShirinDareh slivno područje*

## CALCULATION OF SEDIMENT YIELD USING THE IntErO MODEL IN THE S1-3 WATERSHED OF THE SHIRINDAREH RIVER BASIN, IRAN

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### Abstract

Soil erosion is a natural process caused generally by the force of water (running water and raindrops) or wind. The process involves not only the detachment of soil particles (on-site), but also their transfer and deposition elsewhere in the river basin and out of the catchment (off-site). The assessment of soil erosion may be performed using and analyzing measurements data (sediment discharge series and soil erosion measurements) or applying various analytical models. It is well known fact that the measurements results are available only in a few experimental catchments in most of the countries all over the World and as a consequence the researchers are frequently using the analytical models. For calculation of the Sediment yield in the S1-3 Watershed of Iran we used the IntErO model (Spalevic, 2011) based on the EPM method (Gavrilovic, 1972). Calculated peak discharge from the S1-3 Watershed was  $87 \text{ m}^3\text{s}^{-1}$  for the incidence of 100 years and the net soil loss was  $5,574 \text{ m}^3\text{km}^{-2}$ , specific  $194 \text{ m}^3 \text{ km}^{-2}$  per year. Taking into consideration the results of this study and previous experiences of the other researchers, it was concluded that the IntErO Model may be applied to the other regions similar to Shirindareh watershed for calculation of sediment yield and identification of critical areas in watersheds.

**Key words:** *Sediment yield, IntErO Model, EPM method, River Basin*

## IZRAČUNAVANJE PRINOSA SEDIMENTA, PRIMJENOM IntErO MODELA U SLIVU S1-3 SHIRINDAREH PORJEČJA, IRAN

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### Sažetak

Erozija tla je prirodan proces uzrokovan uglavnom snagom vode (efekat vode koja teče i kapi kiše) ili vjetra. Proces obuhvata ne samo odvajanje čestica tla (on-site), već i njihovo prenošenje i taloženje na nekom drugom mjestu u rječnom slivu (off-site). Procjena erozije tla se može uraditi korištenjem i analizom mjernih podataka (serije ispuštanja sedimenta i mjerenja erozije tla) ili primjenom različitih analitičkih modela. Dobro je poznata činjenica da su rezultati mjerenja dostupni u svega nekoliko eksperimentalnih slivova u većini zemalja svijeta, što za posljedicu ima to da istraživači često koriste analitičke modele. Za izračunavanje prinosa sedimenta u slivnom području S1-3 u Iranu, koristili smo IntErO model (Spalević, 2011) koji se zasniva na EPM metodi (Gavrilović, 1972). Vršno oticanje iz S1-3 sliva je iznosilo  $87 \text{ m}^3 \text{ s}^{-1}$  za učestanost od 100 godina, a neto gubitak tla  $5.574 \text{ m}^3 \text{ km}^{-2}$ , konkretnije  $194 \text{ m}^3 \text{ km}^{-2}$  godišnje. Uzimajući u obzir rezultate ovog istraživanja kao i prethodna iskustva drugih istraživača, zaključeno je da se IntErO model može primjenjivati i na druge regije slične slivnom području Shirindareh u svrhu izračunavanja prinosa sedimenta i identificiranja kritičnih oblasti u slivnim područjima.

**Ključne riječi:** *prinos sedimenta, IntErO model, EPM metoda, slivno područje*

## RELATIONS BETWEEN SOIL CHEMICAL PROPERTIES AND CADMIUM CONTENT IN GREEN MASS OF SILAGE MAIZE

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### Abstract

Cadmium content in soil is important factor which determine content of this heavy metal in plants. However, many other factors including soil pH, content of organic matter, other trace minerals in soil which could reduce or enhance cadmium uptake by roots of plants as well as anthropogenic routes of cadmium contamination (mining, superphosphates, industry) influence on cadmium concentrations in plant tissues. A three years study was conducted to evaluate cadmium content in green mass of silage maize in certain areas of Central Bosnia region. A multiple linear regression (MLR) model was developed to predict maize tissues cadmium concentration as function of different factors such soil cadmium content, pH of soil, organic matter in soil as well as phosphorus, potassium, zinc and iron content in soil. The results indicate huge variability of cadmium content in soil (maximum vs. minimum is more than 3 fold) and green mass of maize (maximum to minimum ratio greater than 100). Cadmium concentration in all investigated samples of maize was below maximum tolerable levels in ruminants nutrition. Using a stepwise multiple linear regression method, a significant model emerged ( $F_{2,14} = 55.193$   $p < 0.001$ ;  $R^2 = 0.887$ ). Significant variables were phosphorus (Beta = 0.813;  $p < 0.001$ ) and potassium (Beta = - 0.401;  $p < 0.005$ ) content in soil. Soil pH, organic matter, cadmium, zinc and iron were not significant in this model. Insignificance correlation between soil and plant cadmium content ( $r = 0.374$ ,  $P = 0.07$ ) is established indicates that the presence of cadmium in the soil may not be the main determinant of its content in plants.

**Key words:** *cadmium, soil chemical properties, silage maize, MLR*

## ODNOS IZMEĐU HEMIJSKIH OSOBINA TLA I SADRŽAJA KADMIJA U ZELENOJ MASI SILAŽNOG KUKURUZA

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### Sažetak

Važna odrednica stepena kontaminacije biljnog materija kadmijem jeste njegov sadržaj u tlu. Međutim, i mnoge druge hemijske karakteristike tla uključujući pH vrijednost, sadržaj organske materije, sadržaj nekih drugih mikroelemenata koji su u interakciji sa kadmijem prilikom njegovog usvajanja u korjenov sistem, te mogućnost kontaminacije različitim antropogenim izvorima (rudnici, fosforna đubriva, industrija) utiču na konačan sadržaj kadmija u biljnom materijalu. Provedeno je trogodišnje istraživanje sa ciljem utvrđivanja sadržaja kadmija u zelenoj masi kukuruza za siliranje na određenim područjima centralne Bosne. Primijenjen je model višestruke linearne regresijske (VLR) analize sadržaja kadmija u zelenoj masi kukuruza kao funkcije sadržaja kadmija u tlu, pH vrijednosti tla, sadržaja organske materije u tlu, te sadržaja fosfora, kalija, cinka i željeza u tlu. Rezultati ukazuju na značajnu varijabilnost sadržaja kadmija kako u tlu (odnos minimuma i maksimuma je više od 1:3), tako i u biljci kukuruza (minimum: maksimum odnos je više od 1:100), pri čemu je sadržaj kadmija u biljci kukuruza sa svih lokaliteta bio u okviru sigurnosne granice potencijalne toksičnosti u ishrani preživara. Pri ispitivanju izvora varijabilnosti sadržaja kadmija u biljci kukuruza ustanovljen je značajan stupanjski logistički regresioni model ( $F_{2,14} = 55,193$ ;  $p < 0,001$ ;  $R^2 = 0,887$ ). Na sadržaj kadmija u biljci kukuruza značajan uticaj su imali sadržaj fosfora (Beta = 0,813;  $p < 0,001$ ) i sadržaj kalija (Beta = - 0,401;  $p < 0,005$ ) u zemljištu. pH vrijednost zemljišta, sadržaj organske tvari, te sadržaj kadmija, cinka i željeza u zemljištu nisu imala signifikantan uticaj na sadržaj kadmija u biljci kukuruza. Statistički nesignifikantna korelacija je utvrđena između sadržaj kadmija u biljci i njegovog sadržaja u zemljištu ( $r = 0,374$ ,  $P = 0,07$ ) što ukazuje da prisustvo kadmija u tlu ne mora biti glavna odrednica njegovog sadržaja u biljkama.

**Ključne riječi:** *kadmij, hemijske osobine tla, silažni kukuruz, multipla regresija*

# INFLUENCE OF THE ANTHROPOGENIZATION ON THE SOIL PROPERTIES DEVELOPED ON SILICATE SUBSTRATES IN THE WESTERN PART OF BOSNIA AND HERZEGOVINA

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## Abstract

This paper analyzes the natural and anthropogenized soils on silicate substrates in the western part of Bosnia and Herzegovina. The aim of the research is to evaluate the impact of anthropogenization on these soils using a method of comparing physical and chemical properties. The research was conducted in 4 locations in Bosanska Krajina of the following soil types: Acidic brown soil on schist of mica, Šabići locality; Acidic brown soil on schist, Donja Lučka locality; Acidic brown soil on shales, Jusufovići locality; Acidic brown soil on sandstone, Baštra locality. In each of these land types, two profiles were opened; one on natural non-arable land and others on anthropogenic-arable land, while the samples were taken in the profile on the horizon. We analyzed the following indicators of soil quality: soil organic matter content, pH, content of available forms of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, analysis of soil adsorption complex by Kappen. The aim of the research is to determine the differences in the elements of soil fertility between anthropogenic and corresponding soils under natural forest or meadow. By comparing the sample results of the analysis from the horizons of natural and cultivated soils, it was concluded that the proper application of agro-technical measures and agro-ameliorative measurements generally did not cause negative effects on the properties of these soils, and often showed a positive impact.

**Key words:** *land use, anthropogenization, fertility*

# UTICAJ ANTROPOGENIZACIJE NA SVOJSTVA ZEMLJIŠTA RAZVIJENA NA SILIKATNIM SUPSTRATIMA PODRUČJA ZAPADNE BOSNE

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## Sažetak

U ovom radu su analizirana prirodna i antropogenizirana tla na silikatnim supstratima područja zapadne Bosne. Cilj provedenih istraživanja je metodom uspoređivanja fizičkih i hemijskih osobina procijeniti uticaj antropogenizacije na ovim tlima. Istraživanje je obavljeno na 4 lokaliteta u Bosanskoj krajini, na slijedećim tipovima tala: Kiselo smeđe tlo na liskunovitim škriljcima, lokalitet Šabići; Kiselo smeđe tlo na škriljcima, lokalitet Donja Lučka; Kiselo smeđe tlo na glinovitim škriljcima, lokalitet Jusufovići; Kiselo smeđe tlo na pješčaru, lokalitet Baštra. Na svakom od navedenih tipova zemljišta otvorena su po dva profila, jedan na prirodnom-neobrađivom tlu i drugi na antropogenom-obrađivom tlu, a uzimanje uzoraka vršeno je iz profila po horizontima. Analizirani su slijedeći indikatori kvaliteta tla: sadržaj organske materije tla, vrijednosti pH, sadržaj pristupačnih formi P<sub>2</sub>O<sub>5</sub> i K<sub>2</sub>O, analiza adsorptivnog kompleksa tla po Kappenu. Cilj istraživanja je utvrditi postoje li razlike u elementima plodnosti tla između antropogeniziranog i korenspodirajućeg tla pod prirodnom šumom ili livadom. Usporedbom rezultata analize uzoraka iz horizonata prirodnih i antropogeniziranih tala došlo se do zaključka da pravilna primjena agrotehničkih i agromeliorativnih mjera uglavnom nije izazvala negativne posljedice na svojstva ovih tala, a nerijetko su pokazala i pozitivan uticaj.

**Ključne riječi:** *način korištenja zemljišta, antropogenizacija, plodnost*

## THE TOTAL AND AVAILABLE CONCENTRATIONS OF MICRONUTRIENTS IN SOILS ON FARMS OF EASTERN CROATIA

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### Abstract

The research objective was to determine the influence of basic soil chemical properties on total concentration and available fractions of essential heavy metals in the soil. Agrochemical soil analyses were conducted at two localities of different soil properties Berak and Vinogradci in eastern Croatia. The soil at the site Berak was neutral (pH average (H<sub>2</sub>O) 6,38), while the soil in Vinogradci was slightly acid (average pH (H<sub>2</sub>O) 6,49). Both soils were poor in organic matter and well supplied with phosphorus and potassium. As expected, at both analyzed sites the highest average concentrations were determined for total Fe, Mn and Zn followed, and the lowest concentrations were for total Cu. Higher total concentrations of analyzed microelements were recorded at the Berak site. The total concentrations of Zn and Cu in all analyzed soil samples were below the maximum permissible concentrations. The highest average concentration of available microelements fraction by EDTA Extraction, were at the Berak site determined for Mn (50.52 mg/kg), then Fe (21.77 mg/kg), Cu (4.78 mg/kg), and the lowest for Zn (1.47 mg/kg). At the Vinogradci site average concentrations of available fraction of microelements determined by EDTA extraction were the highest for Fe (77.09 mg/kg), then Mn (30.75 mg/kg), Cu (4.36 mg/kg), and the lowest for Zn (1.76 mg/kg). Identical order of average concentrations at both sites was also recorded for extraction with DTPA solution. Comparing available fraction of microelements by localities, higher average concentrations of Mn and Cu were found at the site Berak, while on site Vinogradci higher average concentrations were of Fe and Zn. At both sites the DTPA method extracted more of Fe and Mn, an average of 56.94% and 11.84% more than the EDTA method, but the method EDTA extracted more Zn and Cu, an average of 119.48% and 101.71% than DTPA method. The smallest share of the available fraction of the total concentration was recorded for Fe (0.18% by EDTA and 0.23% by DTPA), followed by Mn (5.35% by EDTA and 5.91% by DTPA) and Zn (2.63% by EDTA and 1.20% by DTPA), while the largest share has the Cu (22.22% by EDTA and 11.04% by DTPA).

