Scientific and Professional Society for Environmental Protection of Serbia, Belgrade; ALFA BK University, Belgrade; Engineering Academy of Serbia; Union of Engineers and Technicians of Serbia; Institute for Multidisciplinary Research, Belgrade; Institute of agricultural economics, Belgrade; Bulgarian National Union of Scientists - Ruse, Bulgaria; Bulgarian National Society of Agricultural Engineers; Balkan Environmental Association (B.EN.A.)

Under the patronage of
Ministry of Science, Technological Development and Innovation
Ministry of Environmental Protection of the Republic of Serbia

INTERNATIONAL SCIENTIFIC CONFERENCE

APPLICATION OF ARTIFICIAL INTELLIGENCE IN ENVIRONMENTAL PROTECTION AND AGRICULTURE

COLLECTION OF ABSTRACTS

МЕЂУНАРОДНА НАУЧНА КОНФЕРЕНЦИЈА

ПРИМЕНА ВЕШТАЧКЕ ИНТЕЛИГЕНЦИЈЕ У ЗАШТИТИ ЖИВОТНЕ СРЕДИНЕ И ПОЉОПРИВРЕДИ

ЗБОРНИК АПСТРАКАТА

Belgrade, 24-25 April 2025

Izdavač:
Naučno-stručno Društvo za zaštitu životne sredine Srbije ECOLOGICA,
11000 Beograd, Kneza Miloša 7a

Za izdavača:
emeritus prof. dr Larisa Jovanović, Predsednik UO Društva ECOLOGICA

Urednici:
emeritus prof. dr Larisa Jovanović
prof. dr Sergei Ostroumov
prof. dr Suzana Balaban
ass. prof. dr Milan Brkljač

Štampa: Akademska izdanja, Zemun, 2025.

Tiraž: 200

INTERNATIONAL SCIENTIFIC BOARD / MEĐUNARODNI NAUČNI ODBOR

SCIENTIFIC BOARD / NAUČNI ODBOR

PROGRAM OF THE CONFERENCE

PROGRAM KONFERENCIJE

24.04.2025, THURSDAY / ČETVRTAK

ALFA BK UNIVERSITY, 8 Boulevard of Marshall Tolbukhin, 11070, Belgrade

9:30 – 10:00 A4

REGISTRATION OF PARTICIPANTS

REGISTRACIJA UČESNIKA

10:00 – 10:30 A4

WELCOME SPEECHES / OPENING OF THE CONFERENCE

POZDRAVNI GOVORI / SVEČANO OTVARANJE KONFERENCIJE

10:30 – 13:30 A4

PLENARY LECTURES / PLENARNA PREDAVANJA

S.A. Ostroumov[1], G.G. Matishov[2], E.A. Kriksunov[1], L. Jovanovic[3], Xiang Cai[4]

[1]Moscow State University, Moscow 119991, Russia; [2]South Federal University, Rostov-na-Donu, Russia; [3]ALPHA University, Belgrade, Serbia; [4]Comenius University, Bratislava, Slovakia

Role of innovative approaches in solving some environmental protection problems

Larisa Jovanović, professor emeritus, Alfa BK Univerzitet

Slavko Mentus, akademik SANU

Rare metals, with special reference to rare earths

Dušan Vještica[1], Ilija Ćosić[2], Nikola Gradojević[2], Vladimir Đaković[2]
[1]Kosmos JSC Banja Luka, [2]University of Novi Sad, Faculty of Technical Sciences, Serbia

Artificial Intelligence (AI) and Hydrogen Strategy of the Republic of Serbia

Dr. Marina Kapitalchuk
Shevchenko State University of Pridnestrovie, Tiraspol, Moldova

Using elements of artificial intelligence to determine the relationship between trace elements in the soil-crop system

Prof. dr Marijana Joksimović, Prof. dr Larisa Jovanović
Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia

Application of artificial intelligence in environmental protection

Suzana Balaban[1], Jasmina Đurašković[2]
[1]Alfa BK University, Belgrade; [2]Academy of Applied Studies Polytechnic, Belgrade

Artificial intelligence in agriculture: the path towards a green economy and sustainable growth

Larisa Jovanović, Aleksandra Stojkov Pavlović
Alfa BK University, Belgrade, Serbia

Application of AI in big data analytics in the goal of energy transition: a comparative cost-effectiveness analysis of renewable energy sources versus fossil fuels

Dejan Riznić, Adrijana Jevtić,
University of Belgrade, Technical Faculty in Bor, V.J. 12, 19210 Bor, Serbia

Artificial intelligence in the function of sustainable development

Dušan Jokanović, Vesna Nikolić Jokanović,
University of Belgrade, Faculty of Forestry, Belgrade, Serbia

Modelling of the groundwater flow using Kriging interpolation within ArcGIS

COCTAIL – 13:30-14.00 CEREMONIAL HALL

14:00 – 16:30 A4

CONTRIBUTED LECTURES / NAUČNA SAOPŠTENJA

Dr. Fedor Golubev, Irina Gromyak, Dr. Denis Dogadkin, Prof. Dr. Vladimir Kolotov
Vernadsky Institute of Geochemistry and Analytical Chemistry RAS (GEOHI RAS), Moscow, Russia

ICP-AES and ICP-MS methods in the analysis of the elemental composition of soils and plants in the vicinity of the Unal tailing dump (North Ossetia)

Andrei Safonov[1], Vitalii Nespirnyi[1,2]
[1]Donetsk State University, Donetsk; [2]Economic Research Institute, Donetsk

Visualization and modeling of phytogeochemical profiles of Donbass waste heaps

Miloš Tošović,
University of Belgrade - Faculty of Security studies

Aspects of artificial intelligence in environmental security risk management

Ekaterina Germonova[1], Andrei Safonov[2]
[1]Donetsk National Technical University, Donetsk; [2]Donetsk State University, Donetsk

Forecast of the factor of polemosterss in Donbass for 2025-2026

Milica Zdravković, Miljan Marković, Marina Marković, Vesna Grekulović, Milan Gorgievski, Nada Štrbac, Kristina Božinović
University of Belgrade, Technical Faculty in Bor, Vojske Jugoslavije 12, Bor, Serbia

Application of AI in environmental protection: corrosion and biosorption

Dr. Fedor Golubev, Dr. Denis Dogadkin, Prof. Dr. Vladimir Kolotov
Vernadsky Institute of Geochemistry and Analytical Chemistry RAS (GEOHI RAS), Moscow, Russia

Chemical analysis of plants and soils of the North Ossetia territories adjacent to the polymetallic area by the ICP-MS method and the choice of an internal standard

Dr. Ivan Kapitalchuk,
Shevchenko State University of Pridnestrovie, Tiraspol, Moldova

Forecast of the transformation of the ecosystem structure of the Dniester-Prut interfluve under the influence of climate change

Prof. dr Radule Tošović,
University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia

Preliminary overview of projections of the field of artificial intelligence application in the economic evaluation of mineral reserves

Andjela Stijovic,
Alfa BK University, Faculty of Finance, Banking and Auditing

Application of artificial intelligence in circular economy

Prof. dr Radule Tošović,
University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia

Management, marketing, artificial intelligence and assessment of mineral resources

Miloš Tošović,
University of Belgrade, Faculty of Security studies, Belgrade, Serbia

Copenhagen school of security studies, environmental security and artificial intelligence

Prof. dr Jozefina Beke-Trivunac[1], Prof. dr Snežana Knežević[2]
[1]Alfa BK University; [2]University of Belgrade, Faculty of Organizational Sciences

Environmental finance – blended finance

Finansiranje životne sredine – mešoviti izvori finansiranja

Doc. dr Marko M. Vujić[1], Prof. dr Darko P. Nadić[1], Prof. dr Olja Munitlak Ivanović[2]
[1]University of Belgrade, Faculty of Political Sciences, Jove Ilića 165, Belgrade, Serbia
[2]University in Novi Sad, Faculty of Sciences, DGTHM, Trg Dositeja Obradovića 3, Novi Sad, Serbia

Cross-section and perspective of ecological modernization in the 21st century

Doc. dr Milan Brkljač[1]
[1]Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia

Digital marketing innovations in building brand awareness: emerging trends and strategies

PLENARY LECTURES

PLENARNA PREDAVANJA

ROLE OF INNOVATIVE APPROACHES IN SOLVING SOME ENVIRONMENTAL PROTECTION PROBLEMS

S.A. Ostroumov[1], G.G. Matishov[2], E.A. Kriksunov[1], L. Jovanovic[3], Xiang Cai[4]

[1]Moscow State University, Moscow, Russia; [2]South Federal University, Rostov-na-Donu, Russia; [3]ALPHA University, Belgrade, Serbia; [4]Comenius University, Bratislava, Slovakia

The goals of environmental protection are closely connected to and integrated with the goals of sustainable development. The goals of both environmental protection and sustainable development are multiple and covers the multitude of modern challenges and issues.

Here we would like to briefly consider and analyze the role of innovative technologies in search of solutions to these issues: (1) protection, rehabilitation and sustainable use of aquatic ecosystems; (2) studying and protection of biological factors that are instrumental in protecting some parameters of the biosphere and climate; (3) dissemination of environmental science knowledge.

Innovative technologies are key factors to solution of all of these issues. These are some selected examples:

(1) Protection, rehabilitation and sustainable use of aquatic ecosystems. It is important to use advanced innovative technologies that allow to restore the normal functioning of aquatic ecosystems toward efficient water self-purification. To facilitate this, it is helpful to apply innovative technologies on the basis of the innovative theory of biomachinery of ecosystem-driven water self-purification which was presented in a series of papers in the journals of Russian Academy of Sciences ("Доклады академии наук", "Экология", and others) and in the book of Moscow State University, entitled: "Studying Biotechnology of Biospheric Biomachinery" (Moscow, 2024).

(2) Studying and protection of biological factors that are instrumental in modification and/or regulation of some parameters of the biosphere and climate. The short list of these vital biological factors was formulated and analyzed in the above-mentioned book. Among these biological factors are some fundamental and vital biological processes, e.g., photosynthesis. Globally, photosynthesis contributes to regulation and formation of the current level of carbon dioxide (CO_2) which is 417 ppm or 0.0417% (April 2022). Carbon dioxide is among the most important greenhouse gases that influence the temperature in the atmosphere. Modern biophysical studies of photosynthesis are based on the most advanced technologies.

(3) Dissemination of environmental science knowledge, environmental education. This includes the necessity of rapid analysis of the multiple environmental science papers and books which are being published every month in large quantities. On the basis of this analysis, it is highly needed to produce short easy-to-read digests of the content of these publications. In this work of preparing the short digests, a useful contribution can be made by the instruments of artificial intelligence (AI).

All in all, innovative technologies including AI and others are vital tools in achieving goals of environmental protection and sustainable development.

Keywords: environmental protection, global change, biosphere, climate, artificial intelligence (AI).

RARE METALS, WITH SPECIAL REFERENCE TO RARE EARTHS

[1]Professor emeritus Larisa Jovanović, [2]Academician Slavko Mentus

[1]Alfa BK University, Belgrade, Serbia
[2]Serbian Academy of Sciences and Arts

Rare metals are the conventional name for a group of metals (over 50), highly dispersed and, scarce finding in the earth's crust. Their production began to develop especially after the 2nd World War. The application areas of rare metals in various fields and countries are expanding rapidly. Rare metals are essential for new branches of technology such as high-speed aviation, nuclear power, the production of supersonic rockets, electric cars, batteries and electronics. Their separation from raw materials and obtaining them in pure form is associated with great technological difficulties due to the complexity of the process of obtaining a profitable ore concentrate.

During magmatic processes, lanthanides accumulate in granitoids and especially in alkaline rocks. 33 cerium and 9 lanthanum minerals are known. The remaining lanthanides are included as isomorphous impurities in the crystal lattices of other minerals, mostly rare earths.

In many minerals, lanthanides isomorphously replace Ca, U, Th.

Rare earths (lanthanides) are a set of 17 nearly indistinguishable lustrous silvery-white metals. Compounds with lantanides have applications in technological processes.

Lanthanides are divided into two subgroups: light rare earths (lanthanum La, cerium Ce, praseodymium Pr, neodymium Nd, promethium Pm, samarium Sm), and heavy rare earths (yttrium Y, europium Eu, gadolinium Gd, terbium Tb, dysprosium Dy, holmium Ho, erbium Er, thulium Tm, ytterbium Yb and lutetium Lu).

In natural minerals, lanthanides are found exclusively in the form of a mixture, which is very difficult to separate due to the similarity of chemical properties, but there are numerous applications for which separation is not necessary. However, in the past 50 years, efficient methods of separation and production of pure metals and compounds have been developed.

Methods of separation of lanthanides are based on small differences in the properties of their compounds. Previously, fractional crystallization of salts and fractional precipitation (hydroxides, sulfates, oxalates, etc.) were used for this purpose. In addition, separation schemes exploit the ability of some lanthanides to oxidize to the tetravalent state or reduce to the divalent state (Sm, Eu, Yb).

Lanthanides (in the form of metals, alloys and chemical compounds) are used in various branches of technology. Lanthanide additives improve the structure of alloys, their mechanical properties, corrosion and heat resistance of steel, cast iron, aluminum and other alloys.

Additions of oxides of various lanthanides give the glass special physical properties and colors. Lanthanide oxides are used for coloring porcelain, glazes and enamels. Borides of some lanthanides are used to make cathodes for high-power electronic devices.

