University of Belgrade
Technical Faculty in Bor,
Mining and Metallurgy
Institute Bor

54th International October Conference on Mining and Metallurgy

PROCEEDINGS

Editors:
Ljubiša Balanović
Dejan Tanikić

18-21 October 2023, Bor Lake, Serbia

PROCEEDINGS,

54th INTERNATIONAL OCTOBER CONFERNCE

on Mining and Metallurgy

Editors:

Prof. dr Ljubiša Balanović

Prof. dr Dejan Tanikić

University of Belgrade, Technical Faculty in Bor

Technical Editor:

M. Sc. Miljan Marković

University of Belgrade, Technical Faculty in Bor

Publisher: University of Belgrade, Technical Faculty in Bor

For the publisher: Dean Prof. dr Dejan Tanikić

Circulation: 200 copies

CIP - Каталогизација у публикацији Народна библиотека Србије, Београд

622(082)(0.034.2)
669(082)(0.034.2)

INTERNATIONAL October Conference on Mining and Metallurgy (54 ; 2023 ; Borsko jezero)
Proceedings [Elektronski izvor] / 54th International October Conference on Mining and Metallurgy - IOC 2023, 18-21 October 2023, Bor Lake, Serbia ; [organized by] University of Belgrade, Technical Faculty in Bor and Mining and Metallurgy Institute Bor ; editors Ljubiša Balanović, Dejan Tanikić. - Bor : University of Belgrade, Technical Faculty, 2023 (Niš : Grafika Galeb). - 1 USB fleš memorija ; 1 x 1 x 5 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 200. - Preface / Ljubiša Balanović. - Bibliografija uz svaki rad.

ISBN 978-86-6305-140-9

a) Рударство -- Зборници b) Металургија -- Зборници

COBISS.SR-ID 126659849

Bor Lake, Serbia, October 18-21, 2023

Conference is financially supported by
The Ministry of Science, Technological
Development and Inovation
of the Republic of Serbia

Platinum Donors

ZIJIN SERBIA ZIJIN MINING

ZIJIN SERBIA ZIJIN COPPER DOO

SEVOJNO VALJAONICA BAKRA COPPER MILL

Gold Donors

HBIS GROUP HBIS SERBIA

Dundee PRECIOUS METALS AVALA

Silver Donor

trokuttestgroup

Exhibitions

Labtim

Altium

metalurg

MERIS

1969 ZAJEČAR FMT

REFRATEC

Friends of the Conference

DONAU LAB BEOGRAD

DONCAFÉ

LOLA INSTITUT

THE FOUNDATION 'B.SC. ENG. BOŠKO INJAC'

SCIENTIFIC COMMITTEE

Prof. Dr Dejan Tanikić *(Serbia) - president*
Prof. Dr Nada Štrbac *(Serbia) - vice-president*
Prof. Dr Radoje Pantović *(Serbia) - vice-president*

Dr Ana Kostov *(Serbia)*
Prof. Dr Adam Grajcar *(Poland)*
Prof. Dr Adina Negrea *(Romania)*
Dr Andrei Rotaru *(Romania)*
Prof. Dr Batrić Pešić *(USA)*
Dr Biserka Trumić *(Serbia)*
Prof. Dr Boštjan Markoli *(Slovenia)*
Dr Branislav Marković *(Serbia)*
Prof. Dr Cornelia Muntean *(Romania)*
Prof. Dr Daniela Grigorova *(Bulgaria)*
Prof. Dr Dejan Ivezić *(Serbia)*
Prof. Dr Desimir Marković *(Serbia)*
Prof. Dr Dimitris Panias *(**Greece**)*
Prof. Dr Dimitriu Sorin *(Romania)*
Prof. Dr Dmitry Vasilyev *(Russia)*
Dr Dragan Komljenović *(Canada)*
Prof. Dr Dragan Manasijević *(Serbia)*
Dr Dragan Milanović *(Serbia)*
Prof. Dr Dragan Milovanović *(Serbia)*
Prof. Dr Dragoslav Gusković *(Serbia)*
Prof. Dr Dušan Oráč *(Slovakia)*
Prof. Dr Duško Minić *(Serbia)*
Prof. Dr Endre Romhanji *(Serbia)*
Prof. Dr Essen Suleimenov *(Kazakhstan)*
Prof. Dr Farzet Bikić *(Bosnia and Herzegovina)*
Prof. Emeritus Fathi Habashi *(Canada)*
Prof. Dr Grozdanka Bogdanović *(Serbia)*
Prof. Dr György Kaptay *(Hungary)*
Prof. Dr Ivan Mihajlović *(Serbia)*
Prof. Dr Iveta Vaskova *(Slovakia)*
Prof. Dr Jakob Lamut *(Slovenia)*
Prof. Dr Jasmin Suljagić *(Bosnia and Herzegovina)*
Dr Jasmina Stevanović *(Serbia)*
Dr Jasna Stajić Trošić *(Serbia)*
Prof. Dr Jovica Sokolović *(Serbia)*
Prof. Dr Jožef Medved *(Slovenia)*
Prof. Dr Kaikun Wang *(China)*
Prof. Dr Karl Heinz Spitzer *(Germany)*
Prof. Emeritus Karlo Raić *(Serbia)*
Prof. Dr Kemal Delijić *(Montenegro)*
Prof. Dr Komnitsas Konstantinos *(Greece)*
Prof. Dr Kostas Matis *(Greece)*
Prof. Dr Krzysztof Fitzner *(Poland)*
Prof. Dr Luis Filipe Malheiros *(Portugal)*
Prof. Dr Milan Antonijevic *(Serbia)*
Prof. Dr Milan Trumić *(Serbia)*
Dr Mile Bugarin *(Serbia)*
Dr Milenko Ljubojev *(Serbia)*
Prof. Dr Milovan Vuković *(Serbia)*
Prof. Dr Mira Cocić *(Serbia)*
Mirjam Jan-Blažić *(Slovenia)*
Prof. Dr Mirjana Rajčić Vujasinović *(Serbia)*
Prof. Dr Mirko Gojić *(*Croatia*)*
Dr Miroslav Sokić *(Serbia)*
Prof. Dr Mirsada Oruč *(Bosnia and Herzegovina)*
Dr Nadežda Talijan *(Serbia)*
Prof. Dr Natalija Dolić *(*Croatia*)*
Prof. Dr Nedeljko Magdalinović *(Serbia)*
Prof. Dr Nenad Radović *(Serbia)*
Prof. Dr Nenad Vušović *(Serbia)*
Prof. Dr Nicanor Cimpoesu *(Romania)*
Prof. Dr Nobuyuki Masuda *(*Japan*)*
Prof. Dr Onuralp Yucel *(*Turkey*)*
Prof. Dr Pavel Broz *(*Czech Republic*)*
Prof. Dr Petr Solozhenkin *(*Russia*)*
Prof. Dr Petrica Vizureanu *(Romania)*
Dr Sun Zhongmei *(**China**)*
Prof. Dr Ridvan Yamanoglu *(*Turkey*)*
Prof. Dr Rodoljub Stanojlović *(Serbia)*
Prof. Dr Rositsa Paunova *(**Bulgaria**)*
Prof. Dr Sead Ćatić *(Bosnia* and *Herzegovina)*
Prof. Dr Sergey Krasikov *(*Russia*)*
Dr Slavomír Hredzák *(*Slovakia*)*
Prof. Dr Snežana Milić *(Serbia)*
Prof. Dr Snežana Šerbula *(Serbia)*
Prof. Dr Srba Mladenović *(Serbia)*
Dr Srećko Stopić *(Germany)*
Prof. Dr Stojan Groudev *(Bulgaria)*
Prof. Dr Sulejman Muhamedagić *(Bosnia and Herzegovina)*
Prof. Dr Svetlana Ivanov *(Serbia)*
Prof. Dr Tatjana Volkov-Husović *(Serbia)*
Prof. Dr Tomaš Havlik *(Slovakia)*
Prof. Dr Velimir Radmilović *(Serbia)*
Prof. Dr Velizar Stanković *(Serbia)*
Prof. Dr Vesna Grekulović *(Serbia)*
Dr Vladan Ćosović *(Serbia)*
Vladan Mihailović *(Serbia)*
Dr Vladan Kašić *(Serbia)*
Prof. Dr Vladimir Krstić *(Canada)*
Prof. Dr Vladislav Kecojević *(USA)*
Dr Walter Valery *(Australia)*
Prof. Dr Xuewei Lv *(China)*
Prof. Dr Yong Du *(China)*
Prof. Dr Žarko Radović *(Montenegro)*
Prof. Dr Zdenka Zovko Brodarac *(Croatia)*
Dr Zoran Stevanović *(Serbia)*
Prof. Dr Željko Kamberović *(Serbia)*