**Key words:** *microelements, total content, available fractions*

# UKUPNE I RASPOLOŽIVE KONCENTRACIJE MIKROELEMENATA U TLIMA POLJOPRIVREDNIH GOSPODARSTAVA ISTOČNE HRVATSKE

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## Sažetak

Cilj istraživanja je bio utvrditi utjecaj osnovnih kemijskih svojstava tla na ukupne koncentracije, te raspoložive frakcije esencijalnih teških metala u tlu. Na dva lokaliteta različitih svojstava tla Berak i Vinogradci u istočnoj Hrvatskoj su provedene agrokemijske analize tla. Tlo na lokalitetu Berak je neutralne reakcije (prosjeak pH (H<sub>2</sub>O) 7,20), dok je tlo na lokalitetu Vinogradci slabo kiselo (prosjeak pH (H<sub>2</sub>O) 6,49). Oba tla su slabo humozna, te dobro opskrbljena fosforom i kalijem. Na oba analizirana lokaliteta su prema očekivanju utvrđene najveće prosječne koncentracije ukupnog Fe, slijede Mn i Zn, a najniže su koncentracije ukupnog Cu. Veće ukupne koncentracije analiziranih mikroelemenata su zabilježene na lokalitetu Berak. Ukupne koncentracije Zn i Cu su u svim analiziranim uzorcima tla značajno ispod maksimalno dopuštenih koncentracija. Ekstrakcijom raspoložive frakcije mikroelemenata sa EDTA otopinom najveće prosječne koncentracije su na lokalitetu Berak utvrđene za Mn (50,52 mg/kg), zatim Fe (21,77 mg/kg), Cu (4,78 mg/kg), a najmanje za Zn (1,47 mg/kg). Na lokalitetu Vinogradci su ekstrakcijom raspoložive frakcije mikroelemenata sa EDTA otopinom u prosjeku utvrđene najveće koncentracije raspoloživog Fe (77,09 mg/kg), potom Mn (30,75 mg/kg), Cu (4,36 mg/kg), a najmanje Zn (1,76 mg/kg). Identičan redoslijed prosječnih koncentracija na oba lokaliteta zabilježen je i za ekstrakciju raspoložive frakcije sa DTPA otopinom. Usporedbom pristupačnih frakcija mikroelemenata po lokalitetima, veće prosječne koncentracije Mn i Cu su utvrđene na lokalitetu Berak, a na lokalitetu Vinogradci veće prosječne koncentracije Fe i Zn. Na oba lokaliteta je DTPA metodom ekstrahirano više Fe i Mn, prosječno 56,94% i 11,84% više nego EDTA metodom, ali je EDTA metodom ekstrahirano više Zn i Cu, prosječno 119,48% i 101,71% nego DTPA metodom. Fe ima najmanji udio raspoložive frakcije u ukupnoj frakciji (0,18% prema EDTA i 0,23% prema DTPA), slijede Mn (5,35% prema EDTA i 5,91% prema DTPA) i Zn (2,63% prema EDTA i 1,20% prema DTPA), a najveći udio ima Cu (22,22% prema EDTA i 11,04% prema DTPA).

**Ključne riječi:** mikroelementi, ukupna koncentracija, raspoložive frakcije

## SWISS CHARD YIELD RESPONSE TO VARIOUS FERTILIZATION RATES AT SOIL WITH DIFFERENT AMOUNTS OF CALCIUM CARBONATE

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### Abstract

This paper aims at analysing the response of Swiss chard growth on soils with different amounts of calcaric material to various fertilization rates. The experiment was conducted near Danilovgrad, Montenegro, between March and June 2014. Swiss chard was grown on soils having low (<10%) CaCO<sub>3</sub> content, medium (15-25%) and very high CaCO<sub>3</sub> content (35-45%). Applied fertilization rates corresponded to A (50%), B (100%), and C (150%) of Swiss chard demand in nutrients. An average yield of 31.4±6.8 t/ha of fresh yield was measured for all the treatments and replications. The results indicate very significant difference in fresh yield between treatments C grown on soils with lower CaCO<sub>3</sub> content than in other treatments. The significant differences in yield were found also between different harvesting cycles. Calcium-carbonate content in soil affected significantly the fresh yield of Swiss chard grown with varying fertilizer doses.

**Key words:** *Swiss chard, soil, fertilization, yield, calcium-carbonate*

# UTICAJ RAZLIČITIH DOZA ĐUBRIVA NA PRINOS BLITVE GAJENE NA ZEMLJIŠTIMA SA RAZLIČITIM SADRŽAJEM KALCIJUM KARBONATA

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## Sažetak

Ovaj rad ima za cilj da pokaže uticaje različitih doza đubriva na prinos blitve koja se gaji na zemljištima koja imaju različit sadržaj kalcijum karbonata. Eksperiment je izveden u blizini Danilovgrada, Crna Gora, između marta i juna 2014. godine. Blitva je gajena na zemljištu koje sadrži manji (<10%), srednji (15-25%) i visok (35-45%) sadržaj CaCO<sub>3</sub>. Primenjene doze đubriva odgovaraju potrebama blitve od A (50%), B (100%) i C (150%) za hranivima. Prosečan sveži prinos od 31.4±6.8 t/ha je izmeren za sve tretmane i ponavljanja. Rezultati pokazuju veoma značajne razlike u svežem prinosu između tretmana C koji je gajen na zemljištu sa malo CaCO<sub>3</sub> i ostalih tretmana. Značajne razlike u prinosu su ostvarene i između različitih žetvenih ciklusa. Sadržaj kalcijum karbonata u zemljištu značajno utiče na sveži prinos blitve koja se gaji sa različitim normama đubriva.

**Ključne riječi:** *blitva, zemljište, đubrenje, prinos, kalcijum karbonat*

# DISTRIBUTION AND CONTAMINATION ASSESSMENT OF HEAVY METALS IN AGRICULTURAL SOILS AROUND THE MEFTAH CEMENT PLANT, ALGERIA

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## Abstract

An attempt was made to investigate the concentrations of Cu, Fe and Zn in agricultural soils around the Meftah cement plant, Algeria. Forty soil samples were collected at two depths, 0-10 cm and 10-20 cm. The soil samples were digested with the EPA method and the concentration of heavy metals were determined by atomic absorption spectrometry. The concentrations ranged from 7.22 to 55.75 mg kg<sup>-1</sup> for Cu, 16,160.82 to 19,742.22 mg kg<sup>-1</sup> for Fe and 44.46 to 200.26 mg kg<sup>-1</sup> for Zn. The magnitude of the mean concentration values indicated the following order: Fe >> Zn > Cu for both horizons. In accordance with the European guidelines, the mean concentrations of the metals did not exceed the threshold values for agricultural soils. Concentration of Cu, Fe and Zn metals in surface soils were higher than in subsurface soil samples. The enrichment factor (FE) was applied to assess the soil contamination. The enrichment factor values of Cu and Zn in studied soils ranged from 0.75 to 5.03 and 1.79 to 6.68, respectively. Up to 75% and 5% of soil samples were moderately to highly contaminated with regard to Zn and Cu, compared to the upper continental crust concentrations.

**Key words:** *heavy metals, soil, enrichment factor, cement industry*

# PROCJENA DISTRIBUCIJE I ZAGAĐENOSTI POLJOPROVREDNIH TALA TEŠKIM METALIMA U OKOLINI TVORNICE CEMENTA „MEFTAH“ U ALŽIRU

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## Sažetak

Istraživanje je imalo cilj da ispita koncentracije Cu, Fe i Zn u poljoprivrednim tlima oko tvornice cementa „Meftah“ u Alžiru. S tim u vezi je uzeto po četrdeset uzoraka tla sa po dvije dubine od 0-10 cm i 10-20 cm. Analiza metala je obavljena EPA digestacionom metodom, a koncentracija teških metala određena je metodom atomske apsorpcijske spektrometrije (AAS). Vrijednosti koncentracija metala su iznosile od 7,22 do 55,75 mg kg<sup>-1</sup> za Cu, 16.160,82 do 19.742,22 mg kg<sup>-1</sup> za Fe i od 44,46 do 200,26 mg kg<sup>-1</sup> za Zn. Veličina srednjih vrijednosti koncentracije pokazala je sljedeći poredak: Fe > Zn > Cu u oba analizirana horizonta. U skladu s europskim smjernicama, srednje koncentracije metala nisu prelazile granične vrijednosti za poljoprivredna tla. Koncentracije metala Cu, Fe i Zn su u uzorcima površinskog sloja bile veće od onih iz potpovršinskog sloja. Procjena onečišćenja tla je obavljena uz pomoć metode faktora obogaćivanja (FE). Vrijednosti faktora obogaćivanja za Cu i Zn u ispitivanim tlima, suse kretale od 0,75 do 5,03 i 1,79 to 6,68, respektivno. Do 75%, odnosno 5% uzoraka tla je bilo umjereno do jako onečišćeno u odnosu na Zn i Cu, u poređenju s gornjim koncentracijama kontinentalne kore.

**Ključne riječi:** *teški metali, tlo, faktor obogaćivanja, cementna industrija*

## INTERNATIONAL YEAR OF SOILS (IYS) 2015

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### Abstract

Soil is a fundamental natural resource, and its primary role is to produce food and raw materials. The soil, however, serve other users, beyond the sphere of agriculture and forestry, such as town planning, industry, roads, various landfills, water reservoirs and others. Therefore, the soil is limited, multi-purpose natural good which use has to be rationally and dedicated. Recognizing the critical role of soil as a finite natural resource essential for food security and vital ecosystem functions, the Government of the Kingdom of Thailand has launched an initiative to celebrate an International Year of Soils, „Healthy soil for a healthy life”. The 68<sup>th</sup> United Nations General Assembly declared 2015 the International Year of Soils. According to the Food and Agriculture Organization of the United Nations, the International Year of Soils (IYS) 2015 aims to increase awareness and understanding of the importance of soil for food security and essential ecosystem functions.

At the Assembly were presented the objectives of the International Year of the soil:

- Raise awareness of civil society actors and decision makers of the fundamental role of soil for human existence, their role for food security, climate change adaptation and mitigation, and as a support for productive ecosystems;
- Promote, at all levels, policies and actions for the sustainable management and protection of soil resources;
- Appeal for support and investment in soil activities across the regions aiming at healthy soil to increase food production and global food security;
- Advocate for the enhancement of soil information at all levels to support more effective policies, strategies and actions for sustainable soil management.

We should always have in mind that the ground is not a property of the present generation, but thousands and thousands of generations to come in the future, so we all need, not only during 2015, actively participate in the promotion and protection of soil.

**Key words:** *soil, roles of soil, rational and purposeful use of soil*

## 2015 MEĐUNARODNA GODINA TLA

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### Sažetak

Tlo je temeljni prirodni resurs, a njegova primarna uloga je proizvodnja hrane i sirovina. Tlo, međutim služi i drugim korisnicima, izvan sfere poljoprivrede i šumarstva, kao što su: urbanizam, industrija, prometnice, razna odlagališta, vodne akumulacije i dr. Dakle, tlo je ograničeno, višenamjensko prirodno dobro kojeg treba racionalno i namjenski koristiti. Uviđajući kritičnu ulogu tla kao resursa za osiguranje hrane i djelovanje ekosustava, Vlada Kraljevine Tajlanda objavila je inicijativu obilježavanja Međunarodne godine tla pod nazivom „Zdrava tla za zdrav život”. Na 68. Općoj skupštini Ujedinjenih Naroda, 2015. godina proglašena je Međunarodnom godinom tla. Prema UN-ovoj Organizaciji hrane i poljoprivrede, cilj Međunarodne godine tla je povećati svijest i razumjeti važnost tla za osiguranje hrane i djelovanje životnog ekosustava.

Na Skupštini su predstavljeni ciljevi Međunarodne godine tla:

- Podići svijest građana i onih koji donose odluke o temeljnoj ulozi tala u ljudskom postojanju, njihovoj ulozi u osiguranju hrane, prilagodbi i ublažavanju klimatskih promjena, te kao potpora produktivnom ekosustavu;
- Promovirati, na svim razinama politike i djelovanja, vezane za održivo upravljanje i zaštitu resursa tla;
- Apelirati za podršku i investicije u svim aktivnostima s tлом, diljem regije, usmjerene na zdrava tla koja povećavaju proizvodnju i globalnu sigurnost hrane;
- Dostupnost više informacija o tlu, kako bi se podržale učinkovite politike, strategije i akcije za održivo upravljanje tlima.

Stalno treba imati na umu da tlo nije vlasništvo sadašnje generacije, nego tisuća i tisuća generacija koje dolaze u budućnosti, stoga svi trebamo, ne samo tijekom 2015., aktivno djelovati u promoviranju i zaštiti tla.

**Ključne riječi:** *tlo, uloge tla, racionalno i namjensko korištenje tla*

# ANALYSIS OF RELIEF AND PEDOLOGICAL CHARACTERISTICS IN WEST HERZEGOVINA CANTON OF FEDERATION OF BOSNIA AND HERZEGOVINA

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## Abstract

The subject of the study was relief analysis of West Herzegovina Canton (ZHK), along with its influence on development of soils that were evolutionary and genetically cambic soils on dolomites and limestones.

Two main parameters of relief, altitude and slope, have been used for cartographic representation of agricultural land use in West Herzegovina Canton. Soil types, according to Skoric et al. (1986) taxonomy, with their distribution in Canton have been presented with pedological map with scale 1: 200000 (thumbnail).

Analysis showed 14 different soil types among agricultural land of West Herzegovina Canton. Their chemical and physical characteristics, economic and agricultural importance with distribution were given.

Relief and pedological analysis of soils that were evolutionary and genetically cambic soils on limestones showed influence of altitude and slope on development of certain type. Lithosol was found at altitudes higher than 200 metres and with slopes, with exception of first agricultural zone. Those results have been in correspondence with criteria for zone allocation of agricultural land. Calcomelanosol was found at all altitudes and slopes, especially above 1,000 metres above sea and inclination of 17%. Terra Rossa was found at lower altitudes with slight slopes, mostly to 600 metres above sea and inclination 0-9%. Calcocambisol was found at all altitudes and slope angles, mostly above 200 meters but most of 600 to 1,000 meters and 9-17% inclination. This study confirmed previous researches and knowledge relief influence, as passive pedogenetic factor on soil type development.

