

DEMO, CRATIA

DEMOCRATIA - AQUA - TECHNICA -
CONFERENCE

2022

Innovative technical solution concepts for sustainable water resources management to promote the reduction of regional and local distribution conflicts.

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FOREWORD

PROF. DR. ULRIKE GAYH



Ulrike Gayh is Professor for Environmental and Process engineering and is the Dean of the Master´s program in Water Technology (M.Eng.) at the School of Engineering and Architecture of the SRH University Heidelberg. She conducts international research activities in the field of water technology solutions for the prevention and reduction of local and regional water conflicts. Together with colleagues from the Serbian partner university, the University of Novi Sad, she established the Democratia-Aqua-Technica initiative which deals with the question of innovative technical concepts for sustainable water resource management. She has further research interests in the fields of biogas, wastewater management and water protection. The focus being mainly alternative sanitation systems as well and the removal of micropollutants using alternative adsorbents.

The idea of the initiative Democratia-Aqua-Technica is about transforming local and regional water conflicts into pathways to peace and democracy, incorporating innovative science and technology approaches.

digitalization in the German water sector. During the young scientist research week at the University of Novi Sad, water samples were taken and analyzed in the laboratories. Furthermore, field visits, e.g. to the water works, were carried out.

The DAAD programme „Hochschuldialog mit den Ländern des westlichen Balkans“ funded the project “Democratia – Aqua – Technica III: focus on water conflicts related to water pollution” in 2022.

After two years of changing the project into a digital format, it was great that we had been able to carry it out as it was planned. This E-book provides an overview about the different projects and the different contributions to our annual Democratia-Aqua-Technica conference. Thanks to all participants and partners who made the projects and conference that exciting to everybody.

Four events were planned in 2022 under the umbrella of the Democratia – Aqua –Technica network, which intensified the technical and methodological exchange between the partner universities. The joint project work on socio-political issues also offered an ideal framework for intercultural dialogue at eye level, which in particular provided an exchange of personal experience with civil society engagement.

In 2023 we will continue focusing on agricultural water conflicts. The next Democratia-Aqua-Technica conference will be held in September 2024.

During the study visit in Germany, a group of Master’s students, PhD-students and professors visited from the University of Novi Sad and SRH University Heidelberg visited together the World’s leading trade fair for environmental technologies, the IFAT in Munich. Next to company visits, a focus had been on

Prof. Dr. Ulrike Gayh
Prof. Dr. Maja Turk Seculic

PROF. DR. MAJA TURK-SEKULIĆ

Maja Turk-Sekulić is a Professor of Environmental Engineering at the Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad. She is a Chair of Master’s academic studies program Water Treatment and Safety Engineering, and Vice President of the Serbian Chemical Society (Section for Environmental Chemistry). Her main activities and responsibilities are teaching, research and leadership in national and international scientific projects. Her main areas of specialization are green technologies for wastewater treatment, wastewater management, monitoring and low-cost decontamination and remediation; The partitioning, dispersal and retention of organic pollutants in Biotic and Abiotic Systems; Analysis, environmental processes, and the fate of POPs in the environment, biotic and abiotic transformations. Other fields of specialization are air pollution, gas/particle partitioning, and the partitioning of polychlorinated biphenyls.





SRH HOCHSCHULE HEIDELBERG

The SRH University Heidelberg was founded in 1969, and it is one of the oldest and largest private universities nationwide. It sets standards in the field of education, and at six schools, 42 study programs are offered. A highly important part of this process is the close cooperation between students and tutors. The concept for success: offering new, practical courses of study, individual support and a fast track to the labour market. For the students, this means the best chance of an optimal start in professional life – with a tight network of connections to enterprises and educational institutions worldwide. Cooperation with business enterprises or integration in research projects and colloquia enable the students to make use of the knowledge and skills they have acquired. 92% of the students graduate successfully.

The “CORE-Principle” – Competence-Oriented Research and Education – places the acquisition of occupational competence at the center of the studies. This approach goes far beyond the delivery of theoretical knowledge. The term occupational competence denotes all the skills that enable the students to act independently and successfully in the labour market. Occupational competence can be attained at many levels by acquiring professional competence, methodological competence, self-competence and social competence. Instead of having to deal with numerous subjects at the same time, the students can focus entirely on a maximum of two subjects within one 5-week period. To ensure that students remember what they are learning, the university takes a practical approach to teaching, using case studies, seminars, team projects, role plays and presentations. From the profusion of examination methods available, the method that best fits the skills taught in a particular module is chosen. Scheduling a great number of exams within a short period of time is now a thing of the past, thanks to the new program. The

graduates are capable of proving themselves in a real business environment after their studies. In their roles as mentors and coaches, the teaching staff assist the students in every way possible, be it subject-specific content, study organization or in personal matters.

The School of Engineering and Architecture offers an excellent education that is subject-specific: ready for take-off in working life, with a unique mix of theoretical basics, field trips and internships. Today, being an engineer not only involves planning, designing and optimizing, but it is also about developing design and technical solutions by taking the ecological, social and economic factors into account and staying competitive in the global market. Great importance is placed on the issues of energy efficiency and sustainability, so that future challenges can be met successfully and responsibly.



UNIVERSITY OF NOVI SAD

Faculty of Technical Sciences

With over 1,200 staff and more than 14,000 students currently attending all levels of academic studies, the Faculty of Technical Sciences (FTN) is the largest single faculty of the University of Novi Sad and Serbia, educating over 2,000 postgraduate and nearly 1,000 PhD students at the moment. Founded in 1974, FTN traces its roots back to the establishment of the Faculty of Mechanical Engineering in 1960. Today, the Faculty is comprised of 13 departments conducting research in virtually all areas of engineering.

In addition, FTN encompasses many centers designed to focus intradepartmental efforts, including the Industry/University Collaborative Research Center for Advanced Knowledge Enablement (KOI), established in 2016 as a collaborative effort with the Florida Atlantic University, USA. The main objective of KOI is promotion, support and organization of joint research projects between the industry and FTN researchers.

A regional leader in technology transfer, over the last two decades FTN has spun off over 100 companies, mostly in the domain of ICT, with a turnover of 100 million euros, making this the most important industry locally. To illustrate the dynamics, 40 of these companies were created between 2005 and 2010, employed 850 engineers and were generating 18 million euros already in 2007. Today the spin-offs of FTN employ about 4,000 IT engineers in the region. The two largest ones (Schneider Electric and RT-RK) account for 1,700 of these.

When it comes to research activities of FTN, they are primarily oriented towards the research projects which are directly or indirectly aimed at practical application in industry, supporting innovation and technology development. So far, FTN has successfully completed around 200 projects supported by

the Serbian and Provincial Ministry of Science and Technology and more than 150 international projects realized within different frameworks: FP6, FP7, H2020, EUREKA, COST, IPA, TEMPUS, ERASMUS+ and CEEPUS.

In order to keep up with the high level of performance, the Faculty has co-invested in the development of the Novi Sad Science-Technological (ST) Park, which opened its doors in January 2020, adding 10,000m² of laboratory and office space to its facilities.

The University of Novi Sad, with around 50,000 students and 5,000 employees, is one of the largest educational and research centers in Central Europe. It belongs to the group of comprehensive universities which are characterized by providing training in nearly all fields of science and higher education.

THE PROJECT



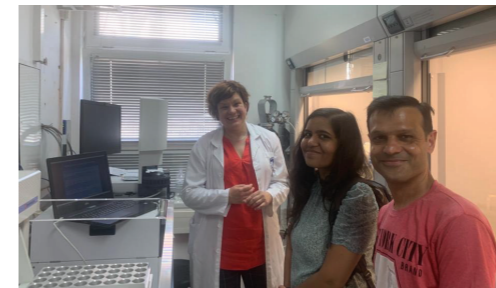
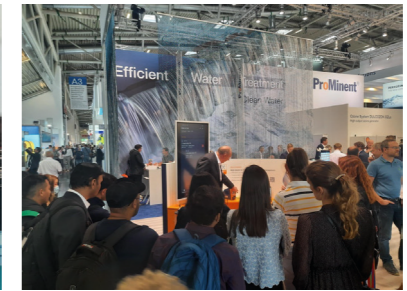
Initiative Democratia-Aqua-Technica

PROJECT IDEA

Innovative technical solution concepts for sustainable water resource management to promote the reduction of regional and local distribution conflicts



Visit of the IFAT



Practical in Novi Sad



Find out more on the website!
www.democratia-aqua.org



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[@democratiaaqua4457](https://www.youtube.com/@democratiaaqua4457)



Instagram
[@hshd_water_technology](https://www.instagram.com/hshd_water_technology)



PROGRAM

DAY 01 – SEPTEMBER 29TH, 2022

09:30 - 09:45 A.M.	Welcome from Prof. Dr. Carsten Diener Prof. Dr. Carsten Diener (Rector SRH University Heidelberg, Germany)
09:45 - 10:00 A.M.	Welcome from project leaders Democratia-Aqua-Technica Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany), Prof. Dr. Maja Turk-Sekulić (University of Novi Sad, Serbia)
10:00 - 10:30 A.M.	Effectiveness of integrated microalgae-nitrifiers process over conventional microalgae-based processes (Piggery wastewater treatment). Gala Stojanovic (University of Novi Sad, Serbia)
10:30 - 11:00 A.M.	Physical and Chemical comparative analysis of two river streams in Germany Ashutosh Bhalariao (SRH University Heidelberg, Germany)
11:00 - 11:30 A.M.	Nature Based Solutions challenge: Multifunctional application of biochar beyond carbon storage Prof. Dr. Maja Turk-Sekulić (University of Novi Sad, Serbia)
11:30 - 12:00 P.M.	Poster presentations / Poster pitches
12:30 - 01:30 P.M.	Lunchbreak / Digital Get-Together in Spatial Chat
01:30 - 02:00 P.M.	Nutrients recovery from biogas plant effluents: an industrial symbiosis model Mehmet Yağcı (Middle East Technical University, Turkey)
02:00 - 02:30 P.M.	Overcoming the shortcomings of traditional computer-based techniques by application of machine learning models Sanja Radovic (University of Novi Sad, Serbia)
02:30 - 03:00 P.M.	Implementation of machine learning in designing and operation of a municipal wastewater treatment plant. Nikesh Zachariah, Dr. Enis Yazici (SRH University Heidelberg, Germany)
03:00 - 03:30 P.M.	Assessment of PM2.5 exposure and health risk in Novi Sad, Serbia Prof. Dr. Jelena Radonić, Sonja Dmitrašinić (University of Novi Sad, Serbia)
03:30 - 04:00 P.M.	YIP – Your Ideas to Practices Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany), Livier der Regil (UNIVA, Mexico) + students YIP-project
04:00 - 06:00 P.M.	Digital city rally Heidelberg – water and architectural highlights of the city

DAY 02 – SEPTEMBER 30TH, 2022

09:30 - 10:00 A.M.	Welcome Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany), Prof. Dr. Maja Turk-Sekulić (University of Novi Sad, Serbia)
10:00 - 10:30 A.M.	Art in situation of conflicts as an approach for social communication, three study cases Dr. Fernando Palacios Mateos (Polytechnic University of Valencia, Spain/SRH University Heidelberg, Germany)
10:30 - 11:00 A.M.	Understanding Global Conflict Through Water Resource Depletion Luke Hally (Heidelberg Institute for International Conflict Research, Germany)
11:00 - 11:30 A.M.	Occupational exposure and cancer risk assessment in an anatomy laboratory Dragan Adamović (University of Novi Sad, Serbia)
11:30 - 12:00 P.M.	Poster presentations
12:30 - 01:30 P.M.	Lunchbreak / Digital Get-Together in Spatial Chat
01:30 - 02:00 P.M.	Holistic Approaches to Solve Conflicts About Water – Results from Workshops 2022 Prof. Dr. Ulrike Gayh, Prof. Dr. Andreas Gerber, Belen Zevallos (SRH University Heidelberg, Germany)
02:00 - 02:20 P.M.	Democratizing water resources monitoring: the role of the open-source movement and digital fabrication Prof. Dr. Arnoud Cuppens (Tierrascan, Paraguay)
02:30 - 03:00 P.M.	Baseline studies of a deforested land for reclamation (physicochemical) Meinster Eduafo (University of Accra Ghana/SRH University Heidelberg)
03:00 - 03:30 P.M.	Harnessing the potential of the Bagre Dam spillage for the socioeconomic development of Northern Ghana (Ghana Water Company Limited, Ghana)
03:30 - 04:00 P.M.	Closure and Outlook Democratia-Aqua-Technica Initiative Prof. Dr. Maja Turk-Sekulić (University of Novi Sad, Serbia) / Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany)

ART FOR CONFLICTS. MIGRATION AND SOUND PRACTICES, THREE STUDY CASES

Dr. Fernando Palacios Mateos
SRH Hochschule Heidelberg – School for Engineering and Architecture

BACKGROUND

European cultural contexts nowadays are established as landscapes of diversity. Based on Migrant, definition: <https://www.iom.int/node/102743> many people in migration situation move below the radar of regulatory institutions or navigate in semi-legal frameworks with a continuous repurposing of their expectations, objectives and their mobility. In this context, sound practices –understood as the set of practices

and actions that, whether premeditated or not, use, involve or derive on sounds– creates purposeful and peaceful ways of interaction between different cultural groups, producing an acoustic environment and territory; a dialogue in the rethinking process of the collective, related to the individual.

THREE STUDY CASES

01 *Breath*, Audiovisual Installation. An interactive work that invites you to participate in it with your own breath. An approach to music in a social perspective, connecting people from different genders, generations and cultures that didn't know each other before. Here, a communication path without words is created, where breath is the guideline for the improvised music. It search's what unifies us, not what divides us. The installation was done at EShID 2021, UPV (Estéticas híbridas de la imagen en movimiento)



Fig. 1: The recording session



Fig. 2: The installation



Fig. 3: The installation

02 *The give*. On Moving Stories exhibition. Developed at the EMIDEKS group (Emotional Interaction Design for Knowledge Sharing –Roskilde University, Denmark–), A Cross-disciplinary collaboration (design, computer science, musicology, museology and anthropology as well as research participants from a variety of backgrounds).

The *give* works with the trajectories of three migrants with different origins (Argentina, Hungary and India) who are currently living in Denmark. The *give* means the act to give, and appeals to what migrants, or “people on the move”, contribute to the host societies. It visualizes the deep and personal values that these peoples bring to new communities. Based on the participants’ own reading of their narrative, the research involves a three step process: First a

video-recorded interview with the migrant where the emotional journey is narrated. Then, this video is edited and, key situations or moments, where emotions arose, are highlighted. In a second video-recorded interview, the migrants observe and hear the first edited interview, to which they respond in different creative ways: improvising music with their instruments or voice, writing a poem, or drawing related to their personal trajectories. The final outcome interrelates shootings from the first and second interviews.

The narratives are divided in different sections (for each one of them), accordingly to distinctive moments that arose during the interviews and are spread out all across the exhibition area. The locations of these fragments can be found with the help of a printed map.

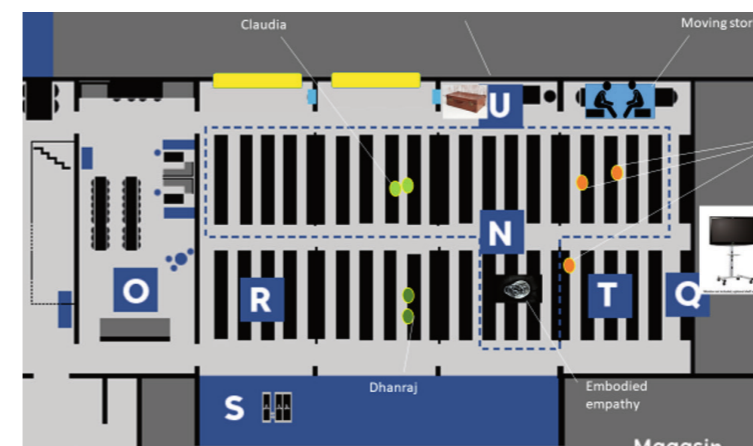


Fig. 4: The map for the installation

Dialogues, Approaches for social interaction. Developed at ISEK (Institut für Sozialanthropologie und Empirische Kulturwissenschaft, Universität Zürich, Switzerland).

An Interactive audio-visual installation that works with the relationship between the semantic content of a spoken message and its prosody. Fourteen participants, all with different mother tongues, living in the city of Zürich tells the sentence "The essential is invisible to the eyes" (from *The Little Prince* book). An original sound file matches any of the languages. The installation was made at Platzpromenade in Zürich.



