Voda za sve : zbornik sažetaka s 10. međunarodne konferencije Voda za sve

Edited book / Urednička knjiga

Publication status / Verzija rada: **Published version / Objavljena verzija rada (izdavačev PDF)**

Publication year / Godina izdavanja: **2024**

Permanent link / Trajna poveznica: https://urn.nsk.hr/urn:nbn:hr:109:915507

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Download date / Datum preuzimanja: **2025-03-29**

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dabar DIGITALNI AKADEMSKI ARHIVI I REPOZITORIJI

10TH INTERNATIONAL CONFERENCE

WATER FOR ALL

10. MEĐUNARODNA KONFERENCIJA

VODA ZA SVE

20 - 22 MARCH 2024
PLITVICE LAKES NATIONAL PARK
CROATIA

20. - 22. OŽUJKA 2024.
NACIONALNI PARK PLITVIČKA JEZERA
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BOOK OF ABSTRACTS I KNJIGA SAŽETAKA

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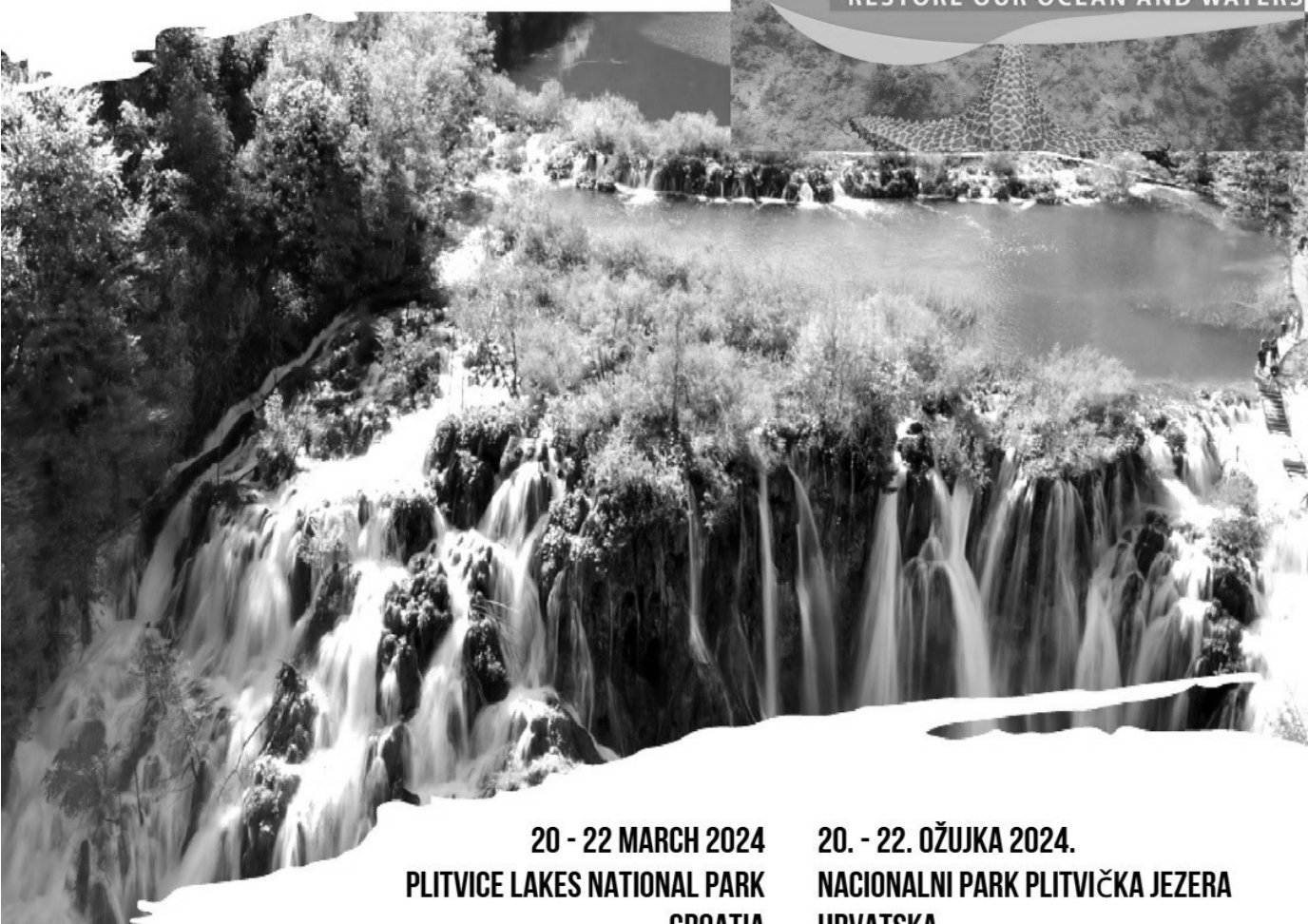

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BOOK OF ABSTRACTS **10th International Conference WATER FOR ALL**
KNJIGA SAŽETAKA ***10. međunarodna konferencija VODA ZA SVE***

Published by Faculty of Food Technology Osijek, Osijek, Croatia
Izdavač *Prehrambeno-tehnološki fakultet Osijek, Osijek, Hrvatska*

Chief and Executive Editor Mirna Habuda-Stanić
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Text prepared by AUTHORS who are fully responsible for the abstracts
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Plenary Session / *Plenarno predavanje*

From the Cause of Climate Change to the Consequences of Climate Change: The Role of Water and the Hydrological Cycle

Ivan GÜTTLER

Croatian Meteorological and Hydrological Service, Ravnice 48, Zagreb, Croatia

Abstract: The burning of fossil fuels – coal, oil, and natural gas – is the primary culprit behind today's climate changes, as well as changes in land use and land management. These activities contribute to the rising concentration of greenhouse gases in the atmosphere, such as carbon dioxide, methane, and nitrous oxide. A warming atmosphere holds more water vapor, another greenhouse gas that intensifies the initial warming. The situation becomes even more complex due to changes in the amount and distribution of water vapor clouds, which can trigger temperature fluctuations in both directions, further disrupting climate stability. For human societies and ecosystems, predictability in precipitation and snowfall patterns are essential. Unfortunately, climate change disrupts these patterns, altering the distribution, frequency, and intensity of wet and dry periods. This presentation will delve into the latest findings from the Intergovernmental Panel on Climate Change on observed and expected changes in the hydrological cycle, particularly in Europe and the Mediterranean – a region highly vulnerable to the ongoing threat of climate change.
Keywords: climate change, water vapor, clouds, hydrological cycle

Plenary Session / *Plenarno predavanje*

Od uzroka do posljedica klimatskih promjena: uloga vode i hidrološkog ciklusa

Ivan GÜTTLER

Državni hidrometeorološki zavod, Ravnice 48, Zagreb, Hrvatska

Sažetak: Aktualne klimatske promjene dominantno su posljedica korištenja i gorenja fosilnih goriva: ugljena, nafte i zemnog plina te promjena u korištenju tla i zemljišta. Ove aktivnosti dovode do porasta koncentracije stakleničkih plinova u atmosferi, kao što su ugljikov dioksid, metan i dušikov oksid. Istovremeno, sve toplija atmosfera sadrži sve više vodene pare, koja se također ponaša kao staklenički plin i pojačava početno zagrijavanje. Dodatnu komplikaciju u klimatskom sustavu predstavljaju promjene u količini i rasporedu oblaka vodene pare. Te promjene mogu dovesti do oscilacija temperature u oba smjera, što dodatno utječe na klimatske uvjete. Za funkcioniranje ljudskih zajednica i ekosustava bitna je prediktabilnost u obrascima oborine i snijega. I u ovom području klimatske promjene se manifestiraju kao promjene u rasporedu, učestalosti i intenzitetu kišnih te sušnih razdoblja. Predavanjem ću prikazati sažete rezultate iz zadnjeg ciklusa Međuvladinog panela o klimatskim promjenama na temu opaženih i očekivanih promjena u hidrološkom ciklusu. Težište će biti na Europi i Sredozemlju, jednoj od najranjivijih područja Svijeta na promjene u klimi koje još ne usporavaju.

Ključne riječi: klimatske promjene, vodena para, oblaci, hidrološki ciklus

PRESENTATIONS
PRIOPĆENJA

10th International Conference WATER FOR ALL
20-22 March 2024
Plitvice Lakes, Croatia

DRINKING WATER AND WASTEWATER TREATMENTS
PRERADA VODE ZA PIĆE I OBRADA OTPADNIH VODA

The influence of rainwater on the organic load of wastewater – WWTP Slavonski Brod

Korana AMBROZIĆ, Valentina VELIKANOVIĆ

Vodovod Ltd. Slavonski Brod, N. Zrinskog 25, Slavonski Brod, Croatia

Abstract: Climate changes are increasingly affecting various segments of society, and weather disasters are becoming more pronounced in the Republic of Croatia as well. Severe weather with heavy rainfall and/or frequent and intense precipitation has a significant impact on the organic load of wastewater in the Slavonski Brod agglomeration. WWTP Slavonski Brod was put into operation in the middle of 2014., and the average value of precipitation between 2015 and 2023 was 784 mm/m^2, while the maximum amount of precipitation was recorded in 2023 was 940 mm/m^2. The length of the public drainage system agglomeration in Slavonski Brod is 265 km, and it consists of 231 km of mixed sewage system and 34 km of divided sewage system. There is a huge negative impact on the influent organic load from bigger and bigger surfaces of asphalt (parking lots of shopping malls, roads and lanes etc.) and merged roofs of the houses. Rainwaters have increased by 23% in 2023. in comparison to 2022. If we're looking the review of the value of influent organic load on a daily and monthly basis in 2022. and 2023. we can see the decrease of organic load and the decrease of the consumption of electric energy for biologic decomposition. But this also leads to the decrease of the efficiency of purification of waste water. It is necessary to invest in the divided public sewage system in the future, but it is also important to divide the rainwater from sanitary waste water while reconstructing the existing public sewage system.

Keywords: rainwater, public sewage system, organic load

Utjecaj oborinskih voda na organsko opterećenje otpadne vode – UPOV Slavonski Brod

Korana AMBROZIĆ, Valentina VELIKANOVIĆ

TD Vodovod d.o.o. Slavonski Brod, Ulica N. Zrinskog 25, Slavonski Brod, Hrvatska

Sažetak: Klimatske promjene sve češće utječu na razne segmente društva, te su sve izraženije vremenske nepogode i u Republici Hrvatskoj. Značajan utjecaj na organsko opterećenje otpadne vode aglomeracije Slavonski Brod imaju upravo olujna nevremena s obilnom kišom i tučom, i/ili učestale i intenzivne oborine. UPOV SB pušten je u rad sredinom 2014.g., a prosječna vrijednost oborina u vremenskom periodu od 2015. do 2023. godine iznosi 784mm/m², dok je u 2023. godini zabilježena ukupna maksimalna količina oborina u navedenom periodu od 940mm/m². Sustav javne odvodnje aglomeracije Slavonski Brod (SJO SB) ukupne je duljine od 265km, od čega je 231km mješovite i 34km razdjelne kanalizacijske mreže. Sve veće asfaltirane površine (parkirališta trgovačkih centara, ceste, staze i dr.) i sve veći broj spojenih krovova kuća na SJO SB, negativno utječu na ulazno organsko opterećenje. Oborinske otpadne vode su u 2023. godini 23% veće u odnosu na 2022. godinu. Prikazom vrijednosti ulaznog organskog opterećenja i količine oborina na dnevnoj i mjesečnoj razini kroz 2022. i 2023.godinu, uočava se smanjenje opterećenja, potrošnje električne energije za biološku razgradnju, ali i smanjenje učinkovitosti pročišćavanja otpadne vode. Nužno je u budućnosti ulagati i graditi razdjelni SJO, ali i prilikom rekonstrukcije postojećeg SJO nastojati razdvojiti oborinsku od sanitarne otpadne vode.

Ključne riječi: oborinska otpadna voda, sustav javne dovodnje, organsko opterećenje

Trends in the field of physical-chemical methods of pharmaceutical removal from water

Amra BRATOVČIĆ[1], Mirna HABUDA-STANIĆ[2]

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[2] Josip Juraj Strossmayer University of Osijek, Faculty of Food Technology Osijek, Franje Kuhača 18, Osijek, Croatia

Abstract: The presence of pharmaceuticals in natural waterways, especially antibiotics, antipyretics and analgesics, has become a global challenge for researchers in terms of finding new innovative solutions for their removal due to their negative impact on the environment and human health. Concentrations of drugs and their metabolites in surface water, groundwater, seawater, and wastewater range from a few nanograms to a few milligrams, while this concentration in wastewater from hospitals and drug manufacturing factories ranges up to several mg/ml. Although these concentrations are not high, the problem is their chemical complexity and non-biodegradability, as well as the long-term impact on humans and aquatic organisms. For the removal of pharmaceuticals from natural watercourses, mechanical, biological, physical-chemical, and mutually combined methods are most often used. In this paper, the focus is on the most recently developed biosorbents (biochar from biomass) with enzymatic physical elimination, nanocomposites, photocatalysts and photoelectrocatalysts, i.e. cheap, efficient and environmentally friendly technologies based on physicochemical methods.

Keywords: biosorbents, nanocomposites, photocatalysts, pharmaceutical photoelectrocatalysts, adsorption, photocatalysis

Trendovi u području fizikalno-kemijskih metoda uklanjanja farmaceutika iz vode

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[2] Sveučilište Josipa Jurja Strossmayera u Osijeku, Prehrambeno-tehnološki fakultet Osijek, Franje Kuhača 18, Osijek, Hrvatska

Sažetak: Prisustvo farmaceutika u prirodnim vodotokovima a naročito antibiotika, antipiretika i analgetika postalo je svjetski izazov za istraživače u smislu iznalaženja novih inovativnih rješenja za njihovo uklanjanje zbog negativnog učinka na okoliš i zdravlje ljudi. Koncentracije lijekova i njihovih metabolita u površinskim vodama, podzemnim vodama, morskoj vodi, i otpadnim vodama se kreće u rasponu koncentracija od nekoliko nanograma do nekoliko miligrama, dok se ta koncentracija u otpadnim vodama bolnica i fabrika za proizvodnju lijekova kreće i do nekoliko mg/ml. Iako naizgled te koncentracije nisu visoke, problem je njihova kemijska složenost i bionerazgradivost, te dugoročan utjecaj na ljude i vodene organizme. Za uklanjanje farmaceutika iz prirodnih vodotokova se najčešće koriste mehaničke, biološke, fizikalno-kemijske, te međusobno kombinirane metode. U ovom radu fokus je na posljednje razvijenim biosorbensima (biougljen iz biomase) uz enzimsku fizičku eliminaciju, nanokompozitima, fotokatalizatorima i fotoelektrokatalizatorima odnosno jeftinim, učinkovitim i ekološki prihvatljivim tehnologijama baziranim na fizikalno-kemijskim metodama.