ORGANIZING COMMITTEE

Prof. dr Ljubiša Balanović, Full Professor *(UB TF Bor) - president*
Prof. dr Saša Stojadinović, Full Professor *(UB TF Bor) - vice-president*
Prof. dr Srba Mladenović, Full Professor *(UB TF Bor) - vice-president*
Dr Ana Kostov, Principal Research Fellow *(MMI Bor) - vice-president*

Prof. dr Nada Štrbac, *Full Professor (UB TF Bor)*
Prof. dr Dragan Manasijević, *Full Professor (UB TF Bor)*
Prof. dr Vesna Grekulović, *Full Professor (UB TF Bor)*
Prof. dr Đorđe Nikolić, *Full Professor (UB TF Bor)*
Prof. dr Milan Radovanović, *Full Professor (UB TF Bor)*
Prof. dr Marija Petrović Mihajlović, *Full Professor (UB TF Bor)*
Prof. dr Zoran Štirbanović, *Associate Professor (UB TF Bor)*
Prof. dr Milan Gorgievski, *Associate Professor (UB TF Bor)*
Prof. dr Saša Marjanović, *Associate Professor (UB TF Bor)*
Prof. dr Ivana Marković, *Associate Professor (UB TF Bor)*
Prof. dr Žaklina Tasić, *Associate Professor (UB TF Bor)*
Doc. dr Dejan Petrović, *Assistant Professor (UB TF Bor)*
Doc. dr Anđelka Stojanović, *Assistant Professor (UB TF Bor)*
Doc. dr Uroš Stamenković, *Assistant Professor (UB TF Bor)*
Dr Jasmina Petrović, *Assistant with PhD (UB TF Bor)*
Vladimir Nikolić, *Assistant (UB TF Bor)*
Milica Zdravković, *Assistant (UB TF Bor)*
Miljan Marković, *Assistant (UB TF Bor)*
Milijana Mitrović, *Assistant (UB TF Bor)*
Milan Nedeljković, *Assistant (UB TF Bor)*
Avram Kovačević, *Teaching Assistant (UB TF Bor)*
Sandra Vasković, *English Lecturer (UB TF Bor)*
Oliver Marković, *IT service (UB TF Bor)*
Violeta Aleksić, *Liquidator (UB TF Bor)*

PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović

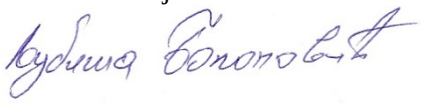

TABLE OF CONTENTS

Plenary Lectures

Velimir R. Radmilović *(SERBIA)*
Energy: One of the biggest challenges in 21st century 3-3

Jing Yu, Mingshui Luo, Junyi Xiang, Yang You, Zhixiong You, Xuewei Lv *(CHINA)*
Efficient extraction of vanadium from vanadium slag 4-8

Invited Lectures

Batrić Pešić *(UNITED STATES)*
The ongoing restructuring of universities to adopt the sophistication offered by internet 11-19

Yaima Filiberto, Alberto Montenegro, Eugenio Alvarez *(SPAIN)*
Machine learning applied to improving the scrap recycling and melting process in all types of ferrous alloys and steel 20-22

Slobodan Kostić, Qi Fenglai, Savo Pirgić, Nenad Botić, Dobrica Milovanović, Čedomir Sušić, Igor Zlatković *(SERBIA)*
Construction of a new sintering plant 180 m2 within the HBIS Group Serbia Iron & Steel 23-26

Satyananda Patra *(INDIA)*
Acid activation of bentonite: Physico-Chemical characterization and application in goethitic iron ore green pelletization 27-35

Ridvan Yamanoglu *(TURKEY)*
Production of metal-based powders by atomization techniques 36-45

Yong Du, Rainer Schmid-Fetzer, Jincheng Wang, Shuhong Liu, Jianchuan Wang, Qiang Lu, Yuhui Zhang, Kai Li *(CHINA, GERMANY)*
Computational design of engineering materials: case studies for a cemented carbide and a heat resistant Al alloy 46-46