**Key words:** *relief, altitude, slope, soil*

# ANALIZA RELJEFA I PEDOLOŠKOG POKROVA NA PODRUČJU ŽUPANIJE ZAPADNOHERCEGOVAČKE U FEDERACIJI BOSNE I HERCEGOVINE

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## Sažetak

U okviru ovog rada izvršena je analiza reljefa na području Zapadnohercegovačke županije (ŽZH), te analiza utjecaja reljefa na razvoj tala, koja su u evolucijsko-genetskom razvoju do kambične klase na vapnencima i dolomitima. Naime, analizirana su dva glavna elementa reljefa: nadmorska visina i nagib terena, te je, temeljem dostupnih podataka, napravljen njihov kartografski prikaz za područje poljoprivrednog zemljišta Zapadnohercegovačke županije. Također, obrađeni su i tipovi tala koji se rasprostiru na području agrozone ŽZH, a njihova prostorna distribucija prikazana je pedološkom kartom M 1: 200.000 (umanjeni preslik), prema klasifikaciji tala Škorić i sur. 1986. godina. Utvrđeno je da na području poljoprivrednog zemljišta-agrozone ŽZH razvijeno 14- tipova tala. Opisan je njihov osnovni značaj, kemijska i fizikalna svojstva, gospodarski značaj, rasprostranjenost na istraživanom prostoru. Analizom reljefa i pedološkog pokrova tala, točnije tipova tala koja su u evolucijsko-genetskom razvoju do kambične klase na vapnencima, utvrđeno je kako nadmorska visina i nagib terena utječu na pojavu pojedinog tipa tla. Kamenjar (Litosol) je utvrđen na visinskim zonama iznad 200 m i na svim nagibima, osim u prvoj agrozonu, gdje nije uopće utvrđen, što je bilo i očekivano sukladno kriterijima izdvajanja pojedinih zona u okviru poljoprivrednog zemljišta. Kalkomelanosol je utvrđen na svim nadmorskim visinama i nagibima, a posebno iznad 1.000 m i 17% nagiba. Crvenica je utvrđena na nižim reljefnim pozicijama i na blažim nagibima terena. Javlja se uglavnom u visinskoj zoni do 600 m n.v. na svim nagibima terena, najčešće na nagibu od 0-9%. Kalkokambisol se, kao i kamenosol, javlja na svim visinskim zonama i nagibima terena. Najviše se javlja na nadmorskim visinama iznad 200 m, najviše od 600-1000 m i na nagibima 9-17%. Kroz ovaj rad potvrđena su dosadašnja istraživanja, odnosno znanstvene spoznaje o utjecaju reljefa, kao pasivnog pedogenetskog čimbenika, na razvoj tala.

**Ključne riječi:** *reljef, nadmorska visina, nagib terena, tlo*

## **TOTAL AND PLANT AVAILABLE TOXIC TRACE ELEMENTS (Cd, Cr, Co AND Pb) AT FARMS OF EASTERN CROATIA**

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### **Abstract**

Maximum permissible concentrations of toxic trace elements are defined by total concentrations in soil. However, numerous studies have shown that soil properties, metal speciation and plant species, especially soil-plant interactions, determine the availability of metals in soils. Therefore, various one-step extraction methods such as EDTA and DTPA have been used to represent the available fraction. Both of these extraction methods are used due to their ability to form very stable, water-soluble and well-defined complexes with metal cations. In present study we observed the extraction of toxic trace elements (Co, Cd, Cr and Pb) from soil by these two methods on two farms (Berak and Vinogradci) in eastern Croatia that have different soil properties. The study included 106 soil samples from depth 0-30 that were collected during 2013-2014. Samples were analyzed for standard soil properties (pH, organic matter, AL-P, AL-K) as well as for total (aqua regia), EDTA and DTPA extractable toxic trace elements (Co, Cr, Cd and Pb). Analyses of main soil properties show wide variety of soils. Soil pH (in H<sub>2</sub>O) was in range 4.4-8.6 (avg: 6.5), thus sampling sites included range from very acid to alkaline soils. Farm in Berak (average pH is 7.2) had more alkaline soils while farm in Vinogradci was acidic (average pH is 5.9). Organic matter varied from 1.1-2.8% (avg: 1.9), average phosphorous was 17.4 mg/100g and potassium 20.9 mg/100g. Total concentration of trace elements extracted by aqua regia show satisfactory results as not one sample had elevated levels of toxic trace elements (Co, Cd, Cr and Pb). In that regard all sites satisfy Croatian regulation on pollutants in agricultural fields. However, EDTA and DTPA extractions show higher availability of Cr, Co and Pb for both extractions (EDTA and DTPA) at farm in Vinogradci where soils are more acidic than at farm Berak. Only available Cd was shown to be higher in Berak than in Vinogradci. Further analysis of plant material is necessary to investigate the relationship of plant uptake and EDTA and DTPA extraction methods on such sites with different pH levels.

**Key words:** *availability, DTPA, EDTA, trace elements*

## UKUPNE I RASPOLOŽIVE FRAKCIJE TOKSIČNIH TEŠKIH METALA (Cd, Cr, Co I Pb) NA POLJOPRIVREDNIM GOSPODARSTVIMA ISTOČNE HRVATSKE

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### Sažetak

Maksimalno dopuštene količine (MDK) toksičnih teških metala određene su ukupnim koncentracijama u tlu. Međutim, brojna istraživanja su pokazala da svojstava tla, specijacija metala, biljne vrste, te posebno interakcija biljka-tlo određuju raspoloživost metala u tlima. Stoga se različite ekstrakcije poput EDTA i DTPA koriste kako bi prikazali raspoloživu frakciju. Obje ove ekstrakcijske metode imaju sposobnost stvaranja vrlo stabilnih, u vodi topljivih kompleksa s metalnim kationima. U našem istraživanju promatrali smo EDTA i DTPA ekstrakciju toksičnih teških metala (Co, Cd, Cr i Pb) na dva lokaliteta u istočnoj Hrvatskoj (Berak i Vinogradci) koji su imali različita svojstva tla. Studija je obuhvatila 106 uzoraka tla s dva lokaliteta (dubina 0-30) koji su prikupljeni tijekom 2013-2014. Uzorci su analizirani za standardna svojstva tla (pH, humus, AL-P, AL-K) kao i za ukupne (zlatotopka), EDTA i DTPA ekstrahirane toksične teške metale (Co, Cr, Cd i Pb). Standardne analize tla pokazuju vidne razlike u svojstvima između dva lokaliteta. Raspon pH (u H<sub>2</sub>O) je bio 4,4.-8,6. (prosjeak: 6,5), dakle tla su se kretala od vrlo kiselih do vrlo alkalnih. Lokalitet u Berku je imao više alkalna tla (prosjeak pH: 7,2), dok su Vinogradci imali više kiselih tla (prosjeak pH: 5,9). Humus je varirao od 1,1-2,8% (prosjeak pH: 1,9), prosječna koncentracija fosfora je bila: 17,4 mg/100g, a kalija: 20,9 mg/100g. Ukupne koncentracije ekstrahiranih toksičnih teških metala su bile ispod MDK za sva četiri analizirana elementa (Co, Cd, Cr i Pb). Međutim, EDTA i DTPA ekstrakcije pokazuju veću raspoloživost Cr, Co i Pb za obje ekstrakcije (EDTA i DTPA) na lokalitetu Vinogradci, gdje su tla kiselija nego na lokalitetu Berak. Jedino se raspoloživost Cd pokazala veća u Berku nego u Vinogradcima. Daljnja istraživanja bi trebala obuhvatiti i analize biljnog materijala kako bi se istražio odnos EDTA i DTPA ekstrahiranih koncentracija s koncentracijama u biljci na tlima s različitim pH.

**Ključne riječi:** DTPA, EDTA, raspoloživost, teški metali

**PRELIMINARY DATA ON PGES (PLATINUM GROUP ELEMENTS)  
AND REE (RARE EARTH ELEMENTS) IN  
URBAN SOILS IN NOVI SAD (SERBIA) IN RELATION TO  
CAR CATALYTIC CONVERTERS EMISSION**

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**Abstract**

In the framework of the Italian-Serbian program of bilateral cooperation funded by the Italian Ministry of the Foreign Affairs (MAECI), a research project with the aim to investigate the heavy metals distribution in urban soils in Rome and Novi Sad has been carried out. In particular, one task of the project was to study the behaviour of „new” pollutants released from car catalytic converters in selected top and bottom soils in two urban parks in Novi Sad. The study of the anthropic pollution by a geochemical multi-element approach could be a useful tool overall in urban areas characterized by a high environmental complexity. Different catalysts honeycomb display typical PGE and REE associations and concentration levels not common in soil and, at the end, in the „natural” environment. Characteristic fingerprint that they displayed permit us to evidence the presence of particles derived from car catalysts. In Serbia car catalyst introduction is relatively recent respect to other European Countries and these preliminary data show that, among PGE, Pt and Pd concentration levels are 0.89 and 0.85 ng/g respectively, resulting still lower or very close to the typical geochemical background for these elements in natural soils and rocks. Then, the presented data can be utilized as useful reference values to assess their accumulation trend in Serbian urban soils. Concerning REE that are usually contained in high percentages in the catalyst honeycomb and released with PGE via car fumes, their average concentrations result lower in Novi Sad top soils ( $\Sigma$ LREE 112 mg/kg) than in Rome ( $\Sigma$ LREE 427 mg/kg), where catalyst were introduced in the early 90s and soil parent material is mainly derived from volcanic rocks. However, the REE distribution patterns result very similar in both cities as well as the HREE concentration levels. These preliminary data evidence that the urban environment is continuously exposed to new pollutants in relation to changes in anthropic activity. Environmental safeguard require useful and innovative tools to check and study the fate of these potential pollutants overall in relation to potential negative effect on population.

**Key words:** *PGE, REE, urban soils, Novi Sad, Serbia*

## PRELIMINARNI PODACI O PGE (PLATINSKA GRUPA ELEMENATA) I REE (RIJETKI ZEMLJIŠNI ELEMENTI) U URBANIM TLIMA NOVOG SADA (SRBIJA) U ODNOSU NA EMISIJU AUTOMOBILSKIH KATALITIČKIH KONVERTERA

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### Sažetak

U okviru „Talijansko-srpskog programa bilateralne suradnje” koji financira Ministarstvo spoljnih poslova Italije, provedeno je istraživanje s ciljem ispitivanja distribucija teških metala u urbanom tlu Rima i Novog Sada. Jedan od zadataka projekta je bio da se istraži ponašanje „novih” zagađivača koje ispuštaju automobilske katalizatori u odabranim gornjim i donjim slojevima tla u dva gradska parka u Novom Sadu. Ispitivanje antropogenog zagađivanja pomoću geohemijskog više-elementnog pristupa moglo bi biti korisno sredstvo, u urbanim područjima visoke ekološke složenosti. Mrežice (poput pčelinjeg saća) različitih katalizatora pokazuju tipične PGE i REE asocijacije i razine koncentracije koje nisu uobičajene za tlo i „prirodno” okruženje. Karakterističan otisak koji pokazuju dozvoljava da dokažemo prisustvo čestica dobivenih iz automobilskih katalizatora. U Srbiji su automobilske katalizatori uvedeni relativno nedavno u odnosu na druge evropske zemlje, a ovi preliminarni podaci pokazuju da, u platinskoj grupi elemenata, razine koncentracije Pt i Pd iznose 0,89 i 0,85 ng/g, što je još uvijek ispod/blizu geohemijskih vrijednosti za ove elemente. Podaci su korisni kao referentne vrijednosti za procjenu trenda akumulacije u urbanim tlama Srbije. Što se tiče REE koji su obično prisutni u visokim postotcima u mrežicama katalizatora, a koji se zajedno sa PGE ispuštaju putem automobilskih isparenja, njihova prosječna koncentracija je niža u površinskom sloju tla u Novom Sadu ( $\Sigma\text{LREE} 112 \text{ mg/kg}$ ) nego u Rimu ( $\Sigma\text{LREE} 427 \text{ mg/kg}$ ), gdje su katalizatori uvedeni početkom devedesetih godina prošlog stoljeća, a stijene vulkanskog porijekla. Mada, obrasci distribucije REE daju veoma slične rezultate u oba grada. Zaštita okoliša zahtijeva korisne i inovativne alate za provjeru i proučavanje ovih potencijalnih zagađivača i njihov potencijalno negativan utjecaj na populaciju.

**Ključne riječi:** PGE (platinska grupa elemenata), REE (rijetki Zemljini elementi), urbana tla, Novi Sad, Srbija

# SUITABILITY OF AGRICULTURAL LAND FOR THE CULTIVATION OF CABBAGE IN THE AREA OF HERZEGOVINA-NERETVA COUNTY

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## **Abstract**

Purpose of this paper was to perform inventory of areas and features of agricultural land in the field of the Herzegovina-Neretva County based on existing data and to assess benefits of agricultural land for cultivation cabbage according to the characteristics of the soil, relief and climate. The evaluation of the land suitability was carried out in line with FAO method (FAO, 1976) according to the agro zone. Based on conducted research it was established that the studied area is very suitable for the production of cabbage. There are 23,249.3 ha (11.68%) suitable land for the production of cabbage and temporarily unsuitable 5,201.2 ha (2.61%) while permanently unsuitable land for intensive production of cabbage are on 170,451.8 ha (85.7%). The main limitations for intensive production of cabbage in the studied area are the slope, the depth of profile and rockiness. According to official data on the state of the current production of cabbage in the studied area and data of suitable land and temporarily unsuitable land the conclusion is that there are basic prerequisites in the form of land resources to expand the production of cabbage in this field.

**Key words:** *agricultural land, climate, relief, suitability, cultivation of cabbage*

# POGODNOST POLJOPRIVREDNOG ZEMLJIŠTA ZA UZGOJ KUPUSA NA PODRUČJU HERCEGOVAČKO-NERETVANSKE ŽUPANIJE

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## Sažetak

Cilj ovoga rada bio je na temelju postojećih podataka izvršiti inventarizaciju površina i značajke poljoprivrednog zemljišta na području Hercegovačko-neretvanske županije, te sukladno značajkama tla, reljefa i klime izvršiti procjenu pogodnosti poljoprivrednog zemljišta za uzgoj kupusa. Procjena pogodnosti zemljišta, izvršena je prema FAO metodi (FAO, 1976), po agrozonama. Temeljem provedenih istraživanja utvrđeno je da je istraživano područje pogodno za proizvodnju kupusa. Pogodnih tala/zemljišta za proizvodnju kupusa ima 23.249,3 ha (7,42%), privremeno nepogodnih 5.201,2 ha (2,61%), dok trajno nepogodnih tala/zemljišta za intenzivnu proizvodnju kupusa ima 170.451,8 ha (85,7%). Osnovna ograničenja za intenzivnu proizvodnju kupusa na istraživanom području su nagib terena, dubina tla i stjenovitost. Temeljem službenih podataka o stanju sadašnje proizvodnje kupusa na istraživanom području i podataka o pogodnim i privremeno nepogodnim tlima dolazimo do zaključka da postoje osnovne mogućnosti, u vidu zemljišnih resursa, za proširenje proizvodnje kupusa na ovom području.

