DEMO CRATIA

DEMOCRATIA – AQUA – TECHNICA

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Funded by the DAAD from funds of the Federal Foreign Office:

DAAD Deutscher Akademischer Austauschdienst
German Academic Exchange Service

Federal Foreign Office

EDITORS
Prof. Dr. Maja Turk-Sekulić
Prof. Dr. Ulrike Gayh
Prof. Dr. Elena Gogina

GRAPHIC CONCEPT
SchulzundSchramm GbR

LAYOUT AND TYPESETTING
SchulzundSchramm GbR

COVER DESIGN
SchulzundSchramm GbR

PROOFREADING
Dr. Augustine Ntiamoah

ORGANIZER
SRH University Heidelberg
University of Novi Sad
Moscow State University of Civil Engineering
Middle East Technical University

FURTHER CONTRIBUTORS
Prof. Benjamin Zierock

ISBN E-PUB
978-3-9822521-5-5

FUNDED BY
The DAAD from funds of the Federal Foreign Office
DAAD – German Academic Exchange Service

09 Foreword

12 SRH Hochschule Heidelberg

14 University Of Novi Sad

16 Middle East Technical University

18 DEMOCRATIA AQUA TECHNICA II

20 The Program I

24 East-West-Dialogue

26 Moscow State University of Civil Enigeering

30 The Program II

34 Water Wars:
How Control Of Access Contributes To International Conflicts

36 Shared Vision Planning – a method for solving regional conflicts

40 Support Of Sustainable Development:
Ecologically And Economically Beneficial Technologies For The Removal Of Emerging Micropollutants From Wastewater Effluents

42 Ideation In Global Teams

44 Cooperative International Education In Humanitarian Engineering

48 Application Of Science In Environmental Decision Making: Alternative Monitoring Of Dissolved Lipophilic Organic Pollutants In The Danube River

50 Sustainable Water and Wastewater Processing

56 Water Footprint Concept In German SME's
Analysis And Outcome

58 Sediment Formation In The Urban Collector System

60 Water Quality Control For Semi Enclosed Coastal Waterbodies

68 Operations Research As Case Studies For Conflict Management

71 Simulation Of A Pressure Swing Adsorption Process For Biogas Upgrading

72 Evaluating Process Of Low-Cost Devices And Their Efficiency For Air Quality Monitoring

74 Development Of Sludge Waste Management Models In Serbia

76 Improvement In Performance Of Anaerobic Digestion Via Conductive Materials; Granular Activated Carbon And Hematite

78 Water Pollutants In Aquatic Environment, Toxicity Potential On Water Quality: A Case Study Of Tanzania

80 PM Emissions As A Consequence Of Cooking Activities

84 Enhanced Removal Of Ciprofloxacin Using Humic-Acid Modified Hydrogel Beads

86 Clean Water and Sanitation from the Aspect of the Covid-19 Pandemic

88 Creating Interactive Posters with Augmented Reality

90 Digital City Rally Heidelberg: Water And Architectural Highlights Of The City

92 Digital rally on Novisad, Ankara & Moscow

94 Initiative Associations

96 Partner

FOREWORD

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.
In 2021 two projects have been funded in the frame of this initiative:

The DAAD programme „Ost-West-Dialog: Hochschuldialog mit den Ländern des westlichen Balkans 2021" funded the project Democratia-Aqua-Technica II. The SRH University Heidelberg, the University of Novi Sad and the Middle East Technical University worked in this project.
In addition, the DAAD programme "Ost-West-Dialog. Akademischer Austausch und wissenschaftliche Kooperation für Sicherheit, Zusammenarbeit und zivilgesellschaftliche Entwicklung in Europa 2021" funded the joint project of the SRH University Heidelberg and the Moscow State University for Civil Engineerung

Due to the Covid-19 pandemic, the whole project plan of both projects changed into a digital format. With a cross-media approach with different digital components the projects could be successfully realized.

This E-book provides an overview about the different projects and the different contributions to our conferences. Thanks to all participants and partners who made the projects and conferences that exciting to everybody.

In 2022 we will continue with both projects focusing on water conflicts related to water pollution. We are looking forward to carry out the third Democratia-Aqua-Technica conference in September 2022.

PROF. DR. ULRIKE GAYH
PROF. DR. ELENA GOGINA
PROF. DR. MAJA TURK SECULIC
PROF. DR. YASEMIN DILSAD YILMAZEL

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.

PROF. DR. MAJA TURK-SEKULIĆ

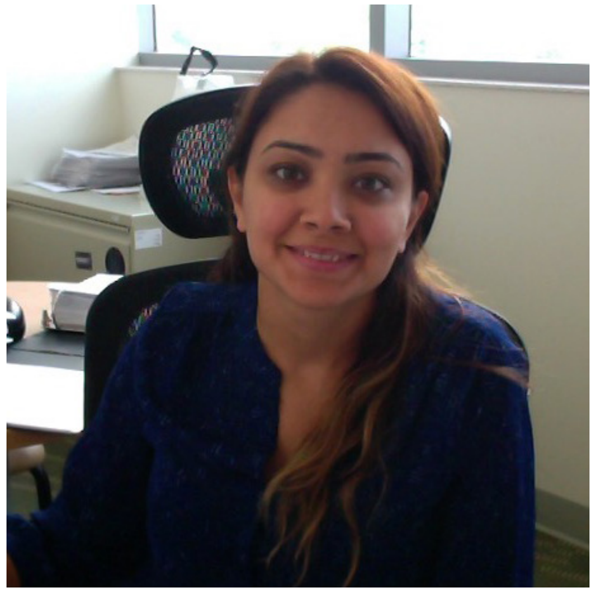
Maja Turk-Sekulić is a Professor of Environmental Engineering at the Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad. She is a Chair of Master´s academic studies program Water Treatment and Safety Engineering, and Vice 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.

ASS. PROF. DR. ELENA GOGINA

Elena S. Gogina, Candidate of Technical Sciences (PhD), Associate Professor of the Department of Water Supply and Wastewater treatment, Moscow state university of civil engineering, Scientific Director of the Scientific and Educational Center "Water Supply and Sanitation", Advisor to the Russian Academy of Architecture and Construction Sciences, Corresponding Member of the Russian Academy of Natural Sciences. The scientific interests of E.S. Gogina are related to the optimization of the operation of treatment facilities, deep biological treatment of wastewater, as well as to the issues of energy conservation in the field of wastewater disposal. With her active participation, more than 40 research and development projects have been completed. In total Gogina E.S. has more than 140 scientific, educational and methodological works, several patents and monographs. Currently Gogina E.S. actively supervises the scientific work of students, graduate students of the department. E.S. Gogina was awarded with diplomas of the Ministry of Education and Science, the Ministry of Construction and Housing and Communal Services.

DR. YASEMIN DILSAD YILMAZEL

Dr. Yasemin Dilsad Yilmazel received her B.S. degree with a dual major in Environmental and Chemical Engineering from the Middle East Technical University (METU) in Turkey. She received her M.S. in Environmental Engineering from METU, while she was a visiting researcher at the University of Stuttgart in Germany. Her research focused on nutrient recovery and value-added product formation from waste materials and residues of biogas plants. In 2014, Dr. Yilmazel received her Ph.D. in Engineering from Villanova University on the topic of hyperthermophilic biohydrogen production from fermentation of renewable feedstocks such as wastewater biosolids and plant biomass. Upon receipt of her Ph.D., Dr. Yilmazel joined Dr. Logan's lab at the Pennsylvania State University as a postdoctoral researcher where she began her research on microbial electrochemical technologies. Between 2016-2018, Dr. Yilmazel worked at Rochester Institute of Technology (RIT) in New York, USA in the Department of Chemical Engineering as an Assistant Professor. Since 2018 Dr. Yilmazel has been working in the Department of Environmental Engineering and leading the Bioprocess Engineering Research Group (BIOERG). Her current research is focused on bioelectrochemical systems for biofuel production from waste materials.



THE BACKGROUND

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. Co-operation 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.

THE BACKGROUND

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.

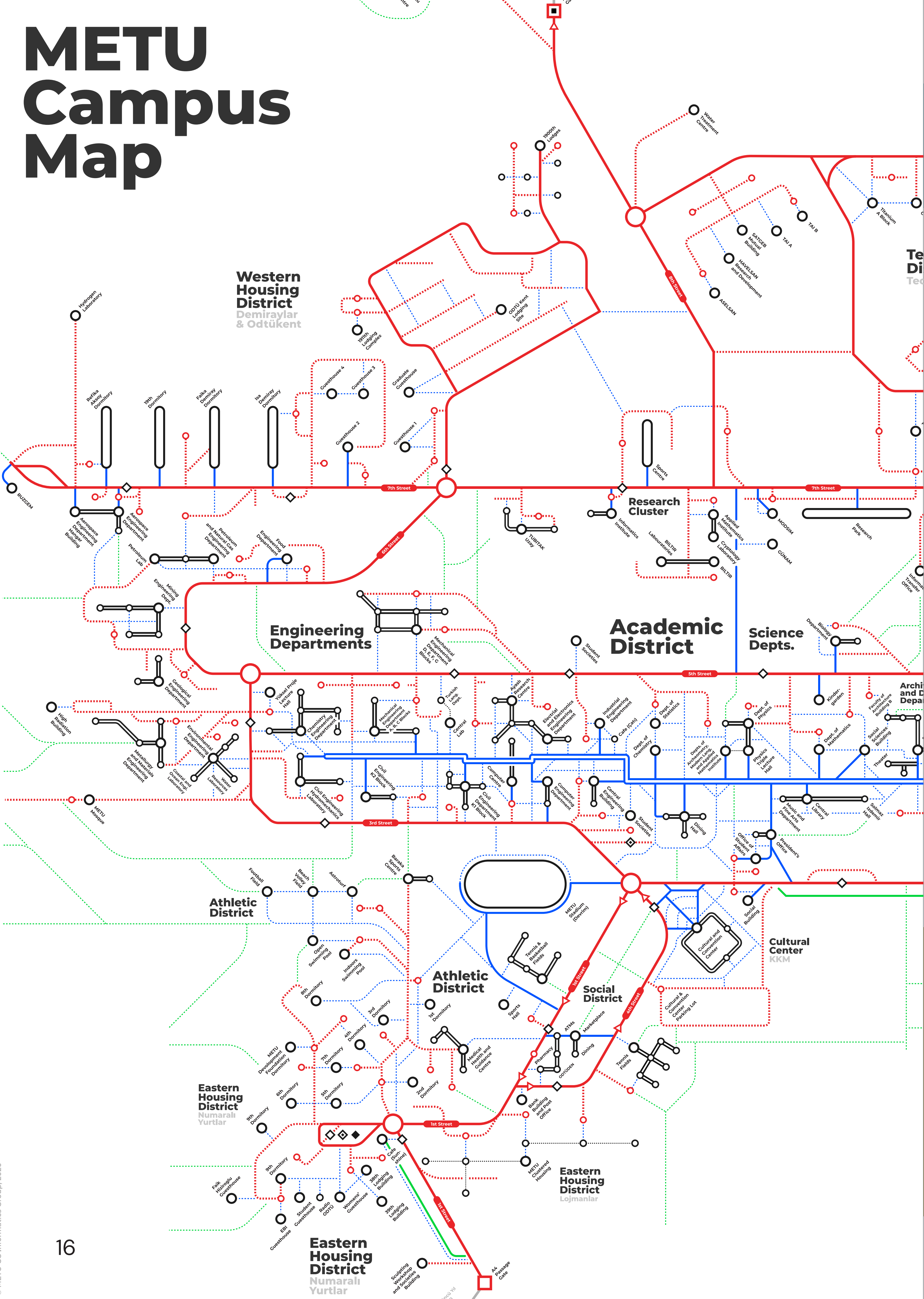
A regional leader in technology transfer, over the last two decades FTN has spun off over 100 companies, mostly in the domain of ICT, with a turnover of 100 million euros, making this the most important industry locally. To illustrate the dynamics, 40 of these companies were created between 2005 and 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 10,000m^2 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.

METU Campus Map



MIDDLE EAST TECHNICAL UNIVERSITY

Middle East Technical University, or Orta Doğu Teknik Üniversitesi, (METU – ODTÜ), founded in 1956, is an international research university, which seeks excellence in serving the country, region and the world. The university is located in the capital of Turkey, in Ankara. The well-deserved reputation of METU is partly a reflection of its leading position in terms of international scientific publications and share of research funds from national scientific research funding agencies, primarily the Scientific and Technological Research Council of Turkey (TÜBİTAK), among the most prominent universities of Turkey. Moreover, METU – as an international research-intensive university – is among the leading universities in Turkey in terms of depth and breadth of international research projects and the amount of funds generated from research activities. Research revenues account for 20-25% on average of annual METU expenditures, including all payroll costs.