Conference Papers

Ordinartsev Denis, Nadezhda Pechischeva, Svetlana Estemirova, Andrey Rempel *(RUSSIA)*
Cr(VI) photosorption on composite sorbent of montmorillonite with amorphous TiO2 49-52

Mikhail Korovkin, Ludmila Ananyeva, Andrey Zherlitsyn, Sergey Kondratyev, Olesya Savinova *(RUSSIA)*
Electro-pulse crushing in high-purity quartz production 53-55

Žarko Radović, Nebojša Tadić *(MONTENEGRO)*
Analytical simulation of EAF dust enrichment 56-59

Nebojša Tadić, Žarko Radović *(MONTENEGRO)*
Thermal and mechanical relaxation of residual streses in cold rolled aluminium alloy strips *60-63*

Dragan Šabaz, Miloš Stojanović, Dejan Petrović *(SERBIA)*
Selection of anchor type using AHP method *64-67*

Miloš Stojanović, Veljko Lapčević, Ivica Vojinović *(SERBIA)*
Blast fragmentation analysis in Jama Bor by using WipFrag software *68-71*

Veljko Lapčević, Toma Jovičić, Slavko Torbica *(SERBIA)*
Mine ventilation model validation by PQ survey *72-75*

Jelena Đorđević, Jelena Stefanović, Sandra Guševac, Ivan Jelić, Stefan Trujić *(SERBIA)*
Life cycle analysis (LCA) of asphalt layers containing recycled asphalt pavement *76-79*

Jelena Ivaz, Dejan Petrović, Predrag Stolić, Mladen Radovanović, Dragan Zlatanović, Saša Stojadinović, Pavle Stojković *(SERBIA)*
Occupational injuries in underground coal mining: statistical analysis of data *80-83*

Jelena Ivaz, Dejan Petrović, Mladen Radovanović, Dragan Zlatanović, Saša Stojadinović, Pavle Stojković *(SERBIA)*
Prediction of methane emissions in coalmine - Soko *84-87*

C. Prochaska, E. Kokkinos, D. Merachtsaki, A. Lampou, E. Peleka, K. Simeonidis, G. Vourlias, A. Zouboulis *(GREECE)*
Recovery of metallic fractions from medical products labelled for single use *88-91*

Nataša Sarap, Marija Janković, Vojislav Stanić, Ivana Jelić, Marija Šljivić-Ivanović *(SERBIA)*
Analysis of gross alpha and gross beta activity in samples around former uranium mine Gabrovnica *92-95*

Dragan Manasijević, Ljubiša Balanović, Ivana Marković, Uroš Stamenković *(SERBIA)*
Latent heat of some aluminium based phase change alloys for thermal energy storage *96-99*

Anđelka Stojanović, Ivica Nikolić, Isidora Milošević *(SERBIA)*
Position of European countries in sustainable resource management *100-103*

Aleksandar Đorđević, Duško Minić, Milena Zečević, Dragan Manasijević *(SERBIA)*
Mechanical and electrical properties of the ternary Ag-Ge-Sn alloys *104-107*

Milena Zečević, Duško Minić, Aleksandar Đorđević, Dragan Manasijević *(SERBIA)*
Effect of chemical composition on the corrosion resistance of the ternary Ag-Ge-Sn alloys *108-111*

Tatiana Aleksandrova, Nadezhda Nikolaeva *(RUSSIA)*
Extraction of low-dimensional structures of nonferrous and noble metals from refractory raw materials *112-115*

Viša Tasić, Tatjana Apostolovski-Trujić, Bojan Radović, Nevena Ristić, Tamara Urošević, Vladan Kamenović, Zvonko Damnjanović *(SERBIA)*
Air quality measurements in the Bor city during the reconstruction of the copper smelter Bor in 2022 *116-119*

Slavica Miletić, Biserka Trumić, Suzana Stanković *(SERBIA)*
Application of control charts in the laboratory for testing the metallic materials *120-123*

Alexey M. Amdur, Sergei A. Fedorov, Andrey A. Forshev, Nikolay V. Grevtsev, Vera V. Yurak *(RUSSIA)*
Technological aspects of the use of peat as a component of pulverated coal fuel for blast furnaces *124-127*

Ljiljana Avramović, Zoran Stevanović, Vanja Trifunović, Radmila Marković, Dragana Božić, Daniela Urošević, Silvana Dimitrijević *(SERBIA)*
Hydrometallurgical treatment of mining waste from Bor - Serbia in aim of copper recovery *128-131*

Daniel Kržanović, Radmilo Rajković, Ivana Jovanović, Milenko Jovanović, Miomir Mikić *(SERBIA)*
Determination the final contour of the open pit Veliki Krivelj for the mining capacity 23.1 million tons of ore *132-135*

Vladan Marinković, Miroslava Maksimović, Milenko Jovanović, Goran Pačkovski *(SERBIA)*
The use of unmanned aerial vehicles for making the precise 3D topo models and orthophoto images *136-140*

Dejan Tanikić, Anđela Stojić, Jelena Đoković, Miloš Stoljiljković *(SERBIA)*
Mechanical characteristics of the shape memory alloy Cu-Zn-Al *141-144*

Ljiljana Avramović, Vanja Trifunović, Zoran Stevanović, Radmila Marković, Dragana Božić, Dejan Bugarin, Silvana Dimitrijević *(SERBIA)*
Copper recovery from RE-flotation tailings by combined process *145-148*

Milenko Jovanović, Daniel Kržanović, Radmilo Rajković, Vladan Marinković, Miroslava Maksimović, Miomir Mikić *(SERBIA)*
Application of hybrid geogrids in mining *149-153*

Stefan Trujić, Miroslava Maksimović, Vladan Marinković, Ljiljana Avramović, Vanja Trifunović, Dragana Božić *(SERBIA)*
Geological exploration of the technogenic deposit - old flotation tailing pit - Bor with the possibility of leaching *154-157*

Zoran Stevanović, Radmila Marković, Ljiljana Avramović, Vojka Gardić, Jelena Petrović, Dragana Božić *(SERBIA)*
Sustainable and smart mining *158-161*

Snežana Ignjatović, Ivana Vasiljević, Branisav Sretković, Milanka Negovanović *(SERBIA)*
Using gravity data to define structural correlation affecting the formation of Neogene basins *162-165*