Ključne riječi: biosorbensi, nanokompoziti, fotokatalizatori, fotoelektrokatalizatori farmaceutici, adsorpcija, fotokataliza

Application of computer modeling in wastewater treatment processes

Mirjana ČURLIN, Magdalena VRGOČ, Virginia LIPOVECI, Marina FUSCO, Dijana GRGAS, Tibela LANDEKA DRAGIČEVIĆ

University of Zagreb Faculty of Food Technology and Biotechnology, Pierottijeva 6, Zagreb, Croatia

Abstract: The use of computer modeling to describe and control wastewater treatment processes and to gain insights into compliance with water quality standards and efficiency processes is of particular importance due to the dynamic and complex treatment processes. In this work, an artificial neural network (ANN) model was developed based on a non-linear optimization technique to search for a pattern in the data and find an optimal network architecture on the monitoring data of the physical, chemical and biological parameters of the WWTP in Beli Manastir. The model was tested for its ability to identify the process and solve the process optimization problem, especially in terms of predicting the chemical oxygen demand (COD) of the plant's output stream as the main indicator of the organic load of municipal wastewater. The availability of the specialized model (and software) should be of great benefit for the development of new strategies for treatment process efficiency.
Keywords: computer modeling, wastewater treatment processes, artificial neural network

The quality of effluents from the washing of polyester/cotton knitted fabrics with a focus on the particle content

Mirjana ČURLIN[1], Tea BUŠAC[2], Kristina ŠIMIĆ[2], Nino DIMITROV[3], Ivona VIDIĆ ŠTRAC[3], Tanja PUŠIĆ[2]

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Abstract: The quality of the effluent from polyester/cotton knitted fabric washing was monitored after 5 and 10 wash cycles with ECE A detergent and a temperature of 60 oC to take preventive and curative measures to reduce the release of microfibrils and microplastics into the water streams. By measuring total suspended solids (TSS), total dissolved solids (TDS), turbidity and particle size distribution using the laser diffraction method, the results of solids content and particle size distribution curve parameters were determined in the effluent from polyester/cotton knitted fabric washing. The analysis of particles released during the washing of polyester/cotton knitted fabrics will contribute to the knowledge of particle pollution of effluents and help in the prevention and cure of microfibre and microplastic pollution of water receptors.
Keywords: polyester/cotton knitted fabrics, washing process, effluents, particle size distribution

Kakvoća efluenata od pranja poliester/pamuk pletiva s naglaskom na sadržaj čestične tvari

Mirjana ČURLIN[1], Tea BUŠAC [2], Kristina ŠIMIĆ [2], Nino DIMITROV [3], Ivona VIDIĆ ŠTRAC [3] i Tanja PUŠIĆ [2]

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Sažetak: Kakvoća efluenata od pranja poliester/pamuk pletiva praćena je nakon 5 i 10 ciklusa pranja uz ECE A detergent i temperaturu od 60 °C s ciljem preventivnog i kurativnog djelovanja na potencijalno smanjenje otpuštanja mikrofibrila i mikroplastike u vodene tokove. Određivanjem ukupne suspendirane tvari (TSS), ukupne otopljene tvari (TDS), mutnoće te raspodjele veličina čestične tvari primjenom metode laserske difrakcije dobiveni su rezultati sadržaja čvrste tvari kao i parametri krivulja raspodjele veličina čestica u efluentima od pranja poliester/pamuk pletiva. Analiza otpuštenih čestica u pranju poliester/pamuk pletiva doprinjet će spoznajama o onečišćenju efluenata česticama te pomoći u preventivnom i kurativnom djelovanju onečišćenja vodenih tokova mikrovlaknima i mikroplastikom.
Ključne riječi: poliester/pamuk pletivo, proces pranja, efluenti, raspodjela veličina člestica

Photocatalytic Degradation of Organic Dyes: Wastewater Treatment by High-Entropy Oxides

Igor DJERDJ[1], Stjepan ŠARIĆ[1], Dalibor TATAR[1], Jelena KOJČINOVIĆ[1], Ronen GOTTESMAN[2], Oded MILLO[3], Doron AZULAY[4]

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Abstract: Five distinct nanocrystalline high-entropy oxides (HEOs) were synthesized using an environmentally friendly sol-gel citrate route. Each HEO crystallized in a fluorite structure, with an average crystallite size ranging from 6 to 8 nanometers. These HEOs, comprising a unique blend of five elements, chosen between rare-earth elements (La, Ce, Pr, Eu, and Gd), and second-row transition metals (Y and Zr), are strategically incorporated within the fluorite lattice. With bandgaps ranging from 1.91 to 3.0 eV, these oxides feature well-aligned valence and conduction bands, facilitating efficient photocatalysis. Their outstanding photocatalytic activity is attributed to the abundance of active sites, enabling the generation of radicals crucial for degrading organic dyes like methylene blue, methyl red, and methyl orange, under 1 sun illumination.

Keywords: high-entropy oxides, photocatalysis, organic dye degradation, wastewater treatment

Fluoride adsorption from water using modified activated carbon

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Abstract: Water containing fluoride concentrations over 1.5 mg/L is a public health problem. Adsorption on activated carbon is one of the most commonly used methods for removing elevated fluoride concentrations in water. This research tested the parameters of fluoride adsorption on four modified activated carbons with nitric acid and hydrogen peroxide. Adsorption properties include initial fluoride concentrations (2-40 mg/L), pH (4-9), the dosage of activated carbon (2-20 g/L), contact time (15-360 min) and temperature (25-45°C). The research results showed a decrease in the proportion of adsorbed fluorides by increasing their initial concentration, while an increase in temperature had a positive effect on the proportion of removed fluorides. The optimal pH value of adsorption at which the largest amount of fluoride is adsorbed is from 4 to 6. Langmuir, Freundlich, Temkin, and Dubinin-Radushkevich isotherms were used to determine the adsorption mechanism. The experimental data showed the best agreement with the Freun-dlich model at all temperatures, while the pseudo-second-order kinetic model best described the adsorption rate. An increase in the adsorption temperature had a positive effect on the adsorption properties of activated carbons for all tested parameters.
Keywords: fluoride determination, fluoride removal, activated carbon, isotherms, kinetics

Denitrifying dephosphatation via nitrite under anoxic condition

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Abstract: Denitrifying phosphate accumulating organisms (DPAOs) under alternating anaerobic and anoxic conditions can use oxygen, nitrite and nitrate as terminal electron acceptor to achieve phosphorus uptake and denitrification. It is sustainable wastewater treatment process with the benefits of lower requirements for carbon source, reduced sludge production and reaction time. Denitrifying dephosphatation via nitrite was investigated under anoxic conditions with 15 mg PO4-P and N/P 3 ratio, with acetate as carbon source. The results indicated that efficient removals of nitrogen (N) up to 100% NO2-N removal and phosphorus (P) up to 78% of PO4-P uptake from denitrifying dephosphatation were achieved.
Keywords: DPAOs, anoxic condition, nitrite, denitrifying dephosphatation

Nature-based solutions for wastewater treatment: Biomaterials for phosphorous recuperation

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Abstract: The green transition is an indispensable and necessary strategy for all human activities today to make every aspect of human action ecologically sustainable. In the field of wastewater treatment, most scientific research is focused on the application of sustainable energy sources in treatment processes, replacing harmful and polluting chemicals and materials with less harmful alternatives, and recovering resources by finding methods for resource recovery and ensuring sustainable solutions for the operation of wastewater treatment plants. Phosphorus is an irreplaceable element from the group of nutrients and a rare resource essential for many processes, especially for agricultural production. However, increased concentrations of phosphorus compounds in natural waters can lead to eutrophication, which disrupts water quality, significantly negatively impacts biodiversity, and harms the overall environmental condition. Since phosphorus reserves on our planet are limited, it is essential to develop and improve natural solutions for phosphorus recovery wherever possible. As wastewater is increasingly viewed as an important secondary source of nutrients, this paper aims to present the results of research conducted to examine the effectiveness of original and/or modified biomaterials as alternative solutions that, when applied, can effectively remove phosphorus from wastewater in an ecologically acceptable and sustainable manner, and further utilize them as value-added materials, namely as organic fertilizers in agriculture.
Keywords: sustainability, adsorbents, biomaterials, wastewater treatment

Prirodna rješenja za pročišćavanje otpadnih voda: Biomaterijali za rekuperaciju fosfora

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Sažetak: Zelena tranzicija neizostavna i nužna je strategija svih današnji ljudskih aktivnosti kako bi se svaki aspekt djelovanja čovjeka učinio ekološki održivim. U području pročišćavanja otpadnih voda, većina znanstvena istraživanja usmjerena su k primjeni održivih izvora energije u procesima pročišćavanja, zamjeni štetnih i onečišćujućih kemikalija i materijala manje štetnim te rekuperaciji, odnosno iznalaženju metoda za oporavak resursa i osiguravanje održivih rješenja za rad uređaja za pročišćavanje otpadnih voda. Fosfor je nezamjenjiv element iz skupine hranjivih tvar i rijedak resurs nužan za mnoge procese, a prije svega nužan za poljoprivrednu proizvodnju, no povećane koncentracije spojeva fosfora u prirodnim vodama mogu dovesti do eutrofikacije koja narušava kvalitetu vodotoka, dovodi do značajnog negativnog utjecaja na biološku raznolikost i opće stanje okoliša. Kako su rezerve fosfora na našoj planeti ograničene, nužno je gdje je moguće razvijati i unapređivati prirodna rješenja za oporabu fosfora.
Kako se otpadne vode sve više promatraju kao značajan sekundarni izvor hranjivih tvari, cilj ovog rada je prikazan rezultata dosadašnjih istraživanja provedenih u cilju ispitivanja učinkovitosti izvornih i/ili modificiranih biomaterijala kao alternativnih rješenja čijom primjenom je moguće na ekološki prihvatljiv i održiv način učinkovito izdvojiti fosfor iz otpadnih voda te ih dalje primjeniti kao materijale s dodanom vrijednošću, odnosno kao organska gnojiva u poljoprivredi.
Ključne riječi: održivost, adsorbensi, biomaterijali, pročišćavanje otpadnih voda

Titanium Phosphate Nanoplates as Selective Adsorbents for Water Purification from Radionuclides Under Emergency Conditions

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Abstract: Much attention has been paid to the accumulation of radioactivity in water sources since the Chornobyl accident in 1986. But the highest public interest was focused again on measurements of radioactivity in water after the Fukushima accident, and the occupation of nuclear power in 2022-till now (Ukraine Radionuclides such as Cs(I) and Sr(II), which are generated during the nuclear fission of uranium, possess high solvation energies, making it very difficult to form strong complexes with ligands. Consequently, the ion exchange process is most suitable and applicable to remove Cs(I) and Sr(II) ions from water. This work creates a novel strategy to construct crystalline layered titanium phosphate (α-phase) ion exchangers synthesized from $TiCl_4$. The present work investigated the influence of various experimental parameters on long- and short-lived radionuclides removal and to determine the optimum procedure for the separation of Sr(II), Cs(I), and UO_2^{2+} ions from solution by this material. The layered α-*TiP* material was easily prepared through the "one-pot" hydrothermal method. The obtained results indicate that at pH from 3 to 8, the removal efficiency of material for radionuclides increased as the pH, adsorbent dose and contact time increased. The material showed high uptake capacities for Cs (168,63 mg/g) and Sr (69,83 mg/g). Generally, the removal efficiency of α-*TiP* was found to be in the order of Cs(I) > Sr(II) > U(VI) during the continuous ion exchange process from polluted waters. The suggested sorption process of water purification could be used for effective water treatment including the conditions of emergencies.

Keywords: titanium phosphate, radionuclides, water purification, ion exchange

Acknowledgements: This study was supported by CSIC grants "UCRANIA DOCTORES 2022". CINN-UNIOVI thanks for the financial support Spanish MINECO MCI-21-PID2020- 113558RB-C41, and PID2020- 119130 GB-I00.

TiO_2-containing NiFe-LDH nanocomposite as adsorbent for removal of Cs(I) and Sr(II) from natural waters

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Abstract: With the risks of ecological disaster that exist today, there is demand for improving the adsorption processes for water treatments, these are motivated by researchers to identify low-cost and sustainable adsorbents with high sorption capacity of radionuclides. Layered double hydroxides (LDHs) attract attention due to it is structure, these materials have a high customization possibility, advantages of relatively simple preparation, and low cost. To enhance the characteristic properties of LDHs, the use of a modification with various support materials. In this work, the carbonate form of Ni(II)/Fe(III) - layered double hydroxides (NiFe-LDH) and their TiO_2-containing nanocomposite (Ti@NiFe-LDH) were produced by drawing upon the facile in-situ co-deposition method. Then, NiFe-LDH and Ti@NiFe-LDH were used to study the removal of radionuclides, namely Sr(II) and Cs(I) from water solutions. It was established that the most effective adsorption of Sr(II) and Cs(I) ions occurs at pH 5 – 9 for NiFe-LDH (~99.50%), and at pH 5 – 7 for Ti@NiFe-LDH (~96%). Studies of the sorption kinetics of Sr(II) and Cs(I) ions showed that equilibrium in the system is 20 min. The adsorption capacity of the NiFe-LDH and Ti@NiFe-LDH relative to Sr(II) ions determine 0.38 mmol/g, and 0.89 mmol/g, respectively. Thus, due to high sorption efficiency and manufacturability, the obtained adsorbent Ti@NiFe-LDH is promising for the removal of Cs(I) and Sr(II) from radioactively contaminated waters.

Keywords: Layered double hydroxides, titanium(IV) oxide, radionuclides, water treatment

Acknowledgments: This study was supported by the Ministry of Economy and Competitiveness (Spain) MCI-21-PID2020- 113558RB-C41, and PID2020- 119130 GB-I00.

The effect of the raw water type and quality on the THMPF reduction efficiency by coagulation and flocculation method

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Abstract: Although naturally present in groundwater and surface water, large quantities of iron, carbonates, natural organic matter and other compounds impair the quality of drinking water. Therefore, the quantity of named substances is desirable within prescribed limits. Various water treatment processes are carried out to meet water quality parameters acceptable for human consumption. One of the most common water treatment procedures is coagulation with flocculation. This physicochemical method can remove unwanted substances and reduce the potential of trihalomethane formation, i.e. disinfectant byproducts. It is based on the destabilization and agglomeration of particles in water by coagulants. Extraction of agglomerated particles is done by filtration of treated water. The coagulation efficiency is influenced by physico-chemical parameters of water such as pH and hardness, as well as the correct selection of coagulants. Three coagulants were used in making of this research: $FeCl_3$, $FeNO_3$ and $FeSO_4$. The comparison of their effectiveness was observed by measuring the following parameters: pH, conductivity, hardness, consumption of $KMnO_4$, total iron concentration, UV absorbance (203 and 254 nm) and the trihalomethane formation potential. Named parameters were measured on six different water samples and each of named coagulants was applied to each water sample.

Keywords: coagulation and flocculation, groundwater, surface water, organic matter

Utjecaj vrste sirove vode na učinkovitost smanjenja THMPF metodom koagulacije i flokulacije

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Sažetak: Željezo, karbonati, prirodne organske tvari i drugi spojevi, u velikim količinama, narušavaju kvalitetu vode za ljudsku uporabu. Navedene su tvari prirodno prisutne u podzemnim i površinskim vodama, no njihova je prisutnost poželjna u propisanim granicama. Različiti procesi obrade i pročišćavanja vode provode se s ciljem postizanja parametara kvalitete vode prihvatljivih za ljudsku potrošnju. Jedan od učestalih postupaka obrade vode jest koagulacija s flokulacijom. Osim uklanjanja neželjenih spojeva iz vode, ovim se postupkom može smanjiti i potencijal nastanka trihalometana koji pripadaju skupini dezinfekcijskih nusprodukata. Koagulacija s flokulacijom jest fizikalno-kemijska metoda koja se temelji na destabilizaciji i aglomeriranju čestica u vodi pomoću koagulanata. Filtracijom obrađene vode izdvajaju se aglomerirane čestice. Osim pravilnog odabira koagulanta, na učinkovitost koagulacije utječu i fizikalno-kemijski parametri poput pH i tvrdoće vode. Cilj ovoga istraživanja bio je usporediti učinkovitost smanjenja potencijala nastanka trihalometana uporabom različitih koagulacijskih sredstava. U tu su svrhu korištena tri koagulanata: $FeCl_3$, $FeNO_3$ te $FeSO_4$. U svrhu usporedbe djelotvornosti navedenih koagulanata, promatrani su parametri poput pH, vodljivosti, ukupne tvrdoće, utroška $KMnO_4$, koncentracije ukupnog željeza, UV apsorbancije (203 i 254 nm) te potencijala nastanka trihalometana. Navedeni su parametri mjereni na šest različitih uzoraka vode te je na svakom uzorku primijenjen svaki od triju koagulanata.
Ključne riječi: koagulacija i flokulacija, podzemne vode, površinske vode, organske tvari

Biosorptive removal of Pharmaceuticals from Wastewater

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Abstract: The presence of pharmaceuticals (a group of Contaminants of Emerging Concern) in the aquatic environment is a major environmental problem, as many of them are poorly biodegradable compounds and therefore prone to bioaccumulation. Consequently, they can be passed through the food chain and have a negative impact on human health. In addition, these compounds often have a detrimental effect on the flora and fauna of the aquatic ecosystems in which they occur. It is therefore necessary to prevent their release into the environment or to remove them from wastewater, which is considered to be their main source. One of the promising methods for the removal of pharmaceuticals from municipal and industrial wastewater is biosorption. The broad definition of biosorption states that biosorption is a process of adsorption on various materials of biological origin (hence also called biosorbents), such as active or inactive microbial biomass, plant (lignocellulosic) biomass, animal materials (bones, feathers), etc. This paper provides an overview of current research on the removal of pharmaceuticals from wastewater by biosorption.
Keywords: pharmaceuticals, biosorption, wastewater

Eggshell: Potential Biosorbent for Synthetic Dyes Removal from Wastewater

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Abstract: The aim of this work was to investigate the biosorption potential of eggshell for the removal of the synthetic dye Congo red (CR) from model solutions and synthetic wastewater. Batch adsorption experiments were performed to investigate different parameters: biosorbent concentration (1 – 15 g/L), contact time (1 – 360 min), dye concentration (10 – 100 mg/L) and temperature (15, 25, 35, 45 °C). The percentage of dye removal increased as the concentration of biosorbent increased, while the amount of adsorbed dye per mass of biosorbent decreased. Increasing the dye concentration (10 – 100 mg/L) resulted in an increase in the amount of CR adsorbed per mass of biosorbent (0.98 mg/g – 4.68 mg/g) and a decrease in the percentage of dye removal (94.10% – 44.32%). The Langmuir equilibrium model better described the biosorption process. In addition, the kinetics of the biosorption process was better described by the pseudo-second order model than by the pseudo-first order model. The removal of dyes from synthetic wastewater with the addition of CR (10 – 100 mg/L) was found to be more effective than the removal of dyes from model solutions, with the percentage of dye removal decreasing with increasing dye concentration (91.20 % – 74.70 % for synthetic wastewater and 94.10 % – 44.32 % for model solutions).