Fig. 5: Menu for the media material

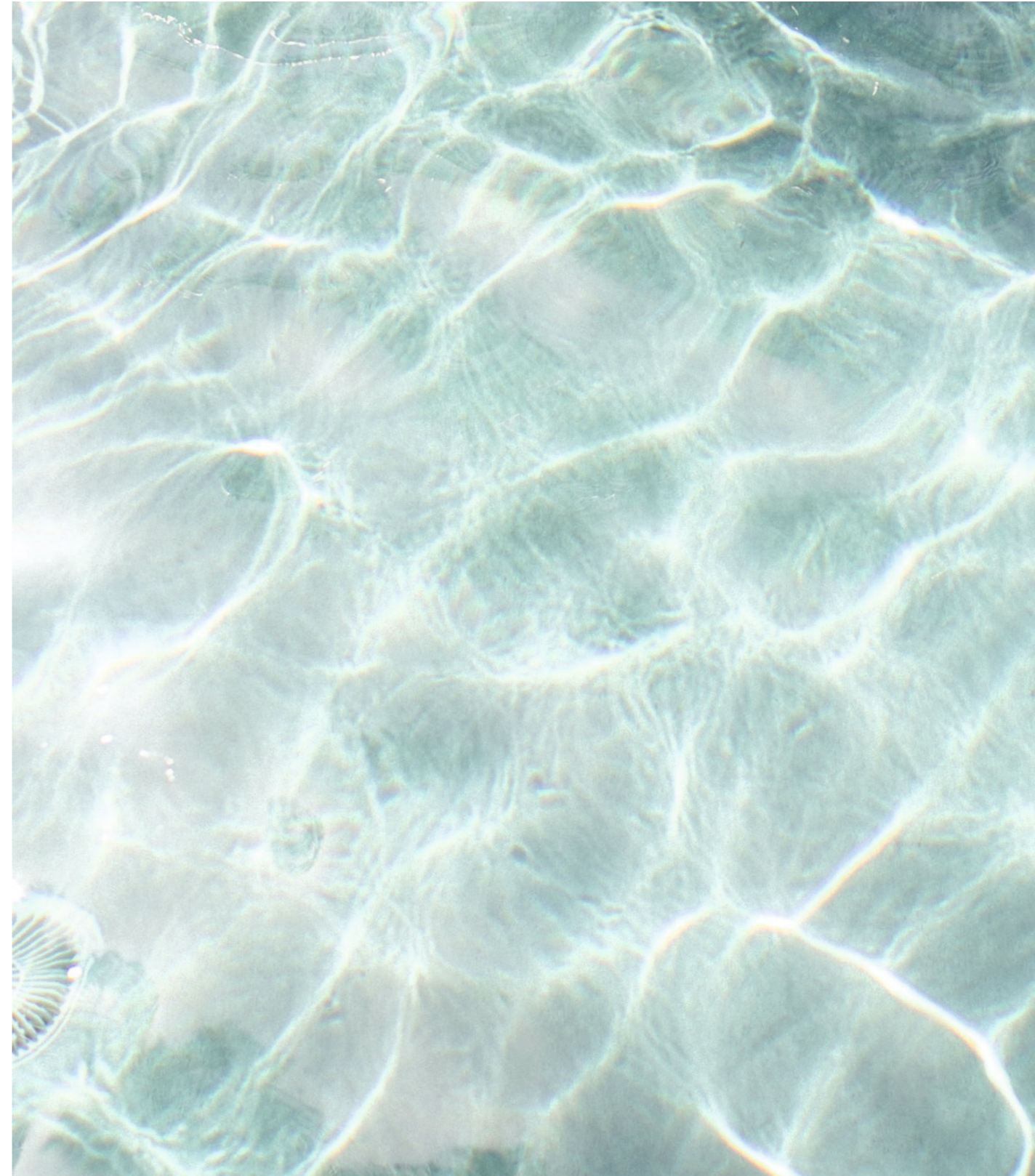


Fig. 6: Installation in Zürich

FINAL CONSIDERATIONS ON ART AND COMMUNICATION

Sound practices (Arts) are rich full epistemological domains.

Arts based project can create processes of mutual recognition among members of European Union nowadays cultural contexts, towards an egalitarian society



UNDERSTANDING GLOBAL CONFLICT THROUGH WATER RESOURCE DEPLETION

Luke Hally
Heidelberg Institute for International Conflict Research

SUMMARY OF PRESENTATION

The presentation focused on understanding global conflict through water resource depletion, specifically focusing on the Libyan conflict from 2011– Present.

The research provides an overview of the climate crisis background of water resource deprivation and depletion, drawing from several databases and report files, such as the UN–Water Report 2021 and World Meteorological Organization Database.

An overview of drought figures was also provided to give broader context to the severity of the contributory factors of water deprivation in global conflict. These data points were provided through sourcing from the Copernicus Climate Change Service and European Drought Observatory, with the latest figures pertaining to European drought and water resource impacts of 2022.

The presentation's core focus was on the Libyan conflict and all relevant impacts the role of water deprivation had on escalating the overall conflict situation and destabilization of national security.

Specifically, the infrastructure works of the Great Manmade River Project were covered in their essential role as a national stabilizer and growth mechanism for sustaining the growing population of Libya within an intensely arid national territory.

This infrastructure project was covered in terms of its historical background, construction and the vital role it plays as the primary supplier of Libyan freshwater resources delivered to the major urban coastal hub cities.

The next contextual background presented was the overall Libyan conflict beginning in 2011 and continuing to the present day. These two background presentations were then overlaid and intertwined in their relevancy as an interlinked relationship in the escalation of the conflict.

The research presented outlined the correlative relationship between the destruction of the GMMR project, the deprivation of water supplies and the deterioration of the security situation within the Libyan national territory. It specifically outlined territorial fault lines of each vying factional control along the aquifer pumping stations and piped infrastructure between the western Government of National Accord territory and eastern Libyan National Army territory of the country, along with the southern Tuareg militia–controlled section.

The role of the GMMR in Libyan power dynamics was outlined within the presentation. An overview of the factional control and destruction of the GMMR influencing conflict and humanitarian crises in Libya was also presented. The presentation outlined the threat of the infrastructure's destruction towards national stability and, most importantly, how it threatens the accessibility of millions of civilians to freshwater supplies in the northern coastal cities.

The presentation concludes with a current status overview of the Libyan conflict and factional fault lines and how the GMMR project has directly influenced Libyan territorial destabilization and conflict risk. The presentation research findings portray a Catch–22 scenario. The current situation of the GMMR finds that the project can be restored with peace, stability and investment. However, the deterioration of the project directly leads to conflict, instability, and hesitancy of foreign investment, thus leading to a potential impasse of resolution. The presentation finalizes with a conclusion that the damage to the GMMR project had devastating effects not only on the security and stability of the country but on the health and well–being of its civilian population, who rely on the water system due to the topography and climate of the nation.

RELEVANT TEXTS AND DATABASES

1. UN, Water Annual Report, 2021
2. World Meteorological Survey State of Climate Services 2021
3. European Drought Observatory, Drought in Europe August 2022
4. IRC International Water and Sanitation Centre, Libya: what role for Great Man–Made River Project in conflict?, 2011
5. Christopher Ward, Sandra Ruckstuhl, Books on Google Play Water Scarcity, Climate Change and Conflict in the Middle East: Securing Livelihoods, Building Peace, 2017, p. 148
6. Ken Nicolson, Water Driven: Revolutionary Cultural Landscapes, 2020, p. 110
7. UNICEF, Libya Water Scarcity and Climate Change: an analysis on WASH enabling environment in Libya, 2022

HOLISTIC APPROACHES TO SOLVE CONFLICTS ABOUT WATER – RESULTS FROM WORKSHOPS 2022

Prof. Dr. Ulrike Gayh, Prof. Dr. Andreas Gerber, Belen Zevallos
SRH Hochschule Heidelberg

INTRODUCTION

According to the Joint Monitoring Programme report [1], around 785 million people do not have access to sufficient fresh water. There is already a correlation between a lack of access to water and an increase in conflict, and this trend is likely to continue in the near future. It is already leading to increasing conflicts, and this trend is likely to continue in the foreseeable future. While monodisciplinary approaches usually have an extremely local or temporary effect, the cooperation between disciplines encourages a holistic perspective of the issues, and as a consequence, fosters sustainable solutions.

The initiative Democratia-Aqua-Technica, as well as the work and research with water conflicts, was funded in 2019. The first online hackathon with a challenge on water conflicts was held in 2020 with participants from partner universities [2]. In 2021, a second online hackathon and presentation about water conflicts was carried out within the project Democratia-Aqua-Technica [2].

As next step, the objective for 2022 was to create a structured collection of ideas for deriving interdisciplinary approaches to solving existing and avoiding future conflicts, as well as to develop first exemplary concepts and subsequent use and development of the idea pool.

In 2022, a water conflict innovation workshop with participants from water but also social sciences was carried out in Germany (Darmstädter Tage der Transformation, Schader Stiftung). The water conflict innovation workshop was held again with international experts During the World Water Congress and Exhibition in Copenhagen in September 2022.

METHODOLOGY

The methodology of the innovation workshops included 4 steps:

- **Step 1:** Brainstorming on root causes for real and potential conflicts about water
- **Step 2:** Structured collection of ideas (morphologic box)
- **Step 3:** Conclusion of innovative solution concepts (group work)
- **Step 4:** Presentation and discussion of results

The brainstorming phase started with the question "What are root causes for real and potential conflicts about water?". Mentimeter has been used for the sessions online, presence or in hybrid more. The goal is to stimulate the workgroup through initial brainstorming session prior to any discussion. Furthermore, the objective is to create a pool of ideas for conflict root causes.

After the brainstorming phase, the structured collection of ideas began with the methodology of a morphological box. The procedure consists of the following steps:

- Formulating the problem.
- Collection of parameters that affect the solution.
- All the possible values of the parameters that were found (creative phase).
- Combine all useful parameter combinations to feasible solutions
- Evaluate the solutions that were found in expert teams.

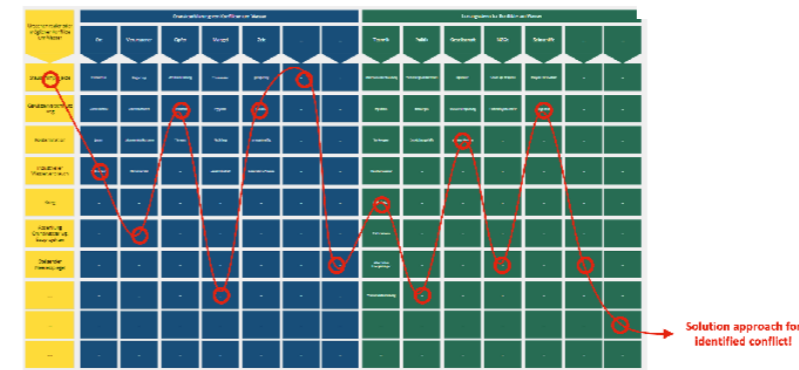


Fig. 1 and 2: Step 3: Description of problem and solution

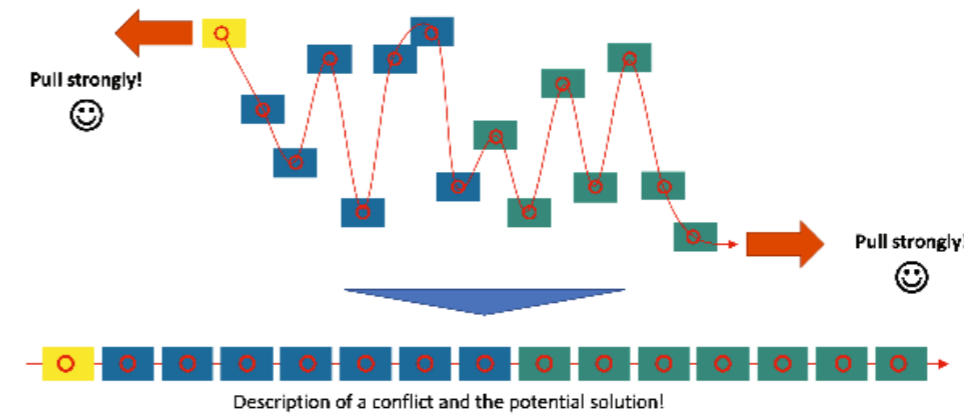


Fig. 3: Brainstorming Results – Root causes for real and potential conflicts about water

RESULTS

As final outcome, a water conflicts matrix was developed. This matrix includes, on the Y-axis, the root causes for water conflicts. The water conflict can be characterised by selecting different characteristics for a certain conflict, e.g., location, originator, time etc. Furthermore, different possibilities for solutions can be selected. These include not just technical but also social solution ideas.

The matrix will be further developed by ongoing workshop sessions with participants from various fields of science, industry and society. A continuous review of the matrix content will be carried out in order to find undiscovered combinations ("lines") of root causes, characteristics and solution approaches for existing and potential water conflicts. This developed matrix can be used to kick off and implement specific improvement projects and/or initiatives. Moreover, "unfolded lines" can be developed to concrete projects and/or initiatives.

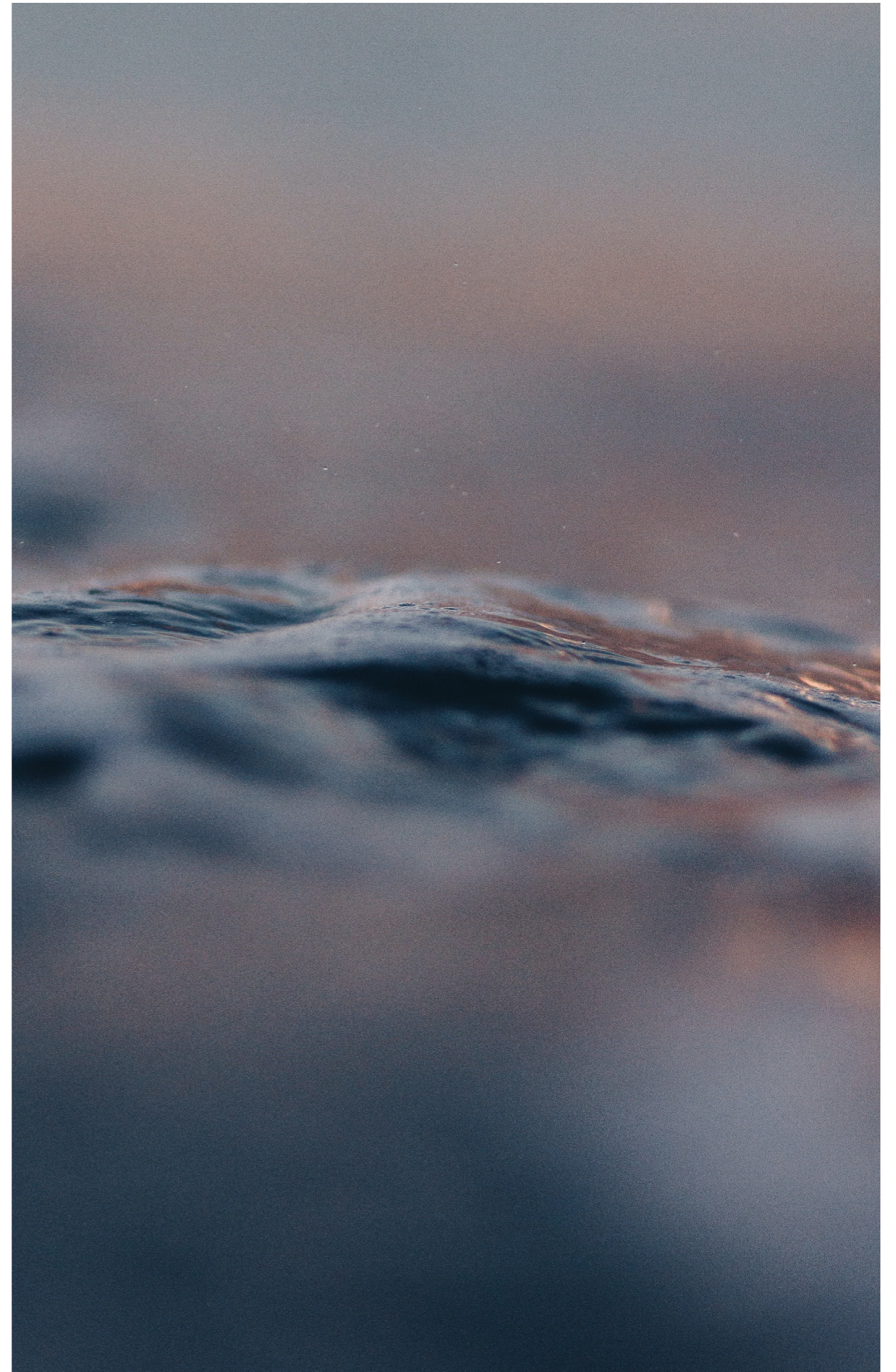


CONCLUSION

In this context, a developable solution space for water conflicts has been established. Based on the morphologic box approach, a model for identification, description and solution finding of existing and potential water conflicts has been developed. Also, the current solution space comprises the results of two workshops with differently skilled audience, and it is open for further contributions from any scientific discipline or social group. Moreover, the initial concretization of individual concepts shows complex root cause scenarios and mostly interdisciplinary solution approaches. This matrix can be used as a catalyst to start new projects and be further developed as a tool to tackle the challenges we have yet to

REFERENCES

1. Steele R. Unicef & World Health Organization. (2019): Progress on household drinking water sanitation and hygiene 2000–2017 : special focus on inequalities. United Nations Children's Fund (UNICEF). Retrieved November 6 2022 from <https://www.unicef.org/reports/progress-on-drinking-water-sanitation-and-hygiene-2019>.
2. Gayh, U & Turk-Seculic M., B. (Eds.) (2021, February): Democratia-Aqua-Technica – E-Book ISBN: 978-3-9822521-1-7, Heidelberg, Deutschland.
3. Gayh, U, Gogina E., Turk-Seculic M., B. (Eds.) (2022, April): Democratia-Aqua-Technica – E-Book ISBN: 978-3-9822521-5-5, Heidelberg, Deutschland.