METU has 41 undergraduate programs within 5 faculties. Additionally, there are 5 Graduate Schools with 105 masters and 70 doctorate programs and a "School of Foreign Languages" which includes the English Preparatory Department. Among 5 faculties, Faculty of Engineering forms one of the most preferred faculties, harboring 14 Engineering Departments.

The Department of Environmental Engineering (DEE) was established in January 1973 in response to the growing concern for the environment and the need for fully qualified engineers capable of undertaking professional responsibilities for optimum development and prudent management of water, air and land resources. The Department evolved from the Sanitary Engineering division of the Civil Engineering Department, which had been offering graduate courses in this field since 1967. In DEE only graduate degree (MS) was offered first. In 1978, the undergraduate program was established and has been accepting students since then. The Department offers the degrees in Bachelor of Science (B.S.), Master of Science (M.S.) and Doctor of Philosophy (Ph.D.). There are currently 13 faculty members and their research interests include but not limited to wastewater treatment, drinking water analysis and quality assessment, solid waste management, environmental modeling, biological and bioelectrochemical processes, environmental biotechnology, water-energy-food nexus and hazardous waste management. The department fully supports international collaboration and has a large number of past collaborations.

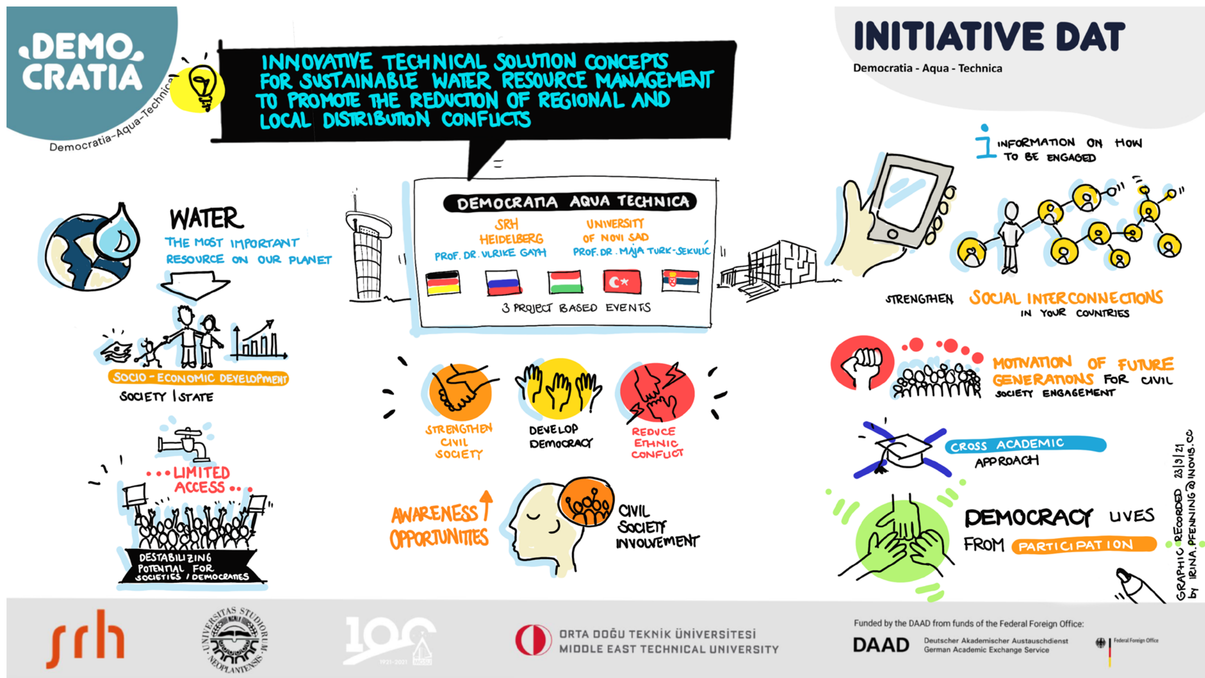
DEMOCRATIA AQUA TECHNICA II

Democratia – Aqua – Technica is a DAAD-financed project within the research programme "Hochschuldialog mit den Ländern des westlichen Balkans" (Higher Education Dialogue with the countries of the Western Balkans).

The interdisciplinary network Democratia – Aqua – Technica, founded in 2019, was initiated by SRH University of Applied Sciences Heidelberg in cooperation with the University of Novi Sad. Three project-based events have been planned under this initiative with partner universities from Russia, Hungary, and Turkey.

The focus of this partnership is on the development of innovative technical solution concepts for sustainable water resource management to promote the reduction of regional and local water-based conflicts and the motivation of the "next generation" for civil society engagement. Building on the experience and results of the first series of events in 2020, University Heidelberg and the University of Novi Sad, together with Middle East Technical University (METU, Turkey), as a new project partner, plan to hold four project-based events to continue with the development of solution concepts. Due to the Corona Virus pandemic, the events planned for 2020 could only be implemented digitally. The focus of the follow-up project is on the in-depth practical implementation of the initial solution approaches developed.

The planned events include a hackathon, a study visit to Germany with a visit to the ACHEMA trade fair, a practical Young Scientist Research Week in Serbia, and a final digital conference. Following a cross-academics approach, the group of participants includes different academic qualification levels (graduate students, PhD students and scientists), who will work together in international and interdisciplinary groups on a project basis across the four events.



SCOPE OF THE PROJECT

The history of many countries is characterized by struggles over natural resources. The resource water is of central importance for the socio-economic development of a society or a state. If this access is restricted, e.g. by pollution, overuse or political conflicts, the associated decline in the social standard of living and general dissatisfaction can lead to massive intra-societal tensions, which have an enormous destabilizing potential for democratic forms of government and society. Both resource scarcity and resource abundance act as internal destabilizing factors through the resulting competition for distribution. This distributional competition occurs between different user groups, e.g., between agriculture and industry, urban and rural populations, or between ethnic groups. In addition, weak rule-of-law structures create a fertile breeding ground for corruption and clientelism in water policy and management.

Because of its importance, water as a resource is often politicized and/or ideologized. Political goals such as maintaining power, regional dominance or ideological dominance outweigh the question of technical solutions for demand-oriented distribution. Whether water supply and wastewater disposal, freshwater production, or water treatment – the spectrum of water technology options for promoting water resource management geared to local and regional needs is diverse and very promising in terms of promoting the reduction of conflicts. Complementary to the technological perspective, water partnerships as alliances between state institutions, companies and civil society actors can make an important contribution to conflict reduction and growth of democracy.

The DAAD is the world's largest funding organisation for the international exchange of students and researchers. The motto of the DAAD is "Change by Exchange". Since it was founded in 1925, around two million scholars in Germany and abroad have received DAAD funding. It is a registered association and its members are German institutions of higher education and student bodies. Its activities go far beyond simply awarding grants and scholarships. The DAAD supports the internationalization of German universities, promotes German studies and the German language abroad, assists developing countries in establishing effective universities and advises decision makers on matters of cultural, education and development policy. More about the DAAD on their website.

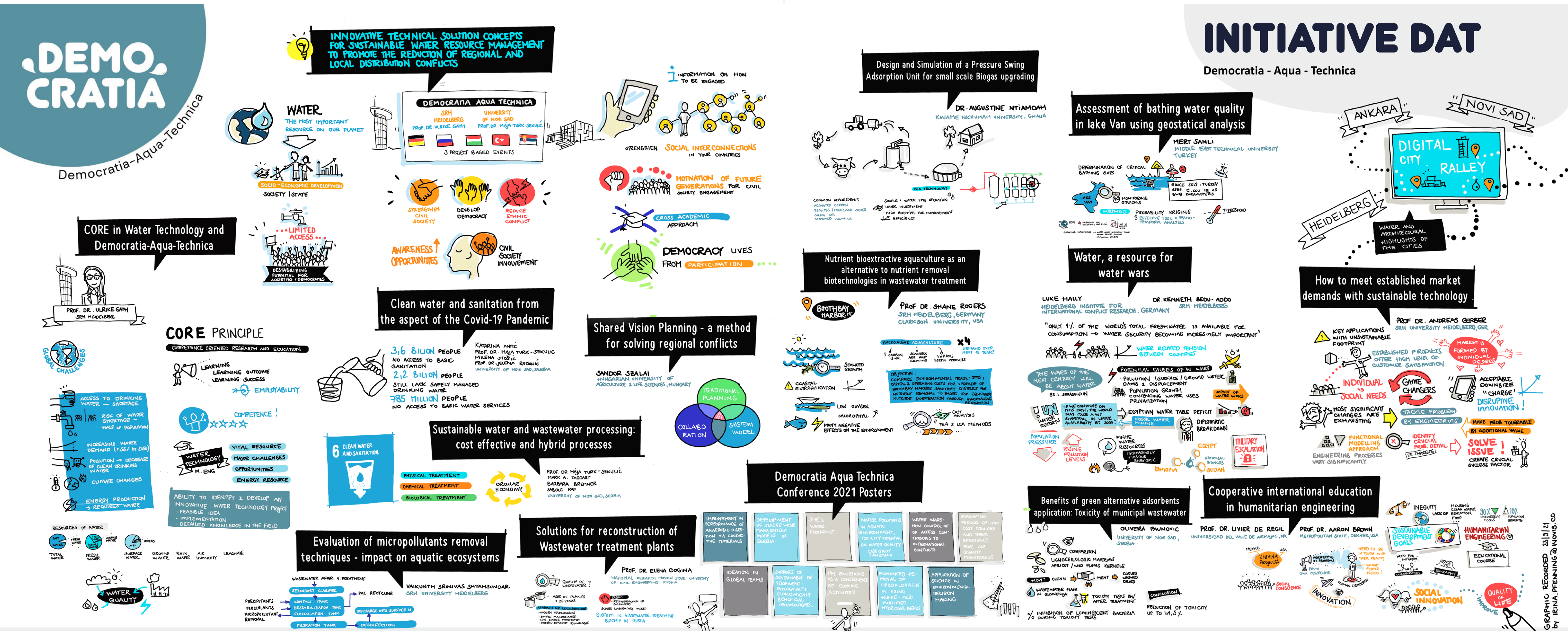
THE PROGRAM 1

23.09.2021

9:30 - 9:45	Welcome from Prof. Dr. Carsten Diener (Rector SRH University Heidelberg, Germany)
9:45 - 10:30	Welcome and Keynote speech - CORE in Water Technology and Democratia-Aqua-Technica - Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany)
10:30 - 11:00	Shared Vision Planning – a method for solving regional conflicts Sandor Szalai (Hungarian University of Agriculture and Life Sciences, Hungary)
11:00 - 11:30	Sustainable water and wastewater processing: Cost effective and hybrid processes contribution to water resource recovery facilities - Prof. Dr. Maja Turk-Sekulić, Mark A. Taggart, Barbara Bremner, Sabolc Pap (University of Novi Sad, Serbia)
11:30 - 12:00	Clean Water and Sanitation from the Aspect of the Covid-19 Pandemic - Katarina Antić, Prof. Dr. Maja Turk-Sekulić, Milena Stošić, Prof. Dr. Jelena Radonić (University of Novi Sad, Serbia)
12:00 - 14:00	Lunchbreak - Poster Session - Digital Get-Together in Spatial Chat
14:00 - 14:30	Nutrient bioextractive aquaculture as an alternative to nutrient removal biotechnologies in wastewater treatment - Prof. Dr. Shane Rogers (SRH University Heidelberg, Germany / Clarkson University, USA)
14:30 - 15:00	Solutions for reconstruction of Wastewater Treatment plants, Prof. Dr. Elena Gogina (National Research Moscow State University of Civil Engineering, Russia)
15:00 - 15:30	Evaluation of micropollutants removal techniques and the impacts of the micropollutants on the aquatic ecosystem and ecosystems services in Germany, Vaikunth Srinivas Shyamsundar (SRH University Heidelberg, Germany)
16:00 - 18:00	Digital city ralley Heidelberg - water and architectural highlights of the city