Keywords: eggshell, biosorption, Congo red, wastewater, isotherm and kinetic model

Algal/bacterial membrane bioreactor for bioremediation of industrial wastewater containing 1,4 dioxane

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Abstract: Oxidation of 1,4 dioxane produces metabolites by-products, involving glycolaldehyde and acids that have geno- and cyto-toxicity impact on microbial degradation. Thereby incorporation of algae with bacteria in the treatment system would eliminate and overcome the accumulation of metabolites that are utilized as a carbon source for build-up of biomass. Therefore, the present study aims to assess the potential of alga/bacteria-based membrane bioreactor (AB-MBR) for biodegradation of 1,4 dioxane-rich wastewater at high imposed loading rate. Three identical reactors i.e. AB-MBR1, AB-MBR2 and AB-MBR3 was operated in parallel at 1,4 dioxane loading rate of 641.7, 320.9 and 160.4 mg/L. d., and HRTs of 6.0, 12 and 24 h. respectively. The AB-MBR1 achieved 1,4 dioxane removal rate of 263.7 mg/L.d., where the residual value in the treated effluent amounted to 94.4±22.9 mg/L. Reducing the 1,4 dioxane loading rate (LR) to 320.9 mg/L.d in the AB-MBR2, maximized the removal rate efficiency of 265.9 mg/L.d., with a removal efficiency of 82.8±3.2%. The minimum value of 1,4 dioxane of 17.3±1.8 mg/L in the treated effluent of AB-MBR3 was obtained at an HRT of 24.0 h and loading rate of 160.4 mg/L.d. The mechanism of 1,4 dioxane degradation in AB-MBR was a combination of volatilization (8.03±0.6%), UV oxidation (14.1±0.9%), microbial biodegradation (49.1±3.9%) and absorption/uptake and assimilation by algae (28.8±2.%). The capabilities of genera Defluviimonas, Thioclava, Luteolibacter, and Afipia . The genera of Defluviimonas, Thioclava, Luteolibacter and Mycobacterium was grown under high 1,4 dioxane LR of 641.7 mg/L.d. The *Chlorophyta* (4.1-43.6%), *Streptophyta* (2.5-21.7%) and *Diatomea* (0.8-1.4%) phyla were dominant for degradation of 1,4 dioxane. The results of this study strongly demonstrated that the bioremediation and bioaugmentation process can safely remove 1,4 dioxane from industrial wastewater while minimizing environmental concerns and reducing economic costs.

Keywords: bioremediation, alga/bacteria-based membrane bioreactor, wastewater

10th International Conference WATER FOR ALL
20-22 March 2024
Plitvice Lakes, Croatia

MONITORING OF WATER QUALITY
MONITORING KAKVOĆE VODA

The influence of container selection on determining selected metals in waters for human consumption

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Abstract: Water sampling is a very important process of collecting a representative portion of water from a specific source, such as a lake, river, well, or tap, for analysis or testing purposes. Sampling water allows scientists, environmentalists, and regulatory agencies to assess its quality, detect pollutants, monitor changes over time, and ensure its safety for human consumption or environmental health. The choice of sample container can vary depending on the purpose of the analysis and the characteristics of the water source. This research was focused on determining metals of interest in waters intended for human consumption in adequately washed plastic and concurrently in glass containers, sampled in the Varaždin County area during 2023. Arsenic, cadmium and lead, were analyzed using an atomic absorption spectrophotometer with a graphite furnace, while aluminium, barium, boron, cobalt, copper, manganese, nickel, selenium, tin, vanadium, and zinc, were analyzed using an inductively coupled plasma optical emission spectrometer. Although according to the standard HRN EN ISO 5667-3, all analyzed metals must be sampled in plastic containers, in some samples, a certain amount of nickel, manganese and vanadium, above the quantification limit was found, while in parallel samples from glass containers, they were not detected or were detected in lower concentrations. The findings suggested that glass containers are better suited for these metals.
Keywords: container choice, metal determination, water sampling

Water monitoring with fast response electromagnetic sensor

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Abstract: Water quality monitoring is a critical aspect of public health and environmental management. Traditional methods of water quality assessment often involve time-consuming laboratory tests and complex multisensor monitoring devices. Our work presents a novel approach for quick and intuitive water quality measurement using electromagnetic sensors. Our research focuses on the concept development and application of an electromagnetic sensor capable of real-time water quality measurement. The sensor utilizes electromagnetic waves to probe the water sample, and the response is analysed to determine various water quality parameters such as pH, ammonium and traces of other metals. Our focus on detection was more on metal materials and magnetical fluids. Furthermore, the real-time data provided by the sensor enables immediate response to changes in water quality, a feature not possible with traditional laboratory tests. Similar devices could be used for monitoring waters in nature in some natural disasters, fires, ponds and industrial environments. The sensor also utilises a non-invasive measuring method with electromagnetic signals with low amplitudes, which do not affect water life. Future work will focus on refining the sensor design for enhanced accuracy.
Keywords: water monitoring, electromagnetics, sensor

Monitoring of phytoplankton in Croatia according to the Water Framework Directive with focus on Plitvice Lakes

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Abstract: The Water Framework Directive (WFD) defines phytoplankton as one of the five biological quality elements (BQE) for assessing the water quality of very large rivers, lakes, transitional and coastal waters. It is a mandatory BQE because it reacts quickly and reliably to environmental changes and is therefore a good ecological indicator of the status of nutrients and eutrophication. Continuous monitoring of phytoplankton in freshwater in Croatia was introduced in 2010 and 2013 with the monitoring of very large rivers and natural lakes, respectively. The method used is Utermöhl analysis, which quantifies phytoplankton as biomass on a monthly basis in the growing season (April-September). In this study, we present the results of phytoplankton monitoring in two large, deep lakes in the Plitvice Lakes system, Kozjak and Prošće. Diatoms dominate in the phytoplankton of both lakes, while the co-dominance of chrysophytes and chlorophytes is more pronounced in Lake Prošće. The Reynlods functional groups that characterise the composition of phytoplankton are A, B, C, D and P in Lake Kozjak and B, C, D, E and F in Lake Prošće. The environmental factors that most influence the biomass and composition of phytoplankton are nutrients, temperature and light availability. The ecological status of Kozjak and Prošće lakes based on phytoplankton is high or good, which means that these two water bodies meet the requirements of the WFD.

Keywords: Biological quality elements, diatoms, environmental factors, Lake Kozjak, Lake Prošće

Occurrence and Distribution of Pharmaceutically Active Compounds (PhACs) in Water and Fish from the Sava River, Croatia

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Abstract: There is accumulating evidence in the literature that pharmaceutically active compounds (PhACs) belong to the most prominent categories of emerging contaminants. Continuous increase in PhACs production and consumption, incomplete removal during conventional sewage treatment and their pseudo-persistence in the aquatic environment raise the concerns about the possible adverse effects in the aquatic biota. Since the toxic effect of a given contaminant depends on the internal concentration in the organism rather than the exposure concentration in water, it is important to determine the concentration of PhACs in different biota tissues. In this work, we will present the results of a field study on the occurrence and distribution of PhACs in water and fish samples, collected in the Sava River. A highly specific LC/MS method, developed for this purpose, allowed simultaneous analysis of 44 PhACs, including representatives of several therapeutic categories as well as their metabolites. Spatial distribution of selected target analytes clearly indicated that the municipal wastewaters represented the main source of PhACs. Comparison of the internal concentrations with the corresponding exposure concentration in water allowed the assessment of the relative bioaccumulation potential of individual PhACs. The results suggested that, generally, PhACs do not belong to highly bioaccumulative compounds, however, bioconcentration factors (BCF) in metabolic tissues tissues can exeed a value of 1000.

Keywords: pharmaceuticals, emerging contaminants, fish, water, Sava River

Examination of the presence and level of heavy metals in the river Miljacka

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Abstract: In this project under the financial support of the Ministry of Science, Higher Education and Youth of Sarajevo Canton, the sources of heavy metals (Cu, Zn, Cd, Pb, Ni, Cr, Co, Fe, Mn and Hg) were examined in the river Miljacka, and the levels of pollution in two different periods, in autumn and early spring. The sources and presence of heavy metals in the water and in the ground (coastal mud) were determined, physical and chemical analyzes of the water were also done in the same periods of the year. This research paper provides an overview of the analysis of mud and water samples from the Miljacka River from ten different sites in the city of Sarajevo from Goat bridge to the estuary of the River Miljacka into the Bosna River. All analyses were performed in the Laboratory for Chemistry of the Faculty of Agriculture and Food in Sarajevo and the laboratory EURO INSPEKT ltd. - "Real INSPECT" Sarajevo. Physicochemical parameters examined in this research work were: turbidity (measured 6.19-32.04 NTU), pH value (6.3-7.72), consumption of KMnO4 (1.94 - 7.39 mg O_2/l), ammonia (0.05 - 4.08 mg N/l), nitrates (0.80 - 2.90 mg/l). All heavy metals and trace elements (Cu, Zn, Cd, Pb, Ni, Cr, Co, Fe, Mn) according to the obtained results were under the references except mercury (Hg) observed higher concentrations from two sites (0.10 µg/l) in both measuring (autumn and spring). Based on the conducted research, we can conclude that the river Miljacka has a higher concentration of nitrates, ammonia, mercury and inadequate turbidity.
Keywords: Miljacka river, coastal mud, heavy metals, water analysis

Dissolved metal(loid) concentrations in water of the karst Krka River: long-term influence of industrial and municipal wastewaters

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Abstract: Metal(loid) variability in the sensitive karst ecosystem of the Krka River was addressed as a possible indicator of exposure to industrial and municipal wastewaters, which represent the main metal contamination sources only 2 km upstream from the Krka National Park (KNP). The study was conducted in four seasons at five locations: industrial wastewaters (IWW), the Orašnica tributary (TOR) directly affected by IWW, near the municipal wastewaters of the Town of Knin (KRK), the Krka River source (KRS) as the reference site, and Brljan Lake (KBL) in KNP. The spatial distribution of dissolved metal concentrations followed the order IWW>TOR>KRK>KBL≥KRS. The most prominent increase in IWW compared to other locations was observed for Fe, Cu, and Zn, elements commonly used in industry. Seasonality pointed to the highest metal levels mostly in the summer, when the water levels and self-purification processes are reduced. Almost all elements had a low tendency to bind with particles, being highly present in the dissolved fraction, therefore confirming their bioavailability and potential toxicity. Although metal(loid) concentrations increased over decades of measurements, they were still low compared to metal-contaminated rivers. However, observed patterns present a warning and indicate the need for the targeted continuous monitoring of this sensitive area.
Keywords: water quality, anthropogenic impact, metal toxicity, metal bioavailability

Determination of nitrite with the use of a spectrophotometer and smartphone as a detector

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Abstract: This paper describes the possibility of applying the Griess reaction to the determination of nitrite in water. Following a simple procedure, optimal parameters were selected that enable good analytical applicability of the methods. The prepared reaction solutions were pink-violet and their absorbance was measured at a wavelength of 540 nm. The spectrophotometric method achieved linearity in the concentrations range from 0.3 to 70.0 µmol L^{-1}, and the detection limit was 0.057 µmol L^{-1}. Also, for smartphone-based analysis, due to the pink-violet color of the solutions, the intensity of the green RGB channel decreased with increasing nitrite concentration. The smartphone camera was used for digital image acquisition, and the free application Color Grab was used for processing and measuring the intensity of the RGB channel. With this analytical method, a linear change in the intensity of the green channel was achieved in the concentrations range from 0.7 to 30.0 µmol L^{-1}, and the limit of detection was 0.5 µmol L^{-1}. The proposed methods were successfully applied for the determination of nitrite in surface water samples.

Keywords: Griess reaction, nitrite, water, smartphone-based analysis, spectrophotometry

Određivanje nitrita primjenom spektrofotometra i pametnog telefona kao detektora

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Sažetak: U ovom radu opisana je mogućnost primjene Griessove reakcije pri određivanju nitrita u vodi. Primjenjena je jednostavna procedura i odabrani optimalni parametri koji omogućuju dobra analitička svojstva metoda. Za pripremljene reakcijske otopine mjerena je apsorbancija pri valnoj duljini 540 nm. Spektrofotometrijskom metodom postignuta je linearna promjena apsorbancije u području koncentracija nitrita od 0,3 do 70,0 µmol L^{-1}, a granica dokazivanja bila je 0,057 µmol L^{-1}. Pri primjeni pametnog telefona kao detektora, zbog ružičaste boje reakcijske otopine, intenzitet zelenog RGB kanala smanjivao se s povećanjem koncentracije nitrita. Kamera pametnog telefona korištena je za digitalno snimanja slike, a besplatna aplikacija Color Grab za obradu i mjerenje intenziteta RGB kanala. Ovom analitičkom metodom postignuta je linearna promjena intenziteta zelenog RGB kanala u području koncentracija od 0,7 do 30,0 µmol L^{-1}, a granica dokazivanja bila je 0,5 µmol L^{-1}. Predložene metode uspješno su primijenjene za određivanje nitrita u uzorcima površinskih voda.