Lanthanides are included in the composition of crystals for lasers (the addition of lanthanide compounds to CaF_2 crystals).
In nuclear technology, lanthanides with a high thermal neutron capture cross-section (Gd, Sm, Eu) are used for radiation protection and reactor control.
In the chemical and light industry, lanthanide compounds are used for the production of varnishes and paints, luminescent compounds (phosphors), catalysts and photoreagents.

Keywords: rare metals, rare earth, lanthanides,compounds,additives,mechanikal properties, methods of separation

ARTIFICIAL INTELLIGENCE (AI) AND HYDROGEN STRATEGY OF THE REPUBLIC OF SERBIA

Dušan Vještica[1], Ilija Ćosić[2], Nikola Gradojević[3], Vladimir Đaković[4]

[1]Kosmos JSC Banja Luka, [2,3.4]University of Novi Sad,
Faculty of Technical Sciences, Novi Sad, Serbia
[1]dusan.vjestica@kosmos.ba, [2]Ilijac@uns.ac.rs,
[3]ngradoje@uns.ac.rs, [4]v_djakovic@uns.ac.rs
[1]orcid.org/0009-0003-0744-566X, [2]orcid.org/0000-0001-9796-4452,
[3]orcid.org/0000-0003-4001-3159, [4]orcid.org/0000-0002-3282-2899.

The global energy transition is becoming increasingly important due to the growing challenges of climate change, dwindling fossil fuel supplies and the need for sustainable development. Green energy, which encompasses renewable energy sources such as solar, wind-generated, hydropower, geothermal, biomass and hydrogen, is becoming a key factor in global efforts to reduce greenhouse gas emissions and transition to a sustainable energy system. Green hydrogen is a promising new technology with the potential to decarbonize a very wide range of business sectors, with the primary task of reducing the carbon footprint, but also with the secondary task of reducing the demand for natural gas and thus influencing the market balance of these two energy sources. Hydrogen will be used in the future as an energy source but also as a battery for energy storage. This makes it an important option in supporting Integrated Energy Systems (IES) by effectively balancing intermittent energy (RES) and uncertainty of energy demand and supply. It is planned that hydrogen will be used in heavy transport (rail and sea), chemical industry (production of ammonia, fertilizer and cement) as well as in the metal industry for production (copper, iron and aluminum). In these applications, hydrogen is used directly or converted into electricity by hydrogen fuel cells during maximum demand and thus constitutes an energy vector. Due to its dual role and application in various applications, hydrogen energy is taking precedence and is becoming more and more recognized in a sustainable energy future, and due to the low energy density of batteries, hydrogen will be important for the continued further development of electric aviation. For these reasons, it is necessary to identify challenges, but also opportunities for the development of green hydrogen projects in the Republic of Serbia. Artificial intelligence (AI) and its applications such as machine learning (ML) and digital twin (DT) are emerging as a powerful tool in bridging the gap between challenges and opportunities. The most important role (AI) is reflected in forecasting analysis in order to optimize processes based on pre-generated variables and through algorithms (ML) to increase the efficiency of the system. The application (DT) provides the possibility of a virtual modeling platform in the simulation and optimization of hydrogen systems through modeling and testing in a virtual environment, as well as in the optimization of fuel cell performance. Applications (AI) and (DT) integrated into energy grids can make a significant contribution through real-time management of the production and consumption process, through the management of smart grids and hydrogen infrastructures. A review of the literature reveals a lack of scientific literature in the

Serbian language written by authors from the Serbian scientific community that deals with the challenges in the field of green hydrogen and the application of tools (AI) in overcoming these challenges. This primarily refers to the application (AI) in the analysis of existing infrastructure, markets (equipment, energy, supply and demand) and the evaluation of all types of risks. The research should identify, explain and propose the best solutions for overcoming the challenges faced by the green hydrogen sector in the Republic of Serbia and thus contribute to the adoption of hydrogen strategies. This paper finds its scientific and practical foundation and justification, emphasizing the possibilities for continuous improvement of production technology, the development of renewable sources as the most important resources for production, storage and transport technologies, pricing policy, sources and methods of financing, financial assistance and support for international projects, but also the development of own financing policies. Summarizing all of the above, we conclude that the basis of the research is the need of society, the scientific and professional community for a unique concept that will enable the adoption of a national hydrogen strategy of the Republic of Serbia with long-term benefits for society as a whole.

Keywords: artificial intelligence, hydrogen strategy, green hydrogen, machine learning, digital twin.

Acknowledgements: This research is supported by the Ministry of Science, Technological Development and Innovation and the Faculty of Technical Sciences, Department of Industrial Engineering and Management, University of Novi Sad through the project "Improving the Quality of Teaching in the Study Programs of the Department through the Implementation of the Results of Scientific Research in the Field of Industrial Engineering and Management".

VEŠTAČKA INTELIGENCIJA (AI) I VODONIČNA STRATEGIJA REPUBLIKE SRBIJE

Dušan Vještica[1], Ilija Ćosić[2], Nikola Gradojević[3], Vladimir Đaković[4]

[1]Kosmos a.d., Banja Luka,
[2,3,4]Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Srbija

Apstrakt: Globalna energetska tranzicija sve više dobija na značaju usled rastućih izazova povezanih sa klimatskim promenama, smanjenjem zaliha fosilnih goriva i potrebom za održivim razvojem. Zelena energija, koja obuhvata obnovljive izvore energije poput solarne, vetrogenerisane, hidroenergije, geotermalne, energije biomase i vodonične energije, postaje ključni faktor u globalnim naporima za smanjenje emisije gasova sa efektom staklene bašte i prelazak ka održivom energetskom sistemu. Zeleni vodonik je obećavajuća nova tehnologija sa potencijalom da dekarbonizuje veoma široku lepezu poslovnih sektora, sa primarnim zadatkom da smanji karbonski otisak, ali i sa sekundarnim zadatkom da umanji potražnju za prirodnim gasom i na taj način

utiče na uspostavljanja tržišne ravnoteže ova dva energenta. Vodonik će se u budućnosti koristi kao energent ali i kao baterija za skladištenje energije. Ovo ga čini značajnom opcijom u podršci Integrisanih energetskih sistema (IES) kroz efikasno balansiranje isprekidanosti (OIE) i neizvesnosti potražnje i ponude energije. U planu je da se vodonik koristi u teškom transportu (železnički i pomorski), hemijskoj industriji (proizvodnja amonijaka, veštačkog đubriva i cementa) kao i u metalskoj industriji za proizvodnju (bakra, gvožđa i aluminijuma). U ovim aplikacijama vodonik se koristi direktno ili pretvara u električnu energiju putem vodonik gorivih ćelija tokom maksimalne potražnje i na taj način on predstavlja energetski vektor. Zbog dvojne uloge i primene u različitim aplikacijama energija vodonika zauzima primat i postaje sve više priznata u održivoj energetskoj budućnosti, a zbog niske gustine energije baterija, vodonik će biti značajan za nastavak daljeg razvoja električne avijacije. Iz navedenih razloga potrebno je identifikovati izazove, ali i mogućnosti za razvoj projekata zelenog vodonika u Republici Srbiji. Veštačka inteligencija (AI) i njene aplikacije kao što su mašinsko učenje (ML) i digital twin (DT) se nameću kao moćni alat u prevazilaženju jaza između izazova i mogućnosti. Najznačajnija uloga (AI) se ogleda u prognostičkoj analizi u cilju optimizacije procesa na bazi unapried generisanih varijabli i kroz algoritme (ML) na povećanju efikasnosti sistema. Aplikacija (DT) pruža mogućnost virtuelne platforme za modeliranje u simulaciji i optimizaciji vodoničnih sistema kroz modeliranje i testiranje u virtuelnom okruženju, kao i pri optimizaciji performansi gorivih ćelija. Aplikacije (AI) i (DT) integrisane u energetske mreže mogu dati svoj značajan doprinos kroz upravljanje procesom proizvodnje i potrošnje u realnom vremenu, kroz upravljanje pametnih mreža (Smart Grid) i vodoničnih infrastruktura. Pregledom literature, uočava se nedostatak naučne literature na srpskom jeziku pisane od strane autora iz srpske naučne zajednice koji se bavi izazovima u oblasti zelenog vodonika i primjenom alata (AI) u prevazilaženju tih izazova. Tu se prije svega misli na primjenu (AI) u analizi postojeće infrastrukture, tržišta (opreme, energenta, ponude i potražnje) i evaluaciji svih vrsta rizika. Istraživanja treba da identifikuju, obrazlože i predlože najbolja rešenja za prevazilaženje izazova sa kojima se suočava sektor zelenog vodonika u Republici Srbiji i na taj način doprinesu donošenuju vodonične strategije. Ovaj rad nalazi svoje naučno i praktično utemeljenje i opravdanost, ističući mogućnosti za kontinualno usavršavanje tehnologije proizvodnje, razvoj obnovljivih izvora kao najznačajnih resursa za proizvodnju, tehnologije skladištenja i transporta, politiku cena, izvore i načine finansiranja, finansijsku pomoć i podršku po međunarodnim projektima, ali i razvoj sopstvenih politika finansiranja. Sumirajući sve navedeno zaključujemo da se u osnovi istraživanja nalazi potreba društva, naučne i stručne zajednice za jedinstvenim konceptom koji će omogućiti donošenje nacionalne vodonične strategije Rebublike Srbije sa dugoročnim benefitima po društvo u celini.

Ključne reči: veštačka inteligencija, vodonična strategija, zeleni vodonik, mašinsko učenje, digitalni blizanac.

Zahvalnica: Ovo istraživanje je podržano od strane Ministarstva nauke, tehnološkog razvoja i inovacija i Fakulteta tehničkih nauka, Departman za industrijsko inženjerstvo i menadžment, Univerziteta u Novom Sadu kroz projekat „Unapređenje kvaliteta nastave na studijskim programima Departmana kroz implementaciju rezultata naučno-istraživačkog rada u oblasti Industrijskog inženjerstva i menadžmenta“.

USING ELEMENTS OF ARTIFICIAL INTELLIGENCE TO DETERMINE THE RELATIONSHIP BETWEEN TRACE ELEMENTS IN THE SOIL-CROP SYSTEM

Dr. Marina Kapitalchuk

Shevchenko State University of Pridnestrovie, Tiraspol, Moldova,
e-mail: marinakapitalchuk@yandex.ru, orcid.org/0000-0003-2618-0823

Selenium is a conditionally essential element for plants, and a vital element for animals and humans. The purpose of this work is to study the effect of its potential antagonists Fe, Mn, Zn, Cu, Cd on selenium accumulation by plants. The empirical material for the analysis was soil and plant samples collected during field expeditions in the Dniester valley. The content of microelements in the samples was determined using an atomic absorption spectrophotometer. Analysis of empirical data showed that there is a linear relationship between the concentration of zinc (q_{Zn}) and selenium (q_{Se}) in the soil: $q_{Se} = 3.44q_{Zn} + 12.21$. However, the dispersion of experimental points is significant, the correlation coefficient at the significance level of 0.05, and is only +0.570. The correlation of selenium with other elements in the soil also turned out to be positive, but the closeness of this relationship is insignificant. Thus, the correlation coefficient for copper was +0.488, for cadmium only +0.463, and for iron and manganese - close to zero. In the above-ground part of sunflower plants, the correlation of selenium with the other elements under consideration was negative in all cases, but the partial correlation coefficients did not differ significantly from zero. The influence of antagonist elements in the soil on the amount of selenium accumulation in the aboveground part of sunflower also turned out to be statistically insignificant, with the exception of cadmium, which shows signs of antagonism to selenium. In this case, the dependence of the selenium concentration (q_{Se}) in plants on the cadmium content (q_{Cd}) in the soil is linear: $q_{Se} = –49.89q_{Cd} + 298.3$. However, even in this case, the dispersion of the experimental values is so great that the correlation coefficient is only –0.426. No relationship was found between the content of gross forms of selenium in soils and its accumulation by plants, which confirms previously obtained results. The picture of the relationship between microelements changes if we consider not the absolute value of selenium accumulation by plants, but the coefficient of biological accumulation (Q_{Se}), defined as the ratio of the amount of an element in a plant to its total content in the soil. In this case, the antagonism of Zn (q_{Zn}) in relation to the intensity of Se accumulation by sunflower is manifested at a statistically significant level (correlation coefficient -0.585 at a significance level of 0.05). This relationship can be presented as follows: $Q_{Se} = 423.6q_{Zn}^{-1.8}$. In relation to Q_{Se} a weak antagonism with cadmium is shown (correlation coefficient -0.417). The closest relationship was found between the coefficient of biological accumulation of selenium by plants (Q_{Se}) and the total content of the same microelement in the soil (q_{Se}). This relationship is well approximated by a power function: $Q_{Se} = 163.82\ q_{Se}^{-1.2}$.The correlation coefficient was –0.720 (with a significance level of at least 0.05). This indicates an increase in the intensity of Se absorption by plants with its decrease in the soil. That is, the nature of the dependence of Q_{Se} of selenium by sunflower on the content of the microelement in the soil corresponds more to a vitally important than a conditionally necessary nutrient.

Key words: selenium, trace elements, interrelation, soil, plants.