24.09.2021

9:30 - 9:45	Welcome from Prof. Dr. Maja Turk-Sekulić (University of Novi Sad, Serbia)
9:45 - 10:30	Modeling of gas-particle partitioning PAHs using Dachs-Eisenreich model - Prof. Dr. Jelena Radonić, Prof. Dr. Maja Turk Sekulić, Mirjana Vojinović Miloradov (University of Novi Sad, Serbia)
10:30 - 11:00	Design and Simulation of a Pressure Swing Adsoprtion Unit for Small Scale Biogas upgrading - Dr. Augustine Ntiamoah (Kwame Nkrumah University of Science and Technology, Ghana)
11:00 - 11:30	Benefits of green alternative adsorbents application: Toxicity of municipal wastewater - Paunovic Olivera, Sabolc Pap, Helena Prosen, Ida Krasevec, Polonca Trebse, Prof. Dr. Maja Turk Sekulic (University of Novi Sad, Serbia)
11:30 - 12:00	Assessment of Bathing Water Quality (BWQ) in Lake Van Using Geostatistical Analyses - Mert Sanli, Assis. Prof. Dr. Yasemin Dilsad Yilmazel (Middle East Technical University, Turkey)
12:00 - 13:00	Lunchbreak - Digital Get Together in Spatial Chat
13:00 - 14:30	Digital city ralley through Ankara and Novi Sad - water and architectural highlights of the cities
14:30 - 15:00	Water, a resource for water wars - Dr. Kenneth Bedu-Addo (SRH University Heidelberg, Germany), Luke Hally (Heidelberg Institute for International Conflict Research, Germany)
15:00 - 15:30	How to meet established market demands with sustainable technology - Prof. Dr. Andreas Gerber (SRH University Heidelberg, Germany)
15:30 - 16:00	Cooperative international education in humanitarian engineering Prof. Dr. Livier de Regil (Universidad del Valle de Atemajac, Mexico), Prof. Dr. Aaron Brown (Metropolitan State University of Denver, USA)
16:00 - 16:30	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)



srh

UNIVERSITAS STUDIORUM NEOPLANTENSIS

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Funded by the DAAD from funds of the Federal Foreign Office:

DAAD Deutscher Akademischer Austauschdienst
German Academic Exchange Service

EAST-WEST-DIALOGUE

East-West Dialogue Prevention and resolution of water conflicts: Advancing management, communication, and technical skills of the next generation leaders is a DAAD-financed project within the research programme "Ost-West-Dialog. Akademischer Austausch und wissenschaftliche Kooperation für Sicherheit, Zusammenarbeit und zivilgesellschaftli-che Entwicklung in Europa 2021" (East-West Dialogue. Academic Exchange and Scientific Cooperation for Security, Cooperation and Civil Society Development in Europe 2021).

Within the framework of the project, the SRH University Heidelberg and Moscow State University of Civil Engineering plan to jointly conduct three project-based events. The planned events include a hackathon, a study visit in Germany and an online conference. Following a cross-academics approach, the participants include different academic qualification levels (graduates, PhD students and scientists) and disciplines, who will work together in international and interdisciplinary groups on a project basis over the three events.

SCOPE OF THE PROJECT

The history of many countries is characterized by struggles over natural resources. The resource water is of central importance for the socio-economic development of a society or a state. If this access is restricted, e.g. by pollution, overuse or political conflicts, the associated decline in the social standard of living and general dissatisfaction can lead to massive intra-societal tensions, which have an enormous destabilizing potential for democratic forms of government and society. Both resource scarcity and resource abundance act as internal destabilizing factors through the resulting competition for distribution. This distributional competition occurs between different user groups, for example, between agriculture and industry, urban and rural populations, or between ethnic groups. In addition, weak rule-of-law structures create a fertile breeding ground for corruption and patronage in water policy and management.
Because of its importance, water as a resource is often politicized and/or ideologized. Political goals such as maintaining power, regional dominance or ideological dominance outweigh the question of technical solutions for demand-oriented distribution. Whether water supply and wastewater disposal, freshwater production or water treatment – the spectrum of water technology options for promoting water resource management geared to local and regional needs is diverse and very promising in terms of promoting the prevention and reduction of conflicts.

Water as a resource is also of central importance for a large number of industries. Not only in energy supply, but also especially in manufacturing and processing industries such as chemicals or agriculture, the use of water is indispensable. Against the backdrop of increasingly limited water availability, entire industries are faced with the challenge of reducing their water consumption and sustainably redesigning their production processes. Due to more frequent droughts, such as the one in April 2020 in the south of Russia, there are massive crop failures and export restrictions. This led to a price increase for wheat on the world market, making foreign exports economically more attractive for Russian companies. At the same time, however, the price increase also led to social conflicts in Russia, as domestic consumer prices for grain as well as for grain products such as bread and flour rose. Another downside is a decline in foreign exchange earnings due to export restrictions, which negatively affects import conditions for Russian companies. At the same time, the Corona pandemic also led to a widespread production freeze in Russia in the spring of 2020, resulting in a drop in the value of the ruble against the dollar and euro, a decline in gross domestic product and waves of layoffs. In combination with rising consumer prices due to the drought, domestic tensions were also heightened.
Citizens, who in many cases are primarily affected by water conflicts, are becoming increasingly involved in civil society organizations at the local, regional, national, and international levels for the resource of water. Despite many attempts by the Russian state to limit this involvement, civil society actors are making an important contribution to conflict reduction and the development of democracy. This is because, complementary to the technological and economic perspective, water partnerships are becoming increasingly important as alliances between state institutions, companies, and civil society. Against the backdrop of diminishing water availability, in many cases exacerbated by climate change, future next generation leaders will be confronted more than ever with water conflicts and their complexity – whether as a mayor, a member of parliament, a leader in a public institution or in a private company.

MOSCOW STATE UNIVERSITY OF CIVIL ENGINEERING (MGSU)

National Research University Moscow State University of Civil Engineering (MGSU) is the leading Russian higher education institution offering degrees in civil engineering. NRU MGSU is an advanced center for research and education implementing the most advanced innovative technologies.

The university was founded in 1921. In 2010, the university was awarded the status of a National Research University, and now it is a high-profile center for education and research.

In the autumn of 2021, Moscow State University of Civil Engineering celebrated its centennial anniversary. Over the years, in an effort to train personnel, develop the institutional environment, and conduct cutting-edge academic research, the University has been an acknowledged power, setting the vector for the integrated development of education, science and business activities, and generating quality of life standards for the whole population of Russia.

The University chairs the Association for Education and Methodology in Civil Engineering, as well as the International Association of Institutions of Higher Education in Civil Engineering uniting 142 institutions of higher education in Russia and CIS countries. The pro-active attitude of MGSU fosters the intensive development of construction education through the generation of new specialties and specializations offered as a response to the building market demand. On May 28, 2021, Industrial Consortium "Construction and Architecture" was founded by MGSU. Its participants are all Russian universities of architecture and civil engineering, relevant research organizations, the State Academy of Sciences (Russian Academy of Architecture and Construction Sciences (RAACS)), and associations of employers. The University is a coordinator of joint academic research projects developed and implemented by the Russian universities of architecture and technology.

MGSU enjoys a well deserved international reputation; it has fruitful established international links with over hundred universities, institutes and centers for research and education based in 38 countries worldwide.

The University is involved in the programs for the support of the international academic mobility of students and employees; it has organized and conducted engineering/foreign language summer schools, attended by foreign students; guided tours to the leading construction facilities and companies, that have adopted and applied the most advanced construction technologies and innovations, have been organized and conducted by the University;

MGSU is a member of various international organizations, including the European Association of Construction Universities and Faculties (AECEF), the European Association of Universities of Technology (SEFI), USEET European Program and International Society for Computing in Civil and Building Engineering (ISCCBE).

MGSU trains engineers, bachelors and masters specializing in civil engineering and applied science. MGSU Postgraduate and Doctoral Schools are principal constituents of the postgraduate professional education system. They offer courses designated for lecturers and academic researchers

substantial professional growth of as holders of graduate degrees. Postgraduate and Doctoral Schools of MGSU offer courses in the following areas: physics and mathematics, biology, technology, economics, earth sciences.

The University has trained over 150 000 specialists from 103 countries.

MGSU today is:
- 7 institutes, 2 affiliates, 35 departments, over 25 research units;
- over 25 scientific and training schools, 8 dissertation councils;
- over 1,000 faculty members, including over 600 candidates and doctors of sciences, members (academicians, corresponding members) of the Russian Academy of Architecture and Construction Sciences (RAACS);
- over 11 500 students, over 400 postgraduates and doctoral students.

Academic research and innovative activities at MGSU are governed by strategic and tactical objectives of the University, a National Research University. The principal objective is to develop the academic research potential and to complete a groundwork for innovative research projects. MGSU lecturers and academic research teams implement academic research projects within the following major areas:

- civil engineering and architectural design, namely, sustainable environment against the background of comprehensive development of territories, inclusive of the architectural, engineering, urban development and social issues;
- comprehensive safety of construction processes, namely, comprehensive safety of construction facilities and building systems, ecological safety of urban lands;
- power and resource efficiency of engineering systems of buildings, structures and the construction-site equipment;
- information technologies applicable in design development, construction operations, maintenance of buildings and research project management;
- advanced construction materials and technologies, nanotechnologies;
- construction of power plants, namely, development and improvement of engineering solutions and technologies applicable in the construction of power plants, waterworks and environmental protection facilities; geotechnical problems of construction operations;
- urban management, economics and management of construction operations, utilities and real estate management.

International activities represent an integral constituent of training of highly qualified and broad-minded specialists proficient in both domestic and international technologies, aware of the world construction practice and competitive in the international labour market.

Each year, over 250 students, postgraduates and lecturers of the University participate in different exchange programs implemented under international cooperation agreements made with our international partners. Over 200 lecturers of our University participate in the University international continuing education, advanced learning and internship programs. In excess of 1500 MSUCE students and lecturers participate in international conferences, seminars, exhibitions and forums every year.

The Mission of the University, acting as the leading higher education institution of the construction industry, is implied in tackling the objectives of proactive systemic staffing and providing expert support in the course of modernization and technological development of the Russian economy in reliance on preservation and multiplication of the best traditions of schools of architecture/civil engineering, integration of the potential of the members of the industry-focused system of civil engineering education and research, cooperation with the industry, highly professional monitoring and assessment of the state of the architectural and construction complex and urban planning in the Russian Federation with a view to (1) the enhancement of the lives of Russian citizens, (2) using construction resources to prevent negative consequences of natural and man-induced disasters, and (3) involvement in the improvement of the industry-focused (construction) constituent of national projects.

The strategic goal of the University is to develop an industry-focused world-class center for research, education, expert examination, analysis, and methodology in compliance with Russia's national development goals, for this center to be ranked high among the institutions of civil engineering science and education, so that it could integrate strong traditions of research and training schools, nurtured within the classical engineering education system, with strengths of innovations and novelties;
the center will pursue a responsible youth-focused social policy, generate, integrate and transfer the knowledge for the benefit of architecture, the construction industry, and urban planning.

The following priority subject areas of the University research and education (PSARE) are identified for the period up to 2030 with regard for international research frontiers, national, industry-focused priorities, and the work in progress: theory of structures; structural engineering, buildings and structures; soil mechanics and geotechnical engineering, bases, foundations and subterranean structures; engineering systems in the construction industry; material science in the construction industry; hydraulic engineering; engineering hydrology and water safety; construction technologies, construction work organization and mechanization; environmental safety of construction works and the urban economy; industrial and fire safety in the construction industry; engineering site investigations for construction purposes; digital technologies in construction and architecture; economics and management in construction and real estate sectors; the housing and utilities sector; the lifecycle management of technically complex and unique construction facilities; architecture, contemporary problems and their solutions; urban planning and most recent urban development trends. Principal areas of development of the University schools of research and teaching are identified with regard for the international prospects of the forth industrial revolution (Industry 4.0) and the need for the country to join the sixth wave of innovation.

One of the developing areas of the university is the ecology of water.
Research and educational center "Water supply and wastewater treatment" was established in 2012 on the base of two university departments: "Water supply" and "Water removal and water ecology"(Institute of ecological building and mechanization). The main goal of center establishment is MGSU clear-cut ascendancy in the field of water supply and water removal by means of new knowledge acquiring, staff training, upgrade qualifications.

Our basic activity of the center are:
- Development of new designing methods, technological scheme, methods of reconstruction and water utility stimulation, front and engineering design, scientific and technical support, check out and start up work
- Laboratory analysis of natural and sewage water using usual certified methods
- Staff training for masters, postgraduate and doctoral candidates
- Upgrade qualification for experts in the area of water supply and water removal

Today the center is one of the leading scientific and educational centers in the Russian Federation in the direction of ""Water supply and wastewater treatment". The Center performs a lot of applied research commissioned by businesses and

participates in the development of regulatory documents. International contacts of the center's employees contribute to the development of international communication in the field of water supply and sanitation and unite specialists from many countries of the world.