Deniz Eylül Akpınar, Batuhan Turgut, Ugur Gurol, Savas Dilibal *(TURKEY)*
Characterization of wire arc additively manufactured wear-resistant bimetallic component *166-169*

Mistreanu Sebastian, Ramona Cimpoeșu, Dragoș Achiței, Mihai Popa, Daniela Lucia Chicet, Vasile Manole, Ana-Maria Scripcariu, Nicanor Cimpoesu *(ROMANIA)*
Sandblasting process influence on stainless steel cutting element properties *170-174*

Đorđe Petrović, Katarina Stanković, Latinka Slavković Beškoski, Ksenija Kumrić *(SERBIA)*
Removal of Cu(II) from aqueous solutions using adsorbent based on chitosan hydrogel beads *175-178*

Jovan P. Šetrajčić, Siniša M. Vučenović *(BOSNIA AND HERZEGOVINA)*
Modified basic properties of electrons in layered nanocrystals with a complex lattice *179-182*

Irena Nikolić, Milena Tadić, Dijana Đurović, Nevena Cupara, Ivana Milašević *(MONTENEGRO)*
Kinetic and thermodynamic aspects of strontium adsorption by steelmaking slag *183-186*

Miomir Mikić, Milenko Jovanović, Sandra Milutonović, Daniel Kržanović, Radmilo Rajković *(SERBIA)*
New flotation plant Veliki Krivelj monitoring plan *187-190*

Miomir Mikić, Radmilo Rajković, Daniel Kržanović, Sandra Milutinović *(SERBIA)*
Recultivation of open pit Veliki Krivelj *191-194*

Farzet Bikić, Khaola Awad, Halim Prcanović, Mirnes Duraković *(BOSNIA AND HERZEGOVINA)*
Analysis of influenced factors on tropospheric ozone content in the city of Zenica during 2020 *195-198*

Sandra Milutinović, Ljubiša Obradović, Daniel Kržanović, Miomir Mikić, Radmilo Rajković *(SERBIA)*
Flotation tail storage methods *199-202*

Sandra Milutinović, Milena Kostović, Ljubiša Obradović, Srđana Magdalinović, Sanja Petrović *(SERBIA)*
Methods of transportation and discharge of tails to flotation tailings pond *203-206*

Uğur Gürol, Ceren Çelik, Müesser Göçmen, Mustafa Koçak *(TURKEY)*
Microstructural and mechanical characterization of armor steel joint welded with sandwich design *207-210*

Branka Pešovski, Milan Radovanović, Vesna Krstić, Danijela Simonović, Silvana Dimitrijević *(SERBIA)*
Electrochemical characteristics of the anodized titanium oxide films in sulfuric acid *211-215*

Duško Đukanović, Nemanja Đokić, Zoran Aksentijević, Daniel Radivojević, Branisal Stakić *(SERBIA)*
Methane as an untapped energy potential of the "Soko" brown coal mine *216-220*

Žaklina Tasić, Marija Petrović Mihajlović, Ana Simonović, Milan Radovanović, Maja Nujkić, Milan Antonijević *(SERBIA)*
Electrochemical methods for the determination of tryptophan and caffeine *221-224*

Isidora Milošević, Anđelka Stojanović, Sanela Arsić, Ivica Nikolić, Ana Rakić *(SERBIA)*
Circular economy in the era of Industry 5.0 *225-228*

Almaida Gigović-Gekić, Elvis Agović, Belma Fakić, Hasan Avdušinović *(BOSNIA AND HERZEGOVINA)*
Effect of delta ferrite on microstructure and hardness welded joints of steel S21800 229-232

Radmila Marković, Dragana Bozić, Zoran Stevanović, Tatjana Apostolovski Trujić, Vojka Gardić, Ljiljana Avramović, Vesna Marjanović *(SERBIA)*
Combining neutralization and adsorption methods for metals removal from Saraka stream 233-236

Ana Petrović, Radmila Marković, Emina Požega *(SERBIA)*
CNTs as potential material for wastewater purification: a review 237-240

Zdenka Stanojević Šimšić, Ana Kostov, Aleksandra Milosavljević, Slavica Miletić *(SERBIA)*
Experimental investigations of cualag alloys with 70 at%Cu 241-244

Ana Kostov, Aleksandra Milosavljević, Zdenka Stanojević Šimšić, Ivan Jovanović *(SERBIA)*
Determination of melt properties in Cu-Fe alloys 245-248

Vladimir Nikolić, Milan Trumić *(SERBIA)*
A simple method of determining of bond work index for finer samples 249-252

Ivan Jovanović, Novica Staletović *(SERBIA)*
Management of risk assessment in environmental protection in surface copper mine 253-256

Jovan P. Šetrajčić, Stevo K. Jaćimovski, Siniša M. Vučenović *(BOSNIA AND HERZEGOVINA)*
Possibility of localized electron states appearance in ultrathin layered crystalline structures 257-260

Jovica Sokolović, Ivana Ilić, Dragiša Stanujkić, Zoran Štirbanović *(SERBIA)*
Application of VIKOR method for comparison of the washability of coals 261-264

Vladimir Jovanović, Dejan Todorović, Branislav Ivošević, Dragan Radulović, Sonja Milićević, Marija Ercegović, Slavica Mihajlović *(SERBIA)*
The process of obtaining biochar and the development of the products thus obtained 265-269

Jelena Petrović, Marija Ercegović, Marija Simić, Marija Koprivica, Jelena Dimitrijević, Marija Marković *(SERBIA)*
Mg/Fe-modified hydrochar with promoted adsorption performances 270-273

Esra Dokumaci Alkan, Nurdan Ari, Murat Alkan *(TURKEY)*
A coating application of IN718 via self-propagating high-temperature synthesis method 274-277

Murat Alkan, Esra Dokumaci Alkan, Dilan Ugurluer, Aslihan Karakanat *(TURKEY)*
Production of AlCoCrCuXFeNi alloys via self-propagating high-temperature synthesis method 278-281

Jarmila Trpčevská, Iveta Vasková, Katarína Pauerová, Martina Laubertová, Dušan Oráč *(SLOVAKIA)*
Zinc volatilization in the primary and the secondary zinc production 282-286

Dragan Ignjatović, Lidija Đurđevac Ignjatović, Vanja Đurđevac, Katarina Milivojević, Ivan Jovanović *(SERBIA)*
Application of the numerical method in the definition of a substrate of circular cross section *287-291*