ИСПОЛЬЗОВАНИЕ ЭЛЕМЕНТОВ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА ДЛЯ ОПРЕДЕЛЕНИЯ ВЗАИМОСВЯЗИ МИКРОЭЛЕМЕНТОВ В СИСТЕМЕ «ПОЧВА-СЕЛЬСКОХОЗЯЙСТВЕННЫЕ РАСТЕНИЯ»

Доц. Марина Капитальчук

Приднестровский государственный университет, Тирасполь, Молдова

Селен является условно необходимым элементом для растений, а для животных и человека жизненно необходимым элементом. Целью данной работы изучить влияние на аккумуляцию селена растениями его потенциальными антагонистами Fe, Mn, Zn, Cu, Cd. Эмпирическим материалом для анализа послужили образцы почв и растений, собранные во время полевых экспедиций в долине Днестра. Содержание микроэлементов в образцах определялось с помощью атомно-абсорбционного спектрофотометра. Анализ эмпирических данных показал, что между концентрацией цинка (q_{Zn}) и селена (q_{Se}) в почве наблюдается линейная зависимость: $q_{Se} = 3,44q_{Zn} + 12,21$. Однако дисперсия экспериментальных точек значительная, коэффициент корреляции на уровне значимости 0,05, и составляет всего +0,570. Корреляция селена с другими элементами в почве также оказалась положительной, но теснота этой взаимосвязи незначительная. Так, коэффициент корреляции для меди составил +0,488, для кадмия всего +0,463, а для железа и марганца – близки к нулю. В надземной части растений подсолнечника корреляция селена с другими рассматриваемыми элементами во всех случаях была отрицательной, но при этом частные коэффициенты корреляции значимо не отличаются от нуля. Влияние элементов-антагонистов в почве на величину накопления селена в надземной части подсолнечника также оказалось статистически незначимым, за исключением кадмия, для которого проявляются признаки антагонизма к селену. При этом зависимость концентрации селена (q_{Se}) в растениях от содержания кадмия (q_{Cd}) в почве имеет линейный характер: $q_{Se} = –49,89q_{Cd} + 298,3$. Однако и в этом случае дисперсия экспериментальных значений настолько велика, что коэффициент корреляции составляет всего –0,426. Взаимосвязи между содержанием валовых форм селена в почвах и его аккумуляцией растениями также не обнаружено, что подтверждает ранее полученные результаты. Картина взаимосвязи между микроэлементами изменяется, если рассматривать не абсолютную величину аккумуляции селена растениями, а коэффициент биологического накопления (Q_{Se}), определяемый как отношение количества элемента в растении к его валовому содержанию в почве. В этом случае проявляется на статистически значимом уровне (коэффициент корреляции –0,585 при уровне значимости 0,05) антагонизм Zn (q_{Zn}) по отношению к интенсивности накопления Se подсолнечником. Эту взаимосвязь можно представить в виде: $Q_{Se} = 423,6q_{Zn}^{-1,8}$. По отношению к Q_{Se} проявляется слабый антагонизм с кадмием (коэффициент корреляции –0,417). Наиболее тесной зависимость оказалась между коэффициентом биологического накопления селена растениями (Q_{Se}) и валовым содержанием этого же микроэлемента в почве (q_{Se}). Эта взаимосвязь хорошо апроксимируется степенной функцией: $Q_{Se} = 163,82\ q_{Se}^{-1,2}$. Коэффициент корреляции при этом составил –0,720 (с уровнем значимости не менее 0,05). Это свидетельствует об увеличении интенсивности поглощения Se растениями при его уменьшении в почве. То есть характер зависимости Q_{Se} селена подсолнечником от содержания микроэлемента в почве больше соответствует жизненно важному, нежели условно необходимому элементу питания.

Ключевые слова: селен, микроэлементы, взаимосвязь, почва, растения.

THE IMPORTANCE OF METAVERSES FOR THE DEVELOPMENT OF CIVILIZATIONS

Prof. dr Marijana Joksimović, Prof. dr Larisa Jovanović

Alfa BK University – Faculty of Finance, Banking and Auditing, Belgrade, Serbia
joksimovicmarijana80@gmail.com, orcid.org/0000-0002-5939-5137 (MJ)
larisa.jovanovic@alfa.edu.rs, orcid.org/0000-0002-1840-819X (LJ)

The application of Artificial Intelligence (AI) in environmental protection, particularly within the ecosystem, is a rapidly evolving area with immense potential to improve the health and sustainability of ecosystems worldwide. Ecosystems, which include forests, oceans, wetlands, and grasslands, are under growing pressure from climate change, pollution, habitat destruction, and unsustainable resource exploitation. AI technologies offer innovative solutions to monitor, manage, and protect these vital ecosystems more efficiently and effectively.

AI's ability to process and analyze vast amounts of environmental data, often in real-time, enables researchers, policymakers, and conservationists to understand and respond to ecosystem dynamics in unprecedented ways. Machine learning algorithms, data analytics, and neural networks are particularly useful in identifying patterns and predicting changes in ecosystems, providing valuable insights into environmental processes such as species migration, biodiversity shifts, and ecosystem service depletion.

One of the primary ways AI is supporting ecosystem protection is through advanced environmental monitoring. AI-powered sensors and satellite imagery, integrated with machine learning models, are used to track deforestation, pollution levels, changes in land use, and disruptions in biodiversity. For example, AI is instrumental in detecting early signs of forest fires, illegal logging, or coral reef bleaching, allowing for quick and targeted interventions. This real-time data processing reduces human error and improves the speed of response, significantly enhancing conservation efforts.

In the field of biodiversity conservation, AI plays a key role in monitoring endangered species and managing protected areas. AI algorithms can process camera trap images and audio recordings to identify species presence or behavior patterns without requiring constant human supervision. This reduces the labor intensity of fieldwork and increases the accuracy of data collection. Additionally, AI can be used to predict the effects of climate change on species distributions and ecosystem services, aiding in the design of more resilient and adaptive conservation strategies.

AI is also transforming ecosystem management through its capacity to simulate complex environmental scenarios and predict the outcomes of different conservation strategies. By modeling various interventions, AI helps optimize ecosystem restoration projects, ensuring that the chosen actions are both ecologically effective and cost-efficient. Furthermore, AI-driven systems can enhance decision-making by supporting sustainable agriculture, land-use planning, and water management, all of which directly impact ecosystem health.

However, despite the potential, the use of AI in ecosystem protection must address certain challenges. The reliance on high-quality, diverse data, the need for interdisciplinary collaboration, and the ethical implications of AI applications must be considered. Additionally, the environmental impact of the energy required to run AI models is a crucial factor that requires balancing with the positive outcomes of ecosystem protection.
AI holds immense promise in safeguarding ecosystems through improved monitoring, more effective conservation strategies, and predictive capabilities. Its integration into ecosystem management could revolutionize the way we understand and protect the natural world, leading to more sustainable and resilient ecosystems for future generations. However, its development and application must be approached with caution to ensure that it fosters environmental sustainability and supports the ethical principles of conservation.

Keywords: Artificial Intelligence, Ecosystem Protection, Environmental Monitoring, Machine Learning, Ecosystem Management, Climate Change, Sustainability, Data Analytics, Conservation Ecosystem Restoration, Predictive Modeling and Environmental Sustainability.

Acknowledgment: This paper is part of the research results on Project U 01/2023 Green economy in the era of digitization and Project U 01/2024 Sustainable development and environmental protection in economy, Faculty of Finance, Banking, and Auditing, Alfa BK University.

ARTIFICIAL INTELLIGENCE IN AGRICULTURE: THE PATH TOWARDS A GREEN ECONOMY AND SUSTAINABLE GROWTH

Suzana Balaban[1], Jasmina Đurašković[2]

[1]Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia
[2]Academy of Applied Studies Polytechnic, Belgrade

The agricultural sector, as a significant segment of the national economy, faces numerous challenges. One of these is its transformation in line with the principles of the green economy. Artificial Intelligence (AI) offers innovative tools that enable production optimization, waste reduction, and more efficient use of natural resources, thereby contributing to a more environmentally friendly and economically viable development of the agricultural sector. The aim of this paper is to analyze the role and importance of AI in modern agriculture, with a particular focus on its contribution to the green economy, economic growth, and sustainable development. Global climate changes, rising demand for food, and limited natural resources require new technologies that enable optimization of agricultural production while simultaneously reducing the negative impact on the environment. AI provides solutions that can improve efficiency and sustainability in agriculture through precision analytics, automation, and predictive models. One of the most important aspects of AI application in agriculture refers to precision farming, which uses data collected via sensors, satellite imagery, and drones to make optimal decisions regarding sowing, irrigation, and plant protection. These data allow farmers to reduce the use of pesticides and fertilizers, directly contributing to environmental protection and soil quality improvement. According to some research, the application of precision agriculture can reduce carbon dioxide emissions by 15–25% and energy consumption by 10–20%. AI also creates a demand for new skills and jobs. From an economic perspective, the application of AI in agriculture fosters innovation and the development of new jobs, especially in data analysis and software solutions for agricultural resource management. The digitalization of agriculture contributes to increased productivity and competitiveness of small and medium-sized agricultural enterprises, enabling sustainable economic growth and poverty reduction in rural areas. Furthermore, improved market access through digital platforms reduces intermediaries and increases profitability for producers. Nevertheless, the challenges of implementing AI in agriculture include high initial costs, the digital divide between developed and developing regions, as well as ethical dilemmas related to data privacy and information ownership. Greater cooperation between government institutions, the private sector, and the academic community is needed to ensure broader accessibility to these technologies and equitable distribution of benefits. In conclusion, artificial intelligence plays a key role in modernizing agriculture and aligning it with the principles of the green economy and sustainable development. Resource optimization, increased production efficiency, and reduced environmental impact are the main benefits of these technologies. Although there are certain implementation challenges, the long-term advantages of AI in agriculture indicate that its further application is necessary for a sustainable future of the global agroecosystem.

Keywords: artificial intelligence, agriculture, green economy, sustainable growth.

ARTIFICIAL INTELLIGENCE IN THE FUNCTION OF SUSTAINABLE DEVELOPMENT

Dejan Riznić, Adrijana Jevtić

University of Belgrade, Technical Faculty in Bor, V.J. 12, 19210 Bor, Serbia
orcid.org/0000-0002-8213-2722, e-mail: driznic@tfbor.bg.ac.rs (DR)
orcid.org/0000-0002-8870-5790, e-mail: ajevtic@tfbor.bg.ac.rs (AJ)

Artificial intelligence (AI) is certainly one of the greatest "inventions" of the modern age. It facilitates and improves people's lives, has the potential to respond to social needs, but also brings new challenges and risks. In order for us as individuals and as a society to catch up with technological development and take advantage of that process, it is important to inform ourselves and learn as much as possible about the different segments of artificial intelligence. The increasing use of artificial intelligence in the 21st century is influencing the social and economic shift towards increased automation, data-driven decision-making and the integration of artificial intelligence systems into various economic sectors and areas of life, affecting the labor market, healthcare, government, industry, ecology and education. Although the field itself is extremely interesting, it is necessary to be fully versed in the capabilities and limitations of artificial intelligence tools and algorithms. The field is constantly developing and improving, so the level of progress is beyond all expectations. The Sustainable Development Goals are still uncertain, as they could either accelerate progress or hinder it. The aim of this work is to help understand the implications of artificial intelligence for business in conditions of rapid technological and social changes in the function of sustainable development. That is why it is important to refresh current knowledge, consult with colleagues from the profession, as well as consult recently published scientific works. AI must serve the moral good of society for its use to be ethical. The dominant example of such essential moral goods are the UN Sustainable Development Goals (SDGs) (United Nations, "The Sustainable Development Goals", 2019). Although AI has a negative impact on some, as part of this set of goals, those with the theme of environmental protection are those goals where AI has the most positive impact, but they are also interesting from the ethical side of artificial intelligence, because they can be understood as something closest to the consensus of humanity in terms of moral goals.

Key words: artificial intelligence, sustainable development, challenges of the modern age, new technologies, environmental protection.

Acknowledgement: The research presented in this paper was done with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade, Technical Faculty in Bor, according to the contract with registration number 451-03-137/2025-03/200131.

VEŠTAČKA INTELIGENCIJA U FUNKCIJI ODRŽIVOG RAZVOJA

Dejan Riznić, Adrijana Jevtić

Univerzitet u Beogradu, Tehnički fakultet u Boru, V.J. 12, 19210 Bor, Srbija
orcid.org/0000-0002-8213-2722, e-mail: driznic@tfbor.bg.ac.rs (DR)
orcid.org/0000-0002-8870-5790, e-mail: ajevtic@tfbor.bg.ac.rs (AJ)

Veštačka inteligencija (Artificial Intelligence – AI), sigurno je jedan od najvećih „izuma" modernog doba. Ona olakšava i unapređuje život ljudi, ima potencijal da odgovori na društvene potrebe, ali takođe donosi i nove izazove i rizike. Kako bismo i kao pojedinci i kao društvo mogli da uhvatimo korak sa tehnološkim razvojem i iskoristimo prednosti tog procesa, bitno je da se informišemo i saznamo što više o različitim segmentima veštačke inteligencije. Sve veća upotreba veštačke inteligencije u 21. veku utiče na društveni i ekonomski pomak ka povećanju automatizacije, donošenja odluka zasnovanih na podacima i integraciji sistema veštačke inteligencije u različite ekonomske sektore i oblasti života, utičući na tržište rada, zdravstvo, vladu, industriju, ekologiju i obrazovanje. Iako je sama oblast izuzetno interesantna, potrebno je biti potpuno upućen u mogućnosti i ograničenja alata i algoritama veštačke inteligencije. Oblast se konstantno razvija i usavršava, tako da je nivo progresa izvan svih očekivanja. Ciljevi održivog razvoja su još uvek neizvesni, kao što bi mogli ili ubrzati napredak ili ga ometati. Cilj ovog rada je da pomogne kako bi se razumele implikacije veštačke inteligencije na poslovanje u uslovima brzih tehnoloških i društvenih promena u funkciji održivog razvoja. Zato i jeste važno osvežiti trenutna znanja, posavetovati se sa kolegama iz struke kao i konsultovati nedavno objavljene naučne radove. AI mora da služi za moralno dobro društva da bi njena upotreba bila etična. Dominantni primer takvih suštinskih moralnih dobara su ciljevi održivog razvoja UN (SDG, Sustainable Development Goals) (United Nations, "The Sustainable Development Goals", 2019). Iako AI ima negativan uticaj na neke, kao deo ovog skupa ciljeva, oni sa temom zaštite životne sredine su oni ciljevi gde AI ima najpozitivniji uticaj, ali su i zanimljivi sa etičke strane veštačke inteligencije, jer se mogu shvatiti kao nešto najbliže konsenzusu čovečanstva u smislu moralnih ciljeva.