INORGANIC ARSENIC REMOVAL CHALLENGES BY UTILIZATION OF LOW-COST ADSORBENTS AND COAGULANTS AS WELL AS COMBINATION OF THESE TECHNOLOGIES

Daria Ilić, Sanja Radović, Sabolč Pap, Maja Turk Sekulić

Arsenic (As) contamination is a global phenomenon as it is reported that more than 1,3% of the current world population are exposed to As concentration higher than 10 µg/L. Due to its carcinogenic effects on living beings, arsenic is concerned as a group-I human carcinogen. As exist in organic and inorganic form, but in water is usually present as inorganic oxyanions As (III) and As (V). Adsorption of As (III) and (V) using natural materials or the wastes products from industrial or agricultural operations has emerged as an option for developing economic and eco-friendly wastewater treatment processes. For the removal of arsenic from water and wastewater, numerous low-cost adsorbents have so far been studied. Biochars, red mud, dry plants, fly ash, zeolites, blast furnace slags, hydrotalcites. Possible routes of arsenic exposure to humans through the water, soil, vegetation and animal food chain are simplified and presented in Figure 1.

EMERGING LOW-COST TECHNOLOGIES AND ADSORBENTS FOR AS REMOVAL

Adsorption - Adsorption of As (III) and (V) using natural materials or the wastes products from industrial or agricultural operations has emerged as an option for developing economic and eco-friendly wastewater treatment processes.

Biochar - Main mechanisms of As uptake on the biochar surface are ion exchange, reactions with ionizable functional groups, interactions with dissolved organic carbon and surface complexation. Impregnation of biochars has been mostly done by applying iron and by zero-valent iron nanoparticles. For instance, biochar modified with Ni and Mn can be efficiently reused, maintaining 98 % removal efficiency after up to three treatment cycles .

Agro-industrial waste - Due to the content of agricultural waste consisted of cellulose, hemicellulose, and lignin, these rich in hydroxyl functional groups materials could be effectively used for metal adsorp-

tion from the liquid phase. Among common agro-industrial waste used for As removal are wheat straw, orange waste, red mud, shrimp shells, leather waste, rice husk, rice polish, a biodiesel residue Pongamia pinnata seed cake, Moringa oleifera and melon rind. Among the most important benefits are selectivity for certain metals, low-cost, easy production and application, the ability of regeneration and supporting waste reusability.

Red Mud - Due to its alkalinity in order to be applicable for As removal it is suggested to be activated by acid or heat activation or its combination, which has been proved an efficient method. Up to 11 % increment has been achieved by combined activation of Bauxsol (red mud). Clays-Bentonite nanoparticles could be modified by Al or Fe and therefore used for As removal. An overall removal achieved by red mud was above 70 %.

Chitosan-based adsorbents. Chitosan, one of the common bioadsorbents, is produced from chitin, which is the structural element in the exoskeleton of crustaceans (shrimp, crabs, shellfish etc.). It is highly hydrophilic and is characterized by a flexible polymer chain and by a large number of hydroxyl and amino groups that represent potential adsorption sites. Iron impregnated chitosan beads are able to adsorb arsenite up to 95 % of the initial value in a broad range of As(III) concentrations

HYBRID/COMBINED SYSTEMS

The hybrid systems are usually reported as systems that are partially low cost. For arsenic removal, a hybrid adsorption-wetland system was applied in constructed wetland represented a low-cost part of the system, whereas as an adsorbent activated alumina was used. This system effectively removed around 90 % of As. Wetlands can be also applied after reverse osmosis for the reduction of As from the discharge stream.

COAGULATION

The *Moringa peregrina* (Figure 2.) seed extract can be used as low-cost coagulants for As(V) removal. In experiment, at optimal pH value (6), while coagulant (*Moringa peregrina*) was added in concentrations between 0.1 and 5 mL/L reduction of initial As(V) concentration (100-500 µg/L) was over 98 %. The *Pistacia atlantica* can be also used as coagulant aid for the same purpose, but usually, it is used with ferric chloride, not as 100 % coagulant .



Fig. 2: Moringa peregrina plant and seeds

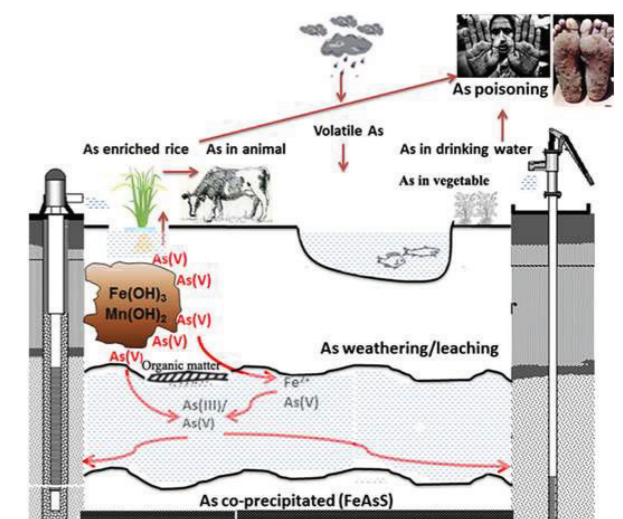


Fig. 1: The main sources and transport routes of As in the environment

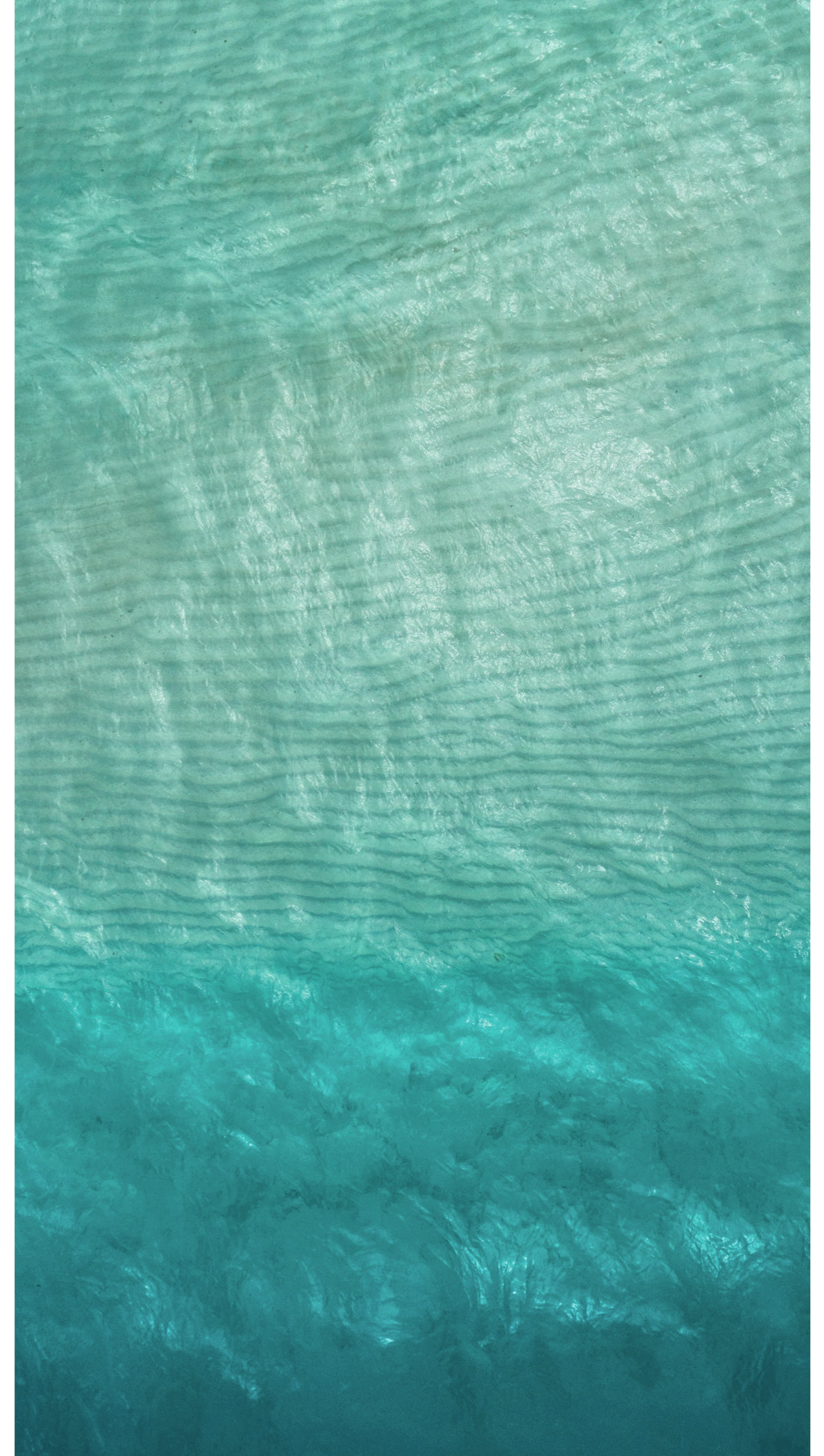
FUTURE PERSPECTIVES AND CHALLENGES

Environmental consequences of toxic As species present in water have been significant over the past decades. Due to critical health consequences of chronic and acute exposure to As, the remediation of As contaminated ground-surface, drinking and irrigated water as well as As contaminated wastewater through environmental friendly and cost effective strategies is an urgent necessity. The use of industrial by-products as a low-cost sorbent will improve waste disposal management in developed as well as

developing countries due to improper waste handling and disposal practices. The economic benefits represented by the use of low-cost waste materials as a precursor, bioenergy production, and non-activation requirements during the production process justify the use of biochar as a promising alternative for active carbon. Table 1 shows comparison of adsorption capacity (Q_{max} mg/g) of various low-cost adsorbents for arsenic removal.

Adsorbent	Initial pH	$C_{Initial}$ (mg/l)	Q_{max} (mg/g)
Bone char	10	0.5-1.5	1.43
Leather waste	1	10-100	26
Red Mud	3.5	10	0.52
C.rihzoma	8	1000	22.04
Calcined Mg-Fe LDHs	6.5	206	202
Tea fungal biomass	7.2	0.9-1.3	0.31
Chitosan	4	400	58
Rice polish	4	0.1-1	0.14

Table 1: Comparison of some adsorption capacity (Q_{max} , mg/g) of various adsorbents to remove arsenic



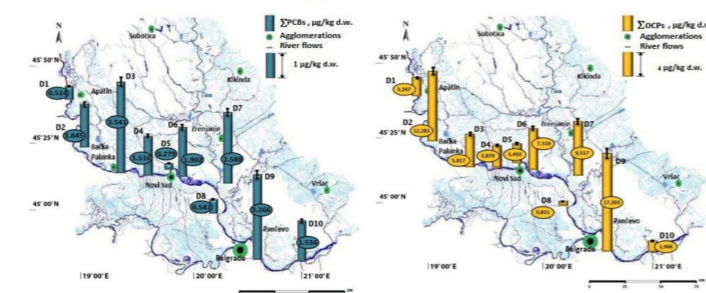
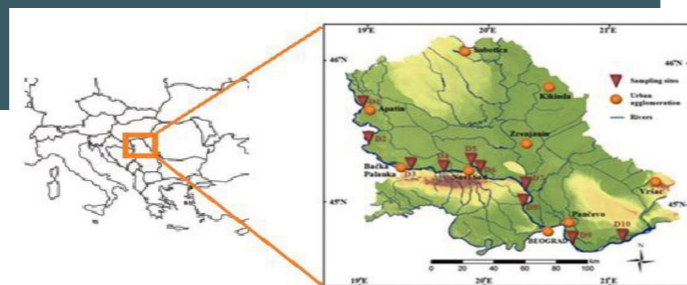
PERSISTENT ORGANOCHLORINE RESIDUES IN DANUBE SEDIMENTS:

APPLICATION OF ARTIFICIAL NEURAL NETWORKS

Maja Brborić, Borivoj Stepanov, Jelena Radonić, Sanja Radović, Maja Turk Sekulić

Lipophilic organochlorine pollutants, such as polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs), are ubiquitous in environmental matrices and represent contaminants that have been proven as highly carcinogenic, toxic and mutagenic, inducing stable genetic alterations with the ability to control irreversible cell division, resulting in the appearance and growth of tumors and cancers.

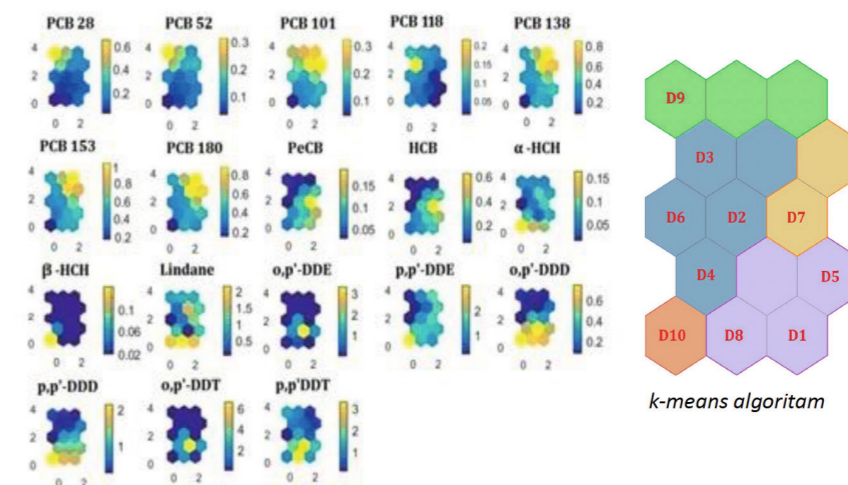
- During 2012 monitoring of Danube River sediments (Serbia) was conducted.
- 10 sampling sites– Apatin (D1), Labudnjača (D2), Neštin (D3), Begeč (D4), Ratno Ostrvo (D5), Šangaj (D6), Knićanin (D7), Belegiš (D8), Ritopek (D9), Dubravica (D10).
- The concentrations and distribution of / PCBs and 13 OCPs were investigated in bottom sediment samples.
- The concentration levels were in the range of 36.55 to 0.27 µg/kg for PCBs and 17.20 to 0.82 µg/kg for OCPs.
- The most frequently detected PCB congeners were with six and seven chlorine atoms collected at three sites near Novi Sad. The compositional profile of OCPs indicates the dominance of ΣDDTtot in almost all localities.



For the purpose of clearer visualization of the obtained results and simpler interpretation of complex multidimensional data sets, a class of artificial neural networks with unsupervised learning was applied – Kohonen's self-organizing maps (KSOM).

Similar color areas within the panel indicate positive correlations between variables, while opposite colors in the same area imply negative ones. In this way, the relationships between all variables in the model can be examined simultaneously or in specific sets.

The localities with the highest load are separated by green clusters (D9), yellow and blue clusters indicate localities with moderate load (D2, D3, D4, D6, D7), while purple and red clusters group localities with the lowest load (D1, D5, D8, D10).



The quantified total concentrations of the tested lipophilic persistent organochlorine pollutants in the sediment samples were relatively low.

Exceedances of maximum permitted concentrations were detected exclusively for DDT and its metabolites DDD and DDE.

The results of the Kohonen neural networks, confirmed the possibility of applying divergent methods to identify and interpret the origin of lipophilic organochlorine pollutants in aquatic sediment and the ability to define matrices obtained from monitoring data.



Fig. 1: Aerial photo of the Paraguay river

DEMOCRATIZING WATER RESOURCES MONITORING:

THE ROLE OF THE OPEN-SOURCE MOVEMENT AND DIGITAL FABRICATION

Dr. Ing. Arnoud Cuppens
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WATER RESOURCES MONITORING

To achieve sustainable water management in practice, not only cooperation between all stakeholders is required, but also the availability of sufficient data about the water resources is key. Indeed, any water-related study, such as the elaboration of water management plans (integrated catchment management, drought management, ecological flow, etc.), and the design of the necessary infrastructure (gates, reservoirs, spillways, etc.) require the availability of monitoring data (water level, flow, etc.). Unfortunately, as is the case in many developing countries, there is a severe lack of water resources monitoring systems in

Paraguay. One reason is the high cost associated with equipment acquisition and maintaining the monitoring system operational. Traditionally, the activity of water resources data collection has been realized by governmental institutions. However, for achieving sustainable water management in Paraguay, it is key that water availability and use is also monitored within the agricultural projects. Therefore, accessible and reliable monitoring tools are needed that are sufficiently robust for the challenging context of agricultural projects in Paraguay and, in addition, are easy to use and maintain by the local staff.

EXAMPLE 1: MONITORING OF WATER AVAILABILITY IN AGRICULTURE

Acquiring accessible and qualitative staff gauges in Paraguay is not straightforward. Unit prices are high, mainly due to import and transport costs as the producing companies are traditionally located in the US and Europe. As an alternative, a staff gauge was designed making use of Computer Aided Design (CAD) and afterwards produced locally in stainless steel (Figure 2a) by making use of digital manufacturing

technologies like CNC laser. The staff gauge was installed in a water reservoir at a small cattle farm (Figure 2b). Measurements are taken at least 3x a week by the local staff using a simple APP created in flutter, while the data is stored in a Firestore cloud database and displayed online by means of a customized dashboard (Figure 3) created in Looker Studio.