Dragan Ignjatović, Lidija Đurđevac Ignjatović, Vanja Đurđevac, Mlađen Supić, Dušan Tašić *(SERBIA)*
Influence of the subsoil bearing capacity during formation of high landsfills *292-296*

Bojana Živković, Jelisaveta Marjanović, Jelena Đokić, Maja Petrović *(SERBIA)*
Soil and rock properties as a basis for the sanitary lanfill settings *297-300*

Milan Gorgievski, Miljan Marković, Nada Štrbac, Vesna Grekulović, Kristina Božinović, Milica Zdravković, Marina Marković *(SERBIA)*
Adsorption kinetics for copper ions adsorption onto onion peels *301-304*

Saba Nourozi, Fatemeh Pourasgharian, Ahmad Khodadadi Darban *(IRAN)*
Recovery of copper from low-grade copper ore using organic acid *305-308*

Maria Krasteva *(BULGARIA)*
Metodology and equipment for researchung corrosion cracking processes in steel 3H14L (BDS 3692-78) *309-312*

Jasmina Nešković, Pavle Stjepanović, Nenad Milojković, Dejan Lazić, Klara Konc Janković, Svetlana Polavder, Ivana Jovanović *(SERBIA)*
Testing the Bond work index on limestone from flue gas desulphurization plant in TPP Ugljevik *313-317*

Biljana Zlatičanin, Sandra Kovačević *(MONTENEGRO)*
Impact of titanium addition on microstructure and properties of as-cast Al-Cu15 alloys *318-321*

Biljana Zlatičanin, Sandra Kovačević *(MONTENEGRO)*
Effect of cooling rate on mechanical properties of binary Al-Cu23 alloys *322-324*

Desislav Ivanov, Irena Peytcheva, Marko Holma *(BULGARIA)*
Horizon Europe AGEMERA project - Agile Exploration and Geo-modelling for European Critical Raw Materials: The potential of Assarel porphyry copper deposit for critical raw materials *325-328*

Shehret Tilvaldyev, Uzziel Caldiño Herrera, Jose Omar Davalos, Manuel Alejandro Lira Martinez, Marlenne Alejandra Hernandez Lira, Diego Adan Villordo Melendez *(CANADA)*
Problems of anthropogenic pollution of space *329-334*

Mohammed Derqaoui, Abdelmoughit Abidi, Abdelrani Yaacoubi, Khalid El Amari, Omar Oabi, Abdelaziz Bacaoui *(MOROCCO)*
Apatite flotation from low-grade sedimentary phosphate ore *335-338*

Nadezhda Kazakova, Alexandar Popov, Georgi Chernev *(BULGARIA)*
Influence of the distribution and content of limestone particles on the properties of blended cements *339-342*

Daniel Ogochukwu Okanigbe, Shade Rouxzeta Van Der Merwe *(SOUTH AFRICA)*
Rocks of Obafemi Awolowo University and Environ, Nigeria: structural analysis of geological contact *343-347*

Vladan Kašić, Ana Radosavljević Mihajlović, Jovica Stojanović, Slavica Mihajlović, Melina Vukadinović, Nataša Đorđević, Ivana Jelić *(SERBIA)*
Study of thermally treated zeolitic tuffs of Serbia, deposits "Zlatokop" and "Općište"-Beočin *348-352*

Vesna Grekulović, Aleksandra Mitovski, Milica Zdravković, Nada Štrbac, Milan Gorgievski, Milovan Vuković, Miljan Marković *(SERBIA)*
Electrochemical behavior of copper in chloride medium in the presence of nettle extract *353-356*

Marko Pavlović, Marina Dojčinović, Muhamed Harbinja, Atif Hođić, Dragan Radulović, Mirjana Stojanović, Zagorka Aćimović *(SERBIA, BOSNIA AND HERZEGOVINA)*
Effects of the application of pyrophylite in the composition of protective coatings *357-360*

Tamara Ristić, Nenad Milosavljević, Dobrica Milovanović *(SERBIA)*
Measures for the processing of iron with a higher incoming phosphorus content at the steel shop *361-365*

Ivana Mikavica, Dragana Ranđelović, Milena Obradović, Jovica Stojanović, Jelena Mutić *(SERBIA)*
Microplastic textile fibers in urban soils of Serbia *366-369*

Jianbo Zhao, Xinnan Zhao, Donglai Ma, Yang You, Zhixiong You, Xuewei Lv *(CHINA)*
Preparation of ferronickel by semi-molten smelting a mixture of two types of laterite ore *370-374*

Mladen Radovanović, Dejan Petrović, Jelena Ivaz, Dragan Zlatanović *(SERBIA)*
Possibility of copper ores exploitation using in situ leaching method *375-378*

Ivan Jelić, Nikola Lekić, Nikola Stanić, Miomir Mikić *(SERBIA)*
Selection of an optimal route for relocation of the Ćehotina river bed *379-382*

Milica Zdravković, Vesna Grekulović, Bojan Zdravković, Nada Štrbac, Milan Gorgievski, Miljan Marković *(SERBIA)*
Electrochemical behavior of steel in 0.1 mol/dm3 HCl in the presence of potato peel juice *383-386*

Ivana Marković, Dalibor Jović, Uroš Stamenković, Dragan Manasijević, Ljubiša Balanović, Milan Gorgievski *(SERBIA)*
Microstructure and thermal properties of leaded brass after quenching *387-390*

Mehmet Ali Yildiz *(SERBIA)*
Hot strip mill walking beam slab reheating project *391-394*

Peter Polyak *(SERBIA)*
Finishing mill automation upgrade at hot strip mill *395-400*

Branislav Potić, Ana Arifović *(SERBIA)*
The metallurgical testing results of the boron mineralized material from Valjevo-Mionica basin *401-406*

Uroš Stamenković, Ivana Marković, Srba Mladenović, Saša Marjanović, Avram Kovačević, Milijana Mitrović, Filip Basarabić *(SERBIA)*
The influence of quenching media on different properties of C45 carbon steel *407-413*

Yang You, Jiabao Guo, Zhixiong You, Xuewei Lv *(CHINA)*
Investigation of the mixing and granulation behavior of iron ore fines in horizontal high-shear granulator *414-417*