Ključne reči: veštačka inteligencija, održivi razvoj, izazovi modernog doba, nove tehnologije, zaštita životne sredine.

MODELLING OF THE GROUNDWATER FLOW USING KRIGING INTERPOLATION WITHIN ArcGIS

Dušan Jokanović, Vesna Nikolić Jokanović

Faculty of Forestry, Belgrade University, Belgrade, Serbia

Groundwater is the main factor that affects the development and existence of forest sites in lowland areas. A continuous layer of water that fills all soil pores and has a positive pressure value is referred to as groundwater. This layer is located in the deeper parts of the soil or in the rock, and its upper limit represents the level of the groundwater. The water present in the soil plays a major role in the existence of oak forests, which are the most dominant association at investigated area. The significant impact of groundwater on the features of lowland sites is reflected in the fact that they lead to an increase in soil moisture to an extent that cannot be compensated directly by rainfalls. Numerous negative human activities have led to the disruption of the natural watering regime (increased oscillations in the level of flood water and groundwater), which has reflected on the stability and vitality of forest ecosystems in lowland areas. Due to global warming and long dry periods, there is an increasingly present trend of groundwater level decline, which has a very negative impact on the development and production characteristics of forest associations in alluviums, especially bearing in mind that pedunculate oak, as a dominant species, is primarily supplied with water from groundwater. Based on the aforementioned facts, it should be noted that knowing of groundwater trend is of a huge practical significance in terms of forest management. For that reason, it is necessary to carry out the monitoring of groundwater fluctuations on piezometric stations, not only to have an insight in current state, but also in order to predict their behaviour in the future. In the paper was used Kriging method, which is one of the geostatistical methods with a great significance for groundwater monitoring. Kriging includes geostatistical techniques which serve to determine the unknown value of some variable based on available data related to so-called control points, and based on structural characteristics of variogram, as well. Kriging assessment is based on the use of existing measurements, whose impact is expressed through appropriate weighting coefficients. The aforementioned assessment must be as accurate as possible, and this is achieved by making the variance of the difference between the real and estimated values at the selected points as small as possible. This value is called the Kriging variance and us designated as an interpolation quality control element. ArcGIS enables spatial analysis of hydrological elements, creation of maps and modelling of groundwater flows. It is important to conduct groundwater modelling in order to determine the proportion of available water between groundwater and rainfalls, which is essential for the management of lowland forests. The recommendation for some future research that will deal with the monitoring of groundwater level fluctuations in forest ecosystems is to include, in addition to Kriging, multi-criteria analysis methods, such as AHP, which are before all based on the determination of weight criteria on the principle of defined priorities.

Key words: Kriging, groundwater, modelling, lowland forests.

MODELIRANJE PROTOKA PODZEMNIH VODA KORIŠĆENJEM KRIGING INTERPOLACIJE U OKVIRU ArcGIS paketa

Dušan Jokanović, Vesna Nikolić Jokanović

Šumarski fakultet, Univerzitet u Beogradu

Podzemna voda je glavni faktor koji determiniše razvoj i postojanje šumskih staništa u nizijskim područjima. Kontinuelni sloj vode koji ispunjava sve zemljišne pore i ima pozitivnu vrednost pritiska označava se kao podzemna voda. Taj sloj je lociran u dubljim delovima zemljišta ili u matičnom supstratu, a njegova gornja granica predstavlja nivo podzemne vode.Voda koja je prisutna u zemljištu ima glavnu ulogu u egzistiranju šuma hrasta lužnjaka, koje predstavljaju dominantnu zajednicu na istraživanom području. Značajan uticaj podzemne vode na karakteristike nizijskih staništa ogleda se u činjenici da dovodi do povećanja vlažnosti zemljišta u meri koju je nemoguće direktno nadoknaditi putem padavina. Brojne negativne antropogene aktivnosti dovele su do poremećaja prirodnog režima vlaženja (povećane oscilacije nivoa podzemnih i plavnih voda), što se reflektovalo na stabilnost i vitalnost šumskih ekosistema u nizijskim područjima. Usled globalnog zagrevanja i dužih sušnih perioda, sve je prisutniji trend opadanja nivoa podzemnih voda, što ima veoma negativan uticaj na razvojno-proizvodne karakteristike šumskih zajednica u aluvijumima, posebno imajući u vidu da se hrast lužnjak, kao dominantna vrsta, vodom prevashodno snabdeva iz podzemnih voda. Imajući u vidu sve pomenute činjenice, treba istaći da je poznavanje trenda podzemnih voda od velikog praktičnog značaja za gazdovanje šumama. Iz tog razloga je neophodno sprovoditi monitoring nivoa oscilovanja podzemnih voda na piezometarskim stanicama, ne samo da bi se imao precizan uvid u sadašnje stanje, već i radi praćenja trenda njihovog ponašanja u budućnosti. U ovom radu je korišćena metoda Kriginga, koja spada u geostatističke metode od velikog značaja za monitoring podzemnih voda. Kriging obuhvata geostatističke tehnike koje služe za određivanje nepoznate vrednosti određene promenljive na osnovu raspoloživih podataka povezanih sa tzv. kontrolnim tačkama, kao i na bazi strukturnih karakteristika variograma. Procena Krigingom bazirana je na korišćenju postojećih merenja čiji se uticaj izražava preko odgovarajućih težinskih koeficijenata. Pomenuta procena mora biti, što je moguće, tačnija, a to se postiže tako što je varijansa razlike između stvarnih i procenjenih vrednosti u odabranim tačkama najmanja moguća. Ova vrednost se naziva varijansa Kriginga i označava se kao element provere kvaliteta interpolacijeArcGIS omogućava prostornu analizu hidroloških parametara, izradu mapa i modeliranje tokova podzemnih voda. Modeliranje podzemnih voda je važno sprovesti da bi se utvrdio udeo u dostupnoj količini vode između podzemnih voda i padavina, a što je od velikog praktičnog značaja za gazdovanje nizijskim šumama. Preporuka za neka buduća istraživanja koja se budu bavila praćenjem oscilovanja nivoa podzemnih voda u šumskim ekosistemima je da se, pored Kriginga, uključe i metode višekriterijumske analize, poput AHP-a, a koji se prevashodno baziraju na određivanju težinskih kriterijuma po principu definisanih prioriteta.

Ključne reči: Kriging, podzemne vode, modeliranje, nizijske šume

APPLICATION OF AI IN BIG DATA ANALYTICS IN THE GOAL OF ENERGY TRANSITION: A COMPARATIVE COST-EFFECTIVENESS ANALYSIS OF RENEWABLE ENERGY SOURCES VERSUS FOSSIL FUELS

Larisa Jovanović, Aleksandra Stojkov Pavlović

Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia

The analytical processing of big data and AI technologies plays a key role in the energy transition, enabling more efficient utilization of renewable energy sources and the optimization of power systems. The utilization of alternative and renewable energy sources represents the only viable strategy that can ensure a successful energy transition, distancing us from outdated and environmentally harmful energy supply systems based on fossil fuels and high carbon emissions. With the support of artificial intelligence (AI) and big data technologies, this transition becomes more predictable, measurable, and feasible, enabling the anticipation of potential energy supply scenarios. This paper explores the application of AI and big data technologies, while a comparative analysis is employed to examine the use of alternative, renewable, and traditional energy sources within the context of the energy transition. Through a comparative analysis, the study examines the advantages, challenges, and production costs associated with alternative, renewable, and conventional energy sources. The findings underscore the potential of data-driven approaches to accelerate the energy transition while highlighting the economic and technological barriers that must be addressed to ensure a sustainable energy future.

Keywords: Carbon footprint, Sustainable energy, Energy transition, Big data, AI.

CONTRIBUTED LECTURES

NAUČNA SAOPŠTENJA

ICP-AES AND ICP-MS METHODS IN THE ANALYSIS OF THE ELEMENTAL COMPOSITION OF SOILS AND PLANTS IN THE VICINITY OF THE UNAL TAILING DUMP (NORTH OSSETIA)

Dr. Fedor Golubev, Irina Gromyak, Dr. Denis Dogadkin, Prof. Dr. Vladimir Kolotov

Vernadsky Institute of Geochemistry and Analytical Chemistry RAS
(*GEOHI RAS*)*, Moscow, Russia*; *f.v.golubev@mail.ru*

As a result of the development of polymetallic ore deposits in mountainous Ossetia, significant dispersion halos of a number of elements were formed and pollution of the surrounding areas with lead, zinc, cadmium, indium, arsenic, nickel, copper, etc. was observed. The accumulation of a number of elements in the soil-plant system exceeded maximum permissible concentrations. This was especially characteristic of lead, cadmium, arsenic, and zinc. In order to identify dispersion halos of heavy metals and a number of other elements, plants capable of concentrating metals and metalloids were studied. The main goal of the studies was to identify plants that could be recommended in the future for phytoremediation of contaminated soils. We have studied 30 plant species growing in close proximity to the Unal tailings dump and thirty soils samples taken from the root zone of each plant the ICP-AES and ICP-MS methods. The determinations were made on ICAP-6500 Duo and XSeries 2 (Thermo Scientific) spectrometers. Soil samples (1-3 g) and plants (1-3 g) were dried to constant weight. Then they were homogenized in a vibratory mill HK40 (Breitlander) with a corundum set. As a result of the studies, it was established that the contaminated areas near the Unal tailings dump contained significant amounts of indium and lead. Therefore, the use of ^{115}In as an internal standard was impossible. High lead content (more than 10 thousand g/t in some soil samples) did not allow using ^{103}Rh as an internal standard, since there is an overlap of the signal from the 206th isotope of the divalent lead ion. However, rhenium was almost completely absent in the studied samples, so we replaced indium with rhenium as an internal standard. ^{187}Re, which has a signal intensity close to ^{115}In, was used to correct the mass spectra. Comparison of the results for a number of standard samples, such as TR-1 (meadow grass mixture), SGHM-1 (loose carbonate-silicate sediments), etc., showed that using ^{187}Re instead of ^{115}In as an internal standard gives quite comparable results. In addition, the analytical center of GEOKHI RAS has developed methods for open acid decomposition for soils and microwave acid decomposition of plant material in the Mars Express system (CEM Corp., USA) for plants. The analyzed mass was 50 mg for soil and 250 mg for plant material. The calibration of the device was carried out using certified aqueous solutions from High-Puritystandards, Merck. The accuracy of the obtained results was confirmed by comparing the results of analysis using ICP-AES and ICP-MS methods of standard samples Tr-1 meadow grass mixture and carbonate-silicate loose deposits SGHM-1.

Keywords: North Ossetia, Unal tailing dump, elemental composition, heavy metals, plants, soils, ICP-AES, ICP-MS, internal standard.

Acknowledgment: The work was carried out within the state assignment of the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences (GEOHI RAS).

VISUALIZATION AND MODELING OF PHYTOGEOCHEMICAL PROFILES OF DONBASS WASTE HEAPS

Andrei Safonov[1], Vitalii Nespirnyi[1,2]

[1] *Donetsk State University, Donetsk, Russia*
[2] *Economic Research Institute, Donetsk, Russia*

The system of quantification of natural environment objects under technogenesis conditions involves the use of certain analytical procedures and methods of secondary synthesis if the set of information on the state of a local ecosystem represents large arrays of quantitative results. For most of the territory of Donbass, the introduction of methods for restoring disturbed ecotopes is a priority environmental task due to significant transformations as a result of increasing anthropogenic activity. The purpose of the work is to visualize a model of several phytogeochemical profiles characteristic of the waste heaps of Donbass using methods of mathematical statistics based on elemental analytical control data. Geophysical and geochemical parameters in industrially developed regions are characterized by a certain dynamism of variability if specific interventions are observed, which is relevant for the territory of Donbass during military events. Some phytogeochemical features of coal mine dumps in Donetsk and Makeyevka were determined. The results obtained are in the stage of constant supplementation with new information, which determines the need for their ordering. Phytogeochemical series of contrasting conditions of Donbass were formed for different taxa and zones of ectopic confinement, for example, using indicator species of bryophytes. For cases when the results of analytical control and structural-botanical examination represent fragmentary information, a special method of restoration (imputation) of missing information in a specific series (sequence) of features has been developed. The presented work functionally combines methodological techniques for assessing the ingredient composition of plants (using the established remediant *Phleum pratense* L. as an example) as part of the programs for phytochemical assessment of raw materials, and takes into account cenotic patterns using the example of successional processes of vegetation formation under the impact of accumulated damage objects. The main objective of the study was to visualize the data, the correct interpretation of which is possible with a more detailed examination and accumulation of information. Based on the obtained primary data, a close correlation was found between the elements, which means that a hypothesis can be formulated and further investigated about their joint entry into the plant organism in the following groups: 1) La-Ce-Sm-Tb-Pr-Nd-Gd; 2) Ho-Y-Dy; 3) Lu-Tm-Er-Yb; 4) Co-Eu; 5) Zr-Hf; 6) Rb-Tl; 7) Ca-Mo; 8) Cr-Ni. Technophile elements migrate according to individual scenarios: Mn, Zn, Cu, Cd, Al. Coincidences of the profiles of waste heaps A and X2, B and X4 are noted in addition to the previous descriptions. In new works, cumulative antagonism of pollutants with Ba, Si, Sr and Sn was revealed. In targeted programs for the remediation of damaged systems, it is fundamentally important to operate with the obtained data on the involvement of toxic elements in biogeochemical processes, which allows freely migrating pollutants to be converted into a bound state in the environment.
The study was carried out within the framework of the topic "Diagnostics and adaptation mechanisms of natural and anthropogenically transformed ecosystems of Donbass", state registration number of R&D 124051400023-4, Azov-Black Sea Mathematical Center, agreement dated 02/27/2025 No. 075-02-2025-1608.