Fig. 2: A Staff gauge in stainless steel fabricated with CNC laser and
B Installation of the staff gauge in a water reservoir at a cattle ranch

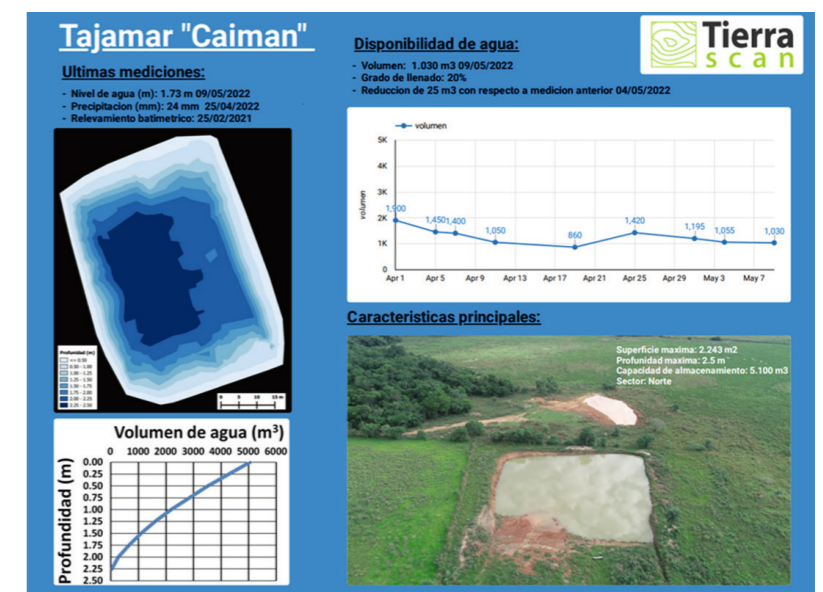


Fig. 3: Example of an online Dashboard (Spanish) displaying the recent measurement values for water level and the current volume of water stored in the reservoir

EXAMPLE 2: DEVELOPMENT OF A MOTORIZED KAYAK FOR HYDROMETRIC DATA COLLECTION

As an alternative to commercially available unmanned surface vehicles for hydrometric data collection (e.g., flow measurement and bathymetric survey), a DIY platform was developed (Figure 4a). The starting point was a small kayak, and several types of open-source electronics were added to obtain both the navigation and data collection functionalities. Testing was done on the Paraguay river, where depth mea-

surements (Figure 4b) were taken by means of a low-cost sonar connected to a GPS and datalogger. The georeferenced depth measurements can be used to create bathymetric survey maps by using open-source [GIS programs](#).

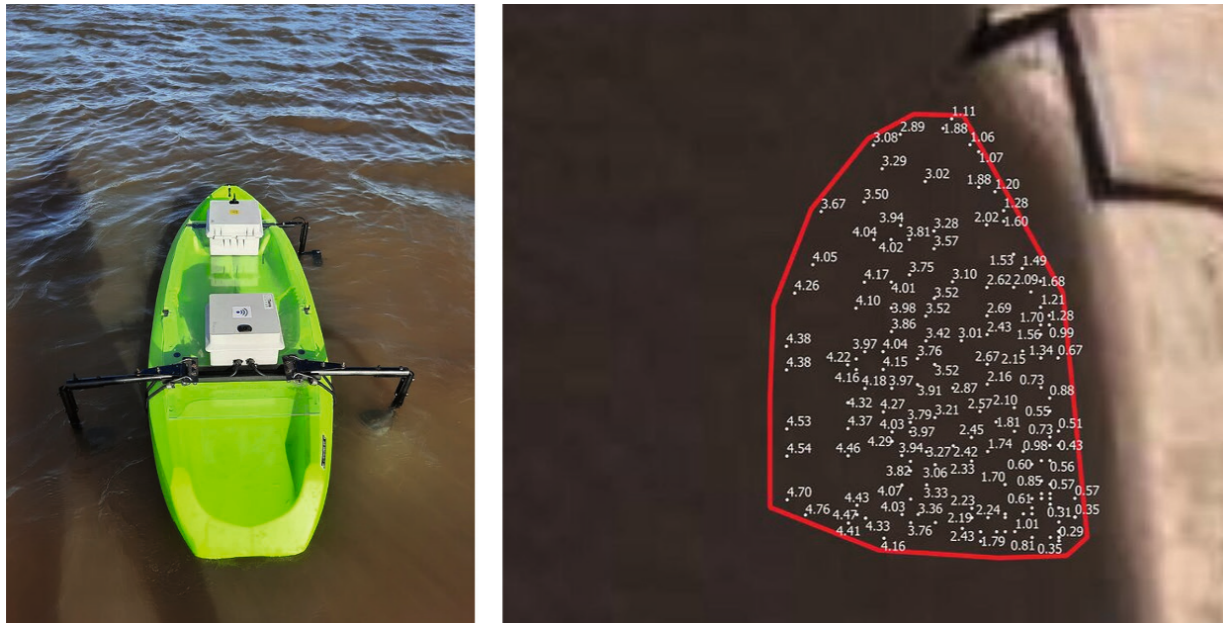


Fig. 4: a) First prototype of DIY monitoring platform and b) georeferenced depth measurements obtained during test on the Paraguay River

OPEN-SOURCE MOVEMENT & DIGITAL FABRICATION

The open-source movement and digital fabrication facilitated the development and application of low-cost, customizable monitoring tools for water resources as demonstrated by means of 2 above examples. Following technological tendencies were key for the development process:

- Availability of low-cost electronics and availability online of the associated codes & tutorials
- Communities sharing building experiences on online forum (+ giving feedback on prototypes)
- Availability of free (or almost free) software applications/services (CAD, Flutter, Firebase, etc.)
- Rise of FABLABs worldwide and the lowering price of fabrication tools

An additional advantage of the open-source and digital fabrication approach is that the monitoring tools can be repaired locally. This is particularly relevant when aiming at maintaining operational monitoring systems in the context of developing countries.



COMPARATIVE ANALYSIS OF TWO RIVER STREAMS IN GERMANY

Ashutosh Bhalerao
SRH University Heidelberg

SUMMARY

Water ensures the survival of all living things on earth. Living things cease to exist without water. Living things can access this resource through a lake, surface water, wells, and groundwater. Out of the total distribution, 0.49% of water is available in the form of rivers. A significant portion of freshwater necessities of living things is fulfilled by this 0.49% of river water available. According to the UN, 1 million people die due to water-related diseases. In Germany, 92% of surface water is polluted. The major contribution to this pollution is the use of land for agriculture. Around 45% of the land is utilized by agricultural activities within southwest Germany. The amount of investment made to date for river development projects was around 45 billion euros since 1954. The root cause of the pollution problem is the excessive use of pesticides affecting biological life. To tackle this problem one of

the solutions is to investigate the ecological conditions of the water bodies regularly. The objective of this study was to determine the pollutant levels in water streams within the study area of the Ochsenbach and Lobbach regions of southwest Germany. For in situ measurements, devices like test strips, multimeter and probes were used to determine the physical parameters, and for ex situ measurements Spectrophotometer was used to determine the chemical parameters. The results indicated that the conductivity levels exceeded standard limits at Ochsenbach. It was also found that the nitrites remain a critical problem as they exceeded significantly from the standard limits. The overall ecological status was found to be good within the two locations Ochsenbach and Lobbach regions of southwest Germany.

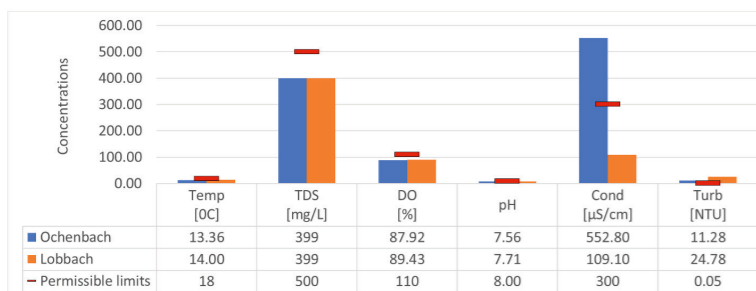


Fig. 1: Physical Parameters

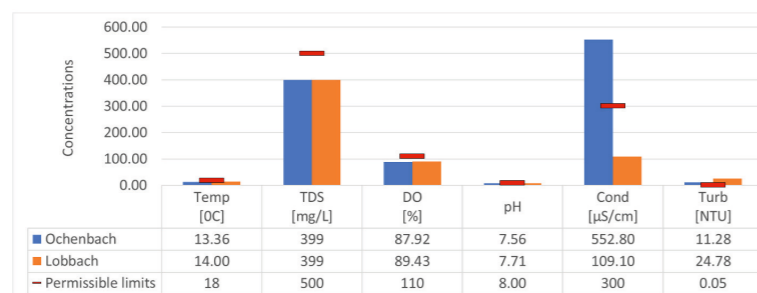
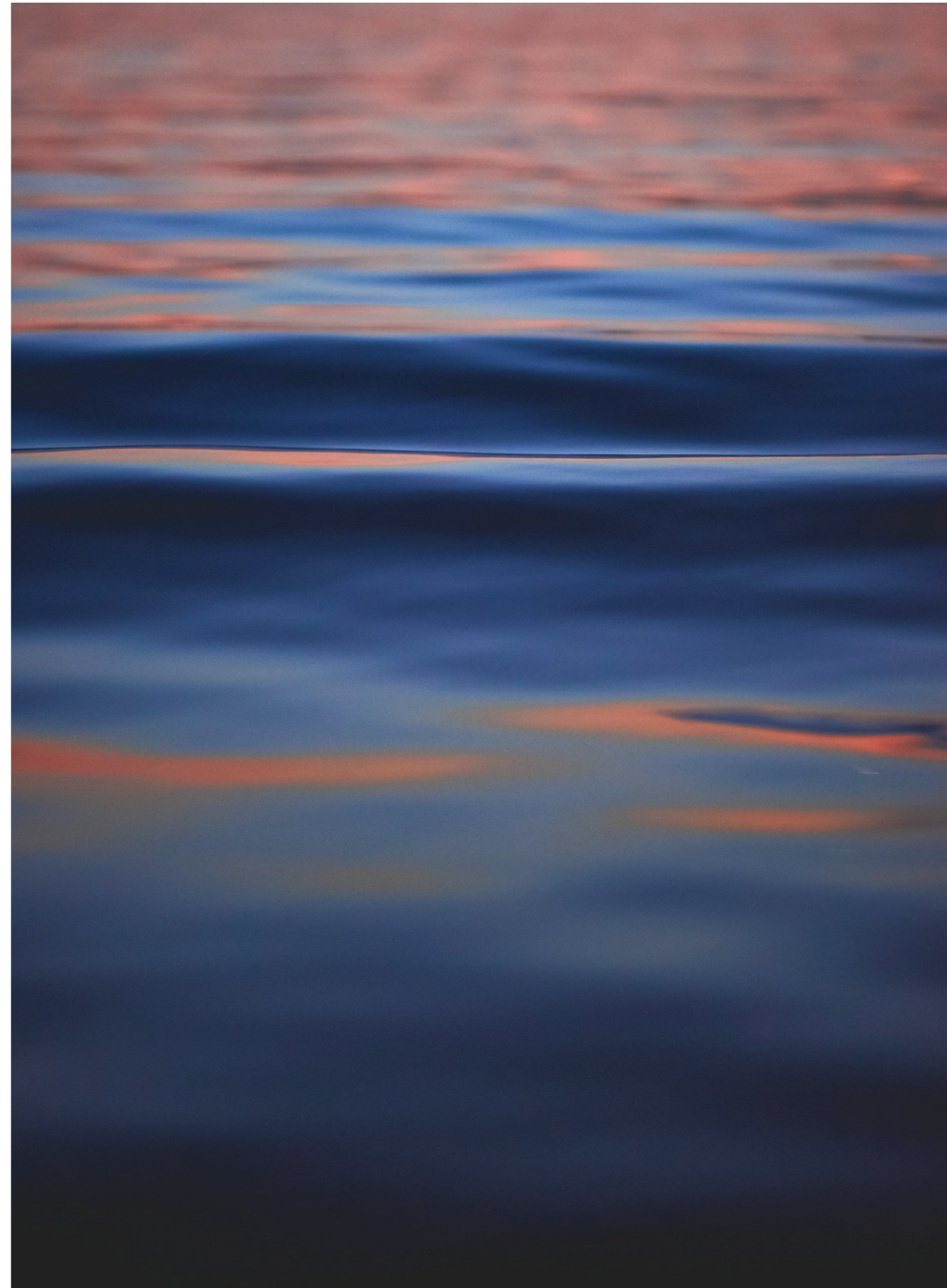


Fig. 2: Chemical Parameters



HARNESSING THE POTENTIAL OF THE BAGRE DAM SPILLAGE FOR THE SOCIOECONOMIC DEVELOPMENT OF NORTHERN GHANA

Adam Yakubu
Ghana Water Company Limited

The Bagre Dam is a multipurpose dam which is located near Bagré Village in Burkina Faso. The dam was constructed in the year 1992 for the purpose of power generation. It has an installed capacity of 16MW with a total water storage capacity of 7 billion m³ and spans over 400km in length.

The Bagre Dam is sited on the White Volta River which is the headstream of the Volta River, Ghana's main waterway. The river emerges from northern Burkina Faso, flows through Northern Ghana and empties into Lake Volta in Ghana.

To build and foster a good relation between Burkina Faso and Ghana, both countries have adopted legal and institutional frameworks for the management of the water resource. In Burkina Faso, it is the Nakanbé Water Board that oversees the activities within the White Volta basin, while in Ghana, it is the White Volta Basin Board. The basin is managed by the parties from both countries through water policies based on the principles of Integrated Water Resources Management (IWRM).

For the past twenty-three (23) successive years, the company responsible for the operation of the Bagre Dam, Société Nationale Burkinabe d'Electricité (SONABEL) Company Limited, has spilled excess water reaching the dam. The spillage, which usually occurs between late August and early October every year, is done to maintain the Dam's 235.1 meters water holding capacity.

The excess water spilled from the dam leads to flooding of downstream communities in Burkina Faso and the five (5) Northern regions of Ghana. Over the past

years, the flooding events have been linked with the loss of lives, properties, farms and human displacement. For instance, in September 2022, when the dam was spilled, three (3) lives were lost with hundreds displaced and extensive damage done to farms (about 3,000 hectares) and enormous properties. Meanwhile, lives lost in 2018, 2020 and 2021 stood at 34, 6 and 10 respectively.

The flooding also pose a water supply threat in the Northern part of Ghana. This is mostly experienced at the Dalun Water Treatment Plant (WTP) of Ghana Water Company Limited (GWCL), where the raw water in-take point of the WTP exceeds its maximum operating level. As a result, people in the Northern enclave of Ghana are denied potable water for a period.

Again, during rainy seasons, there are overwhelming volumes of water which inundates farms and destroy crops and livestock in the northern part of Ghana. The dry season in the area comes with drastic dryness

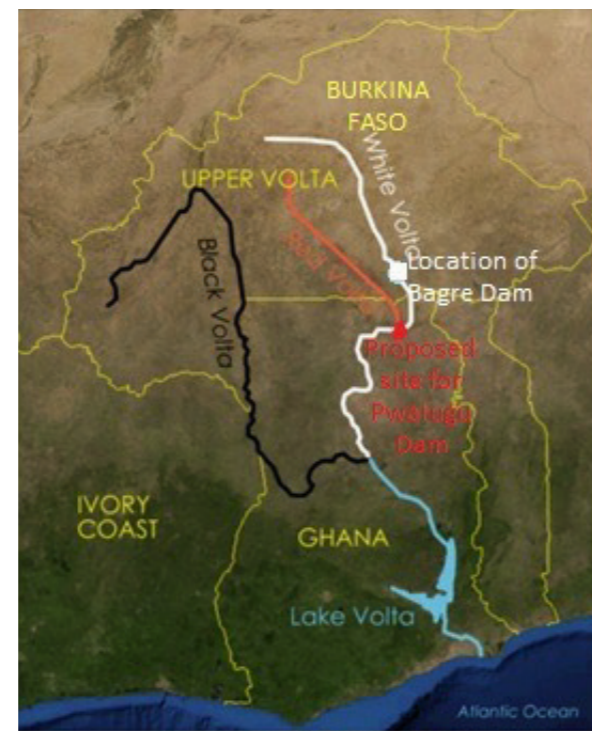


Fig. 1: Location of Bagre Dam (white point) and proposed Pwalugu dam (red point) on Burkina Faso and Ghana Map

Fig. 2: View of Bagre Dam



of all surface water bodies and is associated with increased groundwater contaminant concentration. Ground water access is a problem due to the low water table.

To avert the destructions caused by the excess spilled water from the Bagre Dam in the northern part of Ghana, there exist various technologies that could help Ghana to harness the potential of the spilled water from the Bagre dam for the economic transformation of the people of the five (5) Northern regions of Ghana.

One of the solutions proposed by the incumbent government to address the situation is the construction of the Pwalugu Multipurpose Dam. In that way, the excess water spilled from the Bagre Dam can be intercepted by the Pwalugu Dam. The dam will also be used for power generation, irrigation, and drinking water supply. It is believed that the construction of the Pwalugu Dam will address the flooding situation, the concerns of the farmers in the area and contribute significantly to the national food security agenda in Ghana.



Though not a consideration by the Ghanaian government currently, research has shown that the structural measures such as dikes and retention ponds can be effective in the control of such flooding incidence. Construction of these structural measures among other technologies can mitigate the challenge of flooding resulting from Bagre dam spillage. This can improve the socio-economic status of the people in the five (5) northern regions especially women. There would also be the benefit of all-year round farming in the northern part of Ghana. The above-mentioned measures can be adopted to prevent the case of perennial flooding, interruptions in drinking water supply, recurring loss of properties and lives caused by the spillage from the Bagre Dam.