**Ključne riječi:** *poljoprivredno zemljište, klima, reljef, pogodnost, uzgoj kupusa*

## RISK ASSESSMENT OF LEACHING HERBICIDES IN GROUNDWATER

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### Abstract

The aim of the study is to present the elements which must be considered while determining the risk of the washout of the herbicides. Herbicides have the special ecotoxicological significance because they reach the ground in the significant part of the initial deposit, particularly at the soil herbicides. Herbicides used at corn have special risk because some are potentially mobile, they are used on the large surfaces, they are used in April and May when it rains a lot and because the corn is grown by the rivers. Destiny of the herbicide in the environment, particularly the ground is very complex. It does not depend only on the characteristics of the herbicide, but on the many factors of the environment which are very changeable, in the space as well as in time. Regardless of this fact, there are experimentally determined physical-chemical indicators for each herbicide, that show the possible behavior of herbicides in the environment. Physical-chemical indicators of the herbicide destiny in ground, water and air, and as the indicators of the possible ecotoxicological risks which can appear as the result of the applying of the herbicide on the particular soil and the climate are: distribution coefficient ( $K_d$ ); sorption coefficient ( $K_{OC}$ ); time of the semi-decomposition ( $DT_{50}$ ); water solubility ( $S$ ); Groundwater Ubiquity Score ( $GUS$ ); Henry's Law constant ( $K_h$ ), vapor pressure ( $PV$ ) and the dissociation constant ( $pK_a$ ). Indicators of the physical-chemical characteristics are used for the estimation of the ecotoxicological significance of the particular herbicide. Namely, herbicides, in larger or smaller measure, have „leaching potential“, which is ability to reach the underground water. One of the basic criteria for evaluating the herbicide ability to reach the underground water is related to indicators of mobility and persistency ( $DT_{50}$ ) herbicides, but neglecting some other criteria in that evaluation such as the amount of applying, characteristics of the soil and the aim of the crop growth. In the study, for the herbicides used in Bosnia and Herzegovina according to the EPA criteria, the „trigger“ of the value will be shown and whose reaching can greatly show that the herbicide has a large potential for washout.

**Key words:** *herbicide, potential for the washout, risk*

## PROCJENA RIZIKA OD ISPIRANJA HERBICIDA U PODZEMNE VODE

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### Sažetak

Rad ima za cilj da predstavi elemente koji se moraju uzeti u obzir pri utvrđivanju rizika od ispiranja herbicida. Herbicidi imaju poseban ekotoksikološki značaj, jer značajan dio početnog depozita dospijeva na zemljište, naročito kod zemljišnih herbicida. Poseban rizik kod nas predstavljaju herbicidi koji se primjenjuju u kukuruzu, zbog toga što su neki od njih potencijalno veoma mobilni, što se primjenjuju na velikim površinama, što se primjenjuju u aprilu i maju kada je relativno dosta padavina i što se kukuruz gaji u neposrednoj blizini rijeka. Sudbina herbicida u spoljnoj sredini, a pogotovo u zemljištu je jako složena. Ona ne zavisi samo od osobina herbicida, već od mnogobrojnih faktora spoljne sredine, koji su pri tome, jako promjenljivi, kako u prostoru, tako i u vremenu. Bez obzira na tu činjenicu postoje eksperimentalno utvrđeni fizičko-hemijski pokazatelji za svaki herbicid, koji nam predočavaju moguće ponašanje herbicida u spoljnoj sredini. Fizičko-hemijski pokazatelji sudbine pesticida u zemljištu, vodi i vazduhu, kao i pokazatelji eventualnih ekotoksikoloških rizika, koji mogu da nastanu usljed primjene herbicida na određenom zemljištu i u određenom klimatu su: koeficijent distribucije ( $K_d$ ); sorpcioni koeficijent ( $K_{OC}$ ); vrijeme polurazlaganja ( $DT_{50}$ ); rastvorljivost u vodi ( $S$ ); Groundwater Ubiquity Score (GUS); konstanta Henrijevog zakona ( $K_h$ ), napon pare ( $P_v$ ) i konstanta disocijacije ( $pK_a$ ). Pokazatelji fizičko-hemijskih karakteristika iskorišćeni su i za procjenu ekotoksikološkog značaja pojedinih herbicida. Naime, herbicidi, u manjoj ili većoj mjeri, posjeduju izvjestan „leaching potential“, tj. sposobnost da dospiju u podzemne vode. Jedan od osnovnih kriterijuma za procjenu sposobnosti herbicida da dospiju u podzemne vode se odnosi na pokazatelje mobilnosti i perzistentnosti ( $DT_{50}$ ) herbicida, a zapostavljajući u toj procjeni neke druge kriterijume, kao što je količina primjene, karakteristike zemljišta i cilj gajenja usjeva. U radu će se za herbicide koji se koriste u BiH, prema kriterijumima EPA, prikazati „okidač“ („trigger“) vrijednosti, a čije dostizanje u značajnoj mjeri može da ukaže da herbicid ima veliki potencijal za ispiranje.

**Ključne riječi:** *herbicid, potencijal za ispiranje, rizik*

## MOBILITY OF IMAZETHAPYR IN DEPENDING ON THE CHARACTERISTICS OF THE SOIL

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### Abstract

The aim of the study was to research the mobility of imazethapyr in three types of soil in the disturbed conditions (laboratory labels KDIL, PILKD and PILKE), whose pH in H<sub>2</sub>O varied from 4.55 to 7.01 using the methods of biological testing. In the study it was used PIVOT-M which contains 100 g/l of imazethapyr as ammonium salt and is formulated as the concentrated solution (SL). Imazethapyr was washed out through the PVC columns, with the inner diameter of 45 mm and 20 cm long (4x5 cm). The amount of water used for eluting of the deposit amount of the herbicide suited the amount of 50, 100 and 200 l of water/m<sup>2</sup> and deposite amount of herbicide was 1,0 l/ha. After the washout and draining of the column, the soil column was extruded and divided into the segments of 5 cm. On the soil extract of 5 cm, 10 g of dry and noncontaminated soil of the same type was added to drain the extract and prepare for planting. Soil sample of 110 g of soil (110 g of the soil from the column + 10 g of the „pure“soil) is palced into the pot with the diameter of 5 cm and 8 seeds of oats were planted. Such formed pots are placed into the greenhouse in order to measure biometric indicators aftyer 21 day (fresh mass of the shoot and root, dry mass of the shoot and root). The mobility of imazethapyr depends on the chemical characteristics and mechanical content of the soil. In this study, placing in the regressive dependence of the soil charateristics [humus content (%), clay (%) and sand (%)], as an independent variable, with the amount of water required for elution, as dependent size, they could not demonstrate dependency relationships observed through a linear regression. However, when you observe pH dependence of soil and water volume (CV) required for elution of imazethapyr from the first 5 cm through the exponential regression of the first line, so that inhibition of oats growth, which is grown in the soil from that part of the column, was 10%, and which corresponds values of NOEL, it can be drawn a conclusion that functional dependency is established

## MOBILNOST IMAZETAPIRA U ZAVISNOSTI OD KARAKTERISTIKA ZEMLJIŠTA

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### Sažetak

Cilj rada je bio da se metodama biološkog testiranja istraži mobilnost herbicida imazetapir u tri tipa zemljišta u narušenom stanju (laboratorijske oznake KDIL, PILKD i PILKE), čija je pH u H<sub>2</sub>O varirala od 4,55 do 7,01. Za istraživanje je korišćen preparat PIVOT-M, koji sadrži 100 g/l imazetapira u obliku amonijum soli, a formuliše se kao koncentrovani rastvor (SL). Imazetapir je ispiran kroz PVC kolone, unutrašnjeg prečnika 45 mm i dužine 20 cm (4×5 cm). Količina vode kojom je eluirana deponitna količina herbicida je odgovarala količini od 50, 100 i 200 l vode/m<sup>2</sup>, a deponitna količina herbicida je iznosila 1,0 l/ha. Nakon završenog ispiranja i ocjeđivanja kolone, pristupilo se istiskivanju zemljišnog stupca i njegovoj podjeli na segmente od po 5 cm. Isječku zemljišta od 5 cm je dodato 10 grama suvog i nekontaminiranog zemljišta istog tipa, kako bi se isječak lakše prosušio i pripremio za sjetvu. Zemljišni uzorak od 110 grama zemljišta (100 grama zemljišta iz stubca + 10 grama „čistog“ zemljišta) je smješten u saksiju prečnika 5 cm, u što je usijano 8 sjemenki zobi i tako formirane saksije su stavljene i platenik, da bi se nakon 21 dan od sjetve pristupilo mjerenju biometričkih pokazatelja (svježa masa izdanka i korijena, suva masa izdanka i korijena). Mobilnost imazetapira u zemljištu zavisi od hemijskih osobina i mehaničkog sastava zemljišta. U ovom radu, a stavljajući u regresionu zavisnost karakteristike zemljišta [sadržaj humusa (%), gline (%) i pijeska (%)], kao nezavisno promjenljive, sa količinom vode potrebne za eluiranje, kao zavisne veličine, nisu se mogli dokazati odnosi zavisnosti posmatrani kroz linearnu regresiju. Međutim, kada se kroz eksponencionalnu regresiju prvog reda posmatra zavisnost pH zemljišta i količine vode (KV) potrebne za ispiranje imazetapira iz prvih 5 cm, tako da inhibicija rastezja zobi, koju gajimo u zemljištu iz tog dijela kolone bude 10%, a što odgovara vrijednosti NOEL-a dolazi do zaključka da je tako uspostavljena funkcionalna zavisnost

# EFFECT OF IRRIGATION DRAINAGE-DISCHARGE WATER OF RICE IRRIGATION SYSTEMS ON DARK CHESTNUT SOILS OF SOUTH OF UKRAINE

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## Abstract

Rice growing is one of the most efficient Ukraine's agricultural sectors. Rice cultivation is essential as a factor in the effective use of unproductive land. It improves their fertility and reclamation status, and supports maximum crop yields of rice and forage crops. Rice growing needs big irrigation norm. A large amount of discharges is associated with a large irrigation norm. These occur in bays of the Black Sea. As a result natural water bodies are contaminated with chemicals and sediments, which are taken from rice fields, which may cause a decrease in fish productivity and other indicators of water quality. It is necessary to retrofit drainage-discharge system by automatic regulator of drainage-discharge water level for implementation of the method (Pat. 87665). Two-stage regulation drainage and discharge water of rice irrigation systems (RIS) consists from: I-regulation of level drainage-discharge and ground waters; II-regulation of water input regime. The maximum water flow is fixed in period from the second decade of June to the third decade of July. Drainage-discharge outflow from 1 hectare is 34.8-3,198.5 m<sup>3</sup> per hectare, or 2-28% from water input. Two-stage regulation has too little effect on the qualitative composition of drainage-discharge water, and does not exceeding the maximum permissible concentration of toxic substances in it. Study of the effect of drainage-discharge water irrigation on soil dues on research areas in period 2009-2014 years and on object-analog-Rice irrigation system with closed cycle water use in periods: I-23 years along after its renovation, II-27 years along before its renovation. Investigation showed that long-term irrigation by drainage-discharge water caused to little inside of soil salinity from 0.2%. It is not exceeding the permissible value. With long-term irrigation by drainage-discharge water for decline toxic soil salinity is recommended to use calcium ameliorants. Developed method of for the regulation using of drainage-discharge water of rice irrigation systems reduces losses by percolation, thereby reduced rice irrigation norm to 1,000-1,300 m<sup>3</sup> per hectare. Regulation using of drained-discharge water of rice irrigation systems promotes increase of rice yield to 0.9-1.0 ton per hectare. The implementing overall economic effect of the method of regulation using of drainage-discharge water for rice irrigation systems is 118,666 USD., or 4,876 USD. per hectare.

**Key words:** *soil, salinity, irrigation water quality, rice irrigation system, drainage-discharge water, yield*

# UTICAJ NAVODNJAVANJA TAMNIH KESTENJASTIH TALA U JUŽNOJ UKRAJINI DRENAŽNOM/ISPUSNOM VODOM IZ SISTEMA ZA NAVODNJAVANJE RIŽE

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## Sažetak

Uzgoj riže predstavlja jedan od najučinkovitijih poljoprivrednih sektora Ukrajine. Gajenje riže je ključni faktor korištenja neproduktivnog zemljišta, koji popravljajući njegovu plodnost, te podržava maksimalne prinose usjeva riže i krmnog bilja. Proizvodnja riže zahtijeva visoku normu navodnjavanja. Velike količine ispuštanja su povezane s velikom normom navodnjavanja. To se dešava u zalivima Crnog mora. Rezultat toga je zagađenje vodenih tijela hemikalijama i taloženjima koje dopijevaju sa rižinih polja, što utječe na proizvodnju riže i kvalitet vode. Potrebno je naknadno opremiti odvodno-ispusni sistem automatskim regulatorom nivoa vode koja se odvodi/ispušta da bi se implementirao postupak (Pat. 87665). Dvostepena regulacija odvođenja i ispuštanja vode u sistemu za navodnjavanje riže (RIS) sastoji se od: I-regulacije nivoa odvođene/ispuštane vode i nivoa podzemnih voda; II-regulacije režima unosa vode. Maksimalni protok vode je fiksiran u periodu od druge dekade juna do treće dekade jula. Odljev drenažne/ispusne vode sa 1 hektara iznosi 34,8-3.198,5 m<sup>3</sup> po ha, ili 2-28% unesene vode. Fluktuacija zavisi od procenta područja sadnje riže i stepena regulacije teritorije RIS. Dvostepena regulacija ima mali uticaj na kvalitativni sastav ispusne vode u kojoj koncentracija toksičnih materija ne prelazi maksimalno dozvoljenu granicu. Studija uticaja navodnjavanja drenažnom/ispusnom vodom na tlo istraživanih područja rađena je u periodu 2009-2014 i na objektu analogije – Sistemu za navodnjavanje riže sa zatvorenim ciklusom korištenja vode u periodima: I-23 godine nakon njegove obnove, II-27 godina prije obnove. Istraživanje je pokazalo da je dugoročno navodnjavanje prouzrokovalo mali salinitet unutar tla od 0,2%. To ne prelazi dozvoljenu vrijednost. Za smanjivanje toksične slanosti tla kod dugoročnog navodnjavanja drenažnom/ispusnom vodom preporučuje se upotreba kalcijum amelioranata. Razvijena metoda za regulaciju korištenja drenažne-ispusne vode iz sistema za navodnjavanje riže smanjuje gubitke cijedenjem, čime se norma navodnjavanja riže smanjuje na 1.000-1.300 m<sup>3</sup>/ha. Regulacija korištenja drenažne-ispusne vode iz sistema za navodnjavanje riže doprinosi povećanju prinosa riže na 0,9-1,0 t/ha. Ukupni ekonomski efekat primjene metode regulacije korištenja drenažne-ispusne vode iz sistema za navodnjavanje riže iznosi 118.666 USD, ili 4.876 USD po ha.