Ključne riječi: Griessova reakcija, nitriti, voda, pametni telefon, spektrofotometrija

Various puzzles concerning Radon gas in Croatian drinking water dwellings

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Abstract: The precautionary principle is explicitly laid down in the EU treaty and is one of the starting points of its environmental policy. European Commission made a statement in February 2000 regarding the use of the precautionary principle indicating that the principle should be applied where there is a reasonable suspicion of the existence of a health or environmental risk. Furthermore, the Commission indicates that measures based on the precautionary principle should not be aimed at completely precluding any risk; it assumes that such an effort is unrealistic. The EU adopted the recast Drinking Water Directive in December 2020 and the Directive entered into force in January 2021. The activity concentration of natural radionuclides (or even artificial) has to be monitored in water and is regulatory covered by special national regulations. Council Directive 2013/59/Euratom covers through Annex XVII the long-term risks from radon exposures and is a base for all EU Member States Radon Action Plans (RAP). The long-term goal of Croatian RAP is, by applying well-thought-out and coordinated measures, to contribute to the reduction of radon radiation of people living in the Republic of Croatia and consequently to reduce the risk of lung cancer associated with increased radon radiation. Some of the regulatory issues are performed, but a major Croatian strategy covering the management and monitoring of Radon gas in drinking water is not jet fully established. On the EU level, final consultations on practical implementation of Radon dose coefficients for workers in "water production" industry are in progress and it is expected that, for all MS mandatory, EU Guidance will be issued. This paper aims to contribute to the discussion about the managing Strategy of Croatian drinking water wealth in a scope of protecting biodiversity and human health from any imaginable radioactive abuse.
Keywords: radon, NORM, drinking water, monitoring

Seasonal and spatial variations in water quality of the Karašica Canal in Baranja, Eastern Croatia

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Abstract: The water quality of the Karašica canal was investigated throughout the year from the Croatian-Hungarian border (site S1) to the pumping station (site S7), where the canal waters are pumped into the Danube. Various factors were considered, including hydrology, seasonal influences, and human activities such as land usage and municipal and farm wastewater discharge. Based on the nutrient analysis, water quality was good upstream of the municipal wastewater discharge point. However, a significant downstream increase was observed in ammonium nitrogen, nitrates, and phosphates, with nitrogen compounds increasing 10 to 15 times and phosphates up to 5 times. Halogenated organic compounds (AOX) were detected only in summer and at sites S5 to S7, with levels from 100 to 340 µg Cl/l, while organochlorine cyclodiene pesticides (OCP) were prevalent at all sites and seasons, but exceeding limit values for surface waters at sites S5 to S7 during autumn. High levels of organic pollution and pathogenic bacteria determined at sites S3 (wastewater discharge site) and S7 (water accumulation) suggest significant contamination from mixed wastewater sources and inadequate treatment processes. This monitoring highlights the urgent need for improved agricultural management and wastewater treatment practices to reduce pollution and protect human health and environmental quality.

Keywords: drainage canal, water quality, municipal and farm wastewater, pesticides

Determination of total nitrogen in surface waters

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Abstract: Although nitrogen is one of the most important nutrients for ecosystem functioning and a limiting factor for the productivity of many ecosystems, nitrogen pollution can cause negative ecological effects on the environment, including soil acidification, hypoxia and fish kills. A high concentration of nitrogen is the main factor that leads to eutrophication of the aquatic environment, which results in a decrease in biological diversity and deterioration of water quality. High levels of nitrogen compounds in drinking water increase the risk of disease in humans. Nitrogen overloads is one of the main reasons for the deterioration of surface water quality, therefore, monitoring the nitrogen concentration is essential for maintaining good surface water quality. Human activities have greatly accelerated the input of nitrogen into water systems, resulting in the degradation of water quality. In this paper, surface water samples were analysed, i.e. total nitrogen concentrations were determined in the area of Varaždin and Krapina-Zagorje counties in the period from November 2022 to April 2023. LCK 138 cuvette tests were used to determine the concentration of total nitrogen in individual water samples. The results showed that only 5 locations are in accordance with the Regulation on water quality standards and the state of surface water bodies, i.e. that the concentration values of the total amount of nitrogen are within the prescribed limit values, while the concentrations of the total amount of nitrogen in surface water at the other locations were higher than the prescribed limit values of 2 mg/l N.
Keywords: surface water, total nitrogen, water quality

Benthic algae on tufa barriers in Plitvice Lakes

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Abstract: Tufa barriers are geological structures that form where water pours from one karst lake into another, creating unique cascading systems such as the Plitvice Lakes. The barriers are formed by the deposition of calcium carbonate under favorable environmental conditions, in which autotrophic organisms such as aquatic mosses, algae, and cyanobacteria are actively involved through photosynthesis and respiration, as well as through the production of gelatinous mucopolysaccharides, which serve as the basis for further calcification. The systematic study of benthic algae on the tufa barriers of Plitvice Lakes was carried out in June and September 2016. The study covered six barriers, namely Labudovac, the outflows of lakes Bationvac, Veliko and Gradinsko, the Kozjački mostovi barrier, the inflow to Lake Novakovića Brod and the barrier below the Veliki slap Waterfall. In total, more than 100 diatoms and more than 50 benthic taxa from other algal groups were identified. Diatoms and cyanobacteria were the most abundant, with a significant proportion of red and green algae. *Oocardium stratum*, *Phormidium incrustratum* and *Rivularia haematites* were among the important species in carbonate-rich water, and the endemic diatom *Diploneis plitvicensis* was an interesting find. Nutrient concentration, alkalinity and saturation greatly influenced the composition and abundance of benthic algae on the tufa barriers of Plitvice Lakes.
Keywords: Cyanobacteria, diatoms, Oocardium stratum, alkalinity, calcification

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Abstract: By Decree of the Government of the Republic of Croatia (OG 143/2021) of December 23, 2021, the public institution Josip Juraj Strossmayer Water Institute was established. The Water Institute aims to monitor quality of surface waters, including transitional and coastal waters and groundwater, as well as to carry out laboratory analyses, prepare expert studies for the development of the Water Management Strategy, the River Basin Management Plan, the Flood Risk Management Plan and the Multiannual Programme for the Construction of Hydraulic Structures, preparing scientific and analytical studies for the needs of water management, conducting other scientific research in the field of water management, preparing scientific and analytical studies and analyzing drafts of water legislation and secondary legislation, as well as international cooperation in the field of water management. The Water Institute also prepares and conducts international projects related to water management, develops a model for evaluating the efficiency of public water service providers and prepares reports and analyses on this, prepares scientific and analytical studies and conducts expert opinions in the field of water management and similar tasks in accordance with the applicable laws and other legislation in the field of water management and its Statute. According to the Regulation on Specific Conditions for the Provision of Water Services (OG 70/2023), the Water Institute is responsible for adopting and implementing the curriculum for the professional training of employees of public water suppliers, as well as for regulating the points system and issuing certificates of completed training. The main laboratories of the Water Institute are located in Hrušćica and Šibenik. The Institute's scientists, experts and technicians from the fields of biology and chemistry are responsible for carrying out monitoring and research work, interventions in emergencies and accidental pollution (at expert and operational levels), collecting, systematizing and processing data, and converting data into information that is crucial for the adoption of strategic documents by water management stakeholders in the Republic of Croatia.

Keywords: public institution, monitoring, scientific projects, education

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Sažetak: Uredbom Vlade Republike Hrvatske (NN 143/2021) dana 23. prosinca 2021. osnovana je javna ustanova Institut za vode »Josip Juraj Strossmayer«. Cilj osnivanja Instituta je provedba monitoringa površinskih, uključujući i priobalnih i prijelaznih te podzemnih voda, kao i laboratorijskih poslova, izrada stručnih podloga za izradu strategije upravljanja vodama, plana upravljanja vodnim područjima, plana upravljanja rizicima od poplava i višegodišnjih programa gradnje vodnih građevina, izrada znanstvenih, studijskih i analitičkih podloga za potrebe upravljanja vodama, provedba i drugih znanstvenih istraživanja u području upravljanja vodama, obavljanje poslova izrade znanstvenih i stručnih analiza nacrta zakona i provedbenih propisa te obavljanje poslova međunarodne suradnje u području upravljanja vodama. Institut također priprema i provedi međunarodne projekte iz područja za upravljanje vodama, obavlja poslove izrade modela vrednovanja učinkovitosti poslovanja isporučitelja vodnih usluga te izrađuje izvještaje i analize o istome, izrađuje znanstvene, studijske i analitičke podloge te provodi vještačenja u području upravljanja vodama, kao i slične poslove u skladu s važećim zakonskim i podzakonskim propisima iz područja upravljanja vodama i drugim aktima iz područja upravljanja vodama te svojim Statutom. Institut za vode je temeljem Uredbe o posebnim uvjetima za obavljanje djelatnosti vodnih usluga (NN 70/2023) nadležan za donošenje i provedbu nastavnog plana trajnog stručnog osposobljavanja za djelatnike javnog isporučitelja vodnih usluga, te uređivanje sustava bodovanja i izdavanje potvrda o završenom osposobljavanju. Glavni laboratoriji Instituta za vode nalazi se u Hrušćici i u Šibeniku, a znanstveno, stručno i tehničko osoblje Instituta iz područja biologije i kemije zaduženi su za obavljanje poslova provedbe monitoringa i istraživanja, intervencije tijekom izvanrednih i iznenadnih onečišćenja (ekspertna i operativna razina), prikupljanje, sistematizacije i obrade podataka te prevođenje podataka u informacije ključne za donošenje strateških dokumenata dionika vodnog gospodarstva u Republici Hrvatskoj.

Ključne riječi: javna ustanova, monitoring, znanstveni projekti, edukacija

The importance of macrophytes and rocky substrates for achieving diverse macroinvertebrate community in the karstic rivers

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Abstract: Human impact in the form of hydromorphological degradation is putting freshwater habitats under continuous pressure today. Rivers are losing riparian vegetation, habitat heterogeneity and natural flow velocity. As these habitats provide drinking water, energy, etc., authorities are endeavouring to manage freshwater resources sustainably. In order to achieve sustainability, bioassessment plays an indispensable role, with macroinvertebrates proving to be one of the best studied and most reliable assessment groups. Within the macroinvertebrates, the Ephemeroptera, Plecoptera and Trichoptera, commonly referred to as EPT taxa, occupy a special position due to their sensitivity to changes in natural conditions. The aim of this study was to investigate which hydromorphological pressures affect them the most. Samples were collected from 84 sampling sites in karst rivers in Croatia and 52 EPT taxa were identified (Ephemeroptera – 21, Plecoptera – 11, Trichoptera – 20). The main stress factor affecting the distribution of EPT taxa was the change in river morphology, while hydrological regulation showed no significant influence on the EPT community, possibly due to the karst nature of the studied rivers. The most sensitive EPT taxa were those with the greatest preference for macrophytes and rocky habitats. More tolerant EPT taxa were those with a wide range of habitat preferences and/or taxa that feed on particulate organic matter.

Keywords: bioassessment, hydromorphology, EPT taxa, pressures

Determination of semi-volatile organic compounds (SVOCs) in water using gas chromatographic method with mass spectrometry (GC-MS/MS) and "µDROP" sample preparation

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Abstract: Semi-volatile organic compounds ("SVOCs") are a large group of moderately volatile substances of diverse chemical characteristics: pesticides, polychlorinated biphenyls ("PCBs"), polybrominated diphenyl ethers ("PBDEs"), polycyclic aromatic hydrocarbons ("PAHs"), chloroalkanes (C10–C13), phthalates, phenols, dioxins and organotin compounds. These compounds are considered environmental pollutants and the regulation requires their determination in water, air, soil, etc. This paper presents the method for the determination of semi-volatile compounds in surface, underground, and waste water as well as water for human consumption. The principle of this method is the extraction of compounds of interest from a known volume of water using a "µDrop" extraction solution. The extract is concentrated in a drop at the bottom of a cuvette and transferred by syringe into vial for GC-MS/MS measurement. Identification and quantification is carried out by internal standard technique. This is a new approach to determination of mentioned compounds based on applying small volumes of sample and extraction solution and obtaining a small volume of extract. Therefore, the entire process produces low amounts of chemical waste, which makes the method "green", i.e. environmentally friendly. On the other hand, a high sensitivity of measurement is achieved, thus low quantification limits of individual compounds required by regulation are reached.

Keywords: water, SVOC, µDrop, GC-MS/MS

Određivanje poluhlapljivih organskih spojeva ("SVOC") u vodi metodom plinske kromatografije s masenom spektrometrijom (GC-MS/MS) i "µDROP" pripremom uzorka

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Sažetak: Poluhlapljivi organski spojevi ("SVOC") su velika skupina umjereno hlapljivih tvari s vrlo različitim kemijskim svojstvima i karakteristikama. Uključuju pesticide, poliklorirane bifenile ("PCB"), polibromirane difenil etere ("PBDE"), policikličke aromatske ugljikovodike ("PAH"), kloroalkane (C10–C13), ftalate, fenole, dioksine i organokositrene spojeve. Navedeni spojevi zadržavaju se kao onečišćenja u okolišu te je regulativom propisano njihovo određivanje u sastavnicama okoliša – vodi, zraku, tlu i dr. Ovim radom prikazat će se metoda određivanja poluhlapljivih spojeva u površinskim, podzemnim, otpadnim vodama kao i u vodi za ljudsku potrošnju. Princip metode je da se spojevi od interesa ekstrahiraju iz poznatog volumena vode pomoću "µDrop" otopine za ekstrakciju. Ekstrakt se koncentrira na dnu kivete u kapljici koja se pomoću šprice prenese u vialu za GC-MS/MS mjerenje. Dakle, identifikacija i kvantifikacija se provodi tehnikom plinske kromatografije s masenom spektrometrijom metodom internog standarda. Ovo je novi pristup određivanja navedenih spojeva jer se koriste mali volumeni uzorka i ekstrakcijske otopine te se dobije mali volumen ekstrakta. S obzirom na navedeno, cijeli postupak producira niske količine otpadnih kemikalija što ovu metodu čini "zelenom" odnosno ekološki prihvatljivom. S druge strane postiže se visoka osjetljivost mjerenja čime se dostižu regulativom zahtjevane niske granice određivanja pojedinih spojeva.
Ključne riječi: voda, SVOC, µDrop, GC-MS/MS

Quality control of environmental water sampling and sample handling in an accredited laboratory

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Abstract: Continued confidence in the performance and reliability of examination data is essential for the analytical laboratory, its customers and regulatory bodies. Quality sampling and sample handling procedure is the first step towards valid and trustworthy measurement results. Various mistakes may occur during water sampling process, resulting in substantial errors that cannot be corrected. An accredited laboratory is obliged to establish effective quality control strategies to monitor, detect and identify such errors in order to prevent or reduce them. This paper reports some results of practical application of water sampling and handling quality control conforming to the HRN EN ISO 5667-14:2016 standard in different types of environmental waters: drinking, surface and waste water. Means to implement quality control of water sampling and handling are blanks, duplicate sampling and spiking. Quality control techniques are selected and applied depending on the sampling objectives and the specifics of the sampling procedure for each water type. The frequency of sampling quality control is determined by the productivity of the laboratory. Effective quality control of water sampling and sample handling allows to distinguish invalid or misleading analysis results and directs to appropriate measures that are necessary to ensure and maintain an adequate level of sampling quality.
Keywords: water sampling; QC; practical examples

Croatian National Survey of Persistent Organic Contaminants in Freshwater Biota

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Abstract: Persistent organic pollutants (POPs) are a numerous class of man-made chemicals, whose negative impacts on the aquatic environment have been well-documented in the literature. As a consequence, their use has been strictly regulated by international agreements, such as Stockholm Convention and EU Water Framework Directive (WFD), as well as by national legislation. The WFD List of priority substances includes several representatives of POPs with defined environmental quality standards (EQS) which put a special emphasis on their bioaccumulation in aquatic organisms. This paper aims to present the results of a nationwide survey of persistent organic pollutants in Croatia, based on the analysis of freshwater biota samples collected during 2020 on 46 locations covering different types of surface waters. Several classes of POPs, including chlorinated pesticides, hexachlorobutadiene, polychlorinated biphenyls (PCBs), brominated flame retardants (BFRs), perfluoroalkyl substances (PFAS) and polycyclic aromatic hydrocarbons (PAHs) were determined using validated analytical methods. The results showed that the legacy pollutants, such as chlorinated pesticides and PCBs, are still present in significant concentrations despite the ban of their use. The more recent POPs, such as BFRs and PFAS, also occur at significant levels and their spatial distribution clearly reflects the impact of urbanized areas as the main pollution sources. The most critical contaminants regarding the current EU legislation are polybrominated diphenylethers (PBDEs), which exceeded the adopted EQS values in vast majority of samples.
Keywords: persistent organic pollutants; POPs; monitoring; biota; surface waters

The influence of the sampling location on the assessment of coastal bathing water quality

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Abstract: Spatial variation in fecal indicator bacteria (FIB) counts at bathing sites can be very pronounced and lead to misclassification of water quality, jeopardizing the fulfilment of the main objective of the Bathing Water Directive, the protection of bathers' health. We analyzed the impact of sampling locations, i.e. sampling from the shore and from a boat (near the swimming barrier), on the assessment of bathing water quality at nine coastal bathing sites in Rijeka and Kaštela. In 18/27 (67%) of annual and 8/9 (89%) of final assessments in the period 2021-2023, the differences in the 90th percentiles of FIB values between samples taken from the shore and from the boat resulted in a difference in the bathing water quality category. In 5/18 (28%) of the annual assessments and 2/8 (25%) of the final assessments where there were differences in the water quality category due to sampling location, sampling near the swimming barrier resulted in a lower bathing water quality category. The results suggest that the procedure for determining the monitoring point at bathing sites should be site-specific and not apply equally to all bathing waters. This would avoid possible misclassification of bathing waters and jeopardizing the health of bathers.