ACKNOWLEDGEMENTS

1. Amuquandoh, M. K. (2016). An Assessment of the Effects of the Bagre Hydro Dam Spillage on Ghana-Burkina Faso Relations (Doctoral dissertation, University Of Ghana).
2. <https://watson.brown.edu/chrs/research/seed-grant-bagre-dam-spillage-ghana>
3. The bagre dam spillage conundrum: are early warning systems leading to local actions in flood disaster hotspot communities in northern ghana? (2019)
4. <https://www.geoace.com/app/Riverbank-and-Channel-Protection/Levees-and-Dikes>
5. <https://constructionreviewonline.com/news/pwalugu-multipurpose-dam-in-the-white-volta-region-ghana/>
6. https://en.wikipedia.org/wiki/Pwalugu_Multipurpose_Dam
7. <https://www.vra.com/media/2019/USD%20993%20Million%20Pwalugu%20Multi-Purpose%20Dam%20Project%20Takes%20Off.php>
8. <https://citinewsroom.com/2022/09/burkina-faso-authorities-begin-spillage-of-bagre-dam/>
9. <https://gna.org.gh/2022/09/water-resources-commission-decry-farming-activities-along-buffer-zones/>

OCCUPATIONAL EXPOSURE AND CANCER RISK ASSESSMENT IN AN ANATOMY LABORATORY

Dragan Adamović
University in Novi Sad, Faculty of Technical Sciences

BACKGROUND

Dissecting a human cadaver is an irreplaceable practice in the general training of medical students. Cadavers in anatomy laboratories are usually preserved by formalin, an embalming fluid whose basic component is formaldehyde. Due to its high volatility, the inhalation of formaldehyde is regarded as the dominant source of exposure, along with the possibilities of direct eye contact or percutaneous absorption.

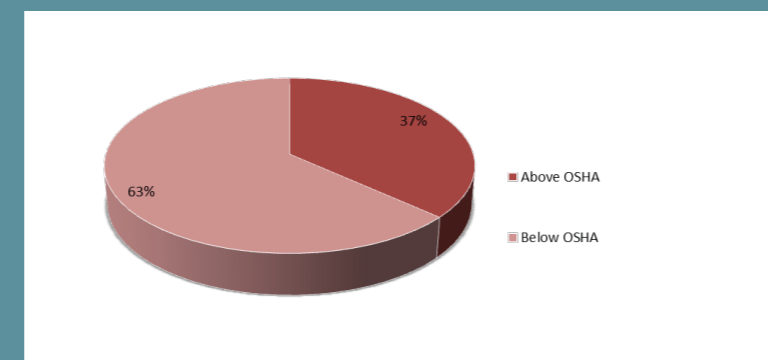


METHODS

The three formaldehyde concentration level sampling campaigns have been conducted at five different locations at the Anatomy Department of the Faculty of Medicine for the purposes of this paper. Indoor air has been continuously sampled during 8 hours of laboratory work and analysed in accordance with the NIOSH Method 3500.

RESULTS

Exceeding of the 8h time-weighted average (8h TWA) values recommended by OSHA (0.75 ppm) was recorded in 37% of samples during the three-month monitoring campaign. Based on the monitoring results, cancer risk assessment of employees and students has been conducted depending on the time spent in different premises of the Department.



CONCLUSIONS

The study emphasizes the importance of reducing the level of exposure to formaldehyde for the safety of the working spaces of anatomical laboratories through the use of formaldehyde-free products and the plastination of anatomical specimens.

OVERCOMING THE SHORTCOMINGS OF TRADITIONAL COMPUTER-BASED TECHNIQUES BY APPLICATION OF MACHINE LEARNING MODELS

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University of Novi Sad, Faculty of Technical Sciences, Department of Environmental Engineering and Occupational Safety and Health, Trg Dositeja Obradovića 6, 21 000 Novi Sad, Serbia

Complex and abundant data obtained within wastewater treatment processes sometimes cannot be efficiently processed by traditional computer-based techniques. Some data does not match simple statistical models, which are mostly used for obtaining linear, exponential or logarithmic relationships between variables. In other words, traditional statistical tools could find complex relationships between different factors challenging. In order to overcome the shortcomings of traditional approaches, advanced approaches, such as machine learning (ML), have been more increasingly implemented. ML is capable of interpretation of high-level abstraction in data and prediction, which enables it to address complex problems in dynamic systems. While statistic infers relationships between variables, ML can make prediction by „learning“ deep patterns in large data with modern algorithms. The application of ML for comprehensive adsorption studies involving biochar is still limited. Most of the published articles within this area of research included optimisation of adsorption process (time, adsorbent dosage etc.), while optimisation of adsorbent production is still mostly done by more traditional statistical approaches. For instance, response surface methodology (RSM), as a collection of mathematical and statistical techniques for experimental optimisation, has been commonly used for mentioned purpose. In the present study, RSM com-

ined with Box-Behnken experimental design with three factors (pyrolysis temperature, time of thermal treatment and iron to biomass impregnation ratio) was used in order to optimise process of alternative biochar production. Orthophosphate removal efficiency was observed as a response that should be maximized. RSM and ANOVA analysis gave valuable results concerning factor's significance and optimised conditions for biochar production with relatively high coefficient of correlation ($R^2 = 0.86$). However, from the literature review it can be concluded that almost in all cases when RSM was compared with machine learning algorithms such as artificial neural network, support vector machine or similar, for experimental optimisation, machine learning models gave better results with a higher coefficient of correlation. Hence, some of the future experiments should consider that facts and try to improve experimental model and accuracy of response predictions by utilisation of advanced computer-based techniques.

This research has been supported by the Ministry of Education, Science and Technological Development of the Republic Serbia through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain".

NUTRIENT RECOVERY FROM BIOGAS PLANT EFFLUENTS:

AN INDUSTRIAL SYMBIOSIS MODEL

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Biogas plant effluents have high concentrations of nitrogen (N) and phosphorus (P) which may cause serious problems to the environment. For example, N and P can cause eutrophication, and N can cause ozone loss and acidification of water bodies. Therefore, the removal of these nutrients is one of the major aims of water treatment. On the other hand, P is a non-renewable source, and it is expected to deplete in near future. For this reason, recovery of P is essential for sustain P demand of the world. Struvite precipitation is adequate technology that meets the removal and recovery of N and P. Struvite is a mineral composed of equimolar concentrations of NH_4^+ , PO_4^{3-} , and Mg^{2+} and precipitates in the alkaline conditions. However, Biogas plant effluents generally contain a low concentration of both magnesium and phosphorus which is the limiting factor of removal

and recovery of nutrients in terms of struvite precipitation. Consequently, addition of these two ions is essential to obtain high nutrient removal and recovery performance. Even if pure chemicals can be used as Mg and P source, their high costs restrain the full-scale applications of struvite precipitation. This study offers waste magnesite dust (WMD), which is mining by-product, as unconventional Mg sources. In Turkey, there is not any commercial utilization of this material and 50,000 tons of WMD are sent to landfills every year. During the study, Mg content of this waste material extracted by applying acidification and obtained solution has used as Mg source. Aim of this study is maximizing product while reducing operational cost and establish industrial symbiosis between mining, bioenergy, and agriculture industries.

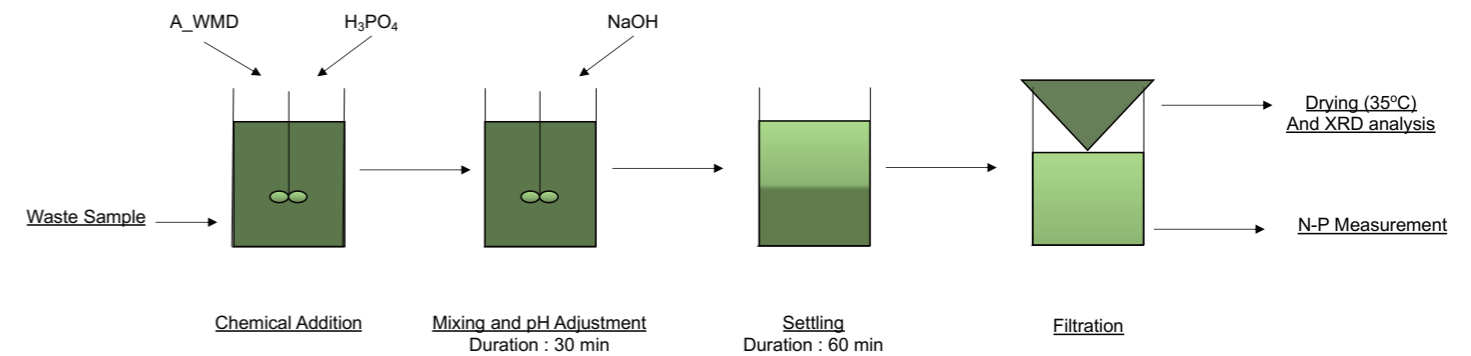
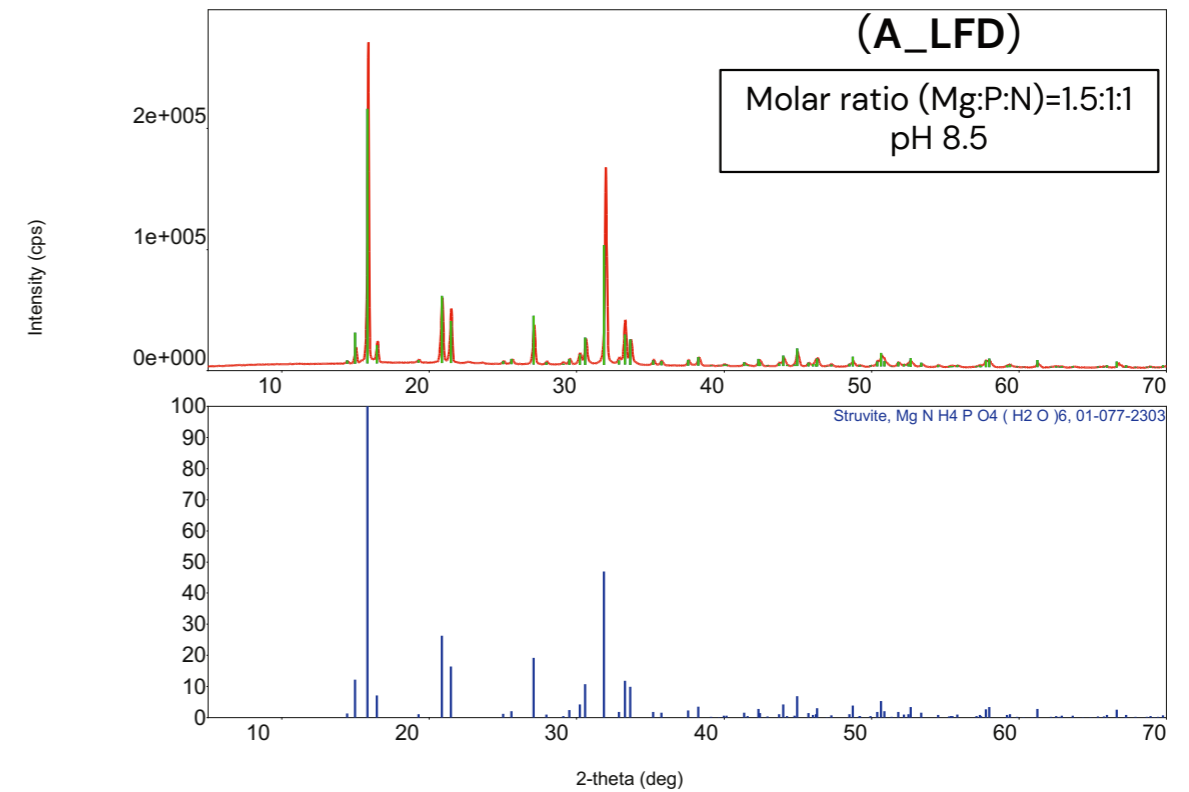
MATERIALS AND METHODS

During the study, biogas plant digestate was exposed to acidification to enrich phosphorus content in liquid fraction and solid-liquid separation applied. Obtained sample named as acidified LFD. (A_LFD). By using chemical equilibrium model, optimum Mg:P:N molar ratio has been chosen as 1.5:1:1.

There are six main steps followed during the experiments. Acidification of digestate and solid-liquid separation (1), acidification of WMD (2), addition of chemicals (3), mixing and pH adjustment of the sample (4), crystallization and settling of struvite (5), and filtration and drying (6).

RESULTS

As a result, over 88 % P and over 97 % N removal and recovery were obtained. Obtained products validated as almost pure struvite by X-ray diffraction analysis. This study proves that low-cost, unconventional Mg source can substitute pure Mg sources.



ASSESSMENT OF PM_{2.5} EXPOSURE AND HEALTH RISK IN NOVI SAD, SERBIA

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Faculty of Technical Sciences, University of Novi Sad, Serbia

BACKGROUND

Airborne particulate matter (PM) pollution can be carried long distances by the wind, can affect areas far from the emission sources and atmospheric visibility, and represents a major health concern. Especially concerning are thoracic and respirable particles (PM_{2.5}). Children, people with cardiovascular and respiratory diseases, diabetes, or obesity, and the elderly are particularly susceptible to pollution effects. Air quality in Novi Sad (NS), the capital of Vojvodina Province, is deteriorated by domestic heating (DH), heating plants (HP), traffic intensity, and by occasional unfavorable meteorological conditions. During 2020, 24 h average daily value concentrations

(conc.) of PM_{2.5} were in the range from 34–150 µg/m³ and 3–38 µg/m³ during heating (HS) and non-heating season (NHS), respectively. The very urban part of NS, without affiliated municipalities, is heated by the City Thermal Power plant (TPP) North, East, West and South. Other areas of the NS municipality are heated by individual boilers and private central heating systems. According to the official data of the Republic Institute for Statistics of Serbia (SRB), in 2019, 2020 and 2021, total number of vehicles registered for the first time in Vojvodina region was 56.389, 52.644 and 57.154 vehicles.

METHODOLOGY AND STUDY AREA

Measurements were conducted at three representative sites in NS by Low-cost Optical Particle Counters. PM_{2.5} in ambient air were sampled during 2020/2021 during the NHS and HS in NS. PM_{2.5} were sampled continuously for 10 days in both seasons. Two sites were in urban traffic zones – first with high traffic activity (TrfA) and primary heating by the TPP (orange area, UTrfS), and second with low residential TrfA and primary DH (US). The third site was placed on the urban/industrial border of the city with primary DH and low residential TrfA (light blue area, UrIS). Within the research, the potential adverse effect of human exposure to a PM_{2.5} through inhalation was investigated by the US EPA risk assessment methodology calculations. According to the methodology used, non-carcinogenic risk (NCR) is defined by the hazard quotient (HQ) and the target NCR value is set at 1.0, for age groups of 16–21, 31–41 and 56 years. The HQ values were calculated as the ratio of the average daily dose (ADD) to the reference dose (RfD).



RESULTS

During NHS measured daily PM_{2.5} conc. at UTrfS, UrIS and US were in the range from 7.32–17.63, 7.71–2.48 and 12.14–29.45 µg/m³, respectively. During HS measured daily PM_{2.5} conc. at UTrfS, UrIS and US were in the range from 11.97–66.08, 10.26–126.68 and 10.83–96.19 µg/m³, respectively. HQ values during NHS at UTrfS, UrIS and US were in the range from 0.16–0.48, 0.17–0.56 and 0.27–0.81, respectively, while during HS, HQ values at all three measuring sites were in the range

from 0.28–1.48, 0.23–4.37 and 0.35–2.62, respectively. According to HQ NCR classification, during NHS HQs were below 1.0 for all three age groups of 18, 36 and 56 years at all measuring sites. During HS at UTrfS, values of HQ were above 1.0 for the population of 18 years, comparing to HQs for the other two age groups which were below 1.0. At UrIS and US, values of HQ for the population of 56, 36 and 18 years old were above 1.0, by descending order.

CONCLUSION

Based on the conducted campaign in NS, the highest PM_{2.5} conc. were measured during HS at UrIS and NHS at US. The average daily values of the PM_{2.5} conc. during NHS did not exceed limit (LV) and tolerance value (TV) (25 µg/m³) set by the SRB and EU regulations at UTrfS, UrIS and US. During HS, average daily values of the PM_{2.5} exceeded set LV and TV at all sites during 8 of 10 sampling days. Comparing average daily PM_{2.5} conc. to 24h WHO LV of 15 µg/m³, the exceedances were observed during both seasons.

Determined HQ values for the population within the age range of 16–21 years indicated that there may be some levels of risks to sensitive individuals as a result of exposure to PM_{2.5} at UTrfS during HS. HQ values determined at the UrIS and US, indicated the highest risk levels of sensitive individuals within the age ranges of 51–61, 31–41 and 16–18 years, because of exposure to PM_{2.5}. During NHS, HQ levels were below 1.0 at all measuring sites and for all age groups, indicating insignificant or negligible risk of exposure to PM_{2.5}.

ACKNOWLEDGEMENTS

This research (paper) has been supported by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain" and Democratia - Aqua - Technica, DAAD: Ost-West-Dialog: Hochschuldialog mit den Ländern des westlichen Balkans 2022.