**Ključne riječi:** tlo, salinitet, kvalitet vode za navodnjavanje, sistem za navodnjavanje riže, drenažno-ispusne vode, prinos

## EDUCATION ON WORLD REFERENCE BASE FOR SOIL RESOURCES (WRB) - EXAMPLE OF GOOD PRACTICE

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### Abstract

The World Reference Base for Soil Resources (WRB) research work started back in 1980. under the program named International Reference Base for Soil Classification (IRB). World Reference Base for Soil Resources was established in 1998., and its design provide easier communication between scientists to whom soil systematic is primary area of research. International Field Course of the World Reference Base for Soil Resources, held in Gödöllő, Hungary, from 01<sup>st</sup> to 05<sup>th</sup> of September, 2015. was organized to celebrate the International Soil Year. Soil Judging Contest of WRB was organized during the course. Students from Bosnia and Herzegovina, primarily students of Faculty of Agricultural and Food Sciences, University of Sarajevo and Faculty of Agriculture, University of Banja Luka attended the course. The above mentioned course and the contest were unique opportunity for students, young scientists and experts as well as those who have been already involved or interested in identification and characterization of the basic soil types all around the world to share information and experience. The unique field study program provided an opportunity to participants to gain new knowledge on Anthrosols, Calcisols, Chernozems, Kastanozems, Phaeozems, Gleysols, Luvisols, Solonetz and Vertisols in accordance to the World Reference Base for Soil Resource. Importance of the continuation of good practices and implementation of this type of field learning about WRB classification is crucial not only at the global level, but also at the regional one. This paper aims to stress the importance of education about WRB classification in order to improve and adapt the national classification system, importance of applied soil science in society in general and to increase the communication with other related disciplines globally.

**Key words:** *WRB, soil, classification, education*

## EDUKACIJA O SVJETSKOJ REFERENTNOJ OSNOVI ZA TLO (WRB) - PRIMJER DOBRE PRAKSE

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### Sažetak

Rad na Svjetskoj referentnoj osnovici za tlo (World Reference Base for Soil-WRB) započeo je davne 1980. godine u okviru programa pod nazivom International Reference Base for Soil Classification (IRB). Svjetska referentna osnovica za tlo završena je 1998. godine i dizajnirana je na način da omogućava lakšu komunikaciju između znanstvenika koji se bave sistematikom tla. U cilju obilježavanja Međunarodne godine tla, organizovan je međunarodni terenski kurs učenja o Svjetskoj referentnoj osnovi za tlo koji je održan u Gödöllő, Mađarska, u periodu 01-05 septembar 2015. godine. Navedeni kurs, u okviru kojeg je organizovano i takmičenje u razumijevanju WRB, pohađali su i studenti iz Bosne i Hercegovine i to sa Poljoprivredno-prehrambenog fakulteta Univerziteta u Sarajevu i sa Poljoprivrednog fakulteta Univerziteta u Banjaluci. Navedeni kurs i takmičenje su bili jedinstvena prilika da studenti, mladi znanstvenici i svi oni koji se bave i koji su zainteresirani za identifikaciju i karakterizaciju osnovnih tipova tala širom svijeta izmjenjuju informacije i iskustva, te kroz jedinstven program terenskog učenja, nauče nešto novo o Anthrosolima, Calcisolima, Černozemima, Kastanozemima, Phaeozemima, Gleysolima, Luvisolima, Solončacima i Vertisolima prema Svjetskoj referentnoj osnovi za tlo. Značaj nastavka dobre prakse i primjene ovog načina terenskog učenja o WRB klasifikaciji je od ključne važnosti ne samo na globalnom nivou, nego i na regionalnom. Ovaj rad ima za cilj da ukaže na značaj edukacije o WRB klasifikaciji u cilju unapređenja i prilagođavanja nacionalnog klasifikacijskog sistema, te važnost primjene znanosti o tlu u društvu općenito i povećanju komunikacije sa ostalim srodinim disciplinama na globalnom nivou.

**Ključne riječi:** *WRB, tlo, sistematika, edukacija*

## COMPARISONS OF HEAVY METALS IN TWO TIME PERIODS IN THE MUNICIPALITY OF ZENICA

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### Abstract

The development of technology and industry has led, in addition to the progress, to the damage of the eco-system. As a result of emissions of various gases and solid particles, pollution of the soil, water, plants, then animals and humans appears. Zenica steelworks was a large pre-war economic entity. During the war, almost all machinery was shut down. After privatization (majority owner of the company Arcelor Mittal) production was launched. In 2008, after 17 years of break and minimum work, production was intensified. In the municipality of Zenica researches of the physiologically active soil layer (about 25cm) are made in two periods (1987-1989; 2011-2014). Investigations were carried out at nine localities: Tetovo, Pehare, Mutnica, Stranjani, Janjicki vrh, Serici, Orahovica, Gradisce and Arnauti. The site is located at a distance of 0.5 to 24 kilometers airline from the center of emissions (taking into account that the steelworks is the largest polluter of explored area) and at an altitude of 322-780 m. The main task of this study was to assess the state of pollution of agricultural land with heavy metals in the pre-war period and to compare the content of pollutants in the period after 20 or more years. This study investigated the following elements: lead (Pb), cadmium (Cd), zinc (Zn), nickel (Ni), iron (Fe), chromium (Cr), molybdenum (Mo), cobalt (Co) and copper (Cu). Analyses were performed by atomic absorption. Analysis of pH, texture, carbonate and humus content were also done.

**Key words:** *contamination, soil, heavy metals, industry*

## POREĐENJE SADRŽAJA TEŠKIH METALA U DVA VREMENSKA PERIODA NA PODRUČJU OPŠTINE ZENICA

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### Sažetak

Razvoj tehnologije i industrije doveo je pored napretka i do oštećenja eko-sistema. Usljed emisije različitih gasova i čvrstih čestica dolazi do zagađenja tla, vode, biljaka, te potom životinja i ljudi. Zenička željezara je bila veliki prijeratni privredni subjekt. Tokom ratnog perioda skoro svi pogoni su bili ugašeni. Nakon privatizacije (većinski vlasnik kompanija Arcelor Mittal) pokrenuta je proizvodnja. U 2008. godini, nakon 17 godina pauze i minimalnog rada, intenzivirana je proizvodnja. Na području općine Zenica istraživanja fiziološki aktivnog sloja zemljišta (oko 25 cm) su izvršena u dva perioda (1987-1989; 2011-2014). Istraživanja su provedena na devet lokaliteta: Tetovo, Pehare, Mutnica, Stranjani, Janjički vrh, Šerići, Orahovica, Gradišće i Arnauti. Lokacije se nalaze na udaljenosti od 0,5-24 km zračne linije od centra emisije (uzimajući u obzir da je željezara najveći zagađivač istraženog područja) i na nadmorskoj visini od 322 do 780 m. Osnovni zadatak ovog rada je da se sagleda stanje zagađenosti poljoprivrednog zemljišta teškim metalima u prijeratnom periodu i da se uporedi sadržaj polutanata u periodu nakon 20 i više godina. Istraživani su sljedeći elementi: olovo (Pb), kadmij (Cd), cink (Zn), nikel (Ni), željezo (Fe), hrom (Cr), molibden (Mo), kobalt (Co) i bakar (Cu). Analize su obavljene metodom atomske apsorpcije. Rađene su i analize pH vrijednosti, teksture, karbonata i humusa.

**Ključne riječi:** *kontaminacija, tlo, teški metali, industrija*

## CONTAMINATION WITH HEAVY METALS AND PAHs IN SOILS OF CANTON SARAJEVO IN PERIOD 2009-2015

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### Abstract

In accordance with the role and importance of which in the world and in our country is attached to soil as a bioproduction factor, the need to examine and protect soil from contamination is imposed. Heavy metals are very common contaminants of soils. Highly toxic and carcinogenic PAHs are natural components of raw petrochemical compounds. Due to their negative influence on plants and animal world as well as on human population, it is necessary to evaluate and determinate heavy metals and PAHs content in soils, especially in ones intended for agricultural production. In this work, we have examined agricultural and urban soils of Canton Sarajevo, for content of heavy metals and polycyclic aromatic hydrocarbons. Analyzed samples were in scattered state, taken from a depth of 0-30 cm. The total amount of determined soil samples was one hundred and twenty (120), during the period of 2009-2015. According to determined general chemical characteristics, soils are from slightly acetous to slightly alkaline. According to mechanical texture composition, examined soils have showed the following texture marks by Ehwald: clay and sandy loam. Using flame/electrothermal atomic absorption spectrometry and gas chromatography with FID detection we have determined the content of seven heavy metals and polycyclic aromatic hydrocarbons. In determining the content of heavy metals following methods were used: BAS ISO 11466:2000 i BAS ISO 11047:2000, and for PAHs the method was BAS ISO 18287:2008. Contents were compared to limit values from „Regulation on determining the allowable amounts of harmful and dangerous substances in soils and methods of their examination” specified in Gazette of Federation BiH No. 72/209.

**Key words:** *contamination, soil, heavy metals, PAHs, AAS method, GC-FID*

## ZAGAĐENOST TEŠKIM METALIMA I PAH-OVIMA U TLIMA KANTONA SARAJEVO U PERIODU 2009-2015. GODINE

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### Sažetak

U skladu sa ulogom i značajem koji se u svijetu i u našoj zemlji pridaje tlu kao faktoru bioprodukcije, nužno se nameće potreba da se tla ispituju i zaštite od kontaminacije. Teški metali su česti zagađivači tala. Vrlo toksični i kancerogeni spojevi PAH-ovi su prirodni sastojci neprerađenih petrohemijskih spojeva. Zbog negativnog djelovanja na biljni i životinjski svijet te na čovjeka, potrebno je ispitati i utvrđivati njihov sadržaj u tlima, posebno onim namijenjenim za poljoprivrednu proizvodnju. U radu su ispitana poljoprivredna i urbana tla u Kantonu Sarajevo, na sadržaj teških metala i policikličnih aromatskih ugljikovodika. Analizirani su uzorci tla u rastresitom stanju, sa dubine od 0-30 cm. Ukupan broj ispitnih uzoraka tla je bio 120, u periodu 2009-2015. godine. Prema ispitanim općim hemijskim svojstvima, tla su blago kisela do blago alkalna, a prema granulometrijskom sastavu, su po Ehwald-u svrstana u ilovače i pjeskovite ilovače. Atomskom apsorpcionom spektrometrijom-plamenom/grafitnom tehnikom i gasnom hromatografijom sa FID detekcijom utvrđeni su sadržaji sedam teških metala i policikličnih aromatskih ugljikovodika. Prilikom određivanja sadržaja teških metala korištene su metode: BAS ISO 11466:2000 i BAS ISO 11047:2000, a metoda BAS ISO 18287:2008 za sadržaj PAH-ova. Sadržaji su komparirani sa graničnim vrijednostima iz Pravilnika o utvrđivanju dozvoljenih količina štetnih i opasnih materija u zemljištu i metode njihovog ispitivanja navedenim u Službenim novinama FBiH, br.72/2009.

**Ključne riječi:** *zagađenost, teški metali, PAH-ovi, AAS metoda, GC-FID*

## DISTRIBUTION OF JERUSALEM ARTICHOKE (*Helianthus tuberosus* L.) IN THE CANTON OF SARAJEVO

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### Abstract

Invasive plant species which also include Jerusalem artichoke (*Helianthus tuberosus* L.), are plants which come from other floral-geographical areas and in process of competition they suppress autochthonous gene by conquering available ecological systems. The spread of foreign species is becoming serious threat to the conservation of natural and semi-natural biotopes. Jerusalem artichoke belongs to the family Asteraceae and it originates from America. It is perennial plant with highly developed root in form of irregular tubers from which emerges each year more perennial stalks. It grows up to 3 m height. In our conditions it does not produce seed, it is reproducing vegetative by tubers. It is used for production of alcohol, in the pharmaceutical and food industry, as fodder and medicinal plant for more than 100 years. In the second half of 20<sup>th</sup> century it has become serious invasive species in all parts of Europe. On the EPPO list Jerusalem artichoke belongs to 34 dangerous invasive species. It is considered as weed of natural areas but it can occur on the agricultural soils and ruderal lands. The aim of this paper is to examine the prevalence of Jerusalem artichoke in the area of Sarajevo Canton. The obtained data can be used for its adequate and more successful suppression.

**Key words:** *invasive species, Jerusalem artichoke, Sarajevo*

## RASPROSTRANJENOST ČIČOKE (*Helianthus tuberosus* L.) NA PODRUČJU KANTONA SARAJEVO

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### Sažetak

Invazivne biljne vrste u koje spada i čičoka (*Helianthus tuberosus* L.), su biljke koje potiču iz drugih florno-geografskih oblasti, a u procesu kompeticije potiskuju autohtoni genofond osvajajući raspoložive ekološke sisteme. Širenje stranih vrsta postaje ozbiljna prijetnja očuvanju prirodnih i poluprirodnih biotopa. Čičoka pripada porodici glavičoka (Asteraceae), a vodi porijeklo iz Amerike. To je višegodišnja biljka sa dobro razvijenim korijenom u obliku nepravilnih gomolja iz kojih svake godine izbija više jednogodišnjih stabljika. Naraste i do 3 m visine. U našim uslovima ne daje sjeme, razmnožava se vegetativno, gomoljima. Već više od 100 godina se koristi za proizvodnju alkohola, u farmaceutskoj i prehrambenoj industriji, kao krmna i ljekovita biljka. U drugoj polovini 20. vijeka postala je ozbiljna invazivna vrsta u svim dijelovima Evrope. Na EPPO listi se nalazi među 34 opasne invazivne vrste. Čičoka se smatra korovom prirodnih područja, ali se može javiti na oranicama i ruderalnim staništima. Cilj ovoga rada je ispitivanje rasprostranjenosti čičoke na području Kantona Sarajevo. Dobijeni podaci mogu poslužiti za njeno adekvatnije i uspješnije suzbijanje.