Keywords: bathing water quality; sampling location; fecal indicator bacteria; spatial variation

Funding: This research was funded by the Croatian Science Foundation, Grant No. IP-2020-02-1880 (project Eurobath)

10th International Conference WATER FOR ALL
20-22 March 2024
Plitvice Lakes, Croatia

WATER AND HEALTH
VODA I ZDRAVLJE

Education of preschool children about the importance of fluid intake - HEPSC project

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Abstract: Since obesity rates in Croatia among children and adults are increasing, and 23 % of adults are obese, which is far exceeding the EU average in 2022 of 16 %, it was observed that it would be helpful to carry out education from the earliest age. As part of the project HEPSC - Healthy Eating Preschools Children (INTERREG IPA Croatia - Bosnia and Herzegovina - Montenegro 2014-2020, HR-BA-ME527), education and evaluation of knowledge (before and after education) of preschool children about healthy nutrition and water intake in 5 kindergartens (250 preschool children) in the area of Šibenik-Knin County was conducted. Although the most important causes of obesity are cultural influences on eating habits and physical activity, studies show that soft drinks and fruit juices are the main reasons for obesity in children. The project's goal was to raise preschool children's awareness and knowledge about food quality, healthy eating habits, and the importance of water intake so that children adopt healthy eating and drinking habits. This study shows that education at an early age has great potential in improving food and liquid intake habits.

Keywords: preschool children, education project, water intake, fluid intake habits
Thematic area: Water and Health Type of presentation: poster / oral presentation

New legislative regulations in the testing of ice for consumption

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Abstract: Ice cubes for human consumption represent water intended for human consumption that has changed from a liquid to a solid aggregate state at atmospheric pressure and a temperature of 0°C. With the release of the new Law on Water for human consumption (OG 30/23), ice cubes for human consumption obtained from water intended for human consumption must meet the values of the conformity parameters prescribed by the Regulation on compliance parameters, analysis methods and monitoring of water intended for human consumption (OG 64/23). According to the data of the ice samples tested so far at the Health Ecology Department of NZZJZ OBŽ and evaluated according to the Microbiological Guidebook for Food (Ministry of Agriculture, 3rd modified edition, 2011.) it is evident that most of the non-conforming samples were due to the parameters of aerobic mesophilic bacteria, *Pseudomonas aeruginosa* and intestinal enterococci. *Pseudomonas aeruginosa* as one of the most common causes of non-conformity is no longer being analysed due to the changes in legislation. Water intended from human consumption from which ice is derived can meet health safety standards, however, ice cubes can be contaminated with microorganisms due to the insanitary handling leading to a serious health problem in immunocompromised people. Therefore, it is important to educate ice handling staff about proper hand washing, keeping the utensils clean and regular and efficient maintenance of ice machines to prevent secondary contamination with *Pseudomonas aeruginosa.*

Keywords: ice cubes for human consumption, ice machines, water intended for human consumption, legislative

Nove odredbe zakonodavstva u ispitivanju konzumnog leda

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Sažetak: Konzumni led predstavlja vodu za ljudsku potrošnju koja je pri atmosferskom tlaku i temperaturi od 0°C prešla iz tekućeg u čvrsto agregatno stanje. Izlaskom novog Zakona o vodi za ljudsku potrošnju (NN 30/23), konzumni led proizveden od vode za ljudsku potrošnju mora ispunjavati parametre sukladnosti propisane Pravilnikom o parametrima sukladnosti, metodama analiza i monitorinzima vode namijenjene za ljudsku potrošnju (NN 64/23 i 88/23). Prema podatcima do sada ispitanih uzoraka leda na Službi za zdravstvenu ekologiju NZJZ OBŽ i ocijenjenih prema Vodiču za mikrobiološke kriterije za hranu (Ministarstvo poljoprivrede, ribarstva i ruralnog razvoja, 3. izmijenjeno izdanje, ožujak, 2011.) najviše nesukladnih uzoraka bilo je zbog aerobnih mezofilnih bakterija, *Pseudomonas aeruginosa* i crijevnih enterokoka. Promjenom u legislativi, jedan od najčešćih uzroka nesukladnosti, *Pseudomonas aeruginosa,* više se ne ispituje u konzumnom ledu. Voda za ljudsku potrošnju koja se koristi za pripremu leda može biti zdravstveno ispravna, međutim kocke leda mogu biti kontaminirane mikroorganizmima zbog nehigijenskih postupaka prilikom rukovanja ledom te izazvati ozbiljnije probleme kod osoba s oslabljenim imunitetom. Zato je važno educirati osoblje koje rukuje ledom o pravilnom pranju ruku, održavanju čistoće pribora koji dolazi u kontakt s ledom, kao i o redovitom i učinkovitom održavanju ledomata, kako ne bi došlo do sekundarne mikrobiološke kontaminacije bakterijom *Pseudomonas aeruginosa*.
Ključne riječi: konzumni led, ledomati, voda za ljudsku potrošnju, zakonodavstvo

Water pollution and human health

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Abstract: Water pollution is a threat to flora, fauna, and human health. Human activities such as agriculture, industrialization, poor water supply and inadequate sewage treatment facilities, as well as natural factors, all lead to water pollution. The water quality is determined by physical, chemical, and biological composition, by monitor-based methods. It requires broad-field sampling as well as pricey laboratory analytics. However, it is time-consuming and feasible for smaller areas. The biggest concern are organic and inorganic pollutants, especially the ones that are toxic and persistent, and therefore, challenging to treat. Regarding biological pollution, enteroviruses cause diarrhea, the most frequent disease caused by poor water quality. Additionally, there are gastrointestinal diseases, dracunculiasis, and parasitic worms. Water pollution also can lead to skin diseases such as melanosis, skin lesions, keratosis, skin infection, scabies, and stunt growth. Not only that, but water pollution is connected to visceral tumors, skin cancer, melanoma. Some water pollutants lead to cancer mortality, to a very small population, kidney, bladder and rectal cancer, gastric and liver cancer, esophageal cancer mortality, lung cancer, cancer incidence in the region. Finally, water pollution affects child health and leads to child malnutrition and stunting, infant and child mortality, goiter, and decreased height as an adult.
Keywords: water pollution; human health; water quality

The molecular phylogeny of selected enteropathogenic bacteria isolated from household drinking water and diarrheal stool samples of HIV/AIDS patients

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Abstract: The provision of reliable drinking water is crucial for people infected with HIV, as they have immunocompromised systems and are at higher risk of waterborne diseases. This study aimed to identify phylogenetic associations between enteropathogenic bacteria from household drinking water and those found in HIV-infected individuals' diarrheal stools in rural Ugu District communities. The study used culture-based methods, PCR targeting 16S rRNA gene, RFLP, sequence analysis, and computational tools. Escherichia isolates showed phylogenetic relatedness, while Vibrio and Salmonella isolates only showed Clustal W alignments. *E. coli* isolates from rural drinking water showed homology with stool specimens, while *Salmonella, Shigella, Vibrio*, and *E. coli* from stool specimens were more diverse. This study was able to provide a pragmatic basis for the application of similar sequences isolated from different sources in order to elucidate evolutionary or genetic relationships.

Keywords: drinking water, genotype, culture-based, PCR-restriction fragment length polymorphism (RFLP)

Wastewater-based epidemiology – an innovative approach to assess lifestyle and dietary habits in Croatian regions

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Abstract: Lifestyle and dietary habits are currently mainly assessed using traditional epidemiological tools, such as surveys and sales statistics. While these methods are useful, they have several limitations due to their subjective nature and/or incomplete data. Wastewater-based epidemiology (WBE), sometimes referred to as sewage chemical information mining, is an objective, cost-effective and timely approach to obtain some relevant epidemiologic information at the population level. It is based on the analysis of specific human urinary biomarkers excreted in sewage and has mainly been used to assess illicit drug consumption. However, municipal wastewater is a potential treasure trove of numerous other chemicals that reflect the population's lifestyle and dietary habits, exposure to contaminants, and health status. This work presents the general concept of WBE and the development of analytical methods, based on liquid chromatography–tandem mass spectrometry (LC-MS/MS), for the determination of several classes of lifestyle and dietary biomarkers in raw municipal wastewater. The methods include the biomarkers of alcohol, nicotine, caffeine, artificial sweeteners, vitamins and several specific compounds from plant and animal foods, and will be used to assess the differences in lifestyle and dietary habits in Croatian regions using the innovative WBE approach.
Keywords: biomarkers; food; lifestyle; sewage epidemiology; wastewater analysis

What's in the pool? A comprehensive identification of disinfection by-products and toxicity assessment of chlorinated and brominated swimming pool water

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Abstract: Exposure to the sun's ultraviolet (UV) light can lead to material damage through the breakage of covalent bonds and subsequent oxidation processes. This is especially detrimental in biological systems, causing skin cell damage, accelerated aging, and various diseases. To mitigate UV exposure, substances known as UV filters are employed, commonly found in sunscreen and personal care products. Despite their protective role, UV filters may undergo auto-degradation, particularly in chlorinated environments like pools (especially with seawater). Our study focused on the transformation of selected UVA and UVB filters under disinfection conditions. The chlorination and bromination experiments revealed the formation of halogenated byproducts, such as chloroanhydrides and chlorophenols, which were identified and followed by sophisticated analytical methods, including gas and liquid chromatography-tandem mass spectrometry and nuclear magnetic resonance spectrometry. The study assessed the comparative toxicity of original UV filters and their chlorinated derivatives on non-target organisms and human lung cells. Variations in effects were observed based on the type of UV filter, alterations post-chlorination, and species-specific responses. This research underscores the environmental implications of UV filter transformation and emphasizes the importance of understanding their fate in disinfection settings for effective sun protection.
Keywords: UV filters, chlorination, disinfection by-products, toxicity

New possibilities of the Bliznec forest trail

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Abstract: The Bliznec forest trail, constructed in 2002 and subsequently renovated, needs complete reconstruction due to the deterioration of the wooden structure caused by moisture, weather conditions, and the large number of visitors. Along the trail, 11 educational boards addressing the importance of ecosystem preservation and biodiversity have been installed, with Braille versions available for accessibility. The Bliznec forest trail stands out as Croatia's first educational trail fully adapted for individuals with disabilities, leading to Croatia's inclusion in the World Tourism Organization (UNWTO) handbook for the first time in 2021. The planned reconstruction of the existing infrastructure of the Bliznec track will also include the arrangement of the bed of the Bliznec stream, over which the promenade passes, as well as the Info center and access parking lot. The design of interventions on the Bliznec stream and promenade involved many experts to preserve the quality of the habitat and water, which are under great anthropogenic influence. The adapted infrastructure of the Bliznec forest trail will provide disabled people with equal opportunities to enjoy nature and activities and ensure accessibility and comfort of movement.

Keywords: Bliznec forest trail, reconstruction, persons with disabilities, accessibility, safety

Nove mogućnosti šumske staze Bliznec

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Sažetak: Šumska staza Bliznec, izgrađena 2002. godine i obnovljena više puta, u sadašnje vrijeme zahtijeva potpunu rekonstrukciju zbog dotrajalosti drvene konstrukcije uzrokovane vlagom i atmosferilijama te od posljedica velikog posjećivanja. Duž staze postavljeno je 11 edukativnih ploča s temama o važnosti očuvanja ekosustava i bioraznolikosti, a tekstovi su dostupni i na Brailleovom pismu. Šumska staza Bliznec je prva poučna staza u Hrvatskoj koja je u potpunosti prilagođena osobama s invaliditetom i zbog koje je 2021. godine Svjetska turistička organizacija (UNWTO) prvi put uvrstila Hrvatsku u svoj priručnik. Planirana rekonstrukcija postojeće infrastrukture staze Bliznec uključit će i uređenje korita potoka Bliznec nad kojim prolazi šetnica te Info centra i pristupno parkiralište. Projektiranje zahvata na potoku i šetnici Bliznec okupilo je mnoge stručnjake kako bi se očuvala kvaliteta staništa i vode koji su pod velikim antropogenim utjecajem. Nova staza će omogućiti pristup svim osobama, bez obzira na njihovu razinu mobilnosti ili vrstu invaliditeta te sigurnost prolaska s postavljenim jasnim oznakama koje će olakšati orijentaciju. Prilagođena infrastruktura šumske staze Bliznec omogućit će osobama s invaliditetom jednake mogućnosti uživanja u prirodi i aktivnostima te osigurati pristupačnost i udobnost kretanja.

Ključne riječi: šumska staza Bliznec, rekonstrukcija, osobe s invaliditetom, pristupačnost, sigurnost

WETLANDS
MOČVARNA STANIŠZA

Hrvatske vode in the "LIFE FOR MAUREMYS" project – Preparation of technical documents for the restoration of pond

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Abstract: The "Life for Mauremys" (LIFE21-NAT-HR-LIFE for Mauremys) is a four-year project aiming to improve the unfavourable conservation status of freshwater turtle species Balkan Terrapin (*Mauremys rivulata*) in Croatia. The project was designed to address all the drivers of *Mauremys rivulata* decline across four sites in Dubrovnik-Neretva County (Stonsko polje, Majkovi, Prljevići, and Konavle). The project coordinator is the University of Zagreb, Faculty of Agriculture, and the project partners are the Public Institution for the Management of Protected Nature Areas of Dubrovnik-Neretva County, the Zagreb ZOO, Hrvatske vode, and Hyla NGO. The project includes complete habitat restoration of the most degraded ponds and additional wetland habitats in four Natura 2000 sites (2,850 hectares), improvement of habitat quality and connectivity, removal of invasive alien species, provision of nesting sites for turtles safe from predators and invasive agricultural practices, and the *Mauremys rivulata* breeding programme. Hrvatske vode is as a project partner in charge of activities under Work Package 2 (WP2) – T.2.3. Restoration of the ponds and canals, including the restoration of three ponds – Majkovi church pond, Prljevići pond, and Ston refugium pond (a pond that needs to be reconstructed) – and the most important canals adjacent to those ponds. This paper presents the hydrogeological research and monitoring activities carried out in preparation to restore the ponds in Ston, Majkovi, and Prljevići. As part of the hydrogeological study, undisturbed samples of the sediment and soil from the ponds were collected and their geochemical composition was determined, their thickness was tested and estimated, the relationship between the soil and rock was analysed hydrogeologically, as well as their hydraulic conductivity and the possibility to add water into the ponds at times of hydrological minimums.

Keywords: *Mauremys rivulata*, habitat restoration, ponds, hydrogeological study, monitoring

Hrvatske vode u projektu LIFE FOR MAUREMYS - Izrada stručnih podloga za obnovu lokvi

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Sažetak: Life for Mauremys (LIFE21-NAT-HR-LIFE for Mauremys) četverogodišnji je projekt pokrenut s ciljem poboljšanja nepovoljnog statusa zaštite slatkovodne riječne kornjače (*Mauremys rivulata*) u Hrvatskoj. Projekt je osmišljen kako bi se prepoznali svi uzroci smanjenja brojnosti *Mauremys rivulata* na četiri područja u Dubrovačko-neretvanskoj županiji (Stonsko polje, Majkovi, Prljevići i Konavle). Koordinator projekta je Sveučilište u Zagrebu Agronomski fakultet, a ostali partneri su Javna ustanova za upravljanje zaštićenim dijelovima prirode Dubrovačko-neretvanske županije, Ustanova zoološki vrt grada Zagreba, Hrvatske vode i Udruga Hyla. Projekt obuhvaća potpunu obnovu staništa najteže degradiranih lokvi i dodatnih vlažnih staništa na četiri područja Natura 2000 (2850 hektara), poboljšanje kakvoće i povezanosti staništa, uklanjanje invazivnih stranih vrsta, osiguranja mjesta za gniježđenje kornjača od predatora i invazivne poljoprivredne prakse te program uzgoja mladunaca *Mauremys rivulata*. Hrvatske vode kao projektni partner zadužene su za aktivnosti iz radnog paketa broj dva (WP2) – T.2.3. Obnova lokvi i kanala, koje uključuju obnovu tri lokve (lokva u Majkovima-crkva), lokva u Prljevićima i lokva Ston refugij (lokva koju je potrebno rekonstruirati) i najvažnijih kanala uz navedene lokve. Ovaj rad daje prikaz hidrogeoloških istraživanja i provedenih monitoringa kao podloge za projekt rekonstrukcije lokve u Stonu i obnove lokve u Majkovima i Prljevićima. U sklopu hidrogeološke studije uzeti su neporemećeni uzorci sedimenta i tla iz lokvi te su geokemijski karakterizirani, ispitana je i procijenjena je njegova debljina, a hidrogeološki je analiziran odnos tla i stijene, njihova hidraulička vodljivost i mogućnost dodavanja vode u lokve u vrijeme hidroloških minimuma.