COMPARING THE EFFICIENCY OF THE BIOFILTRATION SYSTEM WITH HUMIC SUBSTANCES AND RESIN IN HEAVY METALS REMOVAL IN WASTEWATER

Shozeb Javed, Prof. Dr M. R. Ghomi, Prof. Dr Ulrike Gayh
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INTRODUCTION

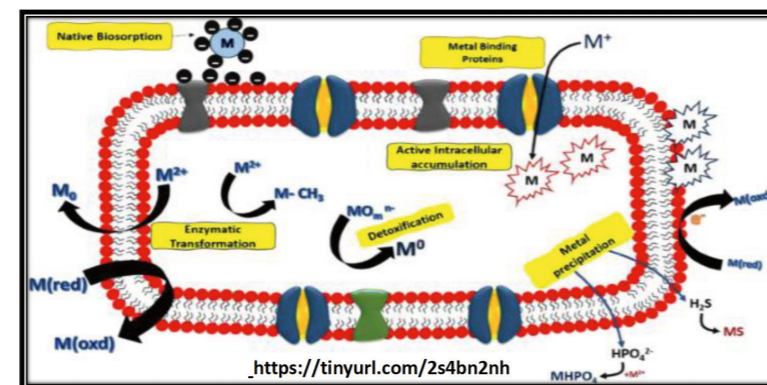
Environmental pollution due to anthropogenic activities and natural resources is increasing daily because of industrialization. It is becoming difficult for scientists to find ways to tackle the contaminants degrading environmental health (1). Heavy metals in water and wastewater are an emerging issue these years due to the growing population, climate change and urbanization, leading to water scarcity throughout the world. The main source of toxic metals in streams is effluents from industries, such as electroplating, paints, plastics and batteries. For this concern, environmental awareness is growing among consumers, and industrialists and legal constraints on the discharge of effluents necessitate a need for cost effective alternate technologies (2). There are various ways to clean the metals from industrial wastewater chem-

ical precipitation, ion exchange, leaching, electrolytes, hydrolysis, reverse osmosis, landfilling, excavation and chemical extraction, activated sludge, membrane filtration and oxidation ditches, and a few others. These methodologies are not always helpful in removing very low concentrations of heavy metals (3).

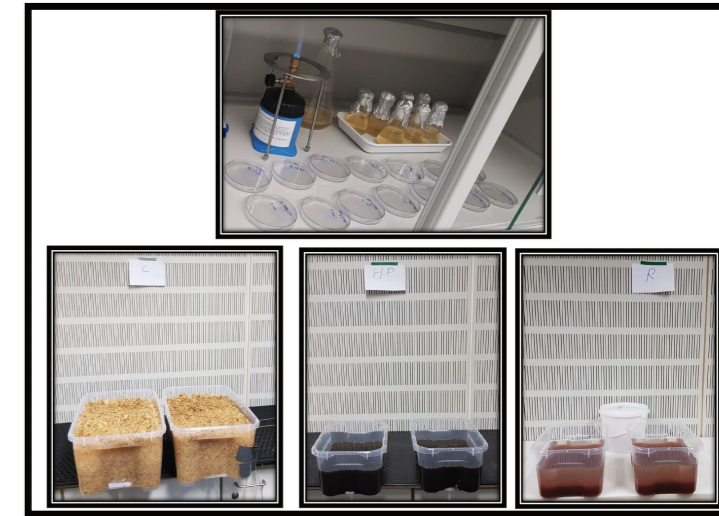
To tackle this problem, biosorption can be used to remove organic pollutants from wastewater and water. The process includes the use of different types of biomasses, including algae, fungi, bacteria and plants. The bacteria involves various ways to remove metals from the wastewater – Biosorption, enzymatic Transformation, Intracellular accumulation, detoxification binding with proteins and precipitation.

METHODOLOGY

Artificial wastewater was created in the water lab of SRH with various concentrations of two heavy metals (Cr and Pb) in distilled water. Bacteria were isolated from the Neckar river for bioremediation as a biofilter using nutrient broth, for initial screening of the culture and then finally in nutrient agar by pour plate method for the final screening. Acclimation was done for 16 days in biofilters as a batch process. Rohm and Hass Amber Lite MB 20 mixed bed exchanger resin supplied from Amazon and Powder humus and Humic Acid (0,1 %) supplied by HUMIN Tech, Germany



was used to compare the efficacy of the two metals removal with the biofilter created. The highest concentration of the metals obtained after the final screening in dilution of 10^6 was administered with 10 L volume in the biofilter set up. On the 17th day (for biofilters) and after 2 hrs in the case of resin and humic substances, the concentration of two heavy metals was determined using kits LCK 306 and 313 and instrument DR 3900 and physical parameters pH, DO and temperature using probes in Multimeter.



RESULT

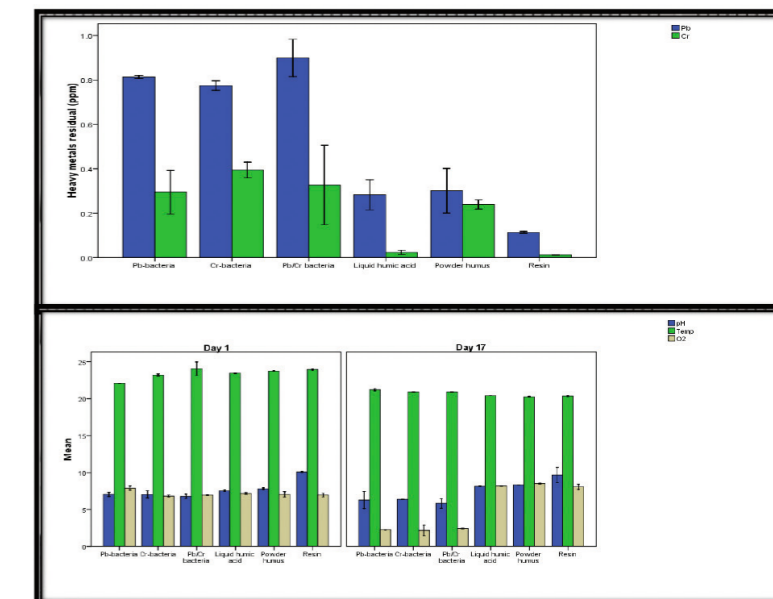
The resin had the highest reduction of lead (0.11 ppm residual), followed by humic acid (0.28) and powdered humus (0.3), and finally by three bacterial biofiltration systems. The chromium, resin and liquid humic acid have shown the greatest amount of mitigation, and their results are significantly different ($P < 0.05$) from powder humus and three biofiltration treatments. The pH in our experiment tended to be acidic in biofilter groups and significantly became different ($P < 0.05$) from humic and resin. The temperature had no significant difference among all groups during our experiment. Finally, dissolved oxygen (DO) showed a huge reduction in biofilter treatments. It shows that the bacterial metabolic activities got the oxygen from the solution containing bacteria rather than resin and humic groups.

CONCLUSION

In conclusion, however, the biofilter had less efficacy to mitigate both Cr and Pb than those of resin and humic groups, but overall showed a good amount of mitigation more than 90% of the initial concentration.

REFERENCES

- Ahemad, M., Khan, M.S., Zaidi, A. and Wani, P.A. (2009). Remediation of Herbicides contaminated soil using microbes. In: Microbes in sustainable agriculture. Khan, M.S., Zaidi, A., Musarrat, J., (eds.) Nova Science Publishers, New York, 261-284.
- Rao, K.R., Rashmi, K., Latha, J.N. Land Mohan, P.M (2005). Bioremediation of toxic metal ion using WWW.DEMOCRATIA-AQUA.ORG biomass of Aspergillus fumigatus from fermentative waste: Indian Journal of Biotechnology.4: 139.
- Carrefno-Sayago, U.F. (2021). Development of microspheres using water hyacinth (Eichhornia crassipes) for the treatment of contaminated water with Cr (VI). Environ. Dev. Sustain. 23, 4735-4746.



COMPARISON BETWEEN TWO CONSTRUCTED WETLAND MODELS:

GERMANY VS. MEXICO

Hamza El Ouassif
-----UU

INTRODUCTION

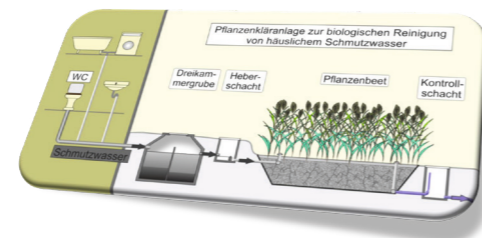
Constructed wetlands are engineered wetlands that mimic the simultaneous physical, chemical, and biological processes occurring in natural wetlands for wastewater treatment purposes using vegetation, soils, and their associated microbial assemblages.

WORMS' CONSTRUCTED WETLAND IN GERMANY

A constructed wetland was built in Worms park in order to pre-treat domestic wastewater before transferring it to the wastewater treatment plant.

The system is a horizontal subsurface flow where wastewater gets stored first in a multi-chamber pit and then pumped beneath a bed of media (gravel, soil & sand) where emergent plants are planted, the wastewater is then flowing through the roots and rhizomes of the plants where different reaction occurs, leading to a treated water.

Some on site analyses have been carried out at the inlet and outlet of the wetland. The results showed that the quality of water had improved mainly turbidity decreased from 190 NTU to 70 NTU only, and Dissolved oxygen increased from 0,24 mg/l to 0,4 mg/l due to oxygen release from the plants during photosynthesis. The plants use nitrogen for their growth as a nutrient leading to a Nitrate decrease from 116 mg/l to mg/l.



Constructed wetlands worms														
Locations	Temp (C)	pH	Conductivity (µS/cm)	DO (mg/l)	TDS (ppm)	Turbidity (NTU)	Hardness (mg/l)	Alkalinity (mg/l)	Chromium (mg/l)	Free Chloride (mg/l)	Nitrate (mg/l)	Sulphate (mg/l)	Chromium (mg/l)	Lead (mg/l)
inlet of the constructed wetland	26,6	7,8	240	0,24	1,7	190	125	120	10	3	1,16	127	0,044	0,23
outlet of the constructed wetland	24,2	7,2	240	0,4	1,8	70	250	40	BDL	0,5	1	110	0,018	out of range

ATEQUIZAYAN'S CONSTRUCTED WETLAND IN GUADALAJARA MEXICO

A small wastewater treatment plant for an estimated 800 inhabitants has implemented an artificial wetland as a tertiary treatment phase after sedimentation and anaerobic digestion stages. The media of the wetland is formed from "Tezontle" volcanic rocks that serve as natural filters and also soil for the "Canan indica" plants that work as absorbers of phosphorus, nitrogen and heavy metals in the water.

The results of the analysis shows that the water quality has improved with a significant decrease in conductivity from 1068 uS/cm, which is considered very high as a consequence of the industrial effluent discharge, to 987 uS/cm due to the removal of dissolved salts and solids also shown as Total dissolved solids that decreased from 544 ppm to 534 ppm

Constructed wetlands Mexico							
Locations	Temp (C)	pH	Conductivity (µS/cm)	DO (mg/l)	TDS (ppm)	Hardness (mg/l)	Alkalinity (mg/l)
inlet of the constructed wetland	22,5	6,87	1068	0,24	544	125	120
outlet of the constructed wetland	22	7,39	987	0,4	534	50	120



STUDY OF REMOVAL OF MICROPO- LLUTANTS FROM WASTEWATER BY ADSORPTION PROCESS BY USING HUMIC SUBSTANCE

Arati Panhalkar, Supervisor : Dr. Ulrike Gayh, Dr. Kenneth Bedu-Addo
SRH Hochschule Heidelberg

INTRODUCTION

A significant number of micropollutants, such as hazardous metals, medicines, pesticides, dyes, surfactants, and others, have contaminated water supplies and are harmful to people and other living things on the planet

PROBLEM STATEMENT

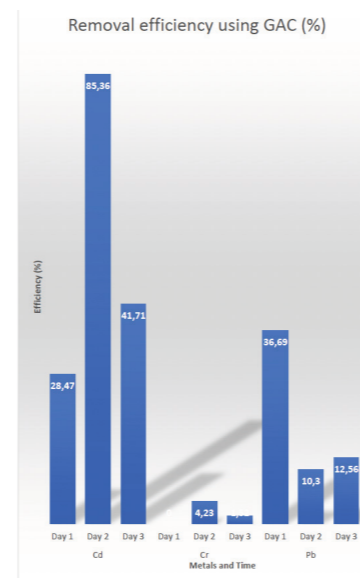
The small amount of micropollutant has a huge impact on the environment. It cannot be decomposed naturally. Treatment plants are not created to eliminate micropollutants particularly.

Objectives:

1. To check the removal efficiency of the Cd, Pb & Cr in adsorption using humic substances.
2. To observe the Cd, Pb & Cr removal efficiency of the Humic substances in comparison with activated carbon

MATERIAL AND METHODOLOGY

- A laboratory scale adsorption unit was designed (Fixed bed adsorption unit).
- Due to the properties of powhumus, high surface area soil was obtained from nekar, added to the dissolved powhumus in the soil, and left in the sun for 15 days. The soil was then included in the adsorption unit together with gravel and fine sand.
- In an adsorption unit, synthetic wastewater was created and processed. Three times the experiment was conducted .A HACH DR3900 spectrophotometer was used for the analysis of the treated water.

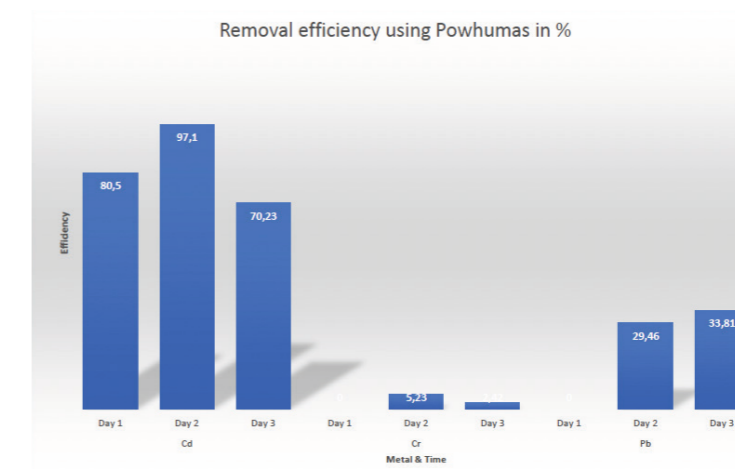


Results:

- Powhumus had a maximum removal efficiency of 97,1 %, 5,23 %, and 33,81 % for Cd, Cr, and Pb.
- GAC's greatest removal efficiencies for Cd, Cr, and Pb were 85,36 %, 4,23 %, and 36,69 %, respectively.

Conclusion:

- Initial and final concentrations of Cd, Cr, and Pb after treatment with fixed bed adsorption columns revealed that Cd was largely eliminated within the intended time range. However, fixed bed adsorption failed to remove the Pb and Cr.
- Pb and Cr required acidic pH.
- Based on the contact time, flow rate, medium weight, surface area, pH, temperature, particle size, and bulk density, fixed bed and mixed contactor adsorption can lower the concentration of Cd, Cr, and Pb



REFERENCES

- Perminova, I. V., & Hatfield, K. (2005). Remediation Chemistry of Humic Substances: Theory and Implications for Technology. In I. V. Perminova, K.
- Metcalf and Eddy I AECOM. (n.d.). Wastewater Engineering: Treatment and Resource Recovery (Fifth Edition). Mc Graw Hill Education
- \Briffa, J., Sinagra, E., & Blundell, R. (2020). Heavy metal pollution in the environment and their toxicological effects on humans. Heliyon, 6(9), e04691. <https://doi.org/10.1016/j.heliyon.2020.e04691>
- Abdulrazak, S., Hussaini, K., & Sani, H. M. (2017). Evaluation of removal efficiency of heavy metals by low-cost activated carbon prepared from African palm fruit. Applied Water Science, 7(6), 3151–3155.

STATISTICAL ANALYSIS AND MODELING OF SPATIO-TEMPORAL VARIATIONS OF AMBIENT FINE PARTICLES IN NOVI SAD

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Air pollution is affected by the traffic regime, meteorological parameters and different types of surface coverage of the observed area, leading to noticeable spatial and temporal variations in the concentration and composition of pollutants.