**Ključne riječi:** *invazivne vrste, čičoka, Sarajevo*

# WATER-LOGGING OF SOIL IS A TWO-EDGED SEASONAL PHENOMENON: COMBINED PHYSICAL-TECHNICAL SOLUTIONS

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## **Abstract**

The problem of water-logging resultant from the rise of ground water table level in soil can be applying the technology of combined drainage between the mole drainage and crossing type at an ideal depth of 1.5 m and a span of 1.5 m among the internal fabricated channels (tunnel), provided the clay rate therein to be 35% and up. The results have shown the great improvement in the physical properties of soil as the apparent density, aerial permeability and water conveyance. At the same times, there has been a possibility of benefiting from the ground water, when its level is not high in the soil, through closing up the tunnel and controlling them according to the status quo in the soil; since it is a water storage that should be benefited from, particularly if its content of salts is low.

**Key words:** *water logging, phenomenon, physical, technical solutions*

# VODOLEŽINE KAO DVOŠJEKLA SEZONSKA POJAVA: KOMBINIRANA FIZIČKO-TEHNIČKA RJEŠENJA

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## Sažetak

Problem vodoležina koje nastaju kao rezultat porasta nivoa podzemnih voda u tlu može se riješiti primjenom tehnologije kombinirane drenaže-lukobranske i poprečne, na idealnoj dubini od 1,5 m i s razmakom od 1,5 m između unutarnjih gotovih kanala (tunela), pod uvjetom da je procenat gline 35% i više. Rezultati su pokazali veliko poboljšanje fizičkih svojstava tla poput prividne gustoće, propusnosti zraka i transporta vode. U isto vrijeme, postoji mogućnost da se izvuče korist od podzemnih voda, kada njihova razina u tlu nije visoka, tako što će se zatvaranjem tunela one kontrolirati u skladu sa status quo u tlu; s obzirom da se radi o pohranjenoj vodi od koje bi se profitiralo, efekat bi bio bolji ako je sadržaj soli nizak.

**Ključne riječi:** *vodoležina, pojava, fizička i tehnička rješenja*

## SOIL ORGANIC CARBON STOCKS IN AGRICULTURAL SOILS IN THE REPUBLIC OF SERBIA

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### Abstract

This paper shows the assessment results of organic carbon stock in agricultural soils on the territory of the Republic of Serbia. The estimates for the calculation of content in t/ha were based on data from 577 sites and from 757 sites for calculation of the content in %. There are various types of soils, climate and altitude on a soil sampling sites. The results show that the average rate of soil organic carbon for the top 30 cm depth of the agricultural soils is 68.99 t/ha, or 1.58%, that belongs to the class of low soil organic carbon content (1-2%). We estimated organic carbon stocks of the agricultural soils of the Republic of Serbia at 1.98% from the total estimated value of the contents on agricultural land in Europe. The methodology applied in this research allows an estimation that is comparable to the international level.

**Key words:** *organic carbon, agricultural soils, stocks*

## REZERVE ORGANSKOG UGLJENIKA U POLJOPRIVREDNOM ZEMLJIŠTU REPUBLIKE SRBIJE

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### Sažetak

U radu su prikazani rezultati procene rezerve organskog ugljenika u poljoprivrednom zemljištu na prostoru Republike Srbije. Procena je rađena na osnovu podataka sadržaja organskog ugljenika sa ukupno 577 lokaliteta za izračunavanje sadržaja u t/ha i 757 lokaliteta za izračunavanje sadržaja u %. Lokaliteti obuhvataju različite tipove zemljišta i pod uticajem su različitih klimatskih faktora i nadmorske visine. Rezultati istraživanja pokazuju da srednja vrednost sadržaja organskog ugljenika do 30 cm dubine u poljoprivrednom zemljištu iznosi 68,99 t/ha, odnosno 1,58 % što pripada klasi niskog sadržaja (1-2%). Procena sadržaja rezerve organskog ugljenika na ukupnoj površini poljoprivrednog zemljišta Republike Srbije iznosi 1,98% od ukupne procenjene vrednosti sadržaja za poljoprivredna zemljišta Evrope. Metodologija primenjena u okviru ovog istraživanja je omogućila dobijanje rezultata uporedivih na međunarodnom nivou.

**Ključne riječi:** *organski ugljenik, poljoprivredno zemljište, rezerva*

## SOILS OF LJUBLJANA MUNICIPAL FOREST

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### Abstract

In municipal forests of Ljubljana (Rožnik area) we made pedological analysis with the aim to classify the soils and to investigate different characteristics of soils. Our goals were to determine the degree of contamination with heavy metals (nickel (Ni), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), zinc (Zn)) and identification of areas where pollution exceeds the permissible limits. For the purpose of the research we systematically choose 31 plots (a grid of 500 m × 500 m) and took soil samples from the depth of 0-30 cm. Results show that values for all heavy metals analysed in soil samples were below limiting value except for lead at one plot, where it exceeds warning value (100 mg kg<sup>-1</sup>). Therefore the main findings indicate that forest soils in Ljubljana are unpolluted with the nickel (Ni), cadmium (Cd), chromium (Cr), copper (Cu) and zinc (Zn) and moderately polluted with lead (Pb) which originates from the time of leaded fuel. Soils in Ljubljana municipal forests have proved to be well preserved and represent one of the cleanest environment in the city of Ljubljana.

**Key words:** *heavy metals, urban forests, soil, environment quality assessment*

## TLA URBANE ŠUME LJUBLJANE

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### Sažetak

U urbanim šumama Ljubljane (područja Rožnika) napravljene su pedološke analize s ciljem klasifikacije i identifikacije osobina tla. Nastojali smo determinirati stepen kontaminacije tla teškim metalima (niklom (Ni), kadmijumom (Cd), hromom (Cr), bakrom (Cu), olovom (Pb) i cinkom (Zn)) i identifikovati područja gdje je zagađenje veće od dozvoljenih graničnih vrijednosti. U svrhu ovog istraživanja sistematski su izabrane 31 površina (mreža 500m x 500 m) i uzeti uzorci tla od 0 do 30 cm dubine. Rezultati pokazuju da su vrijednosti svih teških metala analiziranih uzoraka tla bile ispod dozvoljenih graničnih vrijednosti, izuzev za olovo na jednoj od analiziranih površina koje je prelazilo upozoravajuće vrijednosti (100 mg kg<sup>-1</sup>). S tim u vezi, glavni podaci ovog istraživanja upućuju da šumska tla Ljubljane nisu zagađena s niklom (Ni), kadmijumom (Cd), hromom (Cr), bakrom (Cu) i cinkom (Zn), a umjereno su zagađena olovom (Pb) koji vodi porijeklo iz vremena kada se koristilo gorivo sa olovom. Tla urbanih šuma Ljubljane su se pokazala dobro očuvana i predstavljaju jedan od najčistijih prostora grada Ljubljane.

**Ključne riječi:** *teški metali, urbane šume, tlo, ocjena kvaliteta okoliša*

**FIELD TRIP  
OF THE 9<sup>th</sup> CONGRESS OF  
SOIL SCIENCE SOCIETY OF  
BOSNIA AND HERZEGOVINA**

***NAUČNO/ZNANSTVENO-STRUČNA  
EKSKURZIJA  
9. KONGRESA UDRUŽENJA ZA  
PROUČAVANJE ZEMLJIŠTA/TLA U  
BOSNI I HERCEGOVINI***



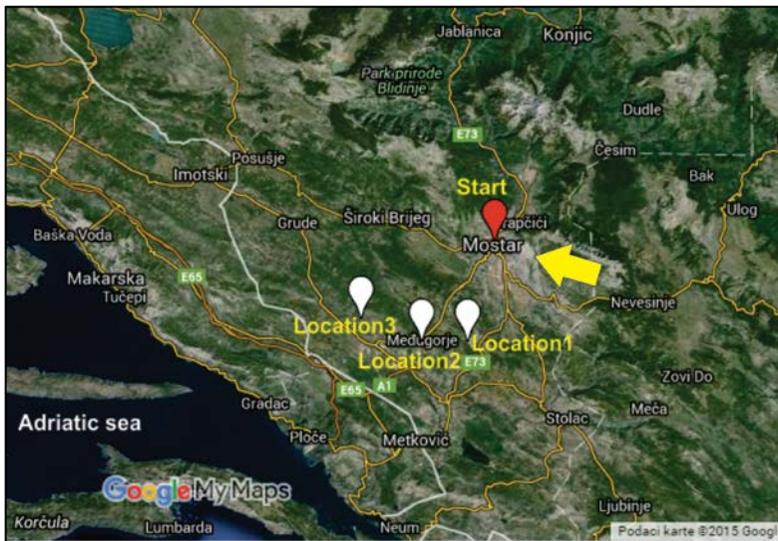
## - Field Trip Reader -

### Area of visit West Herzegovina, Municipalities of Citluk and Ljubuski November 25<sup>th</sup> 2015

#### Introduction

*Terra Rossa* (red soil) is a type of soil developed on limestones and dolomites within the area of the sub-Mediterranean part of Herzegovina. This is one of the most important soil types in the region, typical for the geological substrate, climate and geomorphology. They are considered a lifeblood of Herzegovina's agricultural and vine production and it's one of the most specific landmarks. Restrictions regarding production are mainly related to their depth (shallow soils), contents of the skeleton (skeletal and rocky) and proneness to erosion by water and wind (high speeds from the north). Soil scarcity in this area has caused this soil type to be cultivated since the beginning of the agricultural development, by clearing rocks and creating a fertile oasis for growing certain crops.

**The objective of this field trip** is to show participants a modern way to cultivate these shallow and rocky soil for growing grapes (site 1) and olives (site 3), as well as to present the example of a typical *Terra Rossa* developed on flysch substrate. Flysch substrates usually appear sporadically in Karst areas and represent their green oases.



**Figure 1.** Map of the planned route showing the locations of anthropogenic red soils on limestones and dolomites used as vineyards (**Location 1**), olive production (**Location 3**) and Luvisol from *Terra Rossa* on calcareous supstrate (**Location 2**)  
(link: <https://www.google.com/maps/d/u/0/edit?mid=z3KMZZATpyXY.kQIjSQGaZbpo>)

## About *Terra Rossa*

In the former Yugoslavia, *Terra Rossa* was extensively studied by many authors such as Skoric, Filipovski, Ciric (1985) and it remained as an interesting subject to study by younger authors in the present time, such as Custovic, (1987), Coric (2009) and Durn (2014) and others. According to National classification system it was classified as cambic soils within terrestrial (automorphous) section. According to WRB classification, *Terra Rossa* is located in the reference group of Cambisols and is called Rodic Cambisols (WRB for Soil Resources, 2014).

*Terra Rossa* on limestone and dolomite is a soil of the Mediterranean and sub-Mediterranean areas with ochric humus horizon ( $A_{oh}$ ) that lies directly above cambic ( $B_{tz}$ ) horizon, which has a red color (2.5 YR and 10R hue, chroma > 3). It is formed on pure limestones and dolomites that are karstified, but the soil is non-carbonated. Texture class is usually heavier than loamy, and the structure is stable polyedric.

### Subunits of *Terra Rossa* in National classification system:

<b>Subtype</b>	<b>Subgroup</b>	<b>Form</b>
<i>According to the level of development</i>	<i>According to depth</i>	<i>According to texture</i>
1. Typical	Shallow < 35 cm	Loamy
2. Lesivated	Medium deep 35-70 cm	Clayey-loamy
	Deep > 70 cm	Clayey

Pavicevic (1962), states that *Terra Rossa* is related to the Mesozoic limestone and dolomite. According to the same author, Cretaceous limestone, on which the most typical *Terra Rossas* is formed, dominate coastal parts of the Dalmatian, Herzegovinian and Montenegrin karst. These limestones contain less residuum than Triassic and Jurassic ones. Formation of *Terra Rossa* is associated only with those limestones which have red residues, with a narrow  $SiO_2:R_2O_3$  ratio (1.3-1.5) (Filipovski and Ciric, 1963). In extreme cases, it may be formed on other substrates, but in this case are much less typical. When it comes to the relief, *Terra Rossa* usually occur on slopes of hilly and mountainous terrain, but also on the various forms of karst terrain (sinkholes, bays, etc.), where they are accumulated by transport and deposition from higher terrain. Typical processes are increasing with higher altitude and moving away from the sea.

*Terra Rossa* are soils formed in the specific climate conditions. Their formation requires average annual temperature around 15°C and amount of the rainfall around 1,200 mm/year (Huang, 1967). It is also very important to mention the importance of the northern and southern winds. Bora (Bura) is a strong, cold and dry wind blowing at high speeds in the fall, winter and early spring. It affects the very rapid drying of the soil and thereby makes the climate considerably drier than it is shown by the amount of rainfall. In addition, the power and speed of this wind causes large amounts of fine particles of dry soil to be eroded and carried over long distances. Scirocco (Jugo) has lower strength and intensity compared to Bora and is more favorable for vegetation, since it is warmer and more humid.

In addition to wind erosion and the slow process of soil formation, soil scarcity of the karst region is the consequence of water erosion, which is very strong in this area and appears in two different ways—surface erosion on slopes and karst or deep erosion, where the soil is sinking into the geological substrate. What little soil that is left is run-off by the denudation processes in the lower relief positions, often forming deep deposits, or remains on site in the cracks or sinkholes, forming a shallow profile in combination with a bare limestone substrate.

The human impact in this area is particularly important. Due to the limitations and scarcity of arable land, Herzegovinian peasants knew to appreciate every inch of arable land for thousands of years and invest the maximum effort to make it as productive as possible. Anthropogenization of karst terrains is done to this day in order to increase the arable land area. Deep ploughing and high doses of organic and mineral fertilizers make these agricultural soils highly anthropogenized.

The main morphological property of *Terra Rossa* is the presence of red color as a result of process called rubification, e.g. processes which suit the formation of mineral Hematite instead of Goethite. Although they are texturally classified as heavy soils, *Terra Rossas* have good physical properties, mainly due to their adsorption capacity (9-13  $\text{cmol}_{(+)}$   $\text{kg}^{-1}$ ) and the degree of base saturation (> 95%), among which mainly  $\text{Ca}^{2+}$ , and high stability of coagulated Fe and Al gels and their ability to cement the other particles. With usually large organic matter content, as a result of their intensive fertilization under tobacco production, all these factors affect the establishment of a favorable relationship between soil water and air. They are characterized by low content of available  $\text{P}_2\text{O}_5$  and moderate content of  $\text{K}_2\text{O}$ . Ability to hold water depends on the profile depth. According to Gracanin (1946), typical *Terra Rossa* usually has a neutral or slightly alkaline reaction. Higher acidity is characteristic for illimerised *Terra Rossa*. The appearance of acid reaction is a sign of the metamorphosis of these soils.