Jovica Sokolović, Grozdanka Bogdanović, Velizar Stanković, Gracijan Strainović, Ivana Ilić, Milan Gorgievski, Miljan Marković *(SERBIA)*
Investigation on beneficiation of iron from copper ore of Mauritania Copper Mine (MCM) by magnetic separation *418-421*

Essen Suleimenov, Rustam Sharipov, Galymzhan Maldybayev, Zhibek Orazaliyeva *(KAZAKHSTAN)*
Investigation of the influence of pulsed electric current on the efficiency of decomposition of aluminate solution *422-423*

Lovro Liverić, Tamara Holjevac Grgurić, Sunčana Smokvina Hanza, Wojciech Sitek, Vedrana Špada, Marko Kršulja *(CROATIA)*
Influence of silver content on martensitic transformation of Cu-Al-Ag alloy *424-427*

Hasan Ali Taner, Vildan Onen *(TURKEY)*
Evaluation of the efficiency of different collectors in the chalcopyrite flotation *428-434*

Vesna Conić, Dragana Božić, Miloš Janošević, Ljiljana Avramović, Vanja Trifunović, Dejan Bugarin, Ivana Jovanović *(SERBIA)*
A pyro-hydrometallurgical process for the recovery of zinc from jarosite waste *435-438*

Maria Krasteva, Rumen Petkov *(BULGARIA)*
Research the rate of chemical corrosion of steel 3X14H2 (BDS 3692-78) *439-442*

Srba Mladenović, Bojan Novaković, Ivana Marković, Uroš Stamenković *(SERBIA)*
Effect of casting speed and water flow on tensile strength, elongation and microstructure of continuous cast copper wire *443-447*

Nadira Bušatlić, Ilhan Bušatlić, Dženana Smajić-Terzić *(BOSNIA AND HERZEGOVINA)*
Dependence of compressive strength of geopolymer based on fly ash and alkaline activator ratio *448-451*

Gergana Meracheva, Efrosima Zaneva-Dobranova, Nikolay Hristov *(BULGARIA)*
Hydrocarbon potential of the Lower Paleozoic sediments in NE Bulgaria by geochemistry and well-logging *452-455*

Dragana Marilović, Grozdanka Bogdanović, Sanja Petrović *(SERBIA)*
Leaching of flotation tailings with a solution of sulfuric acid and ionic liquid *456-459*

Ivana Jovanović, Vesna Conić, Dragan Milanović, Daniel Kržanović, Tanja Stanković, Daniela Urošević, Miloš Janošević *(SERBIA)*
Determination of Bond rod mill work index of a very low-grade copper ore *460-463*

Hasan Ali Taner, Ali Aras, Muhammad Hashim Rasa *(TURKEY)*
Investigation of the effect of depressant and collector conditioning times on cobalt recovery by flotation *464-467*

Aleksandar Cvetković, Žaklina Tasić, Marija Petrović Mihajlović, Maja Nujkić, Milan Radovanović, Ana Simonović *(SERBIA)*
Microplastics *468-471*

Sanja Petrović, Srđana Magdalinović, Ljubiša Obradović, Sandra Milutinović, Bojan Drobnjaković, Slađana Krstić *(SERBIA)*
Tailing management: tailings filtering equipment *472-475*

Jelena Stefanović, Jelena Đorđević, Sandra Guševac *(SERBIA)*
XRD analysis of corrosion product formed in industrial aggressive environment *476-480*

Muhamad Ghulam Isaq Khan, Filip Rajković, Miljana Popović, Dejan Prelević, Aleksandar Ćitić, Tamara Radetić *(SERBIA)*
Initiation of abnormal grain growth in cold-rolled sheet of AA5182 Al-Mg alloy: role of texture *481-484*

Danijela Voza, Hesam Dehghani, Milica Veličković *(SERBIA)*
The dissolved oxygen prediction based on the machine learning techniques *485-488*

Hasan Açan, Hasan Ergin *(TURKEY)*
A novel model for minimizing mine closure costs and the optimum final quarry boundry *489-492*

Ivana Jovanović, Dragan Milanović, Oliver Dimitrijević, Vesna Conić, Igor Svrkota *(SERBIA)*
Role of wing tank in DMS process. Suspension velocity through the seal leg orifice – case study *493-496*

Dejan Petrović, Jelena Ivaz, Saša Stojadinović, Predrag Stolić, Dragan Zlatanović *(SERBIA)*
Risk management and mining machines maintenance – a brief review *497-500*

Stefan Đorđievski, Dragana Adamović *(SERBIA)*
History of surface water pollution by mining and metallurgical activities in Bor, Serbia *501-504*

Olivera Dragutinović, Vaso Manojlović, Đorđe Veljović, Stefan Dikić, Marko Simić *(SERBIA)*
Investigation of the properties of Co-Cr-W and Co-Cr-Mo alloys coated with hydroxyapatite for use in dental implants *505-509*

Zoran Karastojković, Dragoslav Gusković, Ognjen Ristić, Zorica Kovačević *(SERBIA)*
About the "relative plasticity" between steel matrix and non-metallic inclusions *510-513*

Aleksandar Jovanović, Mladen Bugarčić, Milena Milošević, Marija Vuksanović, Muna Abdualatif Abduarahman, Miroslav Sokić, Aleksandar Marinković *(SERBIA, LIBYA)*
Modified hybrid cellulose membrane for Nickel(II) ions removal from industrial wastewater *514-517*

Elena Todorova, Nadezhda Kazakova, Georgi Chernev *(BULGARIA)*
Structural investigation via SEM analysis of silica hybrid materials *518-521*

Tanja Kalinović, Jelena Kalinović, Jelena Milosavljević, Ana Radojević, Snežana Šerbula *(SERBIA)*
Atmosperic bulk deposition as environmental quality indicator *522-526*

Gordana Marković, Vaso Manojlović, Miroslav Sokić, Jovana Ružić, Dušan Milojkov *(SERBIA)*
Designing biocompatible high entropy alloys using Monte Carlo simulations *527-530*

Tatjana Volkov-Husović, Sanja Martinović, Ana Alil, Milica Vlahović *(SERBIA)*
Application of image analysis for cavitation erosion resistance monitoring of some engineering materials *531-534*

Milan Nedeljković, Srba Mladenović, Jasmina Petrović, Milijana Mitrović *(SERBIA)*
Changes in the structure and density of copper during the refining smelting process *535-538*

Jasmina Petrović, Srba Mladenović, Ivana Marković, Milan Nedeljković, Milijana Mitrović *(SERBIA)*
Microstructure analysis of EN AW 6061 alloy using a SEM microscope after artificial aging *539-542*