1. Research framework and aim

- Emphasizes statistical modeling of diurnal, temporal and spatial PM_{2.5} concentrations (conc.) in urban area
- Modeling and prediction of PM_{2.5} conc. for Novi Sad (NS) municipality by Land Use Regression methodology (LUR) on many locations
- Greater insight into NS air quality status
- New assessing approaches to population PM_{2.5} exposure

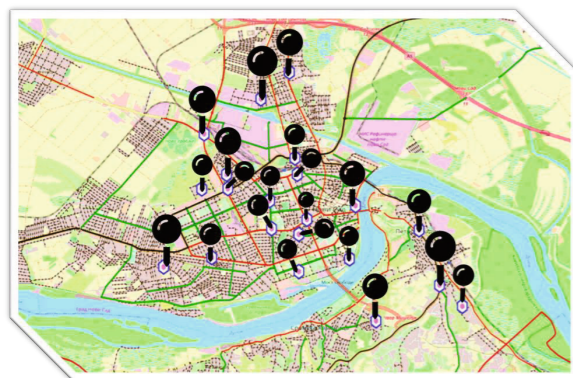


Fig. 1: Sampling map in NS and Petrovaradin and Sremska Kamenica

2. Sampling campaign

- Measured at 21 sites (non-heating (NHS) / heating seasons (HS) in 2020/2021) in urban (UZ), industrial zone (IZ), urban/industrial zone border (UZ/IZ) and urban background (BCG) site (Fig.1)
- PM_{2.5} were sampled using 4 low-volume samplers – Leckel LVSS3 with PM_{2.5} standard inlet and LCOPC – EKÖ “NET, Dunav Net with PMS7003 sensor for PM (Fig.2)
- Sampling duration of LVS was 48 h for 10 days (5 samples per site), LCOPC was measured continuously



Fig. 2: Sampling sites

3. Data modeling basis

- Consists of extraction and selection of potential predictor variables (PV) by the geographica information system (GIS), regression modelling, and model validation
- Dependent PV – measured PM_{2.5} conc. and independent PV – traffic intensity, land cover, meteorology data
- PM conc. estimation based on regression on unsampled localities, using different types of PV (Table 1.) at a specific location or area

Class	Potential predictor variables
Road type	Primary, secondary, tertiary, residential (25-1000 m buffers)
Road length	Total road length, distance to road, distance to different road types
Traffic count	Vehicles/day, different classes (25-1000 m buffers)
Land cover	Area covered by industry, multi-family residential housing
Meteorology	Temperature, wind speed

The regression equation:

- C – mean seasonal conc. – X_i – PV
- C₀ – measured PM_{2.5} conc. – ϵ – error
- α_i – PV coefficient

4. Research results

PM_{2.5} concentration ranges

In Table 2. and 3. – calibrated 24h LCOPC indicative measurements from 21 site during summer and winter ($\mu\text{g}/\text{m}^3$)

Day	UZ _{NS,P,SK}	UZ/IZ _{NS}	IZ _{NS}	BCG _{NS}
1	5.71-17.16	15.74	10.75	7.58
2	5.58-19.8	9.60	16.05	6.18
3	4.89-20.1	17.03	16.33	5.20
4	11-28-20.6	12.47	13.66	10.44
5	7.21-21	13.17	8.36	10.17
6	6.60-23.35	15.16	13.86	7.20
7	4.86-24.38	17.06	18.30	4.83
8	4.06-22.79	16.73	21.50	4.08
9	6.70-18.6	8.40	15.97	7.02
10	6.65-14.76	12.47	7.86	9.34

Day	UZ _{NS,P,SK}	UZ/IZ _{NS}	IZ _{NS}	BCG _{NS}
1	11.56-65.03	95.38	35.54	9.47
2	7.23-68.42	67.97	33.10	31.23
3	10.83-53.92	75.96	31.85	34.37
4	11.58-39.23	30.07	26.75	32.79
5	15.54-69.02	33.50	20.25	33.97
6	8.35-42.02	35.07	34.81	30.55
7	9.96-41.18	31.15	41.19	36.85
8	10.75-59.62	32.43	59.26	53.28
9	13.45-55.24	35.11	40.52	54.14
10	8.79-49.95	8.79	21.46	32.89

PV buffer analysis

Quantification of relationship between eg. secondary road type and PM_{2.5} (Fig.3)

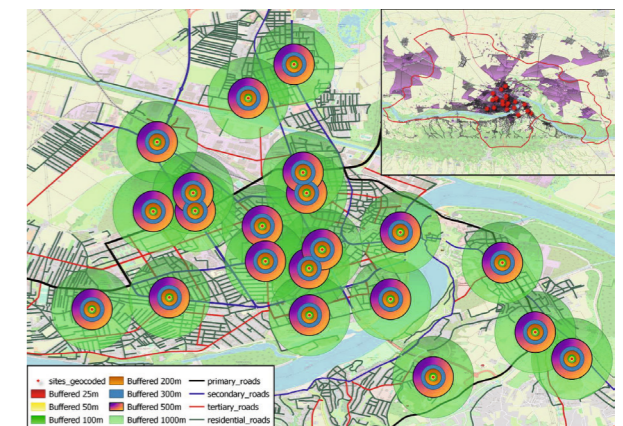


Fig. 3: Secondary road length buffer analysis

Air Quality Index on 21 site in NS (NHS and HS)



Fig. 4: AQI in NHS

Fig. 5: AQI in HS

Research significance

- First time conducted research in NS
- Tailor made-model for NS
- Better insight into the air quality of NS and possible new hot-spots
- Could be used in epidemiological studies
- Enable useful guidance to local and provincial authorities and support their strategic plans regarding air monitoring

ACKNOWLEDGMENT

This research (paper) has been supported by the Ministry of Education, Science and Technological Development through project no. 451-03-68/2020-14/200156

THE IMPORTANCE OF QUALITATIVE GOALS OF WASTE MANAGEMENT

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As a candidate country for European Union membership, Serbia is expected to implement solid waste management strategies that meet EU directives. The results of material flow analysis (MFA) and substance flow analysis (SFA) provide the necessary information when it comes to setting priorities. The role of waste management systems is becoming more significant due to increased production and consumption in all spheres. Systems must be developed and implemented in order to direct hazardous waste substances to appropriate intermediate and final sinks.

modelling waste management systems.

All results in the MFA can be controlled because their basic principle is based on the material balance comparing all inputs, stocks and outputs of a process.

MFA indicates that:

- Home composting has the potential to minimize biodegradable waste entering the collection stream
- Composting reduces the amount of waste that goes to landfills and contributes to compost production as well as well as the high recycling goal implemented by circular economy requirements.

The concentration of many substances in products is quite small but those small quantities of hazardous substances may have a significant effect on the circular use of large amounts of waste. Therefore, technologies should be developed in such a way as to be able to remove them from the cycle.

For a goal-oriented practice, quality and quantity are of equal importance.

Based on the results obtained, carbon can represent either

- the indicator of the potential of resources or
- negative impact on the environment

In order to implement sustainable waste management and meet the objectives of the landfill directive, it is necessary to introduce the diversion of biodegradable waste from landfills.

The software STAN has been applied for the modelled scenario.

MFA and SFA are widely used engineering tools for

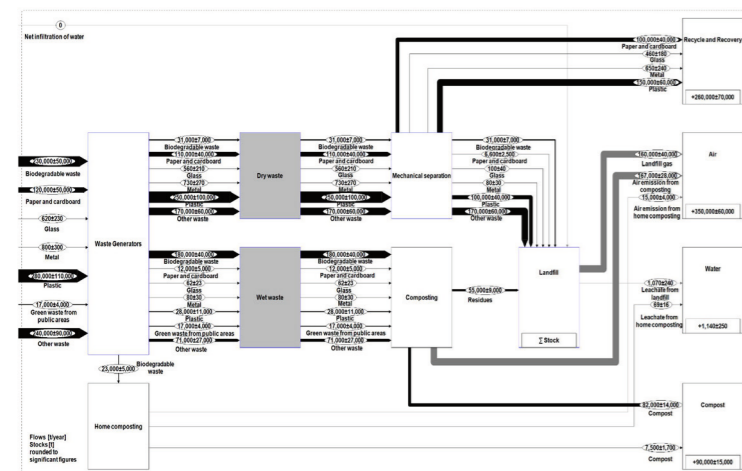


Fig. 1: C flow (Composting + 10% of Home Composting)

WATER FOREST WATER

Dr. Fernando Palacios Mateos
SRH Hochschule Heidelberg

Through reconceptualization of space, this project develops an interactive and interdisciplinary installation that addresses both the sound phenomenon in water nature, and its creative possibilities, and the nature of sound in the water.

From exploration as a procedural method, investigates materials, space and territory, in an interrelated way, as epistemological domains in sound art, from and through the water as the main element.

What is our perception of sound underwater? How does water activates our body and mind when we create sound and visual proposals under the surface? What does this element tell us from our environment? can we appreciate it and recognize ourselves as human beings in this ecosystem?

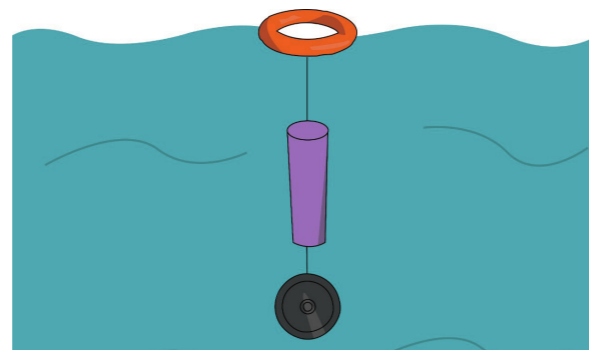
These are some of the questions that the project aims to answer.

Mobile devices will be developed. Energetically autonomous, with different sizes, that produces sound and visual chromatic proposals underwater through tactile activation, the devices will be arranged on the water surface. The participants should enter the water to interact with them. Besides, a system of hydrophones and water cameras will be set, to reproduce the audiovisual proposal outside the surface.

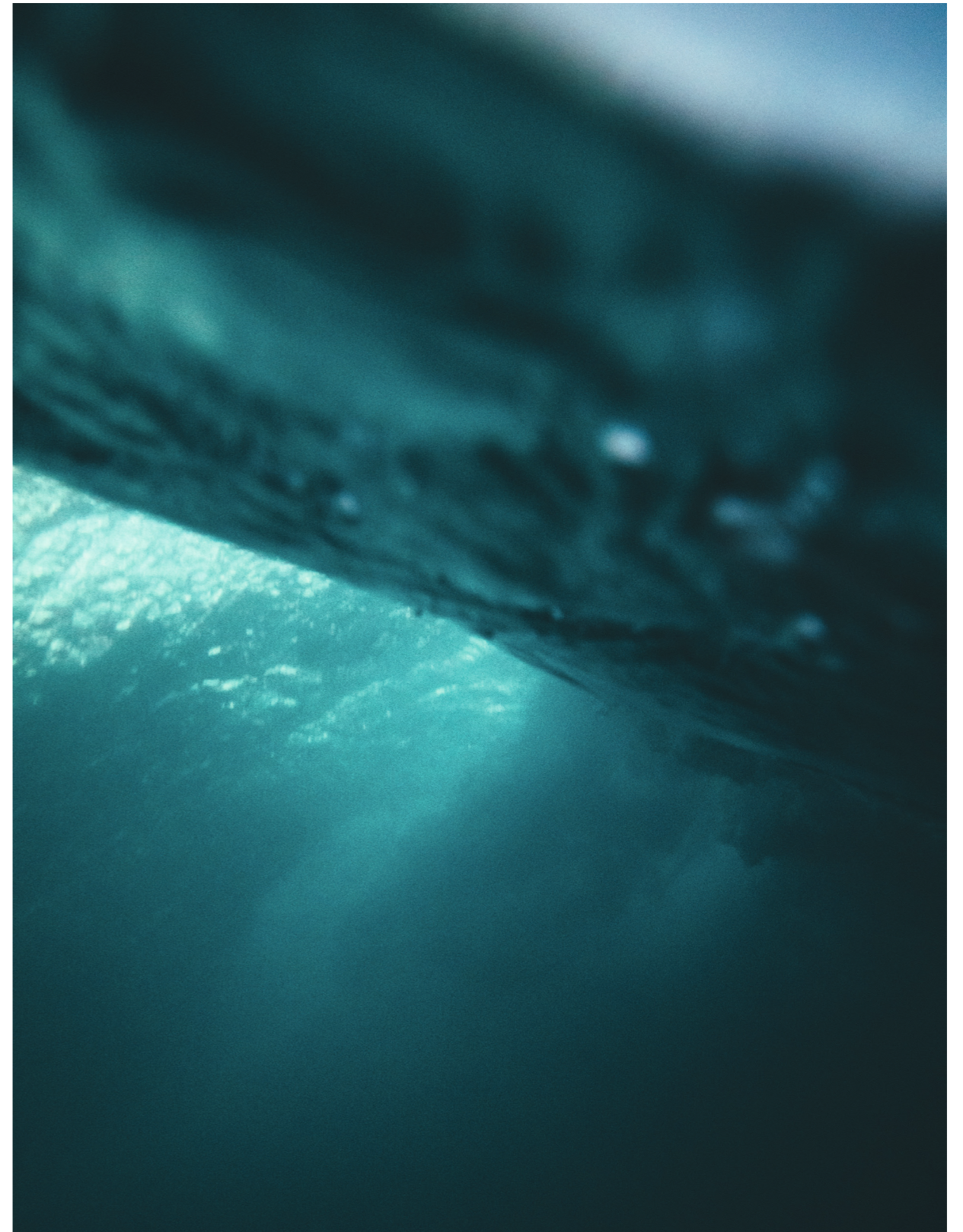
The river Neckar, a tributary of the Rhine, offers an aquatic path of communication that allows us, from the field of sound, to establish spatial and temporal links from the territory. Through the sounds of two factories located on the banks of the river Rhine, a relationship between the past and the present, the person and the water is established from a dialectical perspective.



Landschaftspark Duisburg-Nord



Thyssenkrupp Steel Europe plant in Duisburg



THE FLOW PROJECT

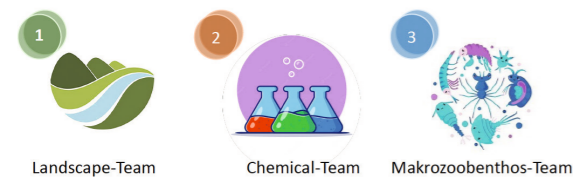
SRH Hochschule Heidelberg, Water Technology

INTRODUCTION

FLOW is a project for the ecological monitoring of flowing waters. The monitoring aims to investigate and evaluate the ecological condition of water bodies together with citizens.

The Ochsenbach and the Lobbach were examined with the BUND group in May and July 2022.

METHODOLOGY



LANDSCAPE ELEMENTS

In Ochsenbach, the stream flow was 0.28 m³/s in May but increased to 0.315 m³/s in July, while the flow of Lobbach decreased from 0.315 m³/s to 0.2969 m³/s. The results are based on the index WFD, 2000. According to the index, Ochsenbach had 3.00 quality classes in May but 2 quality classes in July. On the other hand, Lobbach received 2.00 Gütekasse in both May and July, representing slightly different values. Details can be seen in the QR code.

MAKROZOOBENTHOS

Similarly, all the substrate mapping found in Ochsenbach and Lobbach is shown in the bar chart. Algae, wood and dead wood, living parts of terrestrial plants, sand, clay and clay, stone, etc. were found. Looking at the spear, Ochsenbach also received a poor score on pesticides of 0.24 and a TU of -0.52, while Lobbach received a good score on pesticides of 0.67 and a TU of -3.79. Details of the macrozoobenthos can be found in the QR code.



Fig. 1: Ochsenbach in Schatthausen

Date: 10.05.2022, 13.07.2022

GPS-Coordinate: 49°19'19.34"N, 8°44'50.6"E

Fig. 2: Lobbach in Haag

Date: 24.05.2022, 14.07.2022

GPS-Coordinate: 49°23'22.49"N 08°55'09.17"E

Ochsenbach

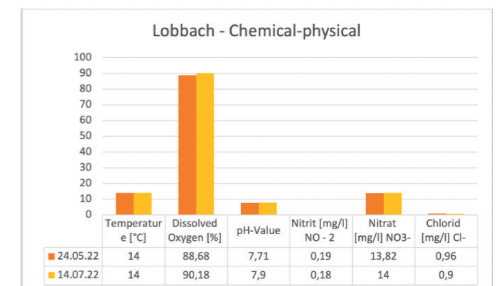
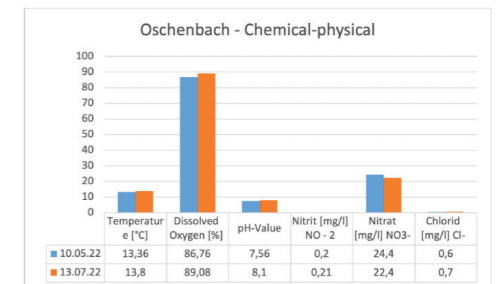
SPEAR pesticides	EQ pesticides	TU estimated
0.24 IV: Poor		-0.52

Lobbach

SPEAR pesticides	EQ pesticides	TU estimated
0.67 II: Good		-3.79

CHEMICAL-PHYSICAL

From the bar chart, we can see in both Ochsenbach and Lobbach that all parameters are more or less in the same range for a given date. Temperature, pH and chloride were very good (Not loaded), DO, nitrite, and conductivity were good (Little loaded), and the nitrate value was neutral (Moderately loaded). Overall, the parameters look good. Details of the chemical-physical can be found in the QR code.



DISCUSSION

- The SPEAR index for Ochsenbach was quality class 4 (poor), Lobbach was quality class 2 (good).
- The condition of the water body in Ochsenbach was quality class 3 (moderate) in May and quality class 2 (good) in July. The condition of the Lobbach water body was quality class 2 (good) in both May and July.
- The Ochsenbach is located near an agricultural environment. This could be the trigger for the elevated nutrient levels and pesticide contamination.
- Several macrozoobenthos species were found, some with high numbers of individuals. Apart from the pollutant and nutrient inputs, the Lobbach appears to be in good condition compared to the Ochsenbach.



Makrozoobenthos

REFERENCE

The SPEAR index is a trait-based biological indicator "SpeciesAtRisk" for analyzing pesticide exposure at a sampling site via macrozoobenthos community composition, see Knillmann et al, 2018; Liess & Von Der Ohe, 2005. See also: <https://www.ufz.de/index.php?de=38122>

Knillmann, S., Orlinskiy, P., Kaske, O., Foit, K., & Liess, M. (2018). Indication of pesticide effects and recolonization in streams. Science of The Total Environment, 630, 1619–1627. <https://doi.org/10.1016/j.scitotenv.2018.02.056>

QR-Code:



WATER EXCURSION

Master Program of Water Technology

INTRODUCTION

The aim of this excursion was to investigate the ecological condition of the water bodies in Southwest Germany.

METHODOLOGY

In situ measurements using Probes, Multimeter, and Test strips and Ex situ measurements using Spectrophotometer.