## LOCATION 1: VINEYARD BLIZANCI, ANTHROPOGENIZED TERRA ROSSA-RIGOSOL

Vineyard „Blizanci“ has been established in 1984 and the preparation activities lasted for a year. The total planted area is 90 hectares, and varieties that are grown are „Zilavka“ as the leading variety (more than 70%) and other cultivars are „Smederavka“, „Bena“ and „Krkosija“. According to the soil map of the municipality of Citluk (Kurtovic, 1978), these soils are classified as *Terra Rossa*, very shallow and very rocky, on limestone. In the absence of arable land, the man on karst fought for every inch of the ground for thousands of years, by manually clearing the soil of bushes and roots, extracting stones and very often bringing fertile soil in sacks, sometimes from the great distances, which was added to the existing soil pool. This is how the conditions were made for agricultural production. In order to protect the soil from erosion, terrain was terraced using the same stone extracted from the soil during clearing, which was then raised as a stone fence/wall, thus creating the unique and distinctive landscapes.

Vineyard Blizanci has been established on the similar way, with only difference that the clearing of the terrain, extraction of rocks and grading was performed with heavy machinery, excavators, bulldozers and rippers (special knives cutting through the depth of 70 cm and ejecting rocks to the surface). What makes this vineyard unique is the surface covered with rocks. This stone mulch protects the soil from evaporation and erosion, while at the same time it enhances the effect of solar radiation, especially to, under normal conditions, shaded parts of the plant.

**Table 1.** Physical and chemical properties of Anthropogenic Terra Rossa - Rigosol

Horizon	Depth (cm)	Bulk density g cm <sup>-3</sup>	Porosity (%)	0,33 bar %	Textural composition (%)			pH		Humus %	Total N %	C/N
					2,0-006	0,06-0,002	< 0,002	H <sub>2</sub> O	KCl			
Ap	0-10	1,11	55,78	35,7	11,1	51,58	37,3	6,3	5,4	2,37	0,14	9,8
Brz	10-30	1,28	50,0	37,6	15,4	52,4	32,2	7,0	6,0	1,48	0,10	8,5
Brz	30-70	1,39	45,7	40,9	11,1	48,76	40,18	7,2	6,1	1,13	0,06	10,9



**Figure 2.** Cultivated soil on rocky limestone substrate, vineyard Blizanci

**Table 2.** Adsorption properties according to Kappen and total amount of oxides (silicate analysis) Antropogenic Terra Rossa - Rigosol

Hor.	Depth cm	meqv/100g of soil			%	Oxide content % from 0-25 cm							
		S	T-S	T		V	SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /R <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	MgO
Ap	0-10	16,9	9,9	26,8	59,4	52,2	25,8	1:2	7,9	17,9	1,1	0,6	20,4
Brz	10-30	24,4	5,9	30,2	80,6								
Brz	30-70	12,9	14,3	27,3	67,5								

A more favorable ratio of textural elements in relation to the uncultivated soils is a result of stone extraction and mixing of horizons during cultivation. Thus, rock content after cultivation is decreased and ranges between 20-55% vol., compared to 2/3 volume of rock in uncultivated soils. The situation is improved in the surface layer in particular, where the stone was completely extracted in some cases.

As a consequence of mixing, texture particles ratio is uniform throughout the depth compared to heavier mechanical composition in the deeper layers of the same uncultivated soils.

**Table 3.** Quantitative balance of the soil by layers based on Partial Bulk density measurement (PBd)

Measurement in	No of profile	Depth in cm	Partial Bulk density (PBd in t/m <sup>3</sup> )	Quantity of the soil (t/ha)	Total quantity of the soil (t/ha)
Natural soil	1	0-10	0,51	510	2020
		10-35	0,34	850	
		35-55	0,33	660	
	2	0-12	0,73	876	1865
		12-35	0,43	989	
Regosol	1	0-20	0,36	720	3960
		20-40	0,95	1900	
		40-60	0,42	840	
		60-80	0,25	500	
	2	0-20	0,10	200	2440
		20-40	0,57	1140	
		40-60	0,35	700	
		60-80	0,20	400	

## LOCATION 2: MEDJUGORJE, CITLUK – LUVISOL FROM *TERRA ROSSA* ON CALCAREOUS SUPSTRATE

In this part of Herzegovina, the common substrates are clastic Eocene sediments represented with calcareous sandstone (calcareenites), conglomerate and marl. Particularly widespread are calcareous sandstones, whose lime arenites are rapidly weathered into the reddish materials and as such are classified as *Terra Rossa*. (Coric, 2001). According to the soil map of the municipality of Citluk (1978) these soils are classified as anthropogenized reddish-brown soils on flysch-„flysch *Terra Rossas*”. According to Kurtovic (1973), herein the substrate decomposition products are more or less mixed with real red materials originating from limestone, thus forming *Terra Rossa* which is significantly different from typical ones according to their characteristics. These are texturally lighter soils in the surface horizons, while the deeper horizons are much heavier, which is reflected in the water-physical properties. Sandy debris of calcarenites make the soil light textured, and the soil with clearly differentiated A-E-Bt-R horizons is developed due to clear differentiation of particles under humid climate conditions (Coric, 2009). Chemical properties of these soils are significantly influenced by the degree of anthropogenization. This deep soil used to be very suitable for tobacco production, but nowadays is largely used for vineyards.

**Table 4.** Physical and chemical properties of Luvisol from *Terra Rossa-Medjugorje, Citluk* (Coric, 2001)

Hor.	Depth (cm)	Textural composition (%)					Texture	pH		Humus g kg <sup>-1</sup>	Total N g kg <sup>-1</sup>
		2-0,2	0,2-0,05	0,05-0,02	0,02-0,002	< 0,002		H <sub>2</sub> O	KCl		
Ap	0-12	12,0	38,6	25,2	9,2	15,0	SL	5,7	4,8	0,7	0,04
E	20-32	10,2	40,8	19,6	8,8	20,6	L	5,2	4,1	0,3	
Btg	32-84	10,4	21,8	21,0	8,6	38,2	CL	5,1	3,9	1,9	0,02

**Table 5.** Adsorption properties of Luvisol from *Terra Rossa-Medjugorje, Citluk* (Coric, 2009)

Hor.	Depth cm	Adsorbed cations (cmol kg <sup>-1</sup> )									CEC	BS (%)	
		Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	IBK	Mn <sup>2+</sup>	Fe <sup>3+</sup>	Al <sup>3+</sup>	H <sup>+</sup>			IKK
Ap	0-12	8,68	0,66	0,01	0,81	10,16	0,10	0,00	0,02	0,01	0,13	10,29	99
Btg	32-84	11,03	1,73	0,01	0,38	13,5	0,01	0,00	1,64	0,34	1,99	15,14	87

**Table 6.** Semi-quantitative mineral composition of the <2mm fraction of B horizons of the investigated soil profiles. Phyllos.+am.=phyllosilicates+amorphous inorganic compound, +=mineral is present in the sample. ?=mineral is probably present in the sample but due to the low content and/or overlapping of diffraction peaks cannot be confirmed with certainty. (Durn et al., 2014)

Profile	Depth (cm)	Quartz (%)	Plagioclase (%)	K-feldspar (%)	Hem.+ Goeth. (%)	Anatase	Gibbsite (%)	Phyllos.+ am. (%)
5	32-84	60	<1	<1	4	?	+	30

**Table 7.** Semi-quantitative mineral composition of the <math><2\mu\text{m}</math> fraction of B horizons of the investigated soil profiles. +=mineral is present in the sample. ?=mineral is probably present in the sample but due to the low content and/or overlapping of diffraction peaks cannot be confirmed with certainty. C/V=Mixed-layer chlorite-vermiculite (Durn et al., 2014)

Profile	Depth (cm)	Quartz (%)	Plagioclase (%)	K-feldspar (%)	Hem.-Goeth. (%)	Gibbsite (%)	Anatase	Kaolinite	Smectite	Vermiculite	Illitic material	Mixed-layer clay mineral	Am. matter
5	32-84	9	?	-	8	-	?	x	xxx	-	?	x	x



**Figure 3.** Terra Rossa on flysch

### LOCATION 3: OLIVE ORCHARD „GREDA”, MOSTARSKA VRATA - ANTHROPOGENIZED *TERRA ROSSA* – RIGOSOL

This orchard has been successively built since 2009. Total area under olive trees is around 40 hectares. The only modern olive oil refinery in Bosnia and Herzegovina has been built close to the orchard. Unlike vineyards Blizanci, in this case the modern machinery was used to cultivate the soil on the rocky surfaces. In order to cultivate this area, the following combination of operations was used: ripping, use of hammer excavator to break large fragments of rocks, collection and disposal of accumulated roots and large rocks, and use of the crusher, which grinds rock fragments up to the size of pebbles and sand and flattens the terrain. Grinding can be repeated after the passage of a special chisel plow with a spring that pulls out the rocks from deeper layers on the surface.



*Figure 4. Terra Rossa on the rocky limestone surface before and after cultivation, Olive orchard „Greda” Mostarska vrata*

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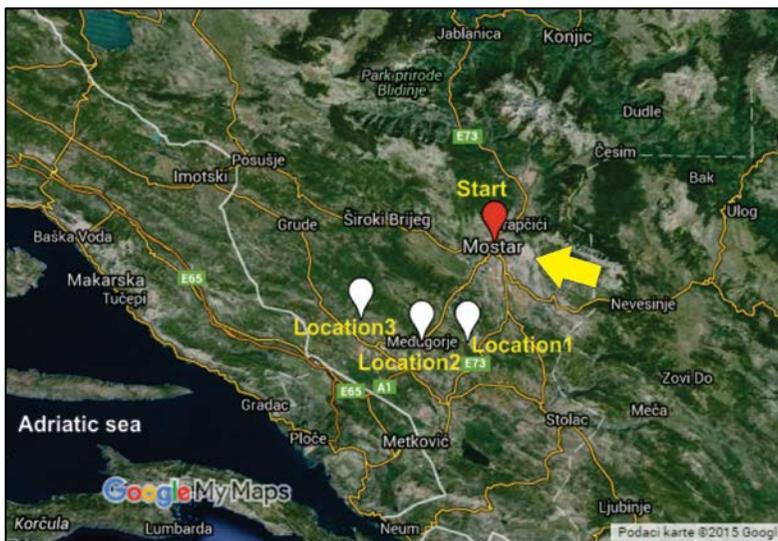
## - Vodič za ekskurziju -

### Zapadna Hercegovina, područje općina Čitluk i Ljubuški 25. novembar/studeni 2015. godine

#### Uvod

Područje interesovanja obuhvata dijelove zapadne Hercegovine, a u užem smislu lokacije koje pripadaju općinama Čitluk i Ljubuški. Prepoznatljivi karstni elementi ovog područja su uočljivi cijelom dionicom puta, a prati ih njima svojstven tip zemljišta - crvenica. Crvenice predstavljaju „žilu kucavicu” poljoprivredne i vinogradarske proizvodnje Hercegovine, kao i jedno od glavnih obilježja pejzaža. S tim u vezi, crvenice su naročito važan element pedološkog nasljeđa i kao takve zaslužuju poseban tretman u planiranju i upravljanju.

**Ekskurzija ima cilj** da se učesnicima približe savremeni načini kultiviranja kamenitih i stjenovitih zemljišta za uzgoj vinove loze i maslina, te pokažu primjeri tipičnih (kredskih) i netipičnih crvenica razvijenih na sporadično zastupljenom flišnom supstratu, kome je svojstvena bujnija vegetacija i izgled „zelenih oaza” u karstnim područjima.



*Slika1. Mapa planiranog puta u okviru ekskurzije i prikaz lokacija antropogeneziranih crvenica na krčenjaku korištenih u vinogradarstvu (Lokacija 1), maslinarstvu (Lokacija 3) i lesiviranog tla iz crvenica na vapnenim kalkarenitima (Lokacija 2)*

(link: <https://www.google.com/maps/d/u/0/edit?mid=z3KMZZATpyXY.kQIjSQGaZbpo>)

## Općenito o crvenicama

Crvenice (*Terra Rossa*) su tema interesovanja brojnih istraživača iz inostranstva i sa prostora bivše Jugoslavije, među kojima je značajno pomenuti od starije generacije Škorića, Filipovskog i Čirića, a od mlađe Čustovića (1987), Čorić (2009) i Durn (2014). Nacionalna klasifikacija svrstava ih u klasu *kambičnih* i razdjel *automorfnihi tala* (Škoriću i dr., 1985), a prema WRB-u crvenice se nalaze u referentnoj grupi *Cambisol* i nazivaju se *Rodic Cambisol* (WRB for Soil Resources, 2014).

Crvenica na krečnjaku i dolomitu je tlo mediteranskog i submediteranskog područja sa ohričnim humusnim horizontom ( $A_{oh}$ ) koji leži neposredno iznad kambičnog ( $B_{rz}$ ) horizonta i koji ima crvenu boju (2,5 YR i 10R hue, a value i chroma  $>3$ ). Formira se na čistim krečnjacima i dolomitima koji su karstificirani, a solum je nekarbonatan. Granulometrijski sastav teži je od ilovastog, a struktura je stabilna poliedrična.

### Podjela na niže klasifikacijske jedinice:

<b>Podtip</b>	<b>Varijitet</b>	<b>Forma</b>
<i>Prema stepenu razvoja</i>	<i>Prema dubini tla</i>	<i>Prema teksturi tla</i>
1. Tipična	Plitka < 35 cm	Ilovasta
2. Lesivirana	Srednje duboka 35-70 cm	Glinovito ilovasta
	Duboka > 70 cm	Glinasta

Crvenica je genetički vezana za jedre mezozojske krečnjake i dolomite (Pavičević, 1962), među kojima u primorskom dijelu (Dalmaciji, Hercegovini i Crnoj Gori) preovladavaju kredne formacije koje daju glavni karakter crvenicama i sadrže manje rezidijuma nego trijasni i jurski krečnjaci i dolomiti. Postanak crvenica se povezuje samo sa onim krečnjacima koji imaju crveni rezidijum sa uskim odnosom  $SiO_2:R_2O_3$  u granicama 1,3-1,5 (Filipovski i Čirić, 1963). Izuzetno crvenice se mogu obrazovati i na drugim supstratima, ali u tom slučaju su mnogo manje tipične. Kada je riječ o reljefu, crvenice se obično pojavljaju na nagibima, brežuljkastom do brdovitom terenu, ali i na drugim karstnim oblicima (vrtače, uvale i sl.) gdje su nagomilane prijenosom i taloženjem sa viših terena. Sa povećanjem nadmorske visine i udaljavanjem od mora netipični procesi u crvenicama sve su više izraženi.