Key projects in the field of water supply and wastewater treatment:
Development of the section "Analysis of wastewater treatment technologies and selection of the most effective for the Central ecological Zone of the Baikal Natural Territory" within the framework of the development of a regional concept for the development of a wastewater disposal system in the central ecological zone of the Baikal natural Territory

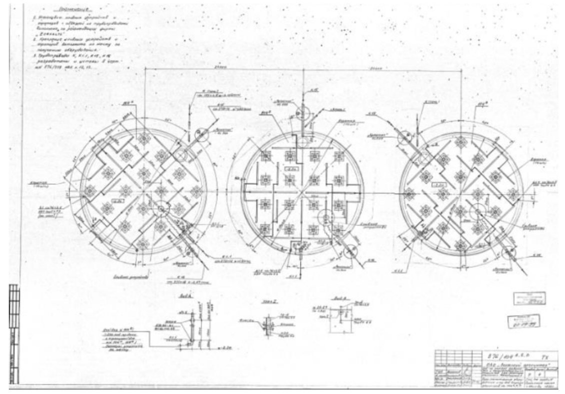


Fig. 2: Study of the causes and factors contributing to the development of corrosion of pipelines in buildings for various purposes

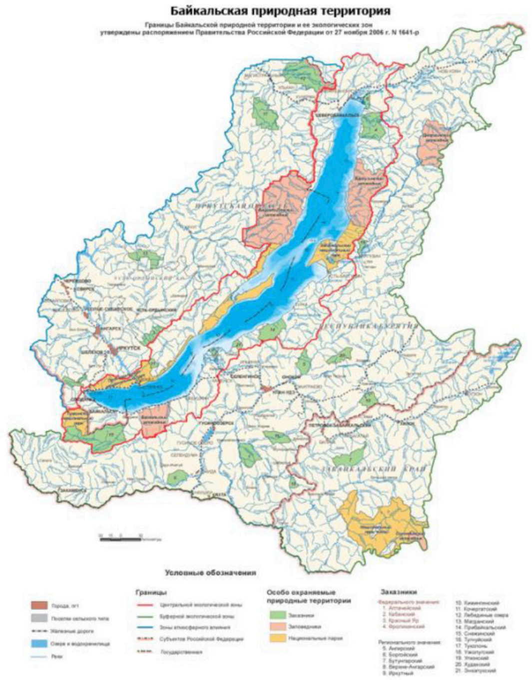


Fig. 1: Estimate of industrial wastewater impact on secondary treatment

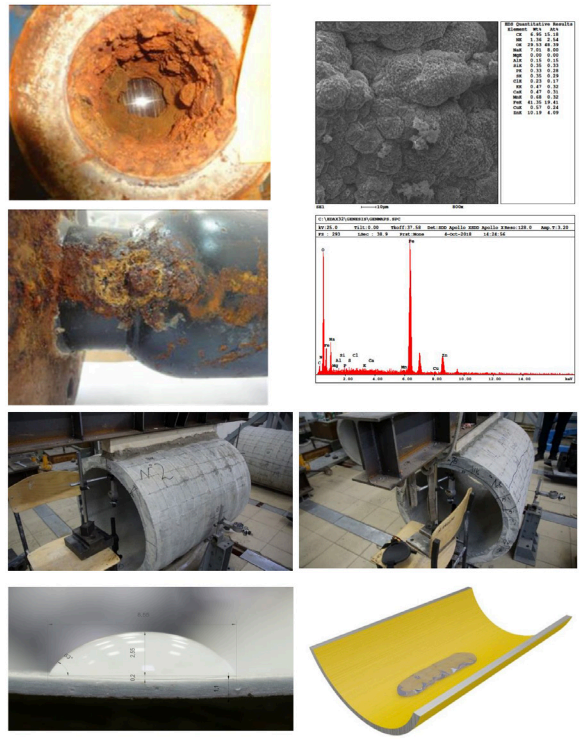


Fig. 3: Study of the properties of internal protective coatings of pipelines

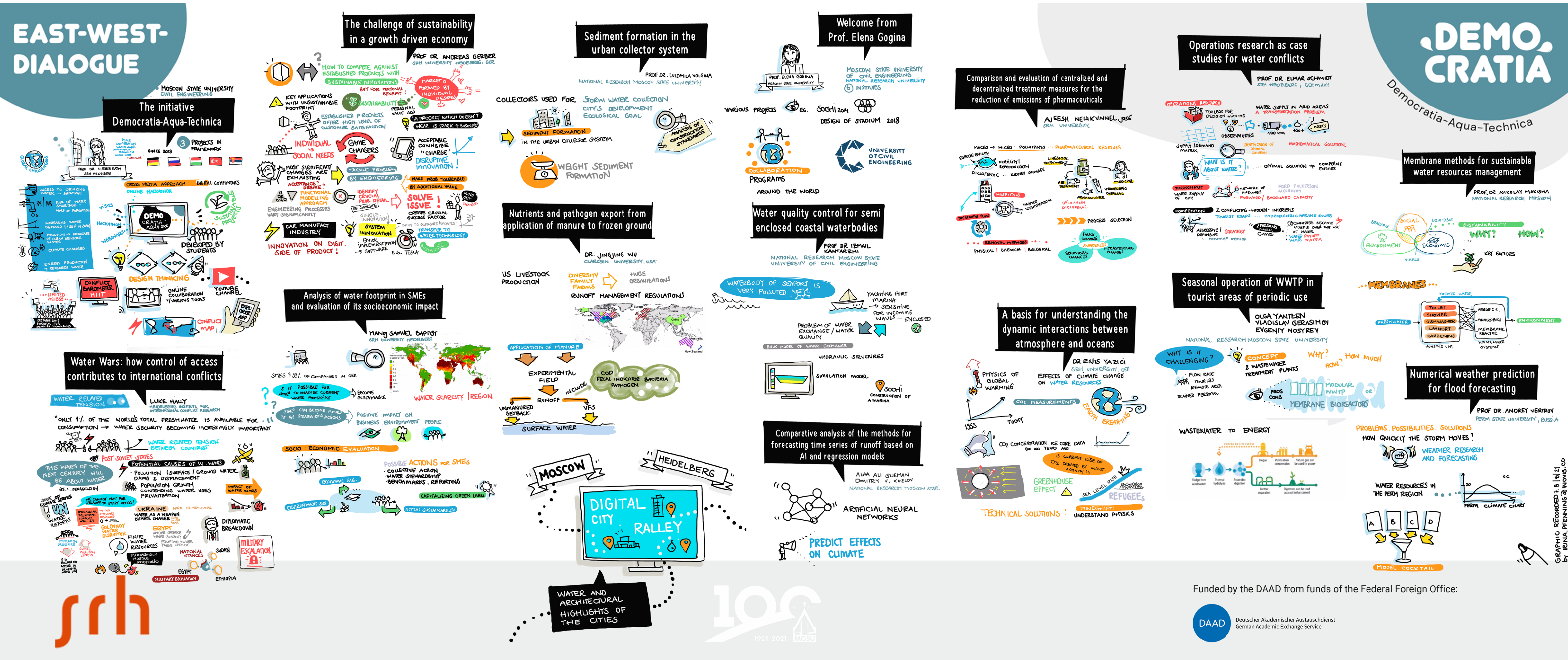
THE PROGRAM 2

07.10.2021

9:30 – 9:45	Welcome from Prof. Dr. Markus Breuer (Vice Rector SRH)
9:45 – 10:30	Welcome and Keynote speech – The initiative Democratia-Aqua-Technica – Prof. Dr. Ulrike Gayh (SRH University Heidelberg, Germany)
10:30 – 11:00	‚Water Wars: How control of access contributes to international conflicts – Luke Hally (Heidelberg Institute for International Conflict Research, Germany)
11:00 – 11:30	The challenge of sustainability in a growth driven economy – Prof. Dr. Andreas Gerber (SRH University Heidelberg, Germany)
11:30 – 12:00	Analysis of Water Footprint in Small and Medium Enterprises (SMEs) and Evaluation of its Socio-Economic Impact – Manoj Samuel Baptist (SRH University Heidelberg, Germany)
12:00 – 13:30	Lunchbreak – Digital Get Together in Spatial Chat
13:30 – 14:00	Sediment formation in the urban collector system – Prof. Dr. Luidmila Volgina, (National Research Moscow State University of Civil Engineering, Russia)
14:00 – 14:30	Nutrients and pathogen export from application of manure to frozen ground – Dr. Jingjing Wu (Clarkson University, USA)
14:30 – 15:00	Water Quality Control for Semi Enclosed Coastal Waterbodies – Prof. Dr. Izmail Kantarzhi (National Research Moscow State University of Civil Engineering, Russia)
15:30 – 17:00	Digital city ralley Heidelberg – water and architectural highlights of the city

08.10.2021

9:30 – 10:00	Welcome from Prof. Dr. Elena Gogina (National Research Moscow State University of Civil Engineering, Russia)
10:00 – 10:30	Seasonal operation of WWTP in tourist areas of periodic use – Olga Yantzen Vladislav Gerasimov, Evgeniy Nosyrev (National Research Moscow State University of Civil Engineering, Russia)
10:30 – 11:00	A Basis for Understanding the Dynamic Interactions between the Atmosphere and the Oceans & Effects of Global Warming on Water Resources – Dr. Enis Yazici (SRH University Heidelberg, Germany)
11:00 – 12:30	Comparative analysis of the methods for forecasting time series of runoff based on artificial intelligence and regression models (River Orontes, Syria) – Alaa Ali Slieman and Dmitry V. Kozlov (National Research Moscow State University of Civil Engineering, Russia)
11:30 – 12:00	Numerical Weather Prediction for Flood Forecasting: Problems, Possibilities and Proposed Solutions – Prof. Dr. Andrey Vertrov (Perm State University, Russia)
12:00 – 13:30	Lunchbreak – Digital Get Together in Spatial Chat
13:30 – 14:00	Comparison and evaluation of centralizes and decentralized treatment measures for the reduction of emissions of pharmaceuticals – Ajeesh Nellikunnel Jose (SRH University Heidelberg, Germany)
14:00 – 14:30	Membrane methods for sustainable water resources management – Prof. Dr. Nikolay Makisha (National Research Moscow State University of Civil Engineering, Russia)
14:30 – 15:00	Operations Research as Case Studies for Water Conflicts – Prof. Dr. Elmar Schmidt (SRH University Heidelberg, Germany)
15:00 – 15:30	Digital city ralley Moscow– water and architectural highlights of the city
15:30 – 16:00	Closure and Outlook: Prof Dr. Ulrike Gayh (SRH) / Prof. Dr. Elena Gogina (NRU)



Funded by the DAAD from funds of the Federal Foreign Office:

DAAD Deutscher Akademischer Austauschdienst German Academic Exchange Service

WATER WARS:

HOW CONTROL OF ACCESS CONTRIBUTES TO INTERNATIONAL CONFLICTS

My research presentation includes a comprehensive overview of the challenges facing water resource scarcity and its threat to global security and stability. The structure of my content served to grant insight toward these threats by showcasing tangible political development case studies of post-Soviet water resource conflicts, in tandem with a regional East-African example. This structure gave the presentation overview a global scope and allowed for the elucidation of further clarity of comprehending the threat variable posed by water resource scarcity.

A select range of report extrapolations derived from the latest relevant consensus on water scarcity from the UN Water Report 2021 and World Meteorological Organization bolstered the examples portrayed. These examples gave an invaluable prelude context of framing the case studies within a global perspective.

Conflict examples of tensions between Kyrgyzstan-Tajikistan and Russia-Ukraine formed the basis of analysing water security threats in critical post-Soviet regions. The devastating and brief war in Central Asia between the states of Kyrgyzstan and Tajikistan over the Golovnoy water disruptor served as the initial example of how water resource access and control can directly lead to open war. The risk of conflict, in this case, is directly correlated with the variable of water scarcity. In regions where this scarcity is high, the chance of regional destabilisation becomes more likely.

The second post-Soviet example utilised in the presentation was the Russian-Ukrainian crisis over control of the Crimean peninsula. In this case study analysis, water access played a vital role in the conflict, with resource access being utilised as a weapon of leverage. This leverage centrality over the North Crimean Canal applied pressure on the already drought-stricken peninsula and heightened military tensions in the region over the potency of its access.