Milijana Mitrović, Saša Marjanović, Biserka Trumić, Jasmina Petrović, Milan Nedeljković *(SERBIA)*
Effects of cold rolling and annealing processes on the microstructure and properties of micro-alloyed copper *543-546*

Makedonka Dimitrova, Jasminka Dimitrova Kapac *(NORTH MACEDONIA)*
Unlocking energy efficiency: financing preferences for SMEs in the Republic of North Macedonia *547-555*

Zoran Štirbanović, Vesna Vojinović, Jovica Sokolović, Maja Trumić *(SERBIA)*
Analysis of the effectiveness of different methods for cutting samples *556-559*

Ivica Nikolić, Isidola Milošević, Anđelka Stojanović *(SERBIA)*
Land turnover increases due to mining: An empirical analysis of Bor, Serbia, 2013-2022. *560-563*

DONORS *565-590*

AUTHOR INDEX *591-596*

```
```

THE DISSOLVED OXYGEN PREDICTION BASED ON THE MACHINE LEARNING TECHNIQUES

Danijela Voza[1], Hesam Dehghani[2], Milica Veličković[1],

[1]Technical Faculty Bor, University of Belgrade, V.J. 12, 19210 Bor, Serbia

[2] Hamedan University of Technology (HUT), Department of Mining Engineering, Hamedan, Iran

Abstract

One of the most reliable indicators of surface water quality is dissolved oxygen (DO). In order to take timely reactions in water pollution prevention and reduction, it is very useful to predict the changes in this parameter. In this study, a comparative analysis of the efficiency of different machine learning models in DO prediction was carried out. The aim was to examine which of the selected techniques indicate the best performance in DO prediction - Decision Tree, Random Forest, Gradient Boost Regression, Support Vector Regression, Multi-Layer Perceptron, and K - Nearest Neighbors Regression (KNN). According to the results, it can be concluded the best-fitted model on the created dataset is KNN.

***Keywords**: Dissolved Oxygen, Machine learning, Prediction, Water quality, Tisa River*

1. INTRODUCTION

In recent decades, significant efforts towards the renewal and protection of water bodies have been recorded. In order to prevent accidents, it is necessary to recognize and identify all the hydrological variations that could cause negative consequences. The best solution is reflected in developing and improving water quality prediction models as an important step towards reliable water resources management. These models can timely warn about the urgency of undertaking adequate measures.

Water quality modeling is an inevitable activity in water resources engineering. Supportive of that is greater attention being paid to this field by environmental scientists and engineers. Studies related to the prediction of surface water quality parameters by different modern neuro-computing models are increasing. In the example of Laguna Lake among machine learning algorithms such as Naive Bayes (NB), Decision Tree (DT), Random Forest (RF), Gradient Boost (GB), and Deep Learning (DL), the DT achieved the highest accuracy and precision. [1] In comparison with the classical approaches such as the Multi-Layer Perceptron (MLP) and Linear Regression (LR), the DL method was shown to be more reliable in the prediction of water quality parameters, such as pH, dissolved oxygen, turbidity, and chloride. [2] The authors Chen et al. (2020) compared the performances of the seven traditional and the three ensemble learning models for the prediction of water quality by applying a large dataset generated by monitoring the quality of the waters of the main river flows and lakes in China. Their study proved that the DT, the RF, and the Deep Cascade Forest (DCF) were the most efficient. [3]

Despite the proven potential of the machine learning approach in the field of ecological management, there is still an insufficient number of research studies and application of machine learning models in the sphere of water resources management, as well as the comparisons of the performances of different ensemble learning models. [3,4] This methodology, however, is in full swing and an increasingly larger number of studies on their application can be expected in this environmental field.

Dissolved oxygen (DO) is one of the most representative indicators of surface water quality. Therefore, finding the most reliable model for the prediction of the values of this parameter is quite important. This research explores an alternative machine learning method in order to predict water

quality using minimal and easily available water quality parameters. The first step in the model was to determine the significance of each of the selected variables in DO prediction by carrying out variable importance analysis. Additionally, machine-learning algorithms were employed aimed at defining the dataset and the technique whose combination led to the most reliable prediction and the lowest costs of monitoring.

2. EXPERIMENTAL

In this study, representative supervised machine learning algorithms were applied for the prediction of the DO value. The modeling processes were conducted using the Rapid Miner Software version 8.9. The methods of Decision Tree, Random Forest, Gradient Boost Regression (GBR), Support Vector Regression (SVR), Multi-Layer Perceptron, and K-nearest neighbors Regression were considered.

2.1 Dataset

The study area is the flow of the Tisa River through Serbia, with all the related tributaries. The dataset consists of measurements of water quality parameters from eleven sampling stations. The selection of the parameters analyzed in this paper was made based on the literature review. [1,5,6] The river Temperature (T), Electrical Conductivity (EC), pH, Ammonium Ion (NH_4-N) and Orthophosphates (PO_4-P) had most frequently been used in similar studies. Accordingly, the mean monthly values of the mentioned parameters were used as the input data for DO prediction. The physicochemical parameters were retrieved from the water quality monitoring system by the Serbian Environmental Protection Agency (SEPA) that samples river quality monthly, whereas the analysis covered the period from January 2011 to December 2018.

3. RESULTS AND DISCUSSION

The initial parameters for examining the efficiency of predicting the DO value were pH, T, EC, NH_4, and PO_4. Firstly, the dataset was subjected to a variable importance analysis, which defines the share of each mentioned parameter in DO prediction. In order to obtain the parameters that, influence the final result on the same scale, the Z-score standardization of the dataset was first performed. According to the results, it can be concluded that the parameter T has the greatest significance for DO prediction. It is only followed by the parameters: pH, PO_4, EC, and ultimately NH_4, as the parameter with the least influence (Figure 1).