Keywords: Donbass, environmental assessment, mathematical statistics in ecology, quality of the natural environment.

ASPECTS OF ARTIFICIAL INTELLIGENCE IN ENVIRONMENTAL SECURITY RISK MANAGEMENT

Milos Tosovic

University of Belgrade, Faculty of Security studies, Belgrade, Serbia

Environmental security risk management represents an increasingly important segment of global politics and national development strategies, especially in the context of prevention of various environmental disasters, climate change and environmental pollution. In a contemporary approach to the improvement and increasing application of artificial intelligence (AI), it offers highly innovative solutions for the analysis, prediction and environmental security risk management. In particular, advanced analytical methods, including machine learning and developed neural networks, can be singled out, which enables more accurate recognition of analytical patterns and decision-making based on initial environmental and security data, which contributes to timely measures of environmental prevention and environmental protection. In the analytical-research sense, the aspects of the application of AI in environmental security risk management are particularly significant, with the consideration of various technologies that can contribute to the reduction of negative consequences for the ecosystems, human health, material, life and business resources. Artificial intelligence initially provides a wider range of possibilities for environmental security management of various risks, so that in the broadest analytical approach, the following can be distinguished: (a) prediction models of environmental pollution; (b) climate change analysis; (c) optimization of environmental aspects of energy resources; and (d) drone and satellite monitoring. In doing so, it should be kept in mind that the successful implementation of AI in environmental security risk management and environmental security requires overcoming special challenges, among which the following should be singled out: (a) availability and quality of data; (b) technical and economic constraints; (c) high implementation costs; and (d) specific ethical issues. The integration of new technologies in environmental security risk management should be accompanied by a regulatory framework that will enable the legally regulated, transparent and responsible use of AI in various aspects of environmental security.

Keywords: ecology, environmental security, risk assessment, AI, security managers.

ASPEKTI VEŠTAČKE INTELIGENCIJE U UPRAVLJANJU EKOLOŠKIM BEZBEDNOSNIM RIZICIMA

Miloš Tošović

Univerzitet u Beogradu, Fakultet bezbednosti, Beograd, Srbija

Upravljanje ekološkim bezbednosnim rizicima predstavlja sve značajniji segment globalne politike i nacionalnih strategija razvoja, posebno u kontekstu prevencije različitih ekoloških katastrofa, klimatskih promena i zagađenja životne sredine. U savremenom pristupu unapređenja i sve veće primene veštačke inteligencije (VI), ona nudi veoma inovativna rešenja za analizu, predikciju i upravljanje ekološkim bezbednosnim rizicima. Posebno se mogu izdvojiti napredne analitičke metode, uključujući mašinsko učenje i razvijene neuronske mreže, što omogućava preciznije prepoznavanje analitičkih obrazaca i donošenje odluka zasnovanih na polaznim ekološkim i bezbednosnim podacima, što doprinosi pravovremenim merama ekološke prevencije i ekološke zaštite. U analitičko-istraživačkom smislu posebno su značajni aspekti primene VI u upravljanju ekološkim bezbednosnim rizicima, uz razmatranje različitih tehnologija koje mogu doprineti smanjenju negativnih posledica po ekosisteme, zdravlje ljudi, materijalne, životne i poslovne resurse. Veštačka inteligencija polazno pruža širi spektar mogućnosti za upravljanje različitim ekološkim bezbednosnim rizicima, tako da se u najširem analitičkom pristupu mogu izdvojiti: (a) modeli predikcije ekološkog zagađenja; (b) analiza klimatskih promena; (c) optimizacija ekoloških aspekata energetskih resursa; i (d) monitoring pomoću dronova i satelita. Pri tome treba naročito imati u vidu da uspešna implementacija VI u upravljanju ekološkim bezbednosnim rizicima i ekološkoj bezbednosti zahteva savladavanje posebnih izazova, među kojima treba posebno izdvojiti: (a) dostupnost i kvalitet podataka; (b) tehnička i ekonomska ograničenja; (c) visoke troškove implementacije; i (d) posebna etička pitanja. Integracija novih tehnologija u upravljanju ekološkim bezbednosnim rizicima treba da bude praćena regulatornim okvirom koji će omogućiti pravno regulisanu, transparentnu i odgovornu upotrebu VI u različitim aspektima ekološke bezbednosti.

Ključne reči: ekologija, ekološka bezbednost, procena rizika, VI, menadžeri bezbednosti.

FORECAST OF THE FACTOR OF POLEMOSTERSS IN DONBASS FOR 2025-2026

Ekaterina Germonova[1], Andrei Safonov[2]

[1]Donetsk National Technical University, Donetsk, Russia
[2]Donetsk State University, Donetsk, Russia

Based on the identified stable trends in the change of phytoindication indicators in 2022-2024, associated with the factor of military events in Donbass, a spatial cartographic model of the further development of the field-stress situation for the next three vegetation seasons was constructed. An assumption was made about the diffuse penetration of the neo-factor of anxiety deep into the monitoring network of the region. In the current view, the territory of Donbass is a zone of protracted socio-political conflict, the negative consequences of which are a profound transformation of natural and historically formed natural-technogenic systems, requiring the introduction of progressive restoration technologies: both the functional structure and the possibility of full use of the resource potential of the region. Cartographic modeling of post-conflict zones and (or) militarization processes is a popular scientific and applied task and is implemented in several stages: in the development of a visualization technique with subsequent quantification of risk and identification of sources of danger.

The purpose of the work is to propose a method for constructing a cartographic model demonstrating the development of the field stress factor in the Central Donbass in a short-term forecast, based on stable trends of the previous observation period.

Similar approaches from geoinformation monitoring of population morbidity foci, hydrogeological surveys in the conditions of impact of technogenic objects, as well as direct developments of botanical and ecological content in the region were used as a methodological basis for performing GIS analysis of factors of adverse consequences of anthropogenic interventions in natural balance processes. The analysis of the identified specific factor of military events (controversy, political stress) involved the characteristics of the morphological and functional status of 45 indicator plant species, including representatives of bryophytes and angiosperms, exhibiting structural plasticity of a phenotypic nature in new geopathogenic zones.

The expected specificity of the shift of militarization load fields on the region will be characterized by a diffuse and uneven advancement deep into the monitoring network from the contact line of the opposing camps, which in geopolitical constructs today corresponds to the transect connecting the cities of Gorlovka, Yasinovataya, Avdeevka and the northern regions of Donetsk. The highest information rhesus is characterized by the signs in the structure of plants of the Asteraceae and Brassicaceae families, however, due to the use of bryophytes in the autumn-winter period, a continuous process of accumulation of new data is ensured, correcting the general conditionally

phytotoxicological situation for the entire observation area. Among the signs of leading importance, including in field diagnostics, the following are distinguished: terate manifestations of vegetative and generative organs of plants: fasciation, dystopia, oligomerization, petalization, hypoplasia, structural syn- and schizo-variations of individual paired parts at different levels of asymmetry manifestation (leaf blade, branching, architectonics of modular components of test organisms). Functional criteria also included frequent cases of manifestations of different categories of chlorosis and necrosis, which can also diagnose specific pollutants or groups of toxicants by their pattern of manifestations.

The study was carried out within the framework of the topic “Diagnostics and adaptation mechanisms of natural and anthropogenically transformed ecosystems of Donbass”.

Keywords: environmental monitoring, polemostress, Donbass, environmental assessment, phytoindication, pollution forecast.

APPLICATION OF AI IN ENVIRONMENTAL PROTECTION: CORROSION AND BIOSORPTION

Milica Zdravković, Miljan Marković, Marina Marković, Vesna Grekulović, Milan Gorgievski, Nada Štrbac, Kristina Božinović

University of Belgrade, Technical Faculty in Bor,
Vojske Jugoslavije 12, Bor, Serbia

Artificial intelligence (AI) plays an important role in the field of scientific research. This paper aims to review the application of AI in corrosion and biosorption. The use of AI can advance the research process in terms of prediction, environmental and cost management, optimization and determination of the influence of parameters. Corrosion is a highly complex process that depends on many factors. Studying the interaction of these factors using AI enables better corrosion control. By applying AI, it is possible to determine the diverse influence of factors under real conditions using the database of numerous researches. In addition to the prevention and monitoring of corrosion and biosorption processes, it is important to focus the application of AI on environmentally friendly methods and chemicals. In this way, it is possible to identify compounds and materials of natural origin that can serve as substitutes for toxic compounds for corrosion protection or heavy metal removal. The importance of using non-destructive methods and monitoring data in real time is particularly emphasized, in order to avoid statistical errors. Optimization with the RSM method for corrosion and biosorption processes is widely used, determining process parameters where the best effect of corrosion protection and biosorption is achieved.

Keywords: AI, corrosion, biosorption, optimization

Acknowledgment: The research presented in this paper was done with the financial support of the Ministry of Science, Technological Development and Innovation of the Republic of Serbia, within the funding of the scientific research work at the University of Belgrade - Technical Faculty in Bor, according to the contract with registration no. 451-03-137/2025-03/200131.

PRIMENA VI U ZAŠTITI ŽIVOTNE SREDINE: KOROZIJA I BIOSORPCIJA

Milica Zdravković, Miljan Marković, Marina Marković, Vesna Grekulović, Milan Gorgievski, Nada Štrbac, Kristina Božinović

Univerzitet u Beogradu, Tehnički fakultet u Boru,
Vojske Jugoslavije 12, Bor, Srbija

Veštačka inteligencija (VI) ima važnu ulogu u oblasti naučnih istraživanja. Cilj ovog rada je pregled primene VI u oblasti korozije i biosorpcije. Primena VI može unaprediti proces istraživanja u smislu predviđanja, upravljanja životnom sredinom i troškovima, optimizacije i određivanja uticaja parametara. Korozija je veoma složen proces koji zavisi od mnogo faktora, ispitivanje interakcije ovih faktora primenom VI omogućava bolju korozionu kontrolu. Primenom VI je moguće utvrditi višestruki uticaj faktora u realnim uslovima prema bazi podataka mnogobrojnih istraživanja. Pored prevencije i praćenja procesa korozije i biosorpcije, važno je usmeriti primenu VI na ekološki prihvatljive metode i hemikalije. Na ovaj način je moguće identifikovati jedinjenja i materijale prirodnog porekla, koja mogu biti zamena za toksična jedinjenja koja se koriste za zaštitu od korozije ili za uklanjanje teških metala. Posebno je naglašen značaj primene nedestruktivnih metoda i praćenja podataka u realnom vremenu, kako bi se izbegle statističke greške. Optimizacija primenom RSM metode za procese korozije i biosorpcije se često koristi, pri čemu se određuju parametri procesa u kojima se postiže najbolji efekat zaštite od korozije i biosorpcije.

Ključne reči: VI, korozija, biosorpcija, optimizacija

Zahvalnica: Istraživanje prikazano u ovom radu urađeno je uz finansijsku podršku Ministarstva za nauku, tehnološki razvoj i inovacije Republike Srbije, u okviru finansiranja naučnoistraživačkog rada na Univerzitetu u Beogradu – Tehničkom fakultetu u Boru, po ugovoru sa matičnim br. 451-03-137/2025-03/200131.

CHEMICAL ANALYSIS OF PLANTS AND SOILS OF THE NORTH OSSETIA TERRITORIES ADJACENT TO THE POLYMETALLIC AREA BY THE ICP-MS METHOD AND THE CHOICE OF AN INTERNAL STANDARD

Dr. Fedor Golubev, Dr. Denis Dogadkin, Prof. Dr. Vladimir Kolotov

Vernadsky Institute of Geochemistry and Analytical Chemistry RAS (GEOHI RAS), Moscow, Russia; f.v.golubev@mail.ru

In North Ossetia, in the Ardon River basin, the Sadon group of lead-zinc polymetallic deposits is concentrated, the extraction of which has had a negative impact on the environment. The consequences of the activities of the Mizur Mining and Processing Plant and the storage of waste in the Unal tailings dump, located near the Nizhny Unal village, have led to environmental pollution with various pollutants.The study of the elemental composition of soils and plants near the Unal tailings dump in North Ossetia, which contains waste from the processing of polymetallic ores, is an important environmental task for assessing their contamination with elements such as cadmium, lead, zinc, etc.