The final section framed the global scope of water scarcity threats in conflict assessment by observing regional actors in the Blue Nile. The context of Egyptian water poverty and access to usable water resources formed the foundation of the background of heightened tensions in the region over the damming of the Upper Nile through the construction of the Grand Ethiopian Renaissance Dam. The components analysed in this dispute included political rhetoric, regional positions of Sudan, Egypt and Ethiopia, diplomatic breakdown and finally, military escalation. The domestic crises of the individual nations' states, notably Ethiopia, were also assessed, contributing to the rising stakes of the water resource-based conflict.

The presentation concluded on the final note of water scarcity directly contributing to rising global conflict threats, reinforced through contextual case study examples of post-Soviet and the Blue Nile region. In tandem with these case studies, international background reporting on water access and usability heightens the chance of escalation in the zero-sum game of national water access and control in regions under the threat of water insecurity.

Luke Hally

Heidelberg Institute for International Conflict Research

HIIK
Heidelberg Institute for International Conflict Research

SHARED VISION PLANNING – A METHOD FOR SOLVING REGIONAL CONFLICTS

WATER AND CLIMATE CHANGE

Several problems are connected with water:

- Decreasing available water quantity
- Changing precipitation patterns (spatial, temporal
- Increasing intensity and as follows, changing water balance elements
- Different availability tendencies in the same catchment
- Transboundary problems mostly, but even on country level
- (Mark Twain: "Whiskey is for drinking. Water is for fighting over.")

FIRST CASE

1. Historic drought event in Northeast of US in the 60s
2. New York City stopped releasing water from its reservoirs into the Delaware River
3. Without that rush of freshwater flowing down the Delaware into the Atlantic Ocean, Atlantic salt water might have been introduced into the river
4. Salt water introduced into the Philadelphia drinking water system
5. The intervention of the US president was requested. Scientifically based solution was requested.

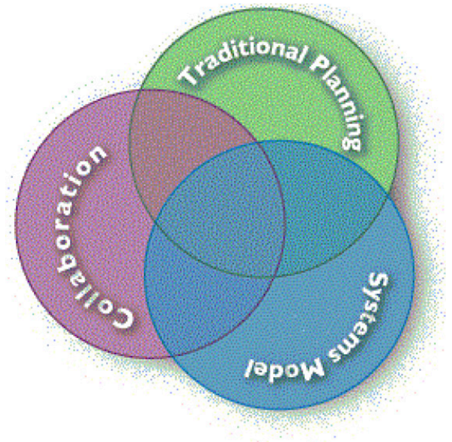
HISTORY

1. Harvard Water Program planning approach ("Design of Water Resources Systems; New Techniques for Relating Economic Objectives, Engineering Analysis, and Governmental Planning„ 1962)
2. Federal "Principles and Standards for Planning Water and Related Land Resources" (1973) ("the P&S„)
3. P&S planning steps were made more suitable for drought management decisions (National Drought Study, 1988)
4. "shared vision model„1991, first in the Potomac River Basin.

CONCEPT AND STRUCTURE

Shared Vision Planning (SVP) is designed to address complexity, manage conflict, promote learning and understanding, and build relationships between stakeholders.

SVP is how technical expertise and analysis is integrated into a collaborative planning process. The traditional planning process is organized around an analytical (decision support) computer model of the water resource system constructed with the participation of stakeholders.



Shared Vision Planning integrates
- tried-and-true Planning principles
- systems modeling
- collaboration

into a practical forum for making water resource management decisions.

STRUCTURE - TRADITIONAL WATER RESOURCES PLANNING

Step 1 — Build a Team and Identify Problems with Stakeholders, Decision-Makers and Experts.
Step 2 — Develop Objectives and Metrics for Evaluation.
Step 3 — Describe the Status Quo Using a Collaboratively Built Model.
Step 4 — Collaboratively Formulate Alternatives Using the Model.
Step 5 — Collaboratively Evaluate Alternatives and Develop Team Recommendations Using the Model.
Step 6 — Implement and Institutionalize the Plan.
Step 7 — Exercise and Update the Plan.

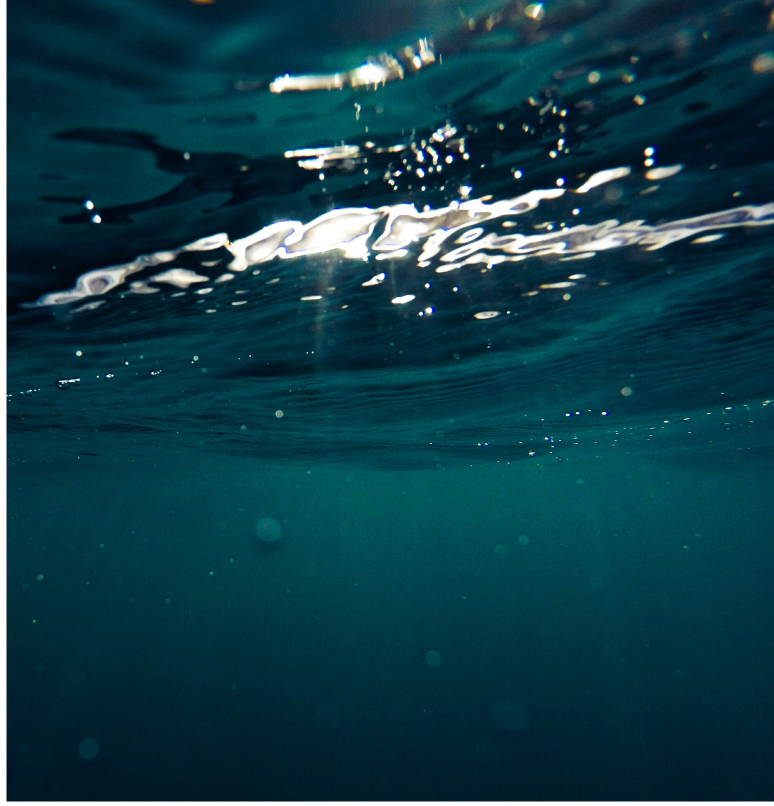
STRUCTURE - COLLABORATIVE NEGOTIATION

SVP relies on collaborative negotiation between different stakeholder groups, rather than technical experts, to apply these planning principles.

Collaborative negotiation can help shape preferences of the participants through mutual understanding and discovery of each other's interests and values, which can lead to the collaborative development of creative alternatives. The idea behind collaborative negotiation is to structure a decision process that is best capable of jointly expanding opportunities for discovering mutually beneficial gains. The idea is not to set up a battle over a fixed amount of water, but rather to encourage people to find a better/larger supply.

SVP PILOT IN HUNGARY - JOINTISZA PROJECT (INTERREG, DANUBE TRANSNATIONAL PROGRAMME)

The JOINTISZA project enhanced the status of waters of the Tisza River Basin. It focused on the interactions of two key aspects of water management — river basin management (RBM) and flood protection — while taking into account the relevant stakeholders who play a pivotal role in the Tisza RBM planning process. The main aim of the project was to further improve the integration of water management and flood risk prevention planning and actions for the next RBM planning cycle, in line with the relevant EU legislation.



PLANNING, MODELLING

Hungary has a large experience on traditional water resources planning.

JRC published the water balance factors for different scenarios for the whole Danube catchment:

Bisselink, B., Bernhard, J., Gelati, E., Adamovic, M., Jacobs, C., Mentaschi, L., Lavalle, C. and De Roo, A., Impact of a changing climate, land use, and water usage on water resources in the Danube river basin, EUR 29228 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-85889-5, doi:10.2760/89828, JRC111817

STAKEHOLDER MEETING 1/2

The followings were ensured

- Openness of the decision-makers to the opinions of the public as well as flexibility of the process to be able to accommodate changes on the course of engagement of different stakeholders.
- Transparency, which is indispensable for building and maintaining trust. Consultation outcomes should also be made available to the public;
- Mutual respect, which creates a safe environment for discussion, and allows all stakeholders to feel confident that their core values will not be compromised;

STAKEHOLDER MEETING 2/2

- Early involvement of stakeholders, if possible, already in setting the terms of reference, to help build trust and establish dialogue between different interest groups from the outset;
- Opportunities for learning through an active dialogue between participants, rather than just by simply presenting information (such as a lecture or presentation);
- Iteration and continuous evaluation by inviting participants to review the process, to reflect on the achievements so far and whether changes are needed to either process or content;
- In some cases, independent facilitation, which may be beneficial when relations between stakeholders are difficult and there is a lack of trust or respect between participants or if it is necessary to ensure that the decisionmaker does not dominate discussions

PARTICIPATION STRATEGY - KEY OBJECTIVES OF THE PUBLIC INVOLVEMENT

- to ensure proper communication, access to information, stakeholder and public involvement in the development and implementation of ITRBMP;
- to provide timely information to the key stakeholders and the public in the basin in the specific phases of the project on the development and implementation of ITRBMP, and particularly on the draft and final documents prepared (active provision of information and access to information including documents); and
- to inform stakeholders and the public of the appropriate opportunities for public participation in the development and implementation of the ITRBMP (consultation or active involvement), to facilitate/collect the input/comments of stakeholders on the draft documents and give them feedback on how these have been taken into account;

MEMBERS OF REGIONAL WATER MANAGEMENT COMMITTEE

- Ministries responsible for water protection and water management
- Responsible water directorate and water authority
- Competent environmental protection, natural protection and water authority
- National park directorates or the notary of the municipality (if locally protected)
- Competent institute for public health and agriculture
- Municipalities in the area of interest
- County municipalities in the area of interest
- Regional tourism board
- Chamber of agriculture, industry and engineers
- Water management associations and companies for public works
- NGOs and scientific organizations in the area of interest with focus on specific topics
- Additionally the national world heritage committee with commenting rights

METHODS USED TO INFORM THE PUBLIC AND INTERESTED PARTIES

- Media (papers, TV, radio)
- Internet
- Digital social networking
- Printed material
- Direct mailing
- Invitations to stakeholders
- Local Authorities
- Meetings

Sandor Szalai, Prof. Janos Fehér

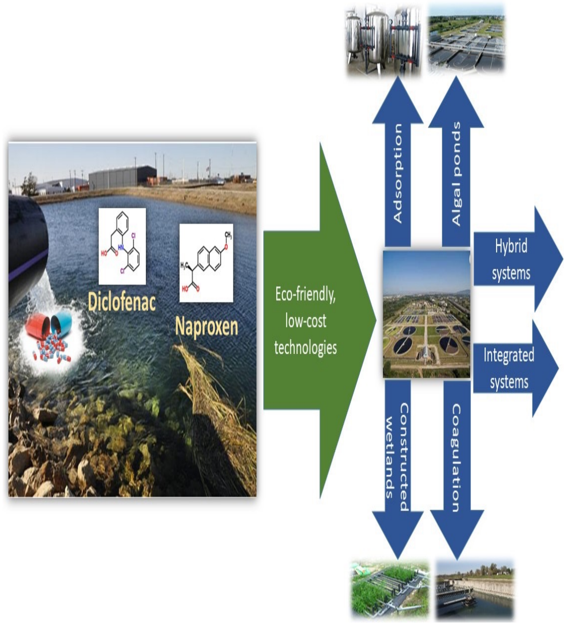
Debrecen University

SUPPORT OF SUSTAINABLE DEVELOPMENT

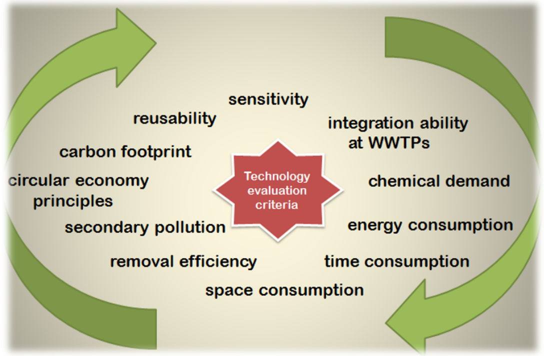
ECOLOGICALY AND ECONOMICALY BENEFICIAL TECHNOLOGIES FOR THE REMOVAL OF EMERGING MICROPOLUTANTS FROM WASTEWATER EFFLUENTS

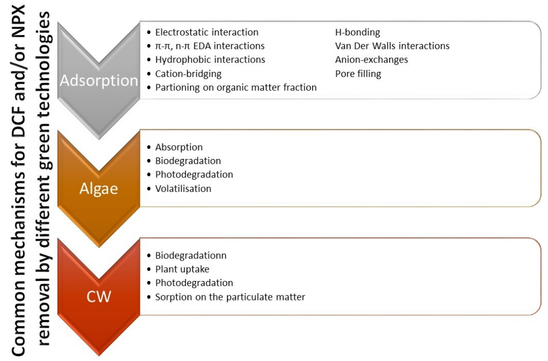
To ensure sustainable wastewater management of interest for both developed and developing countries, priority should be given to the transition from the end-of-pipe to more proactive wastewater pollution prevention. Cost-beneficial, green technologies could pose a promising alternative solution for the removal of emerging micropollutants.