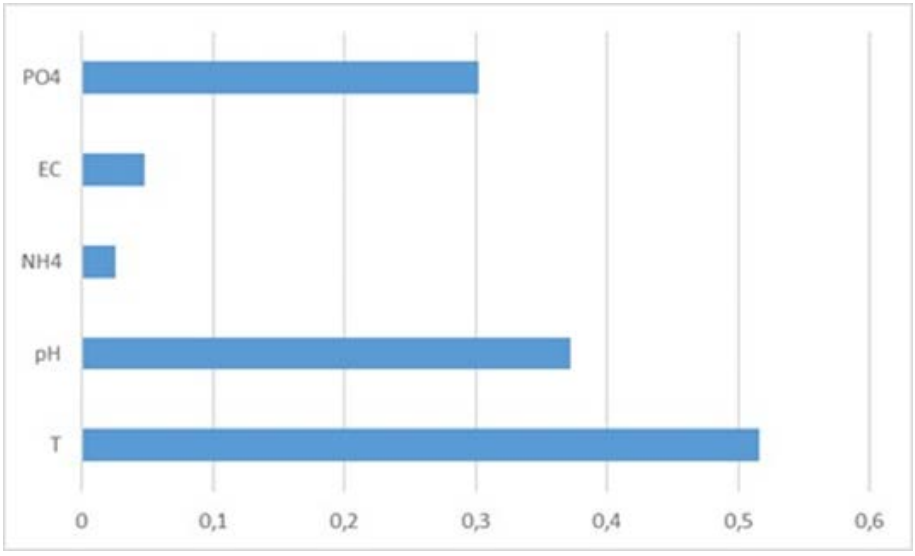

Figure 1 - Variable importance analysis

Further, based on the Model Performance Metrics, a comparison of the predictions with the actual data was made. Correlation Coefficient was used to determine prediction efficiency. It is frequently used to compare models and assess which model provides the best fit to the data. The correlation coefficient (R) is expressed by the values ranging from -1 to +1, where values closer the ± 1 indicate the greater reliability of a predictive model.

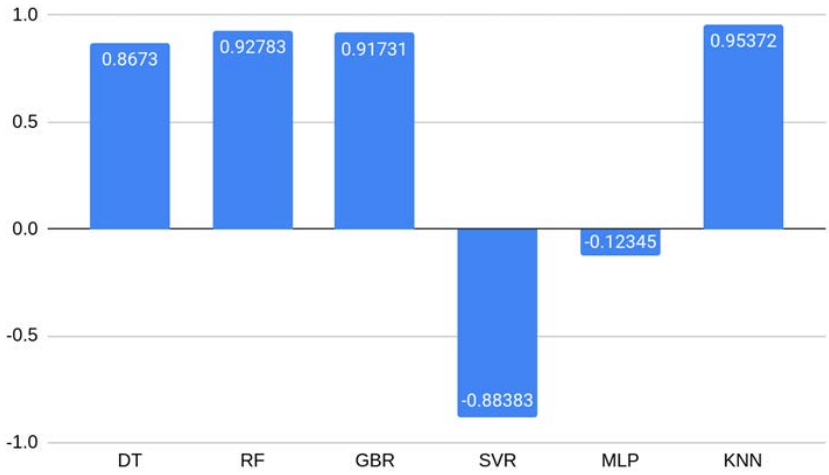

Figure 2. Comparison of model performances

As it can be concluded from Figure 2, the best-fitted model with R= 0.95 is KNN. The KNN model works by the nearest data around the sample. Choosing the number of neighbors (k) is a crucial stage. This method's efficiency depends on selecting samples from the nearest reference database. [7] In this case, the K=3 and the nearest samples are calculated by the distance around the sample.

The main benefits of the KNN method are mathematical simplificity, non-dependence of statistical assumption and the sample space distribution. [8] The KNN method is easy to apply and understand because it doesn't pass through a learning phase. [9] The understandable mechanism and the prediction accuracy of this method make it preferable among the other methods. The obtained results are supported by other studies that proved the advantage of this method in comparison with other machine learning methods. [10,11]

4. CONCLUSION

Surface water quality parameter modeling is regarded as a critical issue that impacts the efficiency and effectiveness of a water resources management system. Finding reliable prediction models and implementing approaches to determine the dominant water quality factors might result in significant cost savings.

The results presented in this paper have indicated that the prediction of the water quality (expressed through the DO values) of the Tisa River on its flow through Serbia can be made with the highest degree of precision by applying the K-Nearest Neighbors Regression, namely in the case when an input dataset consists of the T, pH, PO_4, and EC values.

The recommendations for future studies relate to the input variables selection and the creation of a hybrid model in which an integration of different machine-supervised techniques would be performed, which would help overcome shortcomings and take advantage of each one of them.

ACKNOWLEDGEMENTS

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia, as part of the financing of scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-47/2023-01/ 200131

REFERENCES

[1] L. J. Lerios, V. M. Villarica. Int. J. Mech. Eng. Robot. Res. 8(6) (2019)
[2] A. Solanki, H. Agrawal, K. Khare. Int. J. Comput. Appl. 125(9) (2015) 29-34
[3] K. H. Chen, C. Zhou, Y. Huang, X. Qi, R. Shen, R., F. Liu, M. Zuo, X. Zou, J. Wang, Y. Zhang, D. Chen, X. Chen, Y. Deng, H. Ren. Water Res. 171 (2020) 115454
[4] H. Yajima, J. Derot. J. Hydroinform. 20 (2018) 206–220
[5] S. H. Nemati, M. Fazelifard, O. Terzi, A. M. Ghorbani. Environ. Earth Sci. 74 (2015) 4065
[6] Q. Ren, X. Wang, W. Li, Y. Wei, D. An. Aquac. Eng. 90 (2020) 102085
[7] Ahmed, A.A.M., Jui, S.J.J., Chowdhury, M.A.I. et al. Environ Sci Pollut Res 30 (2023) 7851–7873
[8] W. Luo, S. Huan, H. Fu, G. Wen, H. Cheng, J. Zhou, H. Wu, G. Shen, R. Food Chem. 128 (2011) 555–561
[9] X. C. Nguyen, T. T. H. Nguyen, Q. V. Le, P. C. Le, A. L. Srivastav, Q. B. Pham et al. J Environ Manage 301 (2022) 113868
[10] L. Wang, F. Long, W. Liao, H. Liu Bioresour Technol 298 (2020) 122495.
[11] K. Zidan, S. Sbahi, A. Hejjaj, et al. Environ Sci Pollut Res 29 (2022) 75716–75729

ISBN-978-86-6305-140-9

IOC M&M 2023

IOC M&M 2023

Proceedings IOC M&M 2023

УНИВЕРЗИТЕТ У БЕОГРАДУ
ТЕХНИЧКИ ФАКУЛТЕТ У БОРУ
1961

INSTITUT