Currently, inductively coupled plasma mass spectrometry (ICP-MS) is used for elemental analysis of such samples. During the measurement process, to take into account signal drift, a so-called internal standard is used, which is an isotope of an element that is not present in the samples or whose content in them is negligible. Due to its rare occurrence and the ability to fairly accurately correct the signal change for all elements from lithium to uranium, 115In is used as an internal standard. In some cases, 103Rh is used instead of 115In, which is also quite rare in soil, plant and rock samples. However, waste from the processing of polymetallic ores in North Ossetia contains significant amounts of indium. Elemental analysis of plant and soil samples collected in the vicinity of the Unal tailings dump showed the presence of indium in most cases. As a result, it was not possible to use 115In as an internal standard. The high lead content (in some soil samples more than 10 thousand g/t) did not allow the use of 103Rh as an internal standard, since there is an overlapping signal from the 206th isotope of the divalent lead ion. However, the samples studied were almost completely free of rhenium, so we replaced indium with rhenium as an internal standard. For mass spectra correction we used 187Re, which has a signal intensity close to 115In. A comparison of the results for a number of standard samples, such as TR-1 (meadow grass mixture), SGHM-1 (loose carbonate-silicate deposits), etc., showed that the use of 187Re instead of 115In as an internal standard gives quite comparable results. Thus, rhenium can be used as an internal standard for ICP-MS analysis of soil and plant samples in special cases.

Keywords: North Ossetia, Unal depression, trace elements, internal standard, ICP-MS, heavy metals, plants, soils.

Acknowledgment: The work was carried out within the state assignment of the Vernadsky Institute of Geochemistry and Analytical Chemistry of the Russian Academy of Sciences (GEOHI RAS).

FORECAST OF THE TRANSFORMATION OF THE ECOSYSTEM STRUCTURE OF THE DNIESTER-PRUT INTERFLUVE UNDER THE INFLUENCE OF CLIMATE CHANGE

Dr. Ivan Kapitalchuk

Shevchenko State University of Pridnestrovie, Tiraspol, Moldova
orcid.org/*0000-0003-2448-7493ž*

Forecasting the transformation of the ecosystem structure of a territory under the influence of climate change is a complex task that can be solved using artificial intelligence. The solution to this problem for the territory of the Dniester-Prut interfluve consisted of two stages. At the first stage, a forecast of climate change in the region for a certain period of time was carried out. At the second stage, an assessment of the transformation of the spatial structure of ecosystems in the region as a result of changed climatic conditions was carried out. Only zonal types of ecosystems were considered, which are mainly formed depending on the provision of heat and moisture. The provision of heat was estimated using the sum of temperatures during the vegetation period (∑T0), the provision of moisture – by the moisture coefficient (Km), reflecting the ratio of the amount of precipitation and evaporation. The initial data for the calculation were the results of modeling changes in average monthly air temperatures and precipitation in the region for two time periods (2021–2050 and 2071–2100) [1] and three Representative Concentration Pathways scenarios (RCP2.6, RCP4.5 and PCP8.5) [2]. However, the obtained background values of the parameters ∑T0 and Km are differentiated under the influence of the relief, the height of which in the region varies from 0 to 430 meters. To take this factor into account, the author calculated the vertical distribution of the prognostic parameters ∑T0 and Km depending on the relief height and climate change options. The use of the obtained prognostic parameters ∑T0 and Km in the model of the altitudinal geoecosystem structure of the region made it possible to obtain an idea of the change in altitudinal ranges favorable for the existence of different types of geoecosystems during the implementation of different climate change options. If the RCP 2.6 scenario is implemented, the ecological conditions for the existence of all types of geoecosystems will be preserved, but the altitude of their boundaries will increase by 10 m by 2050, and by 50 m by 2100 relative to the initial level. At the same time, the altitude range with favorable ecological conditions for steppe geoecosystems located at the lower stage will expand, and the altitude range of distribution of forest geoecosystems with optimal moisture of the upper stage will narrow. If the situation develops according to the RCP4.5 or RCP8.5 scenario, by the middle of the 21st century, favorable conditions for the growth of beech forests will disappear on watersheds, and by the end of the century, environmental parameters will become unfavorable for oak forests with optimal moisture. The results of the modeling should be taken into account when developing programs for the restoration of natural ecosystems and the selection of agricultural crops at certain elevations.

Key words: artificial intelligence, climate change, ecosystem structure, forecast

References:

[1] IPCC, 2013: Summary for Policymakers. / Stocker, T.F., D. Qin, G.-K. Plattner, [at al.] (eds.). Cambridge University Press. – Cambridge, UK and New York, NY, USA, 2013.
[2] Corobov R., Trombitsky I., Sirodoev G., Andreev A. Climate change vulnerability: Moldavian part of the Dniester River basin. Chisinau, 2014. 336 p.

ПРОГНОЗ ТРАНСФОРМАЦИИ ЭКОСИСТЕМНОЙ СТРУКТУРЫ ТЕРРИТОРИИ ДНЕСТРОВСКО-ПРУТСКОГО МЕЖДУРЕЧЬЯ ПОД ВОЗДЕЙСТВИЕМ ИЗМЕНЕНИЯ КЛИМАТА

Доц. Иван Капитальчук

Приднестровский государственный университет, Тирасполь, Молдова

Прогнозирование трансформации экосистемной структуры территории под воздействием изменения климата является сложной задачей, которая может быть решена с использованием средств искусственного интеллекта. Решение этой задачи для территории Днестровско-Прутского междуречья состояло из двух этапов. На первом этапе осуществлялся прогноз изменения климата в регионе на определенный период времени. На втором этапе проводилась оценка трансформации пространственной структуры экосистем в регионе в результате изменившихся климатических условий. Рассматривались только зональные типы экосистем, которые в основном формируются в зависимости от обеспеченности теплом и влагой. Обеспеченность теплом оценивалась с помощью суммы температур за вегетационный период (∑T0), обеспеченность влагой – коэффициентом увлажнения (КУ), отражающим соотношение количества атмосферных осадков и испаряемости. Исходными данными для расчета послужили результаты моделирования изменений среднемесячных температур воздуха и осадков в регионе для двух временных периодов (2021–2050 годов и 2071–2100 годов) [1] и трех сценариев Representative Concentration Pathways (RCP2.6, RCP4.5 и PCP8.5) [2]. Однако полученные фоновые значения параметров ∑T0 и КУ дифференцируются под влиянием рельефа, высота которого на территории региона варьирует от 0 до 430 метра. Для учета этого фактора автором выполнен расчет вертикального распределения прогностических параметров ∑T0 и КУ в зависимости от высоты рельефа и вариантов изменения климата. Использование полученных прогностических параметров ∑T0 и КУ в модели высотной геоэкосистемной структуры региона позволила получить представление об изменении высотных диапазонов, благоприятных для существования разных типов геоэкосистем при реализации разных вариантов изменения климата. При реализации сценария RCP 2.6 экологические условия для существования всех типов геоэкосистем сохранятся, но высота расположения их границ увеличится к 2050 году на 10 м, а к 2100 году – на 50 м относительно исходного уровня. При этом высотный интервал с благоприятными экологическими условиями для степных геоэкосистем, располагающихся на нижней ступени, расширится, а высотный диапазон распространения лесных геоэкосистем с оптимальным увлажнением верхней ступени сузится. При развитии ситуации по сценарию RCP4.5 или RCP8.5 к середине XXI века на водоразделах исчезнут благоприятные условия для произрастания буковых лесов, а к концу столетия экологические параметры станут неблагоприятными и для дубрав с оптимальным увлажнением. Результаты моделирования следует учитывать при разработке программ по восстановление естественных экосистем и подборе сельскохозяйственных культур на определенных высотных отметках рельефа.

Ключевые слова: искусственный интеллект, изменение климата, экосистемная структура, прогноз.

Литература:

[1] IPCC, 2013: Summary for Policymakers. / Stocker, T.F., D. Qin, G.-K. Plattner, [at al.] (eds.). Cambridge University Press. – Cambridge, UK and New York, NY, USA, 2013.

[2] Corobov R., Trombitsky I., Sirodoev G., Andreev A. Climate change vulnerability: Moldavian part of the Dniester River basin. Chisinau, 2014. 336 p.

PRELIMINARY OVERVIEW OF PROJECTIONS OF THE FIELD OF ARTIFICIAL INTELLIGENCE APPLICATION IN THE ECONOMIC EVALUATION OF MINERAL RESERVES

prof. dr Radule Tošović, dipl. ecc.

University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia

The contemporary specifics of applying the economic evaluation of mineral reserves in the country's mineral sector are dictated by, among other things, complex conditions: (a) current geopolitical events; (b) strategic realignment; (c) tactical positioning and (d) crisis management. The market economic evaluation of economically increasingly important mineral resources is followed by particularly specific aspects of the functioning of the mineral economy, namely: (a) turbulence of the mineral market; (b) complexity of mineral production; (c) crisis conditions of supply of mineral raw materials; (d) ecological protests of citizens in the local area; (e) growing needs for critical mineral raw materials; and (f) the started race to secure the necessary rare metals for economic activities. In the practical application of the economic evaluation of mineral reserves, the evaluation methodology is constantly being improved according to changes in conditions and the necessity of adapting to existing needs and trends in the mineral economy. At the same time, as part of the economic evaluation methodology, the following can be distinguished: (a) the classic economic evaluation methodology; (b) the application of existing methods and tools in the collection, preparation and processing of data for economic evaluation; and (c) the use of contemporary and latest tools in economic evaluation methodology. The classical economic evaluation methodology includes the analysis of: (a) a set of nine factors of economic evaluation; and (b) three sets of economic evaluation indicators, which include (b1) a set of natural indicators; (b2) a set of value indicators; and (c) a set of synthetic indicators. A set of nine factors individually in a complete view includes: (a1) metallogenetic; (a2) geological; (a3) technical-exploitational or mining; (a4) technological; (a5) marketable; (a6) regional; (a7) social-political-economic-strategic; (a8) geoecological; and (a9) legislative-legal factors. At the same time, each of the mentioned groups includes a large number of individually belonging factors, which require a special geological-economic analysis and consideration. Among the most important methods, the following can be distinguished: (i) the method of economic evaluation without taking into account the time factor, as a classic method; and (ii) the economic evaluation methods taking into account the time factor, which especially include DCF methods, namely NPV and IRR method, as contemporary market evaluation methods. Among the contemporary tools for application in the economic evaluation of mineral reserves, the application of the increasingly present artificial intelligence (AI) is especially included. Considering the very large amount of data and information, which is necessary to collect in the initial basis for the economic evaluation, both by numerous factors and by even more indicators, and then to include them in the method of economic evaluation, the application of AI is imposed as a necessity. This projection of application includes the special designation of three important fields of application of AI, namely: (1) the field of geological exploration; (2) the field of exploitation; and (3) the field of immediate economic evaluation. Although the necessary data from the first two fields are directly used in the third field, the application of AI in the immediate economic evaluation is particularly important, which especially includes; (a) AI in collecting and preparing the necessary data and information; (b) AI in their processing and interpretation; and especially (c) the inclusion of AI in the immediate economic evaluation, which expresses the essence, efficiency and reliability of geological-mining-technological-economic work in the mineral sector and mineral economy of the country.

Key words: economic evaluation, mineral reserves, artificial intelligence, mineral economy.

PRELIMINARNI OSVRT NA PROJEKCIJE POLJA PRIMENE VEŠTAČKE INTELIGENCIJE U EKONOMSKOJ OCENI MINERALNIH REZERVI

prof. dr Radule Tošović, dipl. ecc.