Diclofenac (DCF) and naproxen (NPX) are pharmaceutically active compounds that belong to the group of non-steroidal antiinflammatory drugs (NSAIDs), ubiquiteously present in wastewater effluents, which represent their main source in surfice and groundwaters. An ever-growing consumption, pseudo-persistance and proved toxic effects to biota even at low concentrations ranging from several ng to several µg, makes these pain-killers part of many monitoring and priority lists including NORMAN, REACH, EU WFD Watch list (until 2020) and different national lists of priority substances.
Based on the 11 criteria following technologies were selected and reviewed as low-cost, eco-friendly, and widely affordable technologies for the removal of DCF and NPX from wastewater effluents: adsorption, algae-based systems, constructed wetlands, and coagulation. Some of their combinations/hybrids were also reviewed. With the exeption of coagulation, all technologies achieved high removal rates towards target NSAIDs under optimal conditions. Coagulation was found to be more effective as a pre-treatment where mainly suspended and colloidal particles were removed alowing easier approach of another technology to selectively remove target micropollutants. Algal ponds and constructed wetlands showed advantages of using plants as purification mediums, but they required large space for installation and usually longer hydraulic retention time. On the other hand adsorption was evaluated as very fast and very efficient process which can satisfy principles of circular economy by utilisation of waste materials for the production of low-cost adsorbents. For instance, agro-industrial by-products were found as an attractive and abundant precursors for adsorbent production. Chitosan, clay-based adsorbents and biochars were also used by many researchers for the same purpose. One of the most important adsorbent properties that influence its eco-friendliness and cost is regeneration ability, but it was not yet thoroughly investigated for all adsorbent types.

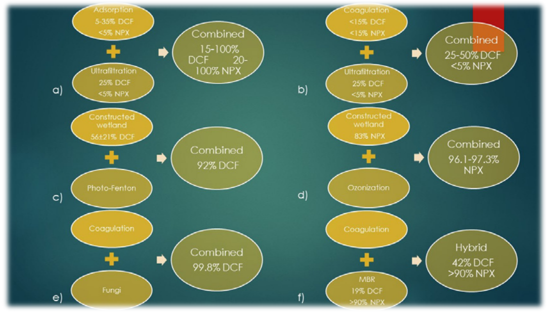


In order to overcome known, existing problems of each technology, integrated/hybrid technologies were applied. Combination of two or more technologies was proved to significantly (up to 70%) enhance removal of DCF and NPX in comparison to the effectiveness of the single technology. Constructed wetlands are one of the most extensively combined technologies.
Although extensive research has been done so far, all mentioned technologies should be more investigated in real and environmentally relevant conditions before their actual application in the real systems.



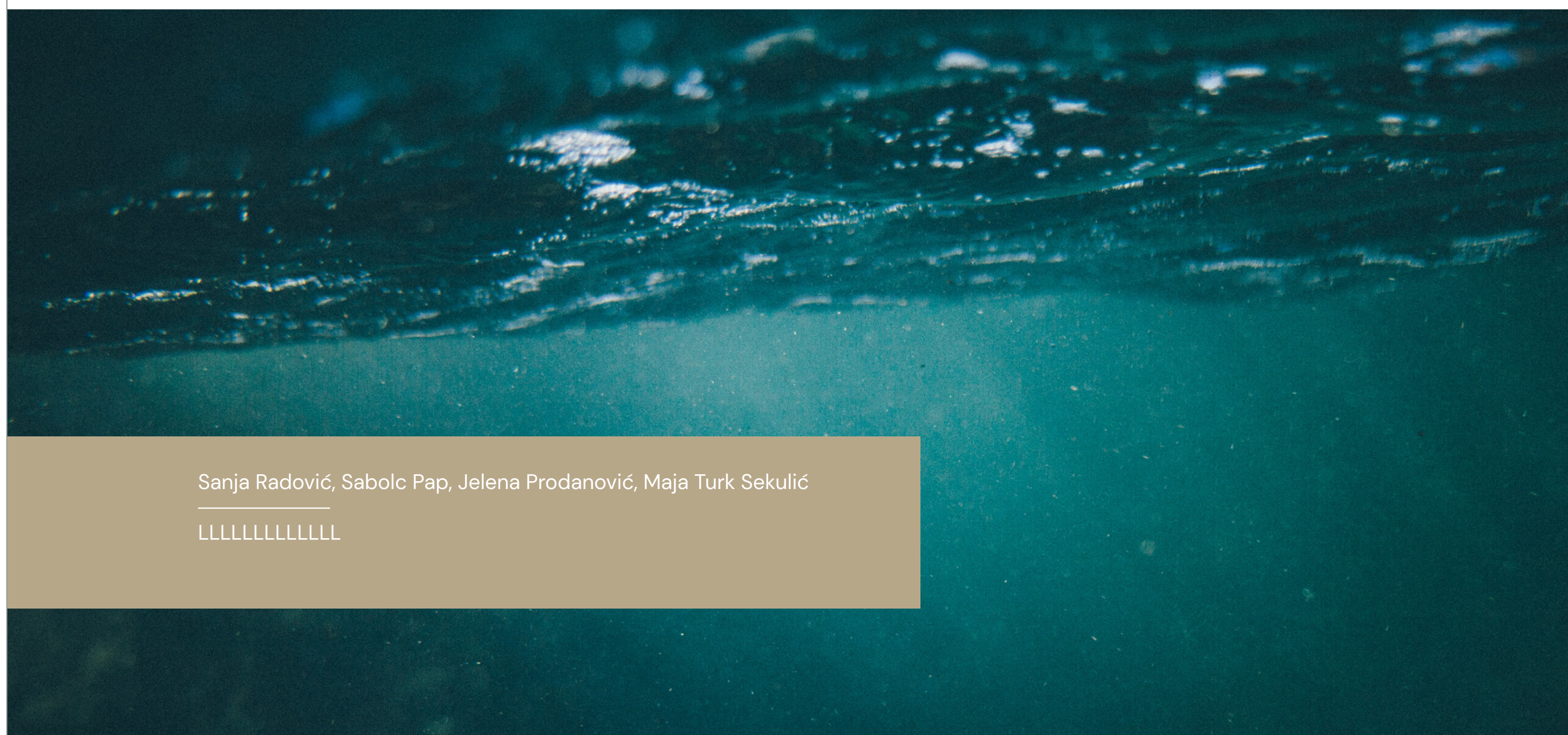


This research has been supported by Innovation Fund, Republic of Serbia, ID 5156 through project Proof of Concept, by the Ministry of Education, Science and Technological Development through the project no. 451-03-68/2020-14/200156: "Innovative scientific and artistic research from the FTS (activity) domain" and mobility funding which facilitated study at Environmental Research Institute in Scotland provided through ERASMUS + Higher Education International Credit Mobility - Project 2018-1_UK01-KA107-047241 between North Highland College, Thurso and Faculty of Technical Sciences, University of Novi Sad, Serbia.



REFERENCES
Arjen Y. Hoekstra, A. K. (2011). The Water Footprint Assessment Manual. Earthscan.
Fabricio Carlos Schmidt, R. R. (2018). Evaluation of Sustainability Practices in SMEs. MDPI,

https://futurefitbusiness.org/
https://waterfootprint.org/en/water-footprint/



Sanja Radović, Sabolc Pap, Jelena Prodanović, Maja Turk Sekulić

LLLLLLLLLLLLL

IDEATION IN GLOBAL TEAMS

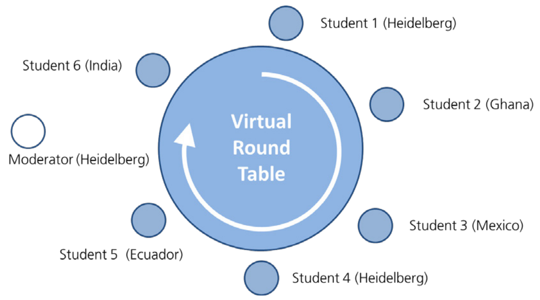
How to foster creativity in global digital collaboration?

CHALLENGE:

- Problems with global footprint require strong international collaboration.
- Especially creative work for basic ideation suffers from missing options to meet in person.
- Problems related to water, climate, pollution etc. need strong contribution from developing countries with limited travelling opportunities.
- Pandemic became further limiting factor.

I. PREPARATION:

Give all team members in time a sound and inviting introduction to required basics, methods and the task.

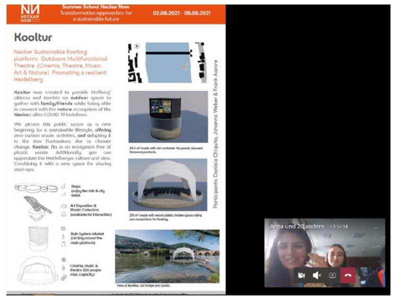


II. COLLABORATION:

Define precisely creative sessions in terms of methods, dramaturgy and communication.

III. DEVELOPMENT AND DOCUMENTATION:

Let team members define their roles, supply state of the art media equipment and make sure there is plenty of sweets in all locations.



SCAN ME!

U. Gayh, A. Gerber, B. Zevallo

SRH University Heidelberg

COOPERATIVE INTERNATIONAL EDUCATION IN HUMANITARIAN ENGINEERING

The effect of Globalization is often thought of as increasing employment and technological acceleration (Council of Europe, n.d.); While this conclusion may have some merit from the perspective of the developed countries, the reality is that globalization has increased the social and economic gaps in the world (Haines, 2001) and the spread of the SARS-CoV-2 virus revealed this disparity. Out of 7.79 billion people, according to the International Telecommunication Union (ITU) in 2018, only 51.2% had access to internet; 840 million, do not have access to energy, 87% live in rural spaces; 66% use firewood or other biomass for cooking or as heating in their homes and more than one million have limited access to clean water supply (World Bank, 2018). An inequality prevails in the world; while one social sector benefits from technological advances, a majority still live in poverty and without access to the benefits of these advances. Nolan (2002) exposed the existing gap between the unmet needs of a large sector of the global population and the advances of technology in terms of access to basic services in housing such as water and energy, among others. As Nolan reports, engineering has focused on improving the lives of 10% of individuals in the world with advanced technology, but has left the remaining 90%, who lack the resources to acquire it, adrift. Authors such as Murphy (2009), Quintanilla (2017) and Van De Vegte (2017) question the way in which engineers and technologists have currently responded to the requirements of the most vulnerable populations, and propose a different position; a more comprehensive, interdisciplinary, more human approach, where an amalgam between hard sciences and social sciences is given room to offer more ad-hoc solutions, i.e., encouraging appropriate technology developments (Schumacher, 1993). By questioning the way in which they are being trained (engineers and other professional technologists) from higher education institutions, it is apparent that there is a need to explore the application of different methodologies in the teaching-learning of engineering, which favor social awareness and focus on the transformative potential for university students (Yfarraguerri Villarreal, 2014; Sotelino Losada, Santos Rego, and Lorenzo Moledo, 2016).

Humanitarian Engineering is one subject that, by its nature, integrates multiple disciplines. It therefore should be taught as an interdisciplinary practice that combines science, technology and innovation, with a mixed approach that comes from the exact sciences and social sciences. Moreover, it can incorporate high impact teaching practices, such as a service-learning method, where students can develop appropriate or intermediate technologies (Schumacher, 1993) in affordable and sustainable projects. This can replace the global (exogenous knowledge) and standardized approach with a localized (endogenous knowledge) method which is specific to the scenario and leverages the resources of a community to help its members to improve and increase their creative and problem-solving capacity (Haba Prieto, 2014; Diwan & Livinston, 1979). This method offers solutions for problems in the vulnerable environment which are accessible and often built on an alternative technological and innovation system to the dominant system in the current economy. In integrating this methodology as a teaching tool, university students become aware of their transformative potential (Yfarraguerri Villarreal, 2014; Sotelino Losada, Santos Rego, & Lorenzo Moledo, 2016). Humanitarian Engineering can help educate students to use their creative abilities to solve problems for vulnerable people. Furthermore, it can help these students recognize the impact of their personal and professional actions on the environment and understand the responsibility for the consequences of their actions. When the student has the opportunity to meet a person face-to-face and directly feel the vulnerable conditions of this person, this generates a personal connection that encourages transformative learning where the students learn the potential that they have through service to meet the need of the other (Yfarraguerri Villarreal, 2014).