Crvenice su, također, klimatozonalna tla za čiji je nastanak potrebna srednja godišnja temperatura oko  $15^{\circ}C$  i godišnja suma padavina  $\geq 1.200$  mm (Huang, 1967). Geneza ovih tala je uslovljena djelovanjem vjetrova bure i juga. Bura je jak, hladan i suh vjetar koji puše velikom brzinom u jesen, zimu i rano proljeće.

Utiče na vrlo brzo sušenje tla i time klimu čini znatno suhljom nego što bi se moglo očekivati s obzirom na količinu padavina. Osim toga, snagom i brzinom puhanja odnose se velike količine najsitnijih čestica suhog tla na velika rastojanja. Jugo je povoljniji vjetar za vegetaciju, jer je topliji i vlažniji te donosi kišu, a i slabijeg je intenziteta. Pored podložnosti eolskoj eroziji, te sporog procesa obrazovanja tla, siromaštvo krša sa tlom je posljedica i procesa vodne erozije koja je vrlo izražena i na ovom području djeluje u dva pravca, po nagibu-površinska i kroz samu geološku podlogu-karstna ili dubinska erozija. I ono malo tla što se obrazuje denudacionim procesima se spira u niže reljefske položaje, obrazujući često duboke nanose ili se ispire u pukotine ili ponore dok se na mjestu stvaranja formira plitak profil u kombinaciji sa ogoljenom krečnjačkom podlogom.

Uticao čovjeka na ovom području je naročito značajan. Zbog ograničenosti i skučenosti obradivih površina, hercegovački seljak je hiljadama godina znao cijeliti svaki pedalj obradivog zemljišta, pa je uložio maksimum truda da ga učini što produktivnijim. U želji za povećanjem obradivih površina antropogenizacija kamenjara se vrši i danas. Duboka obrada, visoke doze organskih i mineralnih gnojiva daju ovim poljoprivrednim tlima visok stepen antropogenizacije.

Karakteristično morfološko obilježje crvenica je boja, koja je posljedica procesa rubifikacije. Mada su crvenice teška glinovita tla, ona ipak imaju dobra fizička svojstva, čemu doprinose kapacitet adsorpcije ( $9-13 \text{ cmol}_{(+)} \text{ kg}^{-1}$ ) i stepen zasićenosti bazama ( $>95\%$ ) među kojima dominira  $\text{Ca}^{2+}$ , te velika stabilnost koaguliranih gela Fe i Al i njihova sposobnost cementiranja drugih čestica. Uz veliki sadržaj organske materije, koji je karakterističan za crvenice zbog intenzivne gnojidbe za proizvodnju duhana, što upućuje na vrlo povoljan odnos između vode i vazduha. Karakterišu se niskim sadržajem pristupačnog  $\text{P}_2\text{O}_5$  i osrednjim sadržajem  $\text{K}_2\text{O}$ . Sposobnost držanja vode zavisi od dubine profila. Tipične crvenice imaju najčešće neutralnu ili slabo alkalnu reakciju, a izraženijom kiselošću se odlikuju ilimerizovane crvenice. Kisela reakcija je znak metamorfoze ovih tala.

## LOKALITET 1: VINOGRAD „BLIZANCI”, ANTROPOGENIZIRANE CRVENICE – RIGOSOLI

Vinograd „Blizanci” je podignut 1984. godine, a priprema terena je trajala oko godinu dana. Ukupna zasađena površina iznosi 90 ha. Sorte koje se uzgajaju su žilavka (>70 %), smederevka, bena i krkošija. U „Pedološkoj karti opštine Čitluk” iz 1978. godine ova tla su tipološki svrstana kao *crvenice vrlo plitke i plitke jako stjenovite na jedrim krečnjacima*. Čovjek se na kršu hiljadama godina borio za svaki pedalj zemlje, ručno krčio teren od makije i korijenja, vadio kamen i vrlo često u džakovima nanosio zemlju stvarajući uslove za poljoprivrednu proizvodnju. Da bi zaštitilo tlo od erozije terasirao je teren, a od gomila izvađenog kamena podizao bi kamene ograde/suhozide, na taj način stvarajući prepoznatljive krajolike.

Slično se dešavalo i pri podizanju vinograda „Blizanci”, s tom razlikom da se krčenje terena, odnosno vađenje kamena i ravnanje terena obavljalo sa teškim mašinama, bagerima, buldožerima i riperima (specijalni noževi koji do dubine od 70 cm rastresaju tlo i izbacuju kamenje na površinu). Vinograd je specifičan po velikim površinama prekrivenim kamenjem, koji ima funkciju malča i štite tlo od isparavanja i erozije.

**Tabela 1.** Fizikalno-hemijska svojstva antropogenizirane crvenice – rigosola

Hor.	Dubina (cm)	Vsg g cm <sup>-3</sup>	P (%)	0,33 bar %	Tekstura (%)			pH		Humus %	Ukupni N %	C/N
					2,0-006	0,06-0,002	< 0,002	H <sub>2</sub> O	KCl			
Ap	0-10	1,11	55,78	35,7	11,1	51,58	37,3	6,3	5,4	2,37	0,14	9,8
Brz	10-30	1,28	50,0	37,6	15,4	52,4	32,2	7,0	6,0	1,48	0,10	8,5
Brz	30-70	1,39	45,7	40,9	11,1	48,76	40,18	7,2	6,1	1,13	0,06	10,9



**Slika 2.** Kultivirano tlo na stjenovitim krečnjačkim površinama u vinogradu Blizanci

**Tabela 2.** Svojstva adsorpcijskog kompleksa (Kappen) i ukupan sadržaj oksida (silikatna analiza) antropogeniziranih crvenica–rigosola

Hor.	Dubina cm	meqv/100g tla			%	Sadržaj u % od 0-25 cm							
		S	T-S	T		V	SiO <sub>2</sub>	R <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub> /R <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	Al <sub>2</sub> O <sub>3</sub>	CaO	MgO
Ap	0-10	16,9	9,9	26,8	59,4	52,2	25,8	1:2	7,9	17,9	1,1	0,6	20,4
Brz	10-30	24,4	5,9	30,2	80,6								
Brz	30-70	12,9	14,3	27,3	67,5								

Kao posljedica vađenja kamena i miješanja horizonata prilikom kultivacije, stvoren je povoljniji odnos teksturnih elemenata u odnosu na nekultivisane kamenjare. Tako je smanjen sadržaj kamenja u solumu čiji se udio nakon kultivacije kreće u rang 20-55% vol, u odnosu na udio kamenja od 2/3 zapremine u nekultivisanim tlima. Posebno je poboljšana situacija u površinskom sloju gdje je na pojedinim površinama kamen potpuno istrijebljen.

Jednako tako miješanjem, teksturni sastav fine zemlje ili sitnice je ujednačen po dubini u odnosu na teži mehanički sastav sitnice u dubljim slojevima na nekultivisanom tlu.

**Tabela 3.** Vertikalna distribucija volumnih gustina tla: analiza parcijalnih gustina antropogeniziranih crvenica–rigosola

Mjereno u	Profil	Dubina	Parcijalna gustoća (PBd u t/m <sup>3</sup> )	Količina tla (t/ha)	Ukupna količina tla (t/ha)
Prirodno tlo	1	0-10	0,51	510	2020
		10-35	0,34	850	
		35-55	0,33	660	
	2	0-12	0,73	876	1865
		12-35	0,43	989	
Rigosol	1	0-20	0,36	720	3960
		20-40	0,95	1900	
		40-60	0,42	840	
		60-80	0,25	500	
	2	0-20	0,10	200	2440
		20-40	0,57	1140	
		40-60	0,35	700	
		60-80	0,20	400	

## LOKALITET 2: MEĐUGORJE, ČITLUK - LESIVIRANO TLO IZ CRVENICE NA VAPNENIM KALKARENITIMA

U ovom dijelu Hercegovine kao geološka podloga nalaze se klastične naslage eocena, a predstavljene su karbonatnim pješčenjacima (kalkarenitima), konglomeratima i laporima. Posebno značajno su rasprostranjeni karbonatni pješčenjaci koji se kao vapneni areniti ubrzano troše u crvenkasti materijal, pa su zbog toga i ova tla svrstavana u crvenice (Ćorić, 2001). Naime, u *Pedološkoj karti općine Čitluk* (Kurtović i sur. 1978) ova tla su tipološki svrstana kao crvenkastosmeđa antropogenizirana tla na flišu-tzv. „flišne crvenice“. Prema Kurtoviću (1973) na ovim supstratima produkti raspadanja su manje ili više izmiješani sa pravim crveničnim materijalom porijeklom sa vapnenca, formirajući na taj način crvenice koje se po osobinama bitno razlikuju od tipičnih. Po mehaničkom sastavu u površinskim horizontima to su lakša tla, u dubljim slojevima znatno teža što se ogleda i u vodno-fizikalnim osobinama. Pješčana trošina kalkarenita tlu daje više pjeskovite teksture, te zbog lakšeg diferenciranja u uvjetima humidne klime razvija se jako diferencirano tlo tipa građe A-E-Bt-R (Ćorić, 2009). Kemijske osobine ovih tala su pod utjecajem stupnja antropogenizacije. Ranije su se najčešće koristila u proizvodnji duhana, a sada su uglavnom pod nasadima vinograda.

**Tabela 4.** Fizikalno-kemijske značajke lesiviranog tla iz crvenice-Međugorje, Čitluk (Ćorić, 2001)

Hor.	Dubina (cm)	Mehanički sastav (%)					Teksturna oznaka po SSM	pH		Humus g kg <sup>-1</sup>	Ukupni N g kg <sup>-1</sup>
		2-0,2	0,2-0,05	0,05-0,02	0,02-0,002	< 0,002		H <sub>2</sub> O	KCl		
Ap	0-12	12,0	38,6	25,2	9,2	15,0	PI	5,7	4,8	0,7	0,04
E	20-32	10,2	40,8	19,6	8,8	20,6	I	5,2	4,1	0,3	
Btg	32-84	10,4	21,8	21,0	8,6	38,2	GI	5,1	3,9	1,9	0,02

**Tabela 5.** Adsorpcijske značajke lesiviranog tla iz crvenice-Međugorje, Čitluk (Ćorić, 2009)

Hor.	Dubina cm	Adsorbirani kationi (cmol (+) kg <sup>-1</sup> )										CEC	BS (%)
		Ca <sup>2+</sup>	Mg <sup>2+</sup>	Na <sup>+</sup>	K <sup>+</sup>	IBK	Mn <sup>2+</sup>	Fe <sup>3+</sup>	Al <sup>3+</sup>	H <sup>+</sup>	IKK		
Ap	0-12	8,68	0,66	0,01	0,81	10,16	0,10	0,00	0,02	0,01	0,13	10,29	99
Btg	32-84	11,03	1,73	0,01	0,38	13,5	0,01	0,00	1,64	0,34	1,99	15,14	87

**Tabela 6.** Semikvantitativna mineraloška analiza u frakciji <2mm B horizonta (32-84 cm); phyllos.+am=filosilikati+amorfnj anorganski dijelovi, +=mineral je prisutan u uzorku; ?=mineral je vjerovatno prisutan, ali s obzirom na malo učešće i/ili preklapanje 'pikova' ne može biti potvrđen sa sigurnošću (Duran i sur. 2014)

Profil	Dubina (cm)	Quartz (%)	Plagioclase (%)	K-feldspar (%)	Hem.+ Goeth. (%)	Anatase	Gibbsite (%)	Phyllos.+ am. (%)
5	32-84	60	<1	<1	4	?	+	30

**Tabela 7.** Semikvantitativna mineraloška analiza u frakciji <2mm B horizonta (32-84 cm):  
 +=mineral je prisutan u uzorku; ?=mineral je vjerovatno prisutan, ali s obzirom na malo  
 učešće i/ili preklapanje 'pikova' ne može biti potvrđen sa sigurnošću, C/V=miješani sloj  
 hlorit-vermikulit (Duran i sur. 2014).

Profil	Dubina (cm)	Quartz (%)	Plagioclase (%)	K-feldspar (%)	Hem.-Goeth. (%)	Gibbsite (%)	Anatase	Kaolinite	Smectite	Vermiculite	Illitic material	Mixed-layer clay mineral	Am. matter
5	32-84	9	?	-	8	-	?	x	xxx	-	?	x	x



**Slika 3.** Lesivirano tlo iz crvenice na vapnenim kalkarenitima

### **LOKALITET 3: MASLINJAK „GREDA” (MOSTARSKA VRATA) - ANTROPOGENIZIRANE CRVENICE – RIGOSOLI**

Maslinjak „Greda” je sukcesivno podizan od 2009. godine, a ukupan produktivna površina iznosi 40 ha. Uz podignuti maslinjak je izgrađena i veoma savremena uljara. Za razliku od vinograda „Blizanci“ na površinama ovog maslinika se koristila savremena mehanizacija za mljevenje kamena na stjenovitim površinama. Izvođenje kultivacije ovih kamenjara podrazumijeva kombinaciju ripovanje, upotrebe bagera čekićara za razbijanje velikih odlomaka stijena, skupljanje i odvoz nakupljenog korijenja i velikih stijena, te upotrebu drobilice koja sitni kamenje do veličine šljunka i pijeska, te ravna teren. Mljevenje se može ponavljati nakon prolaska specijalnog „šizel“ pluga sa oprugama koji vadi na površinu zaostalo kamenje iz dubljih slojeva.



*Slika 4. Kultivirano tlo na stjenovitim krečnjačkim površinama, maslinika „Greda“ Mostarska vrata (lijevo) i prirodan izgled terena prije privođenja (desno)*

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