Beogradski Univerzitet, Rudarsko-geološki fakultet, Beograd, Srbija

Savremene specifičnosti primene ekonomske ocene mineralnih rezervi u mineralnom sektoru zemlje diktirane su između ostalog složenim uslovima: (a) aktuelnih geopolitičkih događanja; (b) strategijskog prestrojavanja; (c) taktičkog pozicioniranja i (d) kriznog menadžmenta. Tržišnu ekonomsku ocenu ekonomski sve značajnijih mineralnih resursa prate posebno specifični aspekti funkcionisanja mineralne ekonomije i to naročito: (a) turbulentnost mineralnog tržišta; (b) složenost mineralne proizvodnje; (c) krizni uslovi snabdevanja mineralnim sirovinama; (d) ekološki protesti građana na lokalnom području; (e) rastuće potrebe za kritičnim mineralnim sirovinama; i (f) započeta trka u obezbeđenju potrebnih retkih metala za privredne aktivnosti. U praktičnoj primeni ekonomske ocene mineralnih rezervi vrši se stalno unapređenje metodike ocene shodno promenama uslova i neophodnosti prilagođavanja postojećim potrebama i trendovima u mineralnoj ekonomiji. Pri tome se u sklopu metodike ekonomske ocene mogu izdvojiti: (a) klasična metodika ekonomske ocene; (b) primena postojećih metoda i alata u prikupljanju, pripremi i obradi podataka za ekonomsku ocenu; i (c) i korišćenje savremenih i najnovijih alata u metodici ekonomske ocene. Klasična metodika ekonomske ocene obuhvata analizu: (a) seta od devet faktora ekonomske ocene; i (b) tri seta pokazatelja ekonomske ocene, koji obuhvataju (b1) set naturalnih pokazatelja; (b2) set vrednosnih pokazatelja; i (b3) set sintetskih pokazatelja. Set od devet faktora pojedinačno u kompletnom prikazu obuhvata: (a1) metalogenetske; (a2) geološke; (a3) tehničko-eksploatacione ili rudarske; (a4) tehnološke; (a5) tržišne; (a6) regionalne; (a7) socijalno-političko-ekonomsko-strategijske; (a8) geoekološke; i (a9) zakonodavno-pravne faktore. Pri tome svaka od navedenih grupa obuhvata veći broj pojedinačno pripadajućih faktora, koji zahtevaju posebnu geološko-ekonomsku analizu i razmatranje. Među najvažnijim metodama se izdvajaju: (i) metoda ekonomske ocene bez uzimanja u obzir vremenskog faktora, kao klasična metoda; i (ii) metode ekonomske ocene sa uzimanjem u obzir vremenskog faktora, u koje naročito spadaju DCF metode, i to NPV i IRR metoda, kao savremene tržišne metode ocene. Među savremene alate za primenu u ekonomskoj oceni mineralnih rezervi naročito spada primena sve prisutnije veštačke inteligencije (VI). S obzirom na veoma veliki broj podataka i informacija, koje je neophodno u polaznom bazisu prikupiti za ekonomsku ocenu, kako po brojnim faktorima, tako i po još brojnijim pokazateljima, a potom iste uključiti u metodu ekonomske ocene, primena VI se nameće kao neophodnost. Ova projekcija primene obuhvata posebno naznačavanje tri značajna polja primene VI, i to: (1) polje geoloških istraživanja; (2) polje eksploatacije; i (3) polje neposredne ekonomske ocene. Iako se potrebni podaci iz prva dva polja, direktno koriste u trećem polju, posebno je važna primena VI u neposrednoj ekonomskoj oceni, koja naročito obuhvata; (a) VI u prikupljanju i pripremi potrebnih podataka i informacija; (b) VI u njihovoj obradi i interpretaciji; i naročito (c) uključivanje VI u neposrednu ekonomsku ocenu, koja izražava suštinu, efikasnost i pouzdanost geološko-rudarsko-tehnološko-ekonomskog rada u mineralnom sektoru i mineralnoj ekonomiji zemlje.

Ključne reči: ekonomska ocena, mineralne rezerve, veštačka inteligencija, mineralna ekonomija.

APPLICATION OF ARTIFICIAL INTELLIGENCE IN CIRCULAR ECONOMY

Andjela Stijovic

Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia, andjelastijovicstud@gmail.com

The circular economy offers an alternative to the traditional linear model, aiming to optimize resource use, reduce waste, and protect the environment. Artificial intelligence (AI) plays a crucial role in this process by enabling advanced data analysis, enhancing recycling processes, and improving supply chain efficiency. This paper examines the application of AI in the circular economy through a review of scientific literature and case studies, focusing on companies utilizing AI for waste sorting, logistics optimization, and reducing environmental impact. Special attention is given to the challenges and opportunities of implementing these technologies in Serbia, considering regulatory frameworks and economic factors. The findings indicate that AI can significantly contribute to sustainable development by improving resource efficiency and waste reduction, but its broader application requires additional investments, workforce education, and regulatory advancements.

Keywords: circular economy, artificial intelligence, recycling, resource optimization, sustainable development.

PRIMENA VEŠTAČKE INTELIGENCIJE U CIRKULARNOJ EKONOMIJI

Anđela Stijović

Alfa BK Univerzitet, Fakultet za finansije, bankarstvo i reviziju, Beograd, Srbija

Cirkularna ekonomija predstavlja alternativu tradicionalnom linearnom modelu, sa ciljem optimizacije korišćenja resursa, smanjenja otpada i zaštite životne sredine. Veštačka inteligencija (VI) ima ključnu ulogu u ovom procesu jer omogućava analizu podataka, optimizaciju reciklaže i efikasnije upravljanje lancima snabdevanja. Ovaj rad analizira primenu VI u cirkularnoj ekonomiji kroz pregled naučnih izvora i studija slučaja, uključujući kompanije koje koriste VI za sortiranje otpada, optimizaciju logistike i smanjenje ekološkog otiska. Poseban fokus je stavljen na izazove i mogućnosti implementacije ovih tehnologija u Srbiji, sa osvrtom na regulatorni okvir i ekonomske aspekte. Istraživanje pokazuje da VI može značajno doprineti održivom razvoju kroz efikasnije korišćenje resursa i smanjenje otpada, ali da je njena šira primena uslovljena dodatnim investicijama, edukacijom stručnjaka i unapređenjem zakonodavstva.

Ključne reči: cirkularna ekonomija, veštačka inteligencija, reciklaža, optimizacija resursa, održivi razvoj.

MANAGEMENT, MARKETING, ARTIFICIAL INTELLIGENCE AND ASSESSMENT OF MINERAL RESOURCES

prof. dr Radule Tošović, dipl. ecc.

University of Belgrade, Faculty of Mining and Geology, Belgrade, Serbia

The contemporary functioning conditions of the mineral economy and the mineral sector of the country, especially in a complex national and international surroundings, require a particularly complex professional and methodological approach in the assessment of mineral resources and the perception of the conditions for their economic valorization. In the various stages of treatment of mineral raw materials, it is necessary to apply processes and methods to create the most favorable conditions for their sustainable use in accordance with the country's mineral policy and mineral strategy, while taking into account market opportunities and investors' interests. In this sense, in the mineral sector, it is necessary to include several groups of activities, among which the application of can be included: (a) management; (b) marketing; (c) artificial intelligence; and (d) assessment of mineral resources. Management as a contemporary scientific and practical discipline, based on certain principles of management, in the mineral sector has a number of specificities, but also uniqueness of applicable branch management, namely: (a) management of geological exploration and (b) management of mineral resources, but also specific aspects of classic types of management, such as: (i) strategic management; (ii) operational management; (iii) financial management; (iv) human resources management; (v) crisis management; (vi) time management, (vii) agile management and others. In addition to all of the above, from the aspect of management, it should be emphasized that the management of enterprises of the mineral sector, as the basic economic subjects of the mineral economy, is of exceptional practical importance The perception of the economic importance of mineral resources through an economic evaluation, which is preceded by an assessment of mineral resources, is particularly specific to distinguish managerial tasks, obligations and responsibilities, on the one hand, business decisions at the enterprise level, on the other hand, and managerial, economic and business success of work on mineral resources, on the third hand. Considering the extent of required managerial data and information and the required degree of processing in this segment, it is necessary to apply contemporary methods of artificial intelligence (AI). Another important component is the application of marketing, as an indispensable activity in the mineral sector and mineral economy. The specificity of mineral production, the final mineral product, the market of mineral raw materials and various social-ecological aspects of the treatment of mineral raw materials from geological exploration, through exploitation, then preparation and processing, obtaining the mineral product and its incorporation into concrete products, requires special preparation, planning and implementation of accompanying marketing activities related to a specific mineral raw material. Given the connection between management and marketing in this part the application of modern methods of AI is also necessary. The application of AI in question is the most prominent in the assessment of mineral resources by all major components, which includes the application of machine learning, deep learning, and big data analytics. It is particularly interesting to use algorithms in the economic assessment of mineral resources, through neural networks, regression analyses, optimization algorithms, etc., in order to use the advantages of AI compared to traditional methods of assessment of mineral resources.

Key words: management, marketing, artificial intelligence, mineral economy.

MENADŽMENT, MARKETING, VEŠTAČKA INTELIGENCIJA I PROCENA MINERALNIH RESURSA

prof. dr Radule Tošović, dipl. ecc.

Beogradski Univerzitet, Rudarsko-geološki fakultet, Beograd, Srbija

Savremeni uslovi funkcionisanja mineralne ekonomije i mineralnog sektora zemlje, naročito u složenom nacionalnom i međunarodnom okruženju, zahteva posebno kompleksan stručni i metodološki pristup u proceni mineralnih resursa i sagledavanja uslova njihove ekonomske valorizacije. U različitim fazama tretiranja mineralnih sirovina neophodna je primena postupaka i metoda za stvaranje najpovoljnijih uslova njihovog održivog korišćenja u skladu sa mineralnom politikom i mineralnom strategijom zemlje, a uz uzimanje u obzir tržišnih prilika i interesa investitora. U tom smislu u mineralnom sektoru je neophodno uključivanje više grupa aktivnosti, među koje se mogu uvrstiti primena: (a) menadžmenta; (b) marketinga; (c) veštačke inteligencije; i (d) procene mineralnih resursa. Menadžment kao savremena naučna i praktična disciplina, bazirana na određenim principima menadžmenta, u mineralnom sektoru ima niz specifičnosti, ali i posebnosti primenljivih granskih menadžmenta, i to: (a) menadžment geoloških istraživanja i (b) menadžment mineralnih resursa, ali i specifične aspekte klasičnih vrsta menadžmenta, kao što su: (i) strategijski menadžment; (ii) operativni menadžment; (iii) finansijski menadžment; (iv) menadžment ljudskih resursa; (v) krizni menadžment; (vi) menadžment vremena, (vii) agilni menadžment i dr. Na sve navedeno treba, sa aspekta menadžmenta, posebno istaći da izuzetan praktični značaj ima menadžment preduzeća mineralnog sektora, kao osnovnih ekonomskih subjekata mineralne ekonomije. U sagledavanju ekonomskog značaja mineralnih resursa kroz ekonomsku ocenu, kojoj prethodi procena mineralnih resursa, posebno je specifično izdvajanje menadžerskih poslova, obaveza i odgovornosti, s jedne strane, poslovnih odluka na nivou preduzeća, s druge strane, i menadžerske, ekonomske i poslovne uspešnosti rada na mineralnim resursima, sa treće strane. S obzirom na obim potrebnih menadžerskih podataka i informacija i potreban stepen obrade u ovom segmentu je neophodna primena savremenih metoda veštačke inteligencije (VI). Druga značajna komponenta je primena marketinga, kao nezaobilazne aktivnosti u mineralnom sektoru i mineralnoj ekonomiji. Specifičnost mineralne proizvodnje, konačnog mineralnog proizvoda, tržišta mineralnih sirovina i različitih društveno-socijalno-ekoloških aspekata tretiranja mineralnih sirovina od geoloških istraživanja, preko eksploatacije, zatim pripreme i prerade, dobijanja mineralnog proizvoda i njegove ugradnje u konkretne proizvode, zahteva posebnu pripremu, planiranje i realizaciju pratećih marketinških aktivnosti vezanih za određenu mineralnu sirovinu. S obzirom na povezanost menadžmenta i marketinga i u ovom delu je neophodna primena savremenih metoda VI. Predmetna primena VI najviše dolazi do izražaja kod procene mineralnih resursa po svim glavnim komponentama, što obuhvata primenu mašinskog učenja, dubokog učenja i analitiku velikog broja podataka. Pri tome je posebno interesantno korišćenje algoritama u ekonomskoj proceni mineralnih resursa, kroz neuronske mreže, regresione analize, algoritme optimizacije i dr., kao bi se iskoristile prednosti VI u odnosu na tradicionalne metode procene mineralnih resursa.

Ključne reči: menadžment, marketing, veštačka inteligencija, mineralna ekonomija.

COPENHAGEN SCHOOL OF SECURITY STUDIES, ENVIRONMENTAL SECURITY AND ARTIFICIAL INTELLIGENCE

Milos Tosovic

University of Belgrade, Faculty of Security studies, Belgrade, Serbia

Contemporary security conditions in current geopolitical, strategic and economic events include the influence of a large number of diverse factors, which are scientifically and methodologically rounded through the Copenhagen School of Security studies. At the same time, in accordance with contemporary security analytical actions, a particularly interesting issue of environmental security is singled out. Its consideration, as well as the consideration of a number of related factors within the Copenhagen School of Security studies, can be significantly improved through the application of artificial intelligence methods and actions. The Copenhagen complex research has its initial scientific foothold directly in the Copenhagen School of Security studies, in the part related to the sectoral approach to security studies, as one of the three theoretical directions of security studies along with the Theory of securitization and the The regional security complex theory. According to the Copenhagen sectoral approach to security studies in question and a complete consideration, 5 characteristic areas, or sectors, can be singled out, namely the following: (1) Military; (2) Political; (3) Economic; (4) Social and (5) Environmental sector. Considering the current environmental trend and the improvement of the application of the binding concept of sustainable development in security analyses, a particularly interesting environmental sector is singled out. In addition to the existence of a separate environmental sector, in a complete approach the analysis of environmental security can be connected with at least 3 mentioned sectors: (i) Economic; (ii) Social; and (iii) Environmental sector. Accordingly, the contemporary environmental security risk management in an analytical basis scientifically and methodologically completely justified can be observed as a multisectoral approach. The application of contemporary analytical methods, among other things, includes innovative contemporary solutions that are enabled by the application of artificial intelligence. It is interesting, both in the part of analysis, prediction and environmental security management, as well as in the application of machine learning, developed neural networks, in order to make appropriate professional, managerial and business decisions on the basis of initial environmental and security data, directed at measures of environmental prevention and environmental protection, as well as the overall improvement of very important environmental security.

Keywords: Copenhagen school of security studies, environmental security, security managers, business decisions, artificial intelligence.