Ključne riječi: *Mauremys rivulata*, obnova staništa, lokve, hidrogeološka istraživanja, monitoring

Heavy metals assessment in the surface waters of Kopački rit as part of the Naturavita project in the period July 2021 - June 2022

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Abstract: Wetlands are key habitats of biodiversity. They are among the most productive ecosystems on Earth. They prevent floods, accumulate pollutants, filter surface water and enrich groundwater. Kopački rit is one of the most preserved wetland habitats in Europe. Kopački rit ecosystem is a result of the hydrological influence of two rivers; Drava and Danube. Heavy metals are part of the most dangerous inorganic pollutants due to tissue bioaccumulation, non-biodegradability and toxicity at low concentrations. Dissolved in water, they are in an ionic form, thus, in a bioavailable form. The chemical status of surface water is based on the annual average concentrations (AAC) of the substances and on the maximum annual concentration (MAC) of the environment quality standards for surface water (EQSs) according to the Regulation on water quality standards (OG 96/2019, 20/2023 and 50/2023-correction). As part of the Naturavita project, sampling and testing of dissolved mercury, nickel, cadmium and lead and their compounds was carried out at 19 locations at Kopački rit in the period from July 2021 to June 2022 through 12 sampling cycles. The results at all measuring stations for indicators nickel, cadmium, lead and their compounds were within AAC and MAC. Significant deviations at all locations were measured for the indicator of mercury and it compounds because the MAC values were higher than the EQSs specified in the Regulation, so the bodies of surface waters at sampling locations are classified in the chemical state category: a good chemical state has not been achieved.

Keywords: wetland ecosystems; heavy metals; Kopački rit; Naturavita project

Prikaz ocjene stanja teških metala u površinskim vodama Kopačkog rita u sklopu projekta Naturavita u razdoblju srpanj 2021. - lipanj 2022. godine

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Sažetak: Močvarna staništa središta su biološke raznolikosti. Svrstavaju se među najproduktivnije ekosustave na Zemlji jer spriječavaju poplave, akumuliraju onečišćujuće tvari, filtriraju površinsku vodu, obogaćuju podzemne vode. Kopački rit jedan je od najočuvanijih močvarnih staništa u Europi, a rezultat je hidrološkog utjecaja dviju rijeka; Drave i Dunava. Teški metali pripadaju najopasnijim anorganskim onečišćujućim tvarima zbog bioakumulacije u tkivima, bionerazgradivosti i toksičnosti pri niskim koncentracijama. Otopljeni u vodi nalaze se u ionskom obliku, odnosno bioraspoloživom obliku. Kemijsko stanje površinske vode utvrđuje se na temelju prosječne (PGK) i maksimalne godišnje koncentracije (MGK) standarda kakvoće vodnog okoliša (SKVO) koji su propisani Uredbom o standardu kakvoće voda (NN 96/2019, 20/2023 i 50/2023-ispravak). U sklopu projekta Naturavita na području Kopačkog rita provedeno je uzorkovanje i ispitivanje otopljene žive, nikla, kadmija i olova te njihovih spojeva na 19 lokacija u periodu od srpnja 2021. do lipnja 2022. godine kroz 12 uzorkovanja. Rezultati na svim mjernim postajama za pokazatelje nikal, kadmij, olovo i njihove spojeve bili su unutar PGK i MGK. Značajna odstupanja na svim mjernim postajama izmjerena su za pokazatelj živa i spojevi žive jer su MGK vrijednosti bile veće od SKVO navedenog u Uredbi pa se tijela površinskih voda razvrstavaju u kategoriju kemijskog stanja: nije postignuto dobro kemijsko stanje.
Ključne riječi: močvarni ekosustavi; teški metali; Kopački rit; projekt Naturavita

Bird flight observation above power lines in baseline survey of LIFE Danube Free Sky project (LIFE19 NAT/SK/001023)

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Abstract: The LIFE Danube Free Sky project is a unique example of cross-sectoral and international cooperation that deals with the problem of bird casualties in interaction with power lines. During the baseline survey, bird flight observation was carried out on certain transects of 10 kV, 35 kV and 110 kV power lines in order to determine the reactions of birds during the flight before the application of protective measures by power companies. The monitoring was carried out in 2022 and 2023 during 12 months with a set dynamic according to the monitoring protocol twice a day, in the morning half an hour before and an hour after sunrise, and in the evening an hour before and half an hour after sunset when bird activity is highest. A total of 99,776 birds were recorded during monitoring. The most numerous species were: common starling, rook, hooded crow and great cormorant. The most frequently recorded species in flight were: hooded crow, great cormorant, common starling and mallard. The most common types of reactions during the flyover were: no apparent reaction, bird flew up and over line and bird flew through the line with no reaction. Most bird flights were observed on the 10 kV transects located within or immediately adjacent to the borders of the Kopački rit Nature Park and on the 110 kV transect that crosses the Drava River. Bird flight observation will continue after the implementation of protective measures to determine their effectiveness.
Keywords: birds, power lines, Kopački rit, monitoring

Monitoring preleta ptica iznad dalekovoda u istraživanju nultog stanja projekta LIFE Danube Free Sky (LIFE19 NAT/SK/001023)

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Sažetak: Projekt LIFE Danube Free Sky jedinstven je primjer međusektorske i međunarodne suradnje koji se bavi problemom stradavanja ptica u interakciji s dalekovodima. Tijekom istraživanja nultog stanja provodio se monitoring preleta ptica iznad dalekovoda na određenim transektima 10 kV, 35 kV i 110 kV dalekovoda kako bi se utvrdile reakcije ptica tijekom preleta prije primjene zaštitnih mjera od strane elektroenergetskih kompanija. Monitoring se provodio 2022. i 2023. godine tijekom 12 mjeseci zadanom dinamikom sukladno protokolu monitoringa dva puta dnevno, ujutro pola sata prije i sat vremena nakon izlaska sunca te navečer sat vremena prije i pola sata nakon zalaska sunca kada je aktivnost ptica najveća. Ukupno je tijekom monitoringa zabilježeno 99 776 ptica. Najbrojnije vrste bile su: čvorak, gačac, siva vrana i veliki vranac. Najčešće zabilježene vrste u preletu bile su: siva vrana, veliki vranac, čvorak i divlja patka. Najčešće vrste reakcija tijekom preleta su bile: nije bilo reakcije, ptice su uzletile i preletile iznad vodiča dalekovoda i ptice su proletile između vodova bez reakcije. Najviše preleta ptica bilo je opaženo na 10 kV transektima koji se nalaze unutar ili neposredno uz granice Parka prirode Kopački rit te na 110 kV transektu koji prelazi rijeku Dravu. Monitoring preleta ptica nastavit će se nakon primjene zaštitnih mjera kako bi se utvrdila njihova učinkovitost.
Ključne riječi: ptice, dalekovodi, Kopački rit, monitoring

Cyanobacterial dynamics in a floodplain lake - coupling between benthic and pelagic populations

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Abstract: Planktonic cyanobacteria are characteristic components of eutrophic waters, and their massive development and potential toxicity raise concerns about their impact on the environment and public health and safety. The diversity and abundance of cyanobacteria in floodplains are related to the development of sediment-associated communities that enable the recruitment of pelagic populations and the water bloom development in summer. We investigated the relationship between the development of planktonic and benthic cyanobacteria in Lake Sakadaš (Kopački Rit floodplain) in 2021. Cyanobacteria dominated the phytobenthos (up to 85.4% of total microphyte abundance), while scarce phytoplankton and the lack of usual blooms were a consequence of intermittent flooding in the late spring and summer months. Flooding combined with nutrients determined the composition of cyanobacteria in plankton and benthos. Redundancy analysis revealed that the abundance of most cyanobacterial taxa was influenced by increasing concentrations of nitrates, ammonia, total phosphorus, dissolved oxygen, high conductivity, and pH. In contrast, only several taxa, including the most abundant *Leptolyngbya* sp. in the phytobenthos, were associated with increasing water depth, temperature and higher total nitrogen concentrations. These results and future monitoring programs will help to identify the most important factors influencing the development and control of cyanobacteria in floodplains.

Keywords: Kopački Rit, phytoplankton, phytobenthos, sediment, *Leptolyngbya*

Plant species of natural and semi-natural stagnant waters around Osijek as purification of municipal water, soil and air

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Abstract: Man has threatened the purity of water, soil and air through his actions; industrial and infrastructural activities. The reserves of drinking water are becoming less and less in the world, and although Croatia has enviable reserves of drinking water, it must be aware of the need to preserve it as much as possible. As recently as two hundred years ago, Osijek was surrounded by a large power plant called Palača, which began to be transformed into arable agricultural land through melioration. As a result, the forests and many plant communities disappeared, which even today within the system of natural waters of stagnant water make a natural cleaning of chemical and other pollution. In the paper, the plant species found at six locations of natural and semi-natural water areas in Osijek and its surroundings are listed and determined. Plant species are classified according to families and their function is determined within the purification criteria. A model of decorating smaller gardens with water surfaces and plants of natural stagnant waters that preserve plant and animal life that is disappearing due to intensive agriculture and urbanization is presented. Within green buildings, such a model provides the possibility of cleaning household municipal water and using purified water as technical water in the household or garden.
Keywords: plants, stagnant water, pollution, purification

Biljne vrste prirodnih i poluprirodnih voda stajaćica okolice Osijeka kao pročišćivaći komunalnih voda, tla i zraka

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Sažetak: Čovjek je svojim djelovanjem, industrijskim i infrastrukturnim aktivnostima ugrozio čistoću vode, tla i zraka. Rezerve pitke vode postaju u svijetu sve manje i iako Hrvatska ima zavidne rezerve pitke vode, mora biti svjesna potrebe što većeg njenog očuvanja. Osijek je još prije dvijesto godina bio okružen velikom močvarom zvanom Palača koja se je počela meliorativno pretvarati u obradivo poljoprivredno tlo. Time su nestale šume i mnoštvo biljnih zajednica koje i danas unutar sustava prirodnih voda stajaćica čine prirodne čistaće kemijskog i drugog zagađenja. U radu su popisane i determinirane biljne vrste pronađene na šest lokacija prirodnih i poluprirodnih vodenih površina u Osijeku i okolici. Biljne su vrste svrstane prema porodicama i određena im je funkcija unutar kriterija pročišćivaća. Prikazan je model uređenja manjih vrtova vodenim površinama i biljkama prirodnih voda stajaćica koje čuvaju biljni i životinjski svijet koji zbog intenzivne poljoprivrede i urbanizacije, nestaje. Unutar zelene gradnje, takav model pruža mogućnost čišćenja komunalnih voda iz domaćinstva i upotrebu pročišćene vode kao tehničke vode u domaćinstvu ili vrtu.

Ključne riječi: biljke, vode stajaćice, zagađenje, pročišćivaći

10th International Conference WATER FOR ALL
20-22 March 2024
Plitvice Lakes, Croatia

WATER AND GREEN TECHNOLOGIES
VODA I ZELENE TEHNOLOGIJE

Green Transition in Chemical Technology: Development and Implementation of Micro-Credentials

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Abstract: The pilot project titled "Green Transition in Chemical Technology" is part of "UL for a Sustainable Society – ULTRA," aimed at revamping higher education at University of Ljubljana for a green and resilient transition. It supports the European Green Deal's goals of climate neutrality, green economy, sustainable industry, and reduced pollution, fostering sustainable green technologies in the chemical sector. The project emphasizes a comprehensive approach, focusing on educating future talent, training technical staff in chemical industry, and informing decision-makers about green and digital transitions. The project plans three targeted workshops with associated micro-credentials for:

- Integrating green technologies in education – for high school teachers;
- Green transition in the chemical and related industries – for industry technical staff;
- Strategic approaches to green technologies – for project/industrial decision-makers.

An interdisciplinary team comprising experts in chemical engineering, chemistry didactics, computer science, digitalization, and law from the University of Ljubljana will conduct these micro-courses as practical-theoretical workshops to impart relevant knowledge and skills. These efforts aim to create a more adaptive and inclusive educational system, enhancing employee evaluation and advancement in Slovenia and beyond. The initiative is jointly funded by the Slovenian government and the EU's NextGenerationEU. For further details, visit the University of Ljubljana's website.

Keywords: green transition, green technologies, micro-credential, lifelong learning

Can green chemistry find solutions for water pollution?

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Abstract: Water pollution is one of the most important environmental problems in the modern age. Enormous industrial activity, population growth and unplanned urbanization have contributed to the serious deterioration of water quality. Industrial water, even natural, is often contaminated with toxic, or sometimes, carcinogenic impurities, causing ecological imbalance and serious human health disorders. Conventional water treatment processes that remove many chemical and microbial pollutants have been known for a long time and are important for public health and the environment. However, their effectiveness has become limited over the past two decades due to the expansion of the scope of the regulated pollutants, rapid population growth and industrial development. To overcome these challenges, green chemistry offers a range of solutions to address water pollution as a globally important environmental problem. Following the establishment of the 12 Principles of Green Chemistry by Anastas and Warner, the implementation of green chemistry principles eliminates or at least greatly reduces the water pollution problems. The green chemistry has an important role in the purification of water, ensure greater efficiency, low costs and minimizing waste generation. This green chemical alternative for water disinfection and removal of contaminants from polluted water such as electrocoagulation, enhanced coagulation, advanced oxidation processes, treatment with ferrate (Fe(VI)) ion, microchannel process technology, bioremediation, etc.
Keywords: green chemistry; wastewater treatment; eco-friendly methods

The influence of chemical modification on the adsorption capacity of bio-adsorbents in the removal of heavy metals from wastewaters

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Abstract: Rapid industrialization and urbanization have led to a significant release of heavy metal ions into the environment, which endangers the environment and human health. Removal of heavy metals from wastewater can be achieved by conventional methods such as ion exchange, chemical precipitation, electrochemical deposition, etc. Unfortunately, the mentioned processes have numerous disadvantages such as incomplete removal, high energy requirements and the creation of toxic sludge. An alternative method that can overcome all the mentioned problems is adsorption technology, especially the use of agricultural and industrial waste as favorable and effective adsorbents. The effectiveness of the adsorbent mainly depends on the physical and chemical properties of its surface. Surface modification can improve the adsorption capacity of bio-adsorbents, moreover, bio-adsorbents can create problems related to chemical and biological oxygen consumption, organic carbon and low adsorption capacity, if used untreated or in raw form. Among the surface modification processes, chemical surface modification is a frequently used method that helps transform low-cost material into high-value products with high adsorption capacity. This paper presents an overview of chemically modified bio-adsorbents used for the removal of heavy metals from wastewater, i.e. the influence of chemical surface modification on their adsorption capacity.
Keywords: adsorption, adsorption capacity, chemical modification, heavy metals, removal

Utjecaj kemijske modifikacije na adsorpcijski kapacitet bio-adsorbenasa u uklanjanju teških metala iz otpadnih voda

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Sažetak: Brza industrijalizacija i urbanizacija doveli su do značajnog ispuštanja iona teških metala u okoliš, čime je ugrožen okoliš i zdravlje ljudi. Uklanjanje teških metala iz otpadne vode može se postići konvencionalnim metodama kao što su ionska izmjena, kemijsko taloženje, elektrokemijska depozicija i dr. Nažalost, spomenuti procesi imaju brojne nedostatke kao što su nepotpuno uklanjanje, visoki energetski zahtjevi i stvaranje toksičnog mulja. Alternativna metoda kojom se mogu prevladati svi navedeni problemi je adsorpcijska tehnologija, posebice korištenje poljoprivrednog i industrijskog otpada, kao povoljnih i učinkovitih adsorbenasa. Djelotvornost adsorbensa uglavnom ovisi o fizikalnim i kemijskim svojstvima njegove površine. Modifikacija površine može poboljšati adsorpcijski kapacitet bio-adsorbensa, štoviše, bio-adsorbensi mogu stvoriti probleme povezane s kemijskom i biološkom potrošnjom kisika, organskim ugljikom i niskim adsorpcijskim kapacitetom, ako se koriste neobrađeni ili u sirovom obliku. Među procesima površinske modifikacije, kemijska modifikacija površine je često korištena metoda koja pomaže transformirati jeftini materijal u visoko vrijedne proizvode s visokim adsorpcijskim kapacitetom. U ovom radu dan je pregled kemijski modificiranih bioadsorbenasa koji se koriste za uklanjanje teških metala iz otpadnih voda, odnosno utjecaj kemijske modifikacije površine na njihov adsorpcijski kapacitet.