Service-Learning is presented as an innovative and effective methodology that can be strategically incorporated for the teaching of ethics in vocational training. It also offers a model where students can learn from the applying their skill to meet technological needs emanating from social realities of communities (Figueroa, 2008; Sotelino Losada et al, 2016; Litchfield, Javernick-Will & Maul, 2015).

Fig. 1: IHES Promotional

THE "INTERNATIONAL HUMANITARIAN ENGINEERING SEMINAR" (IHES)

After the first international experience in 2017 with the "Humanitarian Engineering Program", sponsored by the U.S. Depaetment of State and EXXON Mobile, a second experience was implemented during 2021 in seminar format and in COIL (Collaborative Online International Learning) mode due to the pandemic. The "International Humanitarian Engineering Seminar" (IHES) was created with the collaboration of research professors from the Universidad Pontificia Bolivariana (UPB) in Colombia, SRH University Heidelberg in Germany, the Metropolitan State University of Denver (MSUD) in the United States and the Universidad del Valle de Atemajac Campus Guadalajara (UNIVA) in Mexico. The Center for Competitiveness and Sustainable Entrepreneurship (CCES) and the Center for Scientific Research and Development participated in the latter. (Fig. 1).

Fig. 2: IHES Program

UNIVA and MSUD researchers were responsible for the design of the IHES as part of an educational research project. The general objective of this seminar was to analyze the current situation of the challenges in several communities in relation to the SDGs to promote the generation of ideas/concepts of products and/or interdisciplinary projects of applied research in the field of engineering, architecture, economics and health with a social and humanitarian approach and to offer solutions appropriate to the context; it was carried out in the months of February-March 2021 with a total duration of 14 contact hours, which were distributed between 4 theoretical-conceptual sessions (online) of 60 minutes each, and 8 hours in 4 workshops (online) of 120 minutes each. It concluded with a 120-minute session in which the proposals of the students were presented and evaluated (Fig. 2.)

RESULTS

With the objective of comparing the perception of undergraduate students in relation to Humanitarian Engineering to demonstrate its effectiveness as a service-learning method as compared to other courses, a survey was applied. This survey used two structured questionnaires given before (BE) and after (AE) the intervention carried out through the execution of the International Humanitarian Engineering Seminar (IHES) from February 19 to March 25, 2021 in COIL mode. 41 undergraduate students participated in this COIL course, and of those, 32 completed both questionnaires. A significance level of 0.05 was determined using the students' t-test when comparing dependent means. The results show a significant difference between the mean obtained on the students' perception of their experience with the service-learning methodology in other courses (BE) and during the IHES (AE), which was measured on a scale from 0 (None) to 5 (Completely); in 16 of the 18 indicators on the connection of their professional activities with community service, 14 of these present a significance level of 0.01.

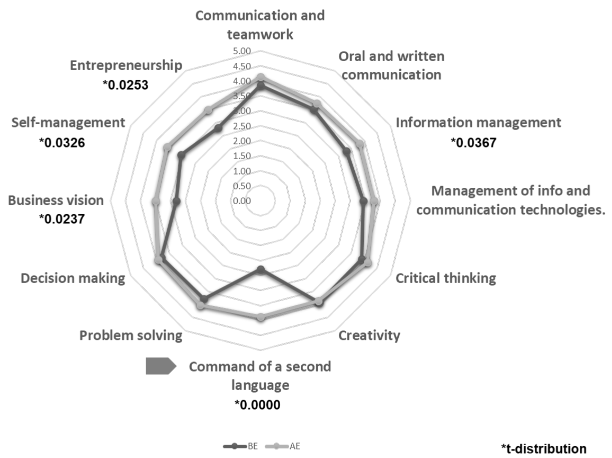


Fig. 3: Development or strengthening of skills

Regarding the development or strengthening of their skills, a positive difference was found in all of them except in the creativity survey. As shown in Fig. 3, five of eleven skills exhibit a significant difference, with the highest differences being in second language skills, business vision and entrepreneurship. As for the development or strengthening of their attitude towards social awareness, Fig. 4 shows differences in all, with six out of twelve being noteable, where empathy and concern for others, and service and social commitment were the most significant.

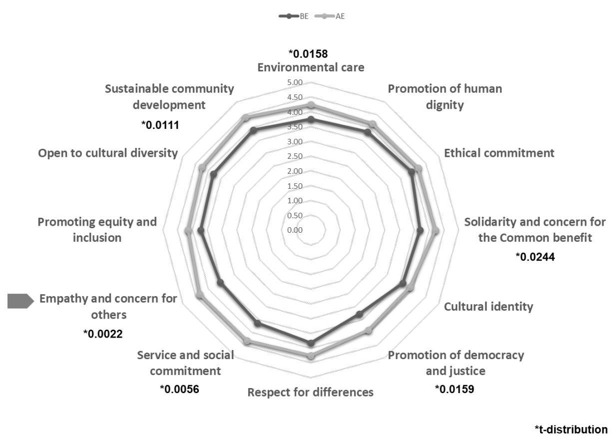


Fig.4: Development or strengthening of attitudes towards a social conscience

Regarding the knowledge about the topics taught, the gap between the two moments can be observed, the Frugal Innovation topic, as well as the Participatory Capitalism and Social Economy topics were the ones that presented the greatest difference (>3) between the means of each group; the Social Innovation topic was the one that presented the smallest difference (2.3). The students perceived that during the development of the IHES, their knowledge of the topics increased by an average of 30% (Fig. 5).

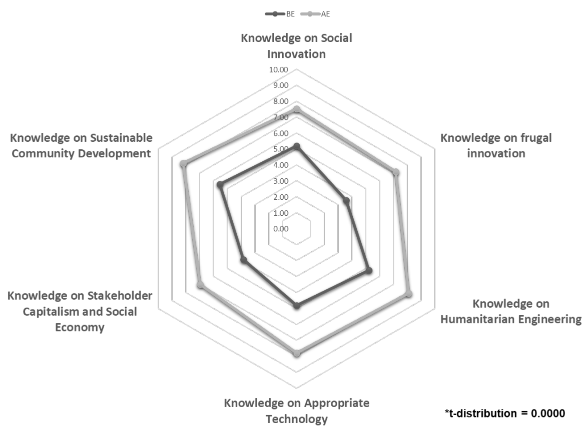


Fig. 5: Knowledge

CONCLUSION

These results confirmed the effectiveness of Humanitarian Engineering as a Service-Learning method based on the favorable change manifested by the undergraduate students in relation to their perception of the experience during the International Humanitarian Engineering Seminar in comparison with their experience in previous courses. It is recommended that higher education institutions might incorporate curriculum of future engineers and technologists that integrates new techniques, strategies and pedagogical methodologies such as what is presented here. By involving students and allowing them to assume responsibility in by an austere environment, and promoting projects that improve capacity for vulnerable communities, these methods encourage student growth and awareness. This approach also allows room for interdisciplinarity, collaboration, and Service-Learning techniques which can encourage appropriate solutions that may be helpful in reducing the aforementioned disparity in technology that vulnerable communities face. Moreover, this pedagogy shows it can bring increased awareness to future engineers and technology students that their skills can be useful in this cause.

REFERENCES

Banco Mundial. (3 de octubre de 2018). Energía. Recuperado de https://www.bancomundial.org/es/topic/energy/overview#1

Council of Europe (s.f.). La Globalización. Recuperado de https://www.coe.int/es/web/compass/globalisation

Diwan, R. K., & Livinston, D. (1979). Alternative development strategies and appropriate technology: science policy for an equitable world order.

Figueroa, A. A. (2008). Ética, Solidaridad Y "Aprendizaje Servicio" en La Educación Superior. Acta Bioéthica, 14(1), 61–67. Recuperado de http://search.ebscohost.com/login.aspx?direct=true&db=fua&AN=35401583&lang=es&site=ehost-live

Haba Prieto, S. (2014). Aceptabilidad social de tecnologías sostenibles para el tratamiento de aguas residuales en áreas urbanas de India. Caso de estudio en Nagpur [TFM]. Universidad Politécnica de Cataluña: Barcelona. Recuperado de https://upcommons.upc.edu/bitstream/handle/2117/76329/TFM_spanish.pdf?sequence=1&isAllowed=y

Litchfield, K., Javernick‐Will, A. & Maul, A. (2015). Technical and Professional Skills of Engineers Involved and Not Involved in Engineering Service. Journal of Engineering Education, 105(1).

Murphy, H. M. (2009). Appropriate technology – A comprehensive approach for water and sanitation in the developing world. Technology in Society, 158-167.

Nolan, Development Anthropology (Boulder: Westview Press 2002)

Quintanilla, M. Á., Parselis, M., Sandrone, D., & Lawler, D. (2017). Tecnologías Entrañables. ¿Es posible un modelo alternativo de desarrollo tecnológico? (OEI, Ed.). Madrid: Los libros de la Catarata.

Schumacher, E. F. (1993). Small is beautiful: A study of economics as if people mattered. Random House

Sotelino Losada, A., Santos Rego, M. Á., & Lorenzo Moledo, M. M. (2016). Aprender y Servir en La Universidad: Una Vía Cívica Al Desarrollo Educativo. Teoría de La Educación. Revista Interuniversitaria, 28(2), 225–248. https://doi.org/10.14201/teoredu282225248

Van De Vegte, J. (2017). Intercultural engineering online: Getting humanitarian engineering on the agenda. Paper presented at the IHTC 2017-IEEE Canada International Humanitarian Technology Conference 2017, 80–84. Recuperado de www.scopus.com doi:10.1109/IHTC.2017.8058205

Yfarraguerri Villarreal, L. (2014). Responsabilidad Social Universitaria: Un Reto de las Instituciones de Educación Superior. Revista Daena (International Journal of Good Conscience), 9(1), 158–187. Retrieved from: http://search.ebscohost.com/login.aspx?direct=true&db=fua&AN=116281265&lang=es&site=ehost-live

Irma Livier De Regil Sánchez Ph.D., Aaron Brown Ph.D.

Universidad del Valle de Atemajac UNIVA Campus Guadalajara, Metropolitan State University of Denver MSUD

APPLICATION OF SCIENCE IN ENVIRONMENTAL DECISION MAKING

Alternative monitoring of dissolved lipophilic organic pollutants in the Danube River

Sediment quality is extremely important factor for the formation of water quality and for various dynamic processes in aquatic ecosystems. In order to have a comprehensive picture of the status of the aquatic system, it is necessary to know and monitor the quality of a given environmental medium.

During 2012 monitoring of Danube River sediments (Serbia) was conducted. For this investigation, 10 samples of bottom sediment from different sites of Danube River through Serbia (Apatin- D1, Labudnjača- D2, Neštin- D3, Begeč- D4, Ratno Ostrvo- D5, Šangaj- D6, Knićanin- D7, Belegiš- D8, Ritopek- D9, Dubravica- D10) were collected using a grab sampler (Fig. 1). Samples were taken to the laboratory in an ice cooler, where they were weighed and sealed to avoid contamination. All sediment samples were analyzed in the laboratory of Research Centre for Toxic Compounds in the Environment - *RECETOX* (Brno, Czech Republic). Passive sampling of lipophilic organic contaminants (LOC) in the sediment was performed using silicone rubber samples.

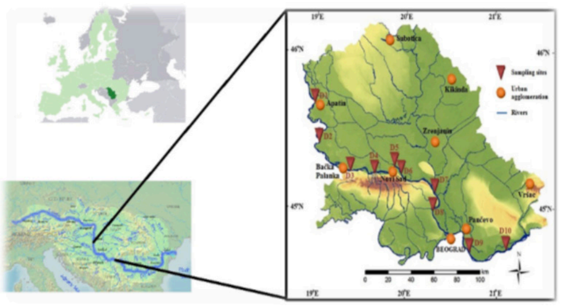


Fig. 1: The map of the sampling sites

Fig. 2: Sediment sampling, preparation and analysis of passive samplers

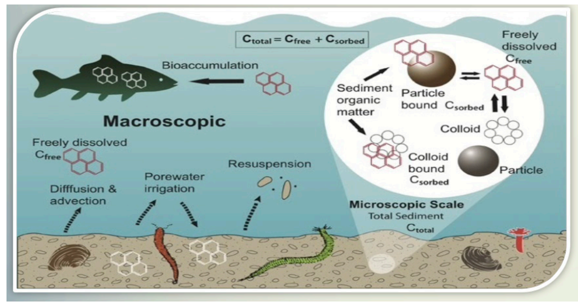


Fig. 3: Conceptual view of contaminant cycling in sediment highlighting the central role of freely dissolved concentration

Freely dissolved concentrations (CW) in the sediment pore water and the accessible/releasable concentrations (CAS) of LOC in sediment are two complementary parameters of bioavailability and are both highly relevant for risk assessment.