KOPENHAŠKA ŠKOLA BEZBEDNOSTI, EKOLOŠKA BEZBEDNOST I VEŠTAČKA INTELIGENCIJA

Miloš Tošović

Univerzitet u Beogradu, Fakultet bezbednosti, Beograd, Srbija

Savremeni bezbednosni uslovi u aktuelnim geopolitičkim, strategijskim i ekonomskim događanjima obuhvataju uticaj većeg broja raznovrsnih faktora, koji su naučno i metodološki zaokruženi kroz Kopenhašku školu bezbednosti. Pri tome se, u skladu sa savremenim bezbednosnim analitičkim postupcima, izdvaja posebno interesantno pitanje ekološke bezbednosti. Njeno razmatranje, kao i razmatranje niza pripadajućih faktora u sklopu Kopenhaške škole bezbednosti može se u značajnoj meri unaprediti kroz primenu metoda i postupaka veštačke inteligencije. Kopenhaško bezbednosno kompleksno istraživanje ima polazno naučno uporište direktno u Kopenhaškoj školi bezbednosti, u delu koji se odnosi na sektorski pristup bezbednosti, kao jednog od tri teorijska pravca bezbednosti uz Teoriju sekuritizacije i Teoriju regionalnih bezbednosnih kompleksa. Prema Kopenhaškom predmetnom sektorskom pristupu bezbednosti i kompletnom razmatranju mogu se izdvojiti 5 karakterističnih oblasti, odnosno sektora, i to sledeći: (1) Vojni; (2) Politički; (3) Ekonomski; (4) Društveni (Socijetalni) i (5) Ekološki sektor. S obzirom na aktuelni ekološki trend i unapređenje primene obavezujućeg koncepta održivog razvoja u bezbednosnim analizama se posebno izdvaja naročito interesantan ekološki sektor. Pored egzistiranja zasebnog ekološkog sektora, u kompletnom pristupu analiza ekološke bezbednosti se može povezati sa najmanje 3 navedena sektora i to: (i) Ekonomskim; (ii) Društvenim; i (iii) Ekološkim sektorom. Shodno tome savremeno upravljanje ekološkim bezbednosnim rizicima u analitičkoj osnovi naučno i metodološki se potpuno opravdano može posmatrati kao multisektorski pristup. Primena savremenih analitičkih metoda, između ostalog uključuje inovativna savremena rešenja koja omogućuje primena veštačke inteligencije. Ona je interesantna, kako u delu analize, predikcije i upravljanja ekološkom bezbednošću, tako i primene mašinskog učenja, razvijenih neuronskih mreža, kako bi se na bazi polaznih ekoloških i bezbednosnih podataka, donosile odgovarajuće stručne, menadžerke i poslovne odluke usmere na mere ekološke prevencije i ekološke zaštite, kao i celovito unapređenje veoma važne ekološke bezbednosti.

Ključne reči: Kopenhaška škola bezbednosti, ekološka bezbednost, menadžeri bezbednosti, poslovne odluke, veštačka inteligencija.

ENVIRONMENTAL FINANCING – BLENDED FINANCING

Jozefina Beke-Trivunac[1], Snežana Knežević[2]

[1]Alfa BK University, Belgrade, Serbia,
e-mail: jozefina.beke@alfa.edu.rs, orcid.org/0000-0002-7394-7006.
[2]University of Belgrade, Faculty of Organizational Sciences, Belgrade, Serbia,
e-mail: snezana.knezevic@fon.bg.ac.rs, orcid.org/0000-0001-9833-7274.

The environment is most often viewed as a common resource. Consequently, the function of environmental conservation and protection is usually assigned to the state. The state fulfills this function by introducing regulations aimed at preserving and protecting the environment. Investing in environmental conservation and protection is costly and does not yield economic returns.
For the private sector, environmental resources are externalities that cost entrepreneurs little or nothing and are generally a source of additional profit. The private sector has no economic incentive to invest in environmental conservation and protection. Therefore, the responsibility for financing environmental protection is typically left to the state. The 1972 report of the Club of Rome (Limits to Growth) was one of the first to warn about the ecological and economic challenges of global development. Likewise, the 1987 Brundtland Report (Our Common Future) was crucial in defining the concept of sustainable development. In 2015, the United Nations established the Sustainable Development Goals (SDGs), a document signed by numerous member states as part of the Agenda 2030. There are 17 goals covering key areas such as poverty eradication, environmental protection, education and healthcare improvement, and the promotion of sustainable development. Although ten years have passed, progress in achieving these goals remains far below expectations. The results of sustainable development financing indicate that the gap in financing and investment ranges between $2.5 trillion and $4 trillion annually. It is clear that the public sector lacks sufficient capital to fund sustainable development goals. The only way to bridge this gap is to encourage the private sector to invest in these initiatives. In this regard, new forms of motivation are being considered—alternatives that would effectively replace profit as the ultimate goal of private entrepreneurship. Existing practices have given rise to a possible model: a combination of financing from both public and private sectors, known as blended financing. Blended financing primarily enables the distribution of risk and high costs. Despite this, the level of risk and costs still exceeds the limits that the private sector is willing to accept. New solutions are being sought in changing incentives that would drive the private sector to invest in environmental conservation and protection. New forms of such instruments are outcome-based bonds.

Keywords: non-profit incentives for environmental financing, role of private sector in environmental financing, environmental goals for private sector.

FINANSIRANJE ŽIVOTNE SREDINE – MEŠOVITI IZVORI FINANSIRANJA

Jozefina Beke-Trivunac[1], Snežana Knežević[2]

[1]Univerzitet Alfa BK, Beograd, Srbija,
e-mail: jozefina.beke@alfa.edu.rs, orcid.org/0000-0002-7394-7006.
[2]Univerzitet u Beogradu, Fakultet organizacionih nauka, Beograd, Srbija,
e-mail: snezana.knezevic@fon.bg.ac.rs, orcid.org/0000-0001-9833-7274.

Životna sredina najčešće se posmatra kao zajednički resurs. Shodno tome, funkcija očuvanja i zaštite životne sredine obično se se dodeljuje državi. Država svoju funkcije obavlja uvođenjem regulative koja ima za cilj očuvanje i zaštitu životne sredine. Ulaganje u očuvanje i zaštitu životne sredine je skupo i ne donosi ekonomski prinos. Za privatan sektor, resursi životne sredine su eksternalije, koje preduzetnika malo koštaju ili ga ne koštaju ništa, i po pravilu su izvor dodatnog profita. Privatni sektor nema ekonomskog interesa da ulaže u očuvanje i zaštitu životne sredine. Zato se funkcija finansiranja životne sredine po pravilu prepušta državi. Izveštaj Kluba Rima iz 1972. godine („Granice rasta“) bio je jedan od prvih koji je upozorio na ekološke i ekonomske izazove globalnog razvoja. Takođe, Brundtlandov izveštaj iz 1987. godine („Naša zajednička budućnost“) bio je ključan za definisanje koncepta održivog razvoja. Ujedinjene nacije utvrdile su 2015. godini dokument o ciljevima održivog razvoja (SDGs) koji je potpisao veliki broj zemalja članica, kao deo Agende 2030. Postoji 17 ciljeva koji pokrivaju ključne oblasti poput iskorenjavanja siromaštva, zaštite životne sredine, unapređenja obrazovanja i zdravstva, kao i promovisanja održivog razvoja. Iako je prošlo već deset godina, napredak u njihovom postizanju daleko je od očekivanog. Rezultati dosadašnjeg finansiranja održivog razvoja pokazuju da jaz u finansiranju i investicijama u održivom razvoju iznosi između 2,5 biliona i 4 biliona dolara godišnje. Jasno je da javni sektor nema dovoljno kapitala za finansiranje ciljeva održivog razvoja. Jedini način na koji se jaz može premostiti je podsticanje privatnog sektora da ulaže u te namene. U tom smislu, razmatraju su novi vidovi motivacije, koji bi dovoljno dobro zamenili profit kao neprikosnoveni cilj privatnog preduzetništva. Dosadašnja praksa iznedrila je, kao mogući model, kombinaciju finansiranja od strane javnog i privatnog sektora, tzv. mešovito finansiranje. Mešovito finansiranje prvenstveno omogućuje podelu rizika i visokih troškova. I pored toga, visina rizika i troškova još uvek premašuje granice koje je privatni sektor spreman da prihvati. Nova rešenja traže se u promeni podsticaja koji bi pokrenuli privatni sektor da ulaže u zaštitu i očuvanje životne sredine. Jedan od instrumenata takvih podsticaja su obveznice sa definisanim ishodom.

Ključne reči: neprofitni podsticaji za finansiranje životne sredine, uloga privatnog sektora u finansiranju životne sredine, ciljevi zaštite životne sredine za privatni sektor.

CROSS-SECTION AND PERSPECTIVE OF ECOLOGICAL MODERNIZATION IN THE 21st CENTURY

Doc. dr Marko M. Vujić[1], Prof. dr Darko P. Nadić[1], Prof. dr Olja Munitlak Ivanović[2]

[1]University of Belgrade, Faculty of Political Sciences, Jove Ilića 165, Belgrade, Serbia
[2]University in Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management, Trg Dositeja Obradovića 3, Novi Sad, Serbia

The first part of the paper will formulate the theory of Ecological Modernization as an emergent form of neoliberal capitalism, through both its forms (weak and strong). The second part of the work will be focused on the effectiveness of the concept itself in a technical-technological sense, ie. will indicate the dual appearance of weak ecological modernization, in an independent form, and as a model of global neoliberal greening of economic processes. Using concrete examples, it will be shown to what extent this practical part of contemporary environmental policy, reconciled with traditional capitalist principles of profit creation, can be potent in solving the central environmental challenges in the XXI century. In the form of a case study, the phenomenon of CO_2 emissions as the dominant cause of climate change, will be presented. Ecological modernization in this part of the work will be faced with the emission of the mentioned gas, in the form of potency to reduce its emission. In this way, we will look at ecological modernization through the only achieved format - the format of weak ecological modernization, and conclude whether the third decade of the XXI century is the last moment to put into practice the concept of strong ecological modernization.

Keywords: Ecological modernization, CO_2, climate change, environmental policy, IPCC.

PRESEK I PERSPEKTIVA EKOLOŠKE MODERNIZACIJE U XXI VEKU

Doc. dr Marko M. Vujić[1], Prof. dr Darko P. Nadić[1], Prof. dr Olja Munitlak Ivanović[2]

[1]Univerzitet u Beogradu, Fakultet političkih nauka, Jove Ilića 165, Beograd, Srbija
[2]Univerzitet u Novom Sadu, Prirodno-matematički fakultet, Departman za geografiju, turizam i ugostiteljstvo, Trg Dositeja Obradovića 3, Novi Sad, Srbija

Prvi deo rada formulisaće teoriju Ekološke modernizacije kao pojavnu formu neoliberalnog kapitalizma, kroz oba njena oblika (slabi i jaki). Drugi deo rada će biti fokusiran na učinkovitost samog koncepta u tehničko-tehnološkom smislu, tj. ukazaće na dvojaku pojavnost slabe ekološke modernizacije, u samostalnoj formi, i kao modela globalnog neoliberalnog ozelenjavanja privrednih procesa. Na konkretnim primerima, biće ukazano u kom obimu ovaj praktični deo savremene ekološke politike, pomiren s tradiconalnim kapitalističkim principima stvaranja profita, može biti potentan u rešavanju centralnih ekoloških izazova u XXI veku. U formi case study biće prikazan fenomen emisije CO_2, kao dominantni uzročnik klimatskih promena. Ekološka modernizacija u ovom delu rada biće suočena s emisijom pomenutog gasa, u formi potentnosti da njegovo emitovanje umanji. Na taj način sagledaćemo ekološku modernizaciju kroz jedini ostvareni format – format slabe ekološke modernizacije, te izvesti zaključak da li je treća decenija XXI veka poslednji trenutak da se u praksu uvede koncept jake ekološke modernizacije.

Ključne reči: Ekološka modernizacija, CO_2, klimatske promene, ekološka politika, IPCC

REGIONAL DYNAMICS OF NIGHTTIME LIGHTS IN SERBIA

Milan Brkljač[1], Branko Brkljač[2]

[1]Alfa BK University, Faculty of Finance, Banking and Auditing, Belgrade, Serbia, e-mail: milan.brkljac@alfa.edu.rs
[2]University of Novi Sad, Faculty of Technical Sciences, Dept. of Power, Electronic and Telecommunication Engineering, Novi Sad, Serbia, e-mail: brkljacb@uns.ac.rs

Satellite observations of nighttime lights have been consistently collected over the last three decades and represent valuable source of geospatial information for different research studies related to human activity. Significant number of research results had been focused on the relationships between economic growth in developing countries and spatially aggregated information about nighttime lights at national and regional levels. In this study we will explore the current landscape of available nighttime lights measurements, and especially focus on recently made harmonized dataset consisting of super-resolved DMSP-OLS (Defense Meteorological Satellite Program-Operational Linescan System) images and NPP-VIIRS (Suomi National Polar-Orbiting Partnership-Visible Infrared Imaging Radiometer Suite) luminosity measurements. Spatially aggregated time series of nighttime lights over administrative regions in Serbia will be analyzed for possible similarities in trend and dynamics over the time span of three decades and their relationship to local economic activity. Presented results will highlight the main characteristics of regional dynamics and indicate possible research directions for further fine-grained spatial analysis of original nighttime lights measurements as potential indicators of temporal and spatial changes in economic activity.

Keywords: satellite observations, harmonized nighttime lights, regional dynamics, economic indicators.

.