Fig. 1: Water Karst Excursion 2021

RESULTS

Water Karst Excursion 2021								
Samples	Temp	pH	Cond	DO	SO ₄ ²⁻	NO ₃	PO ₄	COD
1 Rutschenbrünnele	11	7.21	555	5.51	73.5	4.16	0.147	154
2 Aachquelle	14	7.29	468	7.58	70.7	3.81	0.137	169
3 Danube river	22.9	7.08	815	7.9	70.2	2.73	0.372	1729
4 Schluchseel	18	7.33	993	8.19	70.1	1.01	0.187	2055
5 Reinfall 1	BDL	-	BDL	BDL	69.6	1.27	0.253	BDL
6 Center of Caves	16.7	7.16	581	9.5	68.8	7.6	0.331	4139
7 Inside the caves	BDL	-	BDL	BDL	68.4	5.3	0.154	BDL
8 Entarance of caves	BDL	-	BDL	BDL	69.7	2.55	0.277	BDL
9 Jagerhouse	14	8.16	423	90	71.3	2.76	0.157	4486
10 Donauquelle	BDL	-	BDL	BDL	77.5	3.48	0.198	BDL
11 Fall Water	14.6	8.04	589	9.74	68.8	2.65	0.137	BDL
12 Mossigen	15	7.4	767	2.85	134	0.519	BDL	179
13 Upstream water fall	BDL	-	BDL	BDL	68.9	4.95	0.194	BDL
14 Reinfall 2	18	8.38	356	9.977	71.3	1.03	0.148	124

BDL: Below Detection limits, Temp: Temperature in degree Celsius, Cond: Conductivity in µS/cm, DO: Dissolved oxygen in mg/L, SO₄²⁻: Sulphate in mg/L, NO₃: Nitrate in mg/L, PO₄: Phosphate in mg/L, COD: chemical oxygen demand in mg/L, Chro: Chromium in mg/L



Fig. 2: Water Karst Excursion 2022

Water Karst Excursion 2022										
Samples	Temp	pH	Cond	DO	TDS	Turb	Sal	NO ₃	SO ₄ ²⁻	Chro
1 Boat shed	20.1	8.03	412	7.68	293	0.25	BDL	2.19	83	0.013
2 Danube sink hole	25.9	8.77	807	16.52	585	BDL	0.24	15	87.5	0.018
3 Jägerhaus	22.6	8.24	561	7.35	399	BDL	0.28	2.92	80.5	0.026
4 Pfuhrer See	26.1	8.41	585	12.92	411	BDL	0.29	1.16	85.5	0.018
5 Danub neu ulm	21.5	8.33	587	8.4	418	BDL	0.29	3.82	81.8	0.02
6 Dischingen lake	12.8	7.42	615	9.61	442	BDL	0.32	10.9	79.3	0.021
7 Ega lake	12.9	7.65	599	9.86	427	BDL	0.28	8.44	79.8	0.018
8 Karst water	16.7	7.41	619	BDL	443	BDL	0.32	10.9	79.4	0.017
9 karst and donau	16.7	7.32	892	BDL	583	BDL	0.45	11.4	90.8	0.019

BDL: Below Detection limits, Temp: Temperature in degree Celsius, Cond: Conductivity in µS/cm, DO: Dissolved oxygen in mg/L, SO₄²⁻: Sulphate in mg/L, NO₃: Nitrate in mg/L, PO₄: Phosphate in mg/L, COD: chemical oxygen demand in mg/L, Chro: Chromium in mg/L

CONCLUSION

Overall ecological condition of the water bodies in southwest Germany was found to be in good ecological condition.

REFERENCES

Chemical Quality Standards and Assessment Umiltbundesamt
https://www.umiltbundesamt.de/en/topics/water/rivers/assessment_of_watercourses/chemical_quality_standards_assessment

YIP-PROTOTYPE:

ADSORPTION PROCESS

Jidapa Kasipiyawong

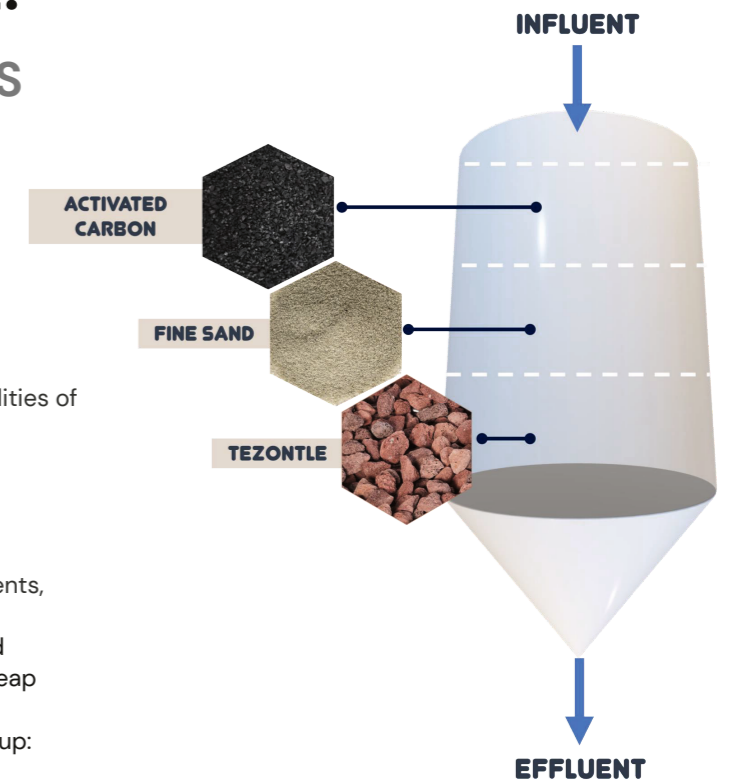


Fig. 1: Schematic diagram of prototype (Adsorption part)

INTRODUCTION

NEEDS according to Adequate technology:

- In accordance with the management capabilities of the locality:
 - Easy installation
 - Easy to build (simple design)
 - Easy to use
- Flexible design to environmental changes: Multi-assembly (adaptable to site requirements, flexible)
- Low costs for implementation, operation and maintenance: Low economic investment, cheap material (Affordable)
- Solve a specific need of a specific social group: Drinkable water
- Open technological knowledge, multipurpose, Reversible, Recoverable, Understandable, Participative and Socially responsible.

METHODOLOGY

Main component

- Activated carbon:** It is useful to remove chemicals which gives odor or taste, e.g. Hydrogen sulfide or chlorine. It is also helpful to remove heavy metals
- Fine sand:** For the removal of floating and sinkable particles as well as suspended materials.
- Tezontle (Volcanic rock):** These are effective at filtering surface contaminants and can store water like a sponge due to their tiny pores.

EXPECTED OUTCOME

The prototype can be used to decrease pollutants for wastewater discharge to water bodies.

RECOMMENDATION

To improve treatment efficiency, a coagulation system with alum dosage should be included before to the adsorption process.

REFERENCES

Haba Prieto (2014): Adequate technology, Quintanilla

SUMMER SCHOOL "NECKAR NOW III"

The School of Engineering and Architecture presented the Third Interdisciplinary Summer School "Neckar Now: "Transformative approaches to a sustainable future — cities for Children", which took place from 22nd until 28th of August 2022.

This year, the event had the opportunity to have a very specific location and assignment towards the improvements of our city for the integration of the children. Owing to the pandemic and its complications involved, we as humans realize just how unprepared our environment is to face this kind of situation, and if there is a thing, we learned from COVID-19, it is

MAIN QUESTIONS

1. How to create an intergenerational experience?
2. How to integrate educational elements?
3. How can we adapt what is already there to the project? (Topography, trees, views...)
4. How can we integrate the community?
5. How can we create spaces that allow different kinds of appropriation?

From the shadowing of well-known professionals with their expertise based on the subject of this year, the impressive results we could bring is that different kinds of suggested questions helped to identify the needs and desires of how the community or neigh-

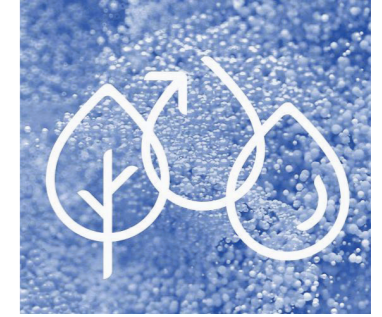
that we need to develop more inclusive and sustainable spaces for the wellbeing of our society.

The participants explored the place for a site analysis in the Basketballplatz in Neckarwiese, Heidelberg. Five groups, with contestants from different disciplines and thirteen diverse countries, were overcome with new perspectives to demonstrate that the place may be intervened in creating a unique and interactive space according to the topic of this year.

bourhood wants a change in the place (recreation, relaxation, interaction, etc), and how as intervenient can bring something that works accordingly to their needs colliding at one point. Site visits for analysis, brainwriting with the 365 method, a milestone presentation, and improvement of it where the five main questions were analyzed and developed alongside expert feedback gave the participants the ability to enhance different approaches.

From the idea of creating a sensory environment and shade for those sunny days through shadow kites, the development of methods and analysis of the site to the reused of activities were some of the concepts implemented as an outcome of this Summer School project.





IFAT MUNICH 2022

MAY 30TH–JUNE 3RD, 2022

TRADE FAIR CENTER MESSE MÜNCHEN

Jidapa Kasipiyawong

Participants: SRH Hochschule Heidelberg; University of Novi Sad



The World's Leading Trade Fair for Environmental Technologies boasts a high international presence and an impressive number of exhibitors and visitors.

IFAT provides a platform for individuals, businesses, and other organisations to share the latest developments in environmental technology, and water, sewage, waste, and raw materials management.



Learned about environmental technologies:

1. Ultra Fine Screens

- for the separation of very fine particles
- remove undegradable and degradable, inorganic and organic material at the same time

2. High Performance Membrane Bioreactor (MBR)

- the most efficient biological wastewater treatment systems
- compact wastewater treatment systems (Small footprint)
- elimination of COD, ammonia, and nitrogen
- concentrate free direct discharge
- Reference plant: Thaioil Clean Fuel plant, Thailand

3. Maximum Yield Technology (MYT®)

- utilization of residual household waste treatment
- covering the raw material and energy content of the waste
- energy sources (fuels, biogas)
- Reference plant: the waste treatment plant Onnut, Thailand



4. Ozone Systems

- the strongest oxidant used in water treatment
- elimination of odour and taste
- oxidation of iron, manganese, arsenic
- reaction with organic substances (breaking into smaller molecules)
- cyclic compounds are broken down

5. Digitalization in the German water sector

- Virtual Reality (VR) technology for wastewater treatment plant simulation
- Moodle Platform (presented by Aditi Das SRH student)



VISIT TO NOVI SAD, SERBIA

A DEMOCRATIA AQUA TECHNICA PROJECT

Hamza El Ouassif
SRH Hochschule Heidelberg

INTRODUCTION

Democracia Aqua Technica project is a cooperation between SRH Hochschule Heidelberg and the University of Novi Sad that focuses on the development of innovative solutions for sustainable water resource management to promote the reduction of water conflicts.

NOVI SAD WATERWORKS

Novi Sad waterworks, the groundwater is treated before supplying it to a population of 250 439 inhabitant. The groundwater is in exploitation by 12 wells, with a flow rate between 100 l/s to 120 l/s. The water is then taken into five treatment stages.

Aeration process: In the first stage, the water enters through the top of the unit, is brought in contact with the air in order to remove dissolved gases, and oxidizes dissolved metals, then collected in the bottom of the unit and transported to the next stage. Automatic monitoring of heavy metals is done in the inlet of this process using a control and an analytical unit due to the characteristic of the groundwater in Serbia that contains a significant amount of heavy metals (Arsenic, Mercury, Lead, Cadmium...).

Filtration process: in this stage, sand filters are used for the removal of suspended matters (manganese in particular).

Ozonation process: it's an advanced oxidation process that involves the production of very reactive oxygen species able to attack a wide range of organic compounds and all microorganisms.

Granular activated carbon process: GAC filter helps remove certain chemicals, particularly organic ones, that give water objectionable odours or tastes.

Chlorination process: the final stage is a disinfection stage using chlorine dioxide, which can kill bacteria and microorganisms.



LABORATORY OF NOVI SAD FACULTY OF SCIENCE & DEPARTMENT OF ENVIRONMENTAL ENGINEERING

The laboratory in the chemistry department at the University of Novi Sad is considered highly sophisticated since it got its accreditation to perform analysis for commercial purposes.

The most common devices used in the labs are High Performance Liquid Chromatography (HPLC), Flame Ionization Detector (FID) and Mass Spectroscopy (MS)...

The water lab present in the department of environmental engineering is also accredited. Analysis for water and wastewater quality can be performed at high level of accuracy. Many devices are used to get those detailed parameters such as spectrophotometer, HPLC... the students carried out an experiment to determine the concentration of Ammonium in two samples, one from landfill leachates and one from domestic wastewater and to test out some lab devices.

DANUBA-TISA-DANUBE CANAL

The Danube-Tisa-Danube canal is used for transportation and navigation purposes. The area visited is where the water level is calibrated for the ships to cross the Danube River easily. A sampling test was carried out using a grab sampler device that removes the sediments from the bottom of the canal. The major problem in the canals is that in some period of the year a significant amount of sediment settle down in the bottom and decrease the water depth, making it hard for ships and boats to navigate freely.



INNOVATIVE TECHNICAL SOLUTION CONCEPTS FOR SUSTAINABLE WATER RESOURCE MANAGEMENT TO PROMOTE THE REDUCTION OF REGIONAL AND LOCAL DISTRIBUTION CONFLICTS

WATER
THE MOST IMPORTANT RESOURCE ON OUR PLANET



DEMOCRATIA AQUA TECHNICA

SRH HEIDELBERG
PROF. DR. ULRIKE GAYH

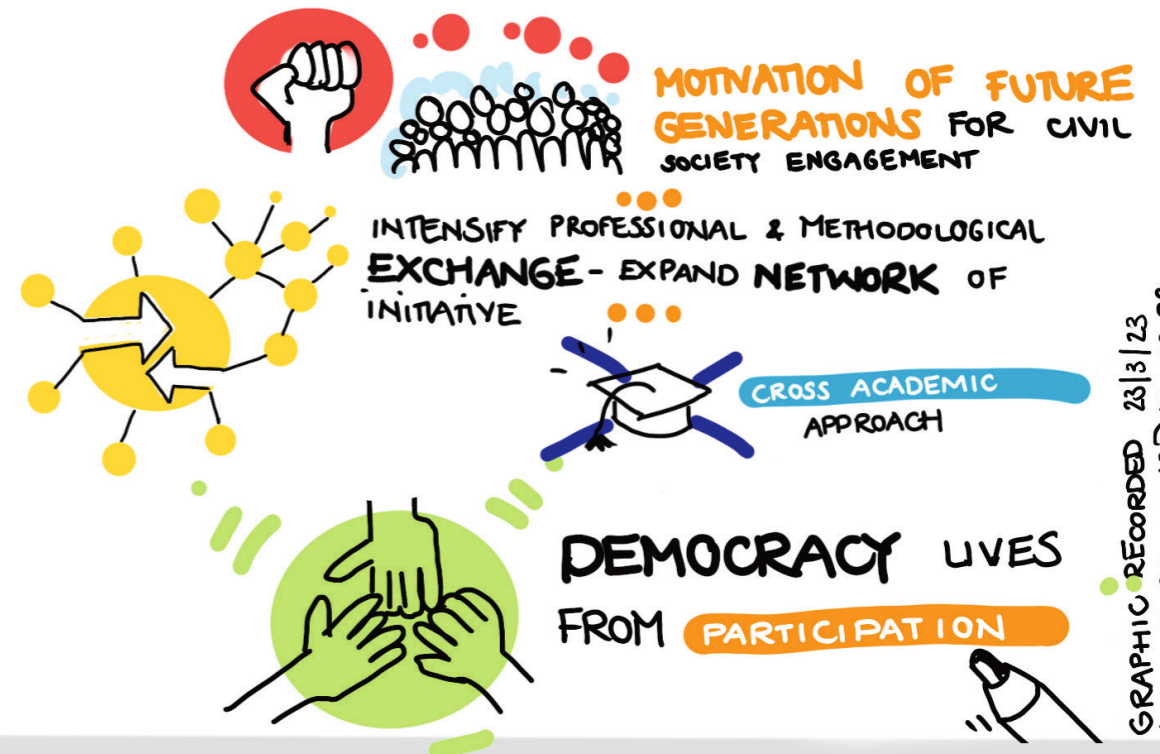
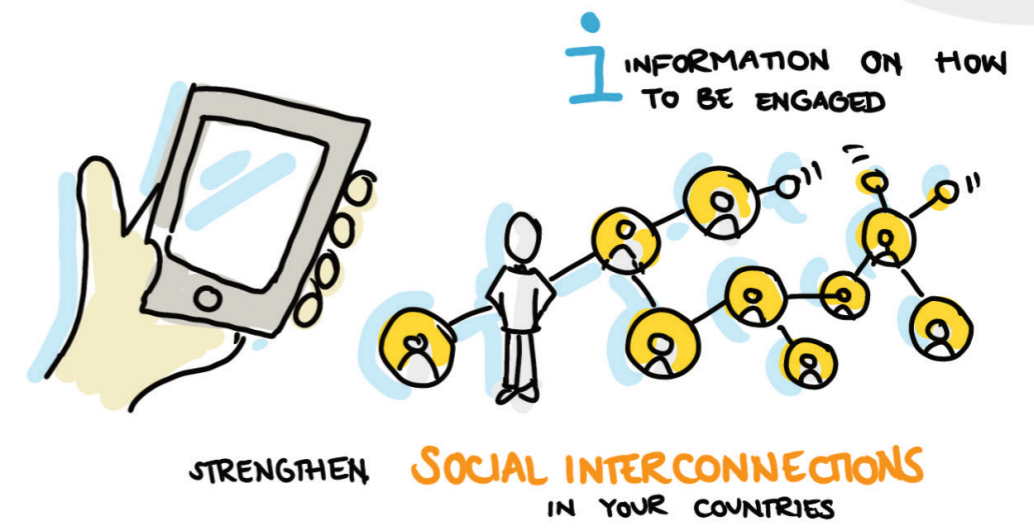
UNIVERSITY OF NOVI SAD
PROF. DR. MAJA TURK-SEKULIC

3 PROJECT BASED EVENTS



INITIATIVE DAT

Democratia-Aqua-Technica III: focus on water conflicts related to water pollution



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