Ključne riječi: adsorpcija, adsorpcijski kapacitet, kemijska modifikacija, teški metali, uklanjanje

EUTOPIA Alliance of European Universities: Water as important topic addressed in learning community Global Connections Transdisciplinary Approach

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Abstract: The learning community was established within the EUTOPIA alliance of ten European universities. It offers a transdisciplinary approach to learning through an innovative and research-led discussion format that encourages students to participate actively. In the past years (2021-2024), we have already held two online events related to the environment with water-related topics. The rest of the projects were focused mainly on migrations resulting from local and global environmental issues (floods, draughts, lack of water, etc.). All projects were based on transdisciplinary topics, i.e. illuminating and connecting the social, political and environmental causes of migration on a global scale, whereby we connected different approaches and professions: social sciences, humanities, natural sciences and technology. The work is based on an interactive learning approach that resulted in the production of different artefacts as posters, films, interviews, social media, poetry, etc. by an international small group of students. Students are first encouraged to watch some prompts on topics of climate change and human mobility, restoration of abandoned industrial sites and Environmental Protection Agency (EPA) functioning related to current political issues. They use another four weeks to organize their group work, to select the topic of their common interest, explore it and present the final artefact to peers and the assessment board. This approach of the learning community assures transdisciplinary work and helps to develop competencies of the student in the area of international teamwork, sustainable development, circular economy and green transition.

Keywords: Eutopia alliance of European universities, learning community, transdisciplinarity

WATER MANAGEMENT
UPRAVLJANJE VODAMA

Integrating Green Technology for Water Protection Education: Empowering Students for a Sustainable Future

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Abstract: In the face of escalating environmental problems, the need for sustainable practices has become increasingly evident. The curriculum of the subject "Green Technology in Modern Society" aims to promote innovative educational approaches that emphasize the integration of environmental technologies for water protection. With a focus on promoting a deeper understanding of a green transition, water conservation, reuse, recycling, and water treatment, this educational model is designed to empower students to become stewards of the environment. Through this approach, students are not only taught theoretical knowledge, but are also engaged in hands-on experiences that promote active learning and problem-solving skills. By immersing students in practical applications of green technologies, such as water treatment systems and sustainable water management practices, educators aim to instill a sense of responsibility and action in protecting precious water resources. The work presented will address the pedagogical strategies used to teach students the importance of water protection and the social and environmental role of green technologies in achieving sustainability goals. Case studies and examples of successful implementation will be presented that illustrate the transformative impact of integrating green technology into the curriculum. Ultimately, this initiative aims to raise a generation of environmentally conscious experts who are able to address pressing water issues and make a meaningful contribution to global efforts towards a sustainable future.

Keywords: green technologies; water protection; water reuse and resources

Ice Jam Hydraulic Modeling Analysis on Lowland Rivers Such as the Danube

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Abstract: Ice floods (Ice Jam) are defined as a phenomenon in which icebergs carried by the current of the watercourse stop at critical sections such as sharp river bends (developed meanders), mouths of tributaries, sections where the fall of the river suddenly decreases, sudden narrowing of the surface of the water mirror, upstream of dams, upstream of bridges, or any obstacles in the river course. Because of the reduced flow rate of that section or the river profile, the water level rises upstream. This water level rise can cause overflow from the main riverbed. Similar to the open stream hydraulic model, in the case of the flow under ice model, the definition of Manning's roughness coefficient (n) is the basic problem. In the Ice Jam hydraulic model, friction against the upper ice surface cannot be ignored; therefore, the hydraulic radius becomes equal to h/2 under an ice cover due to the doubling of the wetted perimeter. This paper analyzes the ice jam occurrence in the winter of 2011/2012 on a 71-km-long section of the Danube River from Zemun to Slankamen. This paper provides suggestions for the hydraulic model calibration of a river with ice jam blockage.
Keywords: Ice Jam, Hydraulic Modeling, Manning's roughness coefficient

Water conflicts on the Gacka and Lika rivers and the role of public authorities and business associations in their management and resolution

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Abstract: Divergent views on the use of water resources have led to an intensification of socio-economic conflicts in the Lika-Senj County in recent years. This paper explores the dynamics of conflicts over water resources of the Gacka and Lika rivers – regarding the construction of reservoirs in Kosinj and the potential new water intake on the Gacka River – and analyzes the role of public authorities and business associations in regulating and resolving these conflicts. The Gacka and Lika river basins, along with their associated water and spatial resources, have become the subject of interest for various stakeholders – from electricity producers, water bottling companies, water supply and drainage, fish farming, tourism, fishing, to local communities, environmental organizations, and civil society. The goals of these stakeholders, partly or entirely conflicting, lead to conflicts that may escalate further if open issues and existing disputes are not addressed in a timely manner. Considering the complexity of economic, social, and environmental factors contributing to tensions related to water management, this paper provides insight into the character and dynamics of conflicts. Furthermore, the paper discusses potential ways in which public authorities at the national and county levels, as well as business associations, can contribute to the resolution of these conflicts and the harmonization of conflicting economic, social, and environmental interests.

Keywords: water conflict, Gacka, Lika, Kosinj, conflict management

Sukobi za vodu na području Gacke i Like i uloga tijela javne vlasti i poslovnih udruženja u njihovom upravljanju i razrješenju

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Sažetak: Suprotstavljeni stavovi po pitanju korištenja vodnih resursa izazvali su posljednjih godina porast društveno-gospodarskih sukoba na području Ličko-senjske županije. Ovaj rad istražuje dinamiku sukoba za vodne resurse rijeka Gacke i Like - oko izgradnje akumulacije u Kosinju i u vezi potencijalnog novog vodozahvata na rijeci Gacki, te analizira ulogu tijela javnih vlasti i poslovnih udruženja u regulaciji i rješavanju tih sukoba. Porječja rijeka Gacke i Like kao i pripadajući vodni i prostorni resursi postali su objekt interesa niza aktera - od proizvođača električne energije, punionica vode, vodoopskrbe i odvodnje, ribogojstva, turizma, ribolova, pa do lokalnih zajednica, ekoloških udruga i građanskog društva. Ciljevi pojedinih aktera, dijelom ili potpuno suprotstavljeni, dovode do sukoba koji mogu dalje eskalirati ukoliko se otvorena pitanja i postojeći prijepori pravovremeno ne adresiraju. Uzimajući u obzir složenost ekonomskih, socijalnih i ekoloških čimbenika koji doprinose napetostima vezanim uz vodu, ovaj rad daje uvid u karakter i dinamiku sukoba. Nadalje, u radu se razmatraju i potencijalni načini na koji tijela javne vlasti na nacionalnoj i županijskoj razini kao i poslovna udruženja mogu doprinijeti razrješenju ovih sukoba i usklađivanju suprotstavljenih gospodarskih, društvenih i ekoloških interesa.

Ključne riječi: sukobi za vodu, Gacka, Lika, Kosinj, upravljanje sukobima

Integrating water protection contents into the curriculum of Sustainable Resources and Raw Materials

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Abstract: This contribution outlines a comprehensive approach to embedding water protection themes into a broader educational framework. The curriculum aims to promote an environmentally conscious generation and connect students to fundamental concepts of sustainable resources management (i.e. resource classification, types of renewable resources). The course includes the influence of general, economic, and social changes in modern human societies on the nature and extent of resource use. This review is crucial for understanding the development of human society and its environmental impact. The syllabus also looks at the assessment of current global resource use and examines the factors driving changes in supply and demand. The impact of energy supply on the environment is examined through life cycle studies of technologies and processes, emphasizing the importance of sustainable practices to reduce environmental damage. The curriculum covers the fundamentals of end-use energy production processes, including conventional and renewable energy sources such as fossil fuels, wind, solar, hydroelectric, nuclear and geothermal with an emphasis on more efficient use of energy in the chemical industry. By participating water conservation into this comprehensive curriculum, students will be equipped with the knowledge and skills they need to contribute to a sustainable future, emphasizing the critical role of water conservation in achieving environmental sustainability and green transition.

Keywords: green transition, water protection, tutoring

Small-scale laboratory models in seepage and stability analyses of embankment dams

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Abstract: This study presents a methodology for the preparation and implementation of numerous tests on small-scale models of embankment dams in laboratory conditions using the *HM 169* experimental device for seepage analysis. The research aims to establish a methodology for creating small laboratory models and conducting experiments that simulate field conditions for installation and material preparation. It is primarily developed for educational purposes - civil engineering students, particularly in courses regarding geotechnical and hydrotechnical engineering. The models were both prepared and tested at the laboratory of the Faculty of Civil Engineering and Architecture in Osijek. The experiments were conducted on dam models of varying heights and slopes using two types of fill materials: quartz sand (1.2 – 2 mm) and sand from the Drava River. Prior to material installation, multiple Proctor tests were carried out to determine compaction properties. Moreover, permeability and strength parameter test of the used materials were planned as they are essential for numerical analyses. During material installation in the experimental device, attention was given to the moisture content, compaction method and layer thickness. Dimensions of the models, such as crest width and slopes were adopted according to recommendations for similar structures in practice. During the experiment, under imposed potential difference and steady flow conditions, the flow through the body of the models was measured. Furthermore, the conditions leading to the stability loss of the models were recorded. The obtained results serve as a base for calculations and numerical analyses, as well as for developing new variants of physical models.

Keywords: laboratory testing, embankment dams, methodology of preparation and test implementation

Primjena malih laboratorijskih modela u analizama procjeđivanja i stabilnosti nasutih objekata

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Sažetak U radu je prikazana metodologija pripreme i provedbe ispitivanja na malim modelima nasutih objekata u laboratorijskim uvjetima primjenom HM 169 eksperimentalnog uređaja za analizu procjeđivanja. Cilj istraživanja je ustanoviti metodologiju izrade malih laboratorijskih modela i provedbe eksperimenta kojima će se simulirati uvjeti pripreme i ugradnje materijala na terenu. Metodologija je razvijena prvenstveno za edukacijske svrhe, za studente građevinarstva posebice u nastavi na kolegijima iz područja geotehnike i hidrotehnike. Modeli su pripremani i ispitivani u laboratoriju Građevinskog i arhitektonskog fakulteta Osijek. Ispitivanja su provedena na modelima nasipa različitih visina i nagiba pokosa primjenom dva tipa nasipnih materijala: kvarcnom pijesku (1.2 – 2 mm) i riječnom (dravskom) pijesku. Prije ugradnje materijala provedena su ispitivanja nasipnih materijala pokusom Proctor za određivanje svojstava zbijanja. U sklopu istraživanja planirano je ispitivanje propusnosti i parametara čvrstoće korištenih materijala za potrebe numeričkih analiza. Prilikom ugradnje materijala u model pažnja je posvećena vlažnosti ugrađenog materijala, načinu zbijanja i debljini slojeva. Odnosi dimenzija modela (širina krune nasipa, nagibi pokosa) usvojeni su u skladu s preporukama za slične građevine u praksi. Prilikom provođenja eksperimenta, pri nametnutoj razlici potencijala i uspostavljenom strujanju, mjeren je protok kroz tijelo nasipa te su zabilježeni uvjeti pri kojima dolazi do pojave gubitka stabilnosti nasipa. Dobiveni rezultati koriste se kao podloga za proračune i numeričke analize, ali i razradu novih varijanti fizikalnih modela.

Ključne riječi: laboratorijsko ispitivanje, nasuti objekti, metodologija pripreme i ispitivanja

European pollutant release and transfer register in Croatia

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Abstract: Industry is a significant source of pollution in Europe due to its air pollutant emissions, wastewater discharges and waste generation. Information on industrial emissions is a valuable tool for monitoring the effectiveness of environmental protection policy and monitoring progress towards a circular, resource-efficient economy. In order to collect and make public available information on the impact of industry on environment, the European Union has adopted Regulation 166/06 on the establishment of the European Pollutant Release and Transfer Register (E-PRTR Regulation).In the Republic of Croatia, this Regulation was implemented for the first time in 2008 with the adoption of the Ordinance on the Environmental Pollution Register, which also prescribed the establishment of the Environmental Pollution Register database (EPR). The EPR contains information on pollutant released to land, air or water and the generation and management of waste in the Republic of Croatia. Information is available to public via EPR public browser and through the ENVI environmental atlas. Data collected for the purposes of reporting to the European Commission, in accordance with the requirements of the E-PRTR regulation, are publicly available through the European Industrial Emissions Portal. In the year 2022 there was 125 EPRTR facilities reported in Croatia. The EPR database is continuously adjusted to new reporting requirements in line with changes in EU policy.
Keywords: industrial pollution, EPR, E-PRTR, Industrial emissions portal

Europski registar ispuštanja i prijenosa onečišćujućih tvari u Hrvatskoj

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Sažetak: Industrijski procesi čine značajan izvor onečišćenja u Europi zbog svojih emisija onečišćujućih tvari u zrak, ispuštanja otpadnih voda te stvaranja otpada. Informacije o industrijskim emisijama predstavljaju važan alat za praćenje učinkovitosti politike zaštite okoliša te praćenje napretka prema kružnom, resursno učinkovitom gospodarstvu. U svrhu prikupljanja i objave informacija o utjecaju industrijskih postrojenja na sastavnice okoliša Europska unija donijela je 2006. godine Uredbu o uspostavi Europskog registra ispuštanja i prijenosa onečišćujućih tvari (E-PRTR uredba). U Republici Hrvatskoj je ova Uredba prvi puta implementirana 2008. godine donošenjem Pravilnika o registru onečišćavanja okoliša kojim je propisana i uspostava baze Registra onečišćavanja okoliša (ROO). ROO sadrži informacije o emisijama u zrak, ispuštanju onečišćujućih tvari u otpadnim vodama te o nastanku i gospodarenju otpadom u RH, a isti su javno dostupni putem javnog preglednika ROO te putem ENVI atlasa okoliša. Podaci prikupljeni za potrebe izvješćivana prema Europskoj Komisiji, sukladno zahtjevima E-PRTR uredbe, javno su dostupni i putem europskog Portala o industrijskim emisijama. U 2022. godini u ROO je evidentirano 125 E-PRTR obveznika. Baza ROO kontinuirano se usklađuje s novim zahtjevima za izvješćivanje sukladno izmjenama EU politika.

Ključne riječi: industrijska onečišćenja, ROO, E-PRTR, Portal o industrijskim emisijama

Water balance - the key to man's relationship with water

Siniša MARIČIĆ

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Abstract: The various forms and quantities of water have been noticed by man since time immemorial and began to be followed. From observing and exploiting the benefits of water and avoiding its dangers, man developed more and more powerful ways of "taming" natural water. Over time, his influence became more and more dominant. In understanding the natural state and planning targeted operations, creating a water balance was inevitable. The paper discusses the process of water balancing and its use. The water balance of individual organisms (plants, animals, humans) and complex systems such as water bodies (rivers, lakes, seas) includes the absorption and release of water. For example, the human body needs constant intake of water, and without it, death occurs within 5 days. Water management has a great responsibility to provide water as the basis of life, but also to implement protection against water hazards. In this human activity, balancing refers to the quantitative recording of the entire water cycle in order to establish water balance. In these efforts (spatial and temporal redistribution of water), reservoirs proved to be irreplaceable. However, the water cycle is changing, for which numerous examples can be cited, such as the occurrence of extreme precipitation and the melting of glaciers. The question arises: Will the scope of changes be kept within the limits of the manageable. Until now, and in the future, the key to man's relationship with water is in the analysis of the water balance. In addition to economic and social elements, general policy is also created from it. The paper describes the essence of the water balance and indicates its components. The importance of a good engineering design of the balance sheet is emphasized, i.e. determining the appropriate spatial and temporal limits of the balance sheet system and adopting its influential and credible components. The role of well-designed and properly conducted field measurements of balance components is emphasized. The paper provides illustrative examples of water balancing: climate balances (Walter's climate diagram) of some Slavonic regions, surface water balance of Kopački rit, surface soil balances of some agricultural crops, balance of deeper aquifers, balance of accumulation (lakes/ponds), global balance (Earth) and similar.

Keywords: water balance, water cycle, spatial and temporal redistribution of water, accumulation, measurement of balance components

Vodna bilanca - ključ odnosa čovjeka prema vodi

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Sažetak: Različite pojavne oblike i količine vode čovjek je od iskona zamijetio i počeo pratiti. Od promatranja i iskorištavanja dobrobiti vode te izbjegavanja opasnosti od nje, čovjek je razvijao sve moćnije načine „kroćenja" prirodne vode. Vremenom je njegov utjecaj postajao sve dominantniji. U spoznavanju prirodnog stanja te planiranju ciljanih zahvata nezaobilazno je bilo poimanje tzv. vodne bilance. U radu se raspravlja o postupku bilaciranja vode i njegovoj upotrebi. Ravnoteža vode pojedinih organizama (biljaka, životinja, ljudi) i složenih sustava kao što su vodena tijela (rijeke, jezera, mora) obuhvaća apsorpciju i otpuštanje vode. Primjerice, za ljudsko tijelo neophodan je stalni unos vode te bez njega u roku 5 dana nastupa odumiranje. Vodno gospodarstvo ima veliku odgovornost da osigura vodu kao temelj života, ali i da provodi zaštitu od opasnosti vode. U ovoj ljudskoj djelatnosti bilanciranje se odnosi na kvantitativno bilježenje cjelokupnog ciklusa vode u cilju uspostave ravnoteže vode. U tim naporima (prostorne i vremenske preraspodjele vode) kao nezamjenljive su se pokazale akumulacije. No, ciklus vode se mijenja, za što se može navesti brojne primjere, kao što su pojave ekstremnih oborina i otapanje ledenjaka. Nameće se pitanje: Hoće li se opseg promjena zadržati u granicama upravljivog. Dosad, ali i ubuduće, ključ čovjekovog odnosa prema vodi je u analizi vodne bilance. Uz ekonomske i društvene elemente, iz nje se kreira i opća politika. U radu se opisuje suština vodne bilance te se ukazuje na njene komponente. Ističe se važnost dobrog inženjerskog koncipiranja bilance, tj. određivanja primjerenih prostornih i vremenskih granica bilancnog sustava te usvajanja njenih utjecajnih i vjerodostojnih komponenti. Naglašava se uloga dobro osmišljenih i pravilno provedenih terenskih mjerenja komponenti bilance. U radu se navode ilustrativni primjeri vodnog bilanciranja: klimatske bilance (Walterov klima dijagram) nekih slavonskih regija, površinska bilanca voda Kopačkog rita, bilance površinskog tla nekih poljoprivrednih usjeva, bilanca dubljih vodonosnika, bilanca akumulacije (jezera/bare), globalna bilanca (Zemlje) i sl.

Ključne riječi: vodna bilanca, vodni ciklus, prostorna i vremenska preraspodjela vode, akumulacije, mjerenje komponenti bilance

High diversity of waters, communities and stressors – design of the fish index for ecological state estimation in the European ichthyological 'hot spot'

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Abstract: Determination of the ecological state of any water body is crucial for its adequate protection and is, moreover, requested by the Water Framework Directive. Employment of multimetric indices, that integrate various anthropogenic threats to water systems with answers of different aspects of fish communities, upgraded describing and monitoring ecological state of freshwater systems. Nevertheless, design of multimetric indices that describe the ecological state of water bodies based on fish have already turned out to be difficult for the Mediterranean region due to often presence of species-poor and ecologically tolerant fish fauna, high endemicity and serious lack of localities with undisturbed fish communities. The developmental procedure of the ecological state indices for natural water bodies in Croatia based on fish as a biological element was hindered by similar obstacles, particularly by exceptionally high endemicity present in rivers of the Adriatic watershed, a great number of distinct water types and significant anthropogenic pressures. Nevertheless, based on the comprehensive sampling of fish communities throughout Croatia and following the appropriate statistical procedure, we were able to identify stressors acting on different types of freshwater systems, as well as answers of fish communities to them, and, finally, describe the ecological state of natural water bodies throughout Croatia and propose measures that will most likely help in achieving improvement and/or maintenance of their ecological states.
Keywords: Croatia; ecological state, fish communities, multimetric index, threats

Thinking about water protection from the beginning to the end of apple juice production

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Abstract: The topic of the paper is how the entire path from growing apples to the packaging of apple juice is good for the environment, with an emphasis on water protection. Organic cultivation of apple trees, including the fruit, has significant advantages over conventional cultivation. It promotes the realization of biological diversity and increases the standard of living with the limited use of chemical agents. Chemical agents affect the soil and water, and thus the flora and fauna. Organic farming achieves high yields and quality and reduces the impact on the mentioned components of the environment. By raising awareness and responsibility towards the environment, in addition to organic farming, the packaging in which the product is packaged also becomes important. Adequate and suitable choices of packaging material as well as the possibility of their recycling are highlighted in the paper. The entire path from the cultivation of organic apples to the production of healthy juice packed in recyclable packaging is a complex engineering system. In order to refine the goals and understand the most important features of the system, as well as to identify key variables and factors, four conceptual models were developed: an activity cycle diagram, a causal loop diagram, a cause-effect diagram, and a Petri net. These conceptual models provide an image that describes the real world, that is, object systems, and are the basis for creating computer models.
Keywords: ecological cultivation, water protection, production of healthy juice, recyclable packaging, conceptual models

Misleći na zaštitu vode od početka do kraja proizvodnje soka od jabuke

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Sažetak: Tema rada je kako cijeli put od uzgoja jabuka do ambalaže soka od jabuke bude dobar za okoliš s naglaskom na zaštitu voda. Ekološki uzgoj stabala jabuka, pa tako i ploda ima znatne prednosti pred konvencionalnim uzgojem. Njime se potiče ostvarenje biološke raznolikosti i povećava standard života uz ograničenu upotrebu kemijskih sredstava. Kemijska sredstava utječu na tlo i vode, a time i na biljni i životinjski svijet. Ekološkim uzgojem ostvaruju se visoki prinosi, velike kvalitete te se smanjuje utjecaj na navedene sastavnice okoliša. Podizanjem svijesti i odgovornosti prema okolišu, osim ekološkog uzgoja, postaje važna i ambalaža u koju se proizvod pakira. U radu su istaknuti adekvatni i pogodni izbori ambalažnog materijala kao i mogućnost njihova recikliranja. Cijelokupni put od uzgoja ekoloških jabuka, proizvodnje zdravog soka pakiranog u reciklabilnu ambalažu čini složen inženjerski sustav. Radi oplemenjivanja ciljeva i razumjevanja najvažnijih značajki sustava, kao i za identifikaciju ključnih varijabli i čimbenika razvijena su četiri konceptualna modela: dijagram ciklusa aktivnosti, dijagram uzročnih petlji, uzrok - posljedica dijagram te petrijeve mreže. Ovi konceptualni modeli daju sliku kojom je opisan stvarni svijet, odnosno objektni sustava, a osnova su za izradu računalnih modela.
Ključne riječi: ekološki uzgoj, zaštita vode, proizvodnja zdravog soka, reciklabilna ambalaža, konceptualni modeli

Sava river streamflow reconstruction based on TRW chronologies of narrow-leaved ash (*Fraxinus angustifolia* Vahl)

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Abstract: Current high water wave protection systems are based on statistical models and assessments of the risk of occurrence over a given time period, though with very short measurement periods, usually following catastrophic events. Ongoing monitoring of basic hydrological data (streamflow and river water levels) and climate data are the basis for sustainable water management and long-term flood control planning. Measurement of hydrological parameters of large rivers are primarily limited to short time periods of not more than 50 years, particularly in southeast Europe. The lack of data has proven to be particularly negative during this period of global climate change, when non-seasonal flooding (during summer) is becoming increasingly frequent, and the resulting damages greater. The aim of this study was to analyse the possible use of tree ring width chronologies of trees growing in floodplain areas to reconstruct streamflow of Sava river. The results indicated the significant potential of narrow-leaved ash (*Fraxinus angustifolia* Vahl) to reconstruct the summer streamflow (R2=0.45). These results can serve to develop long-term data series on the summer flow rates of the river, thereby enabling better insight into the spatial and temporal dynamics of the river, with the goal of more successful sustainable management of floodplain areas.

Keywords: dendrochronology, narrow-leaved ash, river Sava, streamflow reconstruction

Rekonstrukcija protoka rijeke Save pomoću kronologije prirasta poljskog jasena (*Fraxinus angustifolia* Vahl)

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Sažetak: Trenutni sustavi obrane od visokih vodnih valova temeljeni su na statističkim modelima i procjenama rizika pojave istih u određenom vremenskom razdoblju, a napravljeni su na osnovu vrlo kratkih mjerenja uglavnom nakon katastrofalnih događaja. Kontinuirano praćenje osnovnih hidroloških čimbenika (protoka i vodostaja rijeka) uz klimatološka motrenja temelj su održivog vodnog gospodarenja i dugoročnog planiranja obrana od poplava. Mjerenja hidroloških parametara velikih rijeka uglavnom su ograničena na kratka razdoblja, ne dulje od 50 godina, naročito u jugoistočnoj Europi. Nedostatak takvih podataka se pokazao naročito negativan u vremenu globalnih promjena klime kada su pojave izvan sezonskih (ljetnih) poplava učestalije, a štete sve veće. Cilj ovoga istraživanja bio je analizirati mogućnost uporabe kronologija širina godova stabala koja rastu u poplavnim područjima za rekonstrukciju protoka rijeke Save. Rezultati istraživanja ukazuju na značajan potencijal poljskog jasena (*Fraxinus angustifolia* Vahl) u rekonstrukciji ljetnog protoka rijeke Save (R^2=0.45). Dobiveni rezultati mogu poslužiti za razvoj dugoročnih podataka o ljetnim protocima rijeke te tako omogućiti bolji uvid u prostorno-vremensku dinamiku rijeka radi uspješnijeg održivog upravljanja poplavnim područjima.
Ključne riječi: dendrokronologija, poljski jasen, rijeka Sava, rekonstrukcija protoka

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AIRsight | Infrared/Raman microscope Two-in-one solution for microplastic analysis

Danijela IVANDIĆ, Mirela ŽUPAN, Mirna MARKUSI TOMLJANOVIĆ

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Abstract: Microplastic pollution of rivers and oceans is spreading globally, and there are concerns about its impact on living organisms. In recent years, much research has been conducted to gain scientific knowledge about the distribution of microplastics in many countries worldwide. When exposed to UV light, rain, wind, and physical friction that makes it brittle, the plastic released into the environment breaks up into even smaller microplastics. The AIRsight Infrared/Raman microscope is a new type of microscope that incorporates a Raman unit into an infrared microscope, enabling both Raman and infrared analysis to be performed on a single instrument, analyses that previously required separate instruments. Using AIRsight, measurements of microplastics below 5 µm are possible without spectrum interpretation error.
Keywords: Shimadzu AIRsight, IR and Raman spectroscopy, microplastics

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AIRsight | Infracrveni/Ramanov mikroskop
Dva u jedan rješenje za analizu mikroplastike

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Sažetak: Onečišćenje rijeka i oceana mikroplastikom širi se globalno, a postoji i zabrinutost zbog njegovog utjecaja na žive organizme. Posljednjih godina provode se brojna istraživanja kako bi se stekla znanstvena saznanja o distribuciji mikroplastike u mnogim zemljama diljem svijeta. Pri izlaganju UV svjetlu, kiši, vjetru i fizičkom trenju koje ju čine krhkom, plastika ispuštena u okoliš raspada se na još manju mikroplastiku. Kako je veličina mikroplastike koju treba identificirati iz godine u godinu sve manja, odabir adekvatnih analitičkih instrumenata od iznimne je važnosti. AIRsight mikroskop nova je vrsta mikroskopa koji uključuje Raman jedinicu s infracrvenim mikroskopom, omogućavajući provođenje Raman i infracrvene analize na jednom instrumentu, analize koje su prethodno zahtijevale odvojene instrumente. Koristeći AIRsight moguća su mjerenja mikroplastike ispod 5 µm bez pogreške interpretacije spektra.
Ključne riječi: Shimadzu AIRsight, IR i Raman spektroskopija, mikroplastika

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eDNA Applications in Water Quality Monitoring

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Abstract: Nowadays, directives such as the Water Framework Directive seek to safeguard water quality through regular water monitoring and restoration initiatives. Biological assessment is one of the integral elements in determining the ecological status of the water bodies. It evaluates communities (*e.g.* plants, animals, phytoplankton, diatoms), known as Biological Quality Elements (BQEs), by assessing elements such as taxonomic composition, abundance, and biomass. Considering the number of water bodies subject to monitoring, conventional methods of biological assessment have shown to be time-consuming, expensive, and limited by the lack of taxonomical expertise. This highlights the need for more efficient and scalable approaches as offered by environmental DNA (eDNA) techniques. Analysis of DNA present in the water, through qPCR/ddPCR methods (species-specific approach) or metabarcoding techniques (multi-species approach), enables a rapid and effective way of identifying present organisms. Labena d.o.o. has established a state-of-the-art molecular laboratory (eDNA Labs), dedicated to eDNA analysis. Through participation in various European projects and service provisions, protocols were established and successfully implemented for the detection of invasive species (signal crayfish, blue crab) and pathogens (crayfish plague), rare and endemic species (stone crayfish, European eel, angel shark), as well as for estimation of biodiversity (detection of fish, diatom, and phytoplankton communities).
Keywords: environmental DNA, water quality, metabarcoding, ddPCR, eDNA laboratory

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Debris flow protection with flexible ring net barriers – 20 years of experience

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Abstract: Flexible ring net barriers against debris flow have been installed worldwide during the last 20 years mainly for the purpose of debris retention and a few as erosion control. An increasing number of client projects (50 barriers within Switzerland, more than 150 worldwide by 2023) shows the interest in this solution. This article highlights different special applications such as one single barrier providing a very large retention capacity, an example of several barriers in line and filled up barriers for erosion control. Advantages and challenges for the use of flexible ring net barriers are discussed on a technical and economic level and needs for maintenance and replacement works are addressed.
Keywords: Debris flow, flexible ring net barriers, experience, maintenance

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AGROPROTEINKA

IZVOR - ING d.o.o.
za građenje, nadzor i projektiranje
J. J. STROSSMAYERA 5
VALPOVO
tel/fax: 031333538

LABORATORIJ
ZA GEOKEMIJU OKOLIŠA
SVEUČILIŠTE U ZAGREBU
GEOTEHNIČKI FAKULTET

meal PASS

10TH INTERNATIONAL CONFERENCE

WATER FOR ALL

20 - 22 MARCH 2024
HOTEL JEZERO
PLITVICE LAKES NATIONAL PARK
CROATIA

ORGANIZERS I ORGANIZATORI