Multi-ratio equilibrium passive sampling (MR–EPS) was developed, providing estimates of both bioavailability parameters, i.e. contaminant's accessibility in sediment and concentrations in porewater.

Equilibrations of passive samplers with sediment at largely different sampler–sediment mass ratios, allow construction of a part of a (de)sorption isotherm, which yields the CW in the pore water at a low sampler-sediment ratio (minor depletion of the sediment phase) and the accessible or releasable concentration in the sediment at high sampler-sediment ratio (maximum depletion of the sediment phase).

Individual PCBs were quantified with CW below 0.1 pg/L of 15% equilibration, noting remarkable sensitivity of passive sampling technique sediments. The highest detected concentrations, calculated as the mean value of 4 test samples, were recorded for ΣPAHs (locality D8), then for OPFRs (D6), while the levels of ΣOCPs, Σpolycyclic musks and ΣPCBs were extremely low.

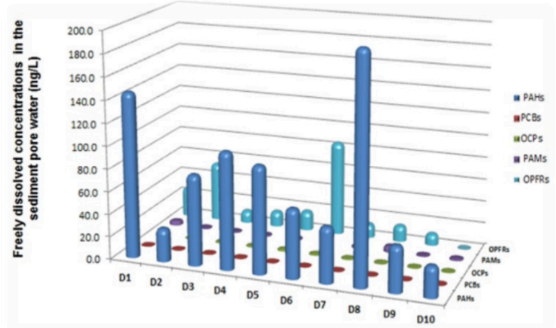


Fig. 2: Freely dissolved concentrations in the sediment pore water

Elevated CAS,0 concentration values are often correlated with high organic carbon content, i.e. high sedimentation sorption capacity. The highest registered values of available concentrations in sediment were ΣPAHs at locality D2 (250.22 µg/kg), followed by ΣOPFRs at locality D3 (47.68 µg/kg) and ΣOCPs at locality D6 (5.81 µg/kg).). Concentrations of ΣPCBs and Σpolycyclic musks were very low with the highest values recorded at locality D3 and D10, respectively.

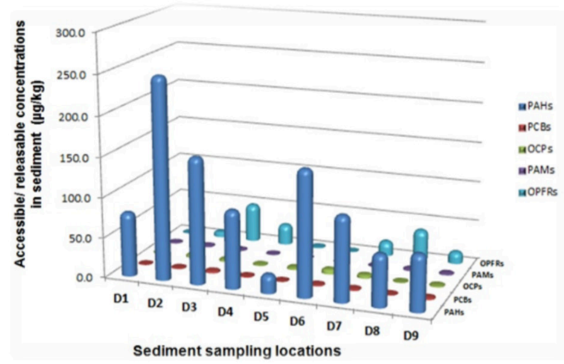


Fig. 3: Accessible/releasable concentrations of lipophilic organic contaminants in sediment

ACKNOWLEDGEMENTS

This research was supported by the Ministry of Education, Science and Technological Development, Republic of Serbia (III46009 and TR34014), the Czech Ministry of Education, Youth and Sports (LM2015051) and the European Structural and Investment Funds, Operational Programme Research, Development, Education (CZ.02.1.01/0.0/0.0/16_013/0001761).

PhD Maja Brborić, research associate

University of Novi Sad, Faculty of Technical Sciences, Department of Environmental Engineering and Occupational Safety and Health, Trg Dositeja Obradovica 6, Novi Sad, Serbia.

SUSTAINABLE WATER AND WASTEWATER PROCESSING

COST-EFFECTIVE AND HYBRID PROCESSES CONTRIBUTION TO WATER RESOURCE RECOVERY FACILITIES

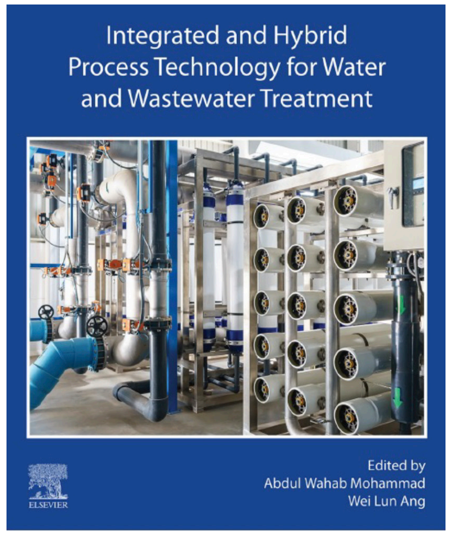
- The problems of water scarcity – recognized worldwide because it is being acknowledged as one of the sustainable development goals (SDGs) of United Nations Member States in 2015 (United Nations, 2020)
- SDG 6 – dedicated to water
- To ensure availability and sustainable management of water and sanitation for all.

- Safe and affordable drinking water for all
- Reduction of water pollution through wastewater treatment
- Minimum release of hazardous chemicals and materials to waterway
- Improvement of water-use efficiency
- Promotion of Integrated water resource management (IWRM) and Reuse technologies (United Nations, 2020)

- A lot of challenges for wastewater treatment plants in recent period
- A lot of efforts and investigations – answers and solutions that would lead to
  - » More sustainable operation of modern wastewater treatment plants (WWTP)
  - » Converting them to water resource recovery facilities (WRRF)

- The major current concerns in the wastewater treatment field:
  - » Nutrient and micropollutant removal
  - » Resource recovery
- Wastewater treatment plants (WWTPs) – solutions – operate as sustainably as possible

- Resource recovery – one of the major initiatives in the wastewater treatment field
- No longer – treatment facilities
- Opportunities to recover – added-value products – more sustainable solutions
- Phosphorus – irreplaceable nutrient – scarce resource



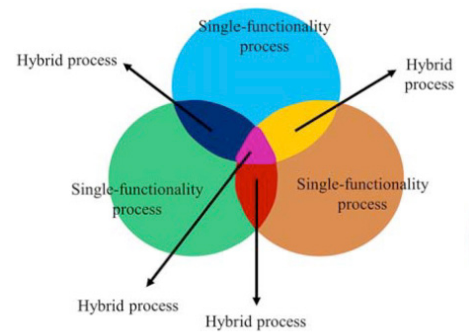
Abdul Mohammad, Wei Ang (2021): The typical water and wastewater treatment technologies can generally be categorized into three classes: physical, chemical, and biological processes

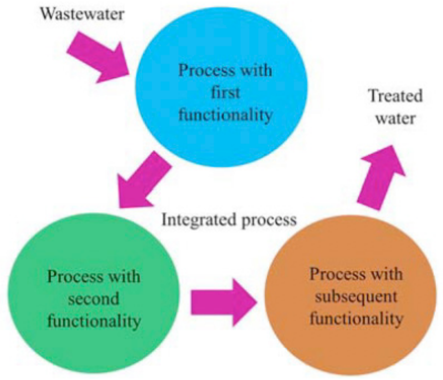
PHYSICAL TREATMENT
- Screening
- Grit chamber
- Flotation
- Media filtration
- Membrane filtration
- Adsorption
- Ultraviolet radiation

CHEMICAL TREATMENT
- Coagulation
- Flocculation
- Oxidation
- Ion exchange
- Ozonation
- Disinfection
- Softening
- Catalytic reduction

BIOLOGICAL TREATMENT
- Phytoremediation
- Constructed wetlands
- Microbial biodegradation
- Digester
- Bioreactor
- Aerobic
- Anaerobic

Regardless of the advancement in water and wastewater treatment technologies, there is still no technology that can achieve the desired treatment targets in just a standalone single treatment process.



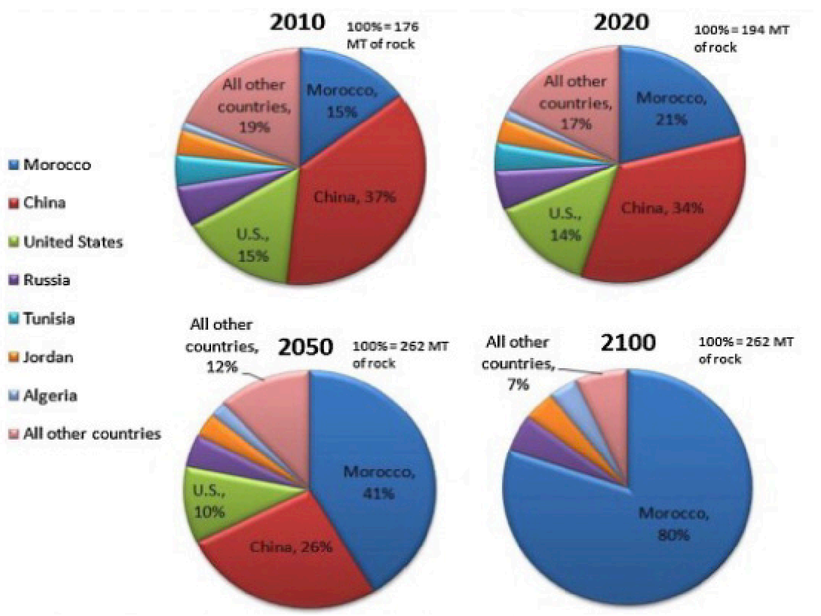


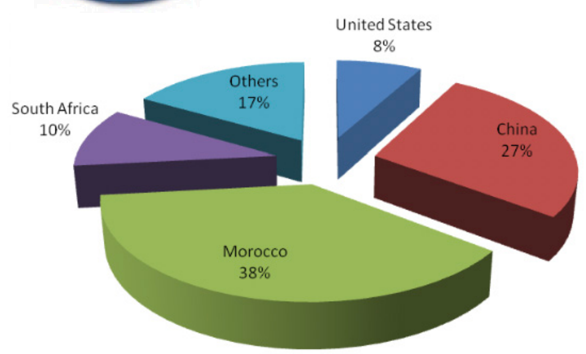
1. Integrated and hybrid process technology
2. Design approach and sustainability of advanced integrated treatment
3. Integrated water and resource recovery network for combined domestic and industrial wastewater
4. From molecular to large-scale phosphorous recovery from wastewater using cost-effective adsorbents: an integrated approach
5. Biological polishing of liquid and biogas effluents from wastewater treatment systems
6. Utilization of low-cost waste materials in wastewater treatments
7. Forward osmosis-based hybrid processes for water and wastewater treatment
8. The integrated/hybrid membrane systems for membrane desalination
9. Integrated/hybrid treatment processes for potable water production from surface and ground water
10. Clean water reclamation from tannery industrial wastewater in integrated treatment schemes: a substantial review toward a viable solution
11. Hazardous and industrial wastewaters: from cutting-edge treatment strategies or layouts to micropollutant removal
12. Current advances in coal chemical wastewater treatment technology
13. Anammox process: role of reactor systems for its application and implementation in wastewater treatment plants
14. Industrial wastewater recovery for integrated water reuse management
15. Integrated and hybrid processes for oily wastewater treatment
16. Hybrid membrane processes for treating oil and gas produced water
17. Electro-bioremediation strategies for sustainable and ecofriendly depollution of textile industrial wastewater
18. Integrated processes and anaerobic granular sludge bioreactors for synthetic-fiber manufacturing wastewater treatment

19. Sulfate radical-based advanced oxidation processes for industrial wastewater treatment
20. Phosphorus recovery from nutrient-rich streams at wastewater treatment plants
21. Emerging micropollutants in municipal wastewater: occurrence and treatment options
22. Municipal wastewater treatment processes for sustainable development
23. Low-cost technologies for the treatment of municipal and domestic wastewater
24. Hybrid membrane technology for waste treatment and resource recovery from aquaculture effluent
25. Treatment of piggery wastewater with an integrated microalgae-nitrifiers process: current status and prospects
26. Olive-mill wastewater: a paradigm shift toward its sustainable management
27. Approaching zero liquid discharge concept using high-rate integrated pilot-scale bioreactor in the palm oil mill effluent (POME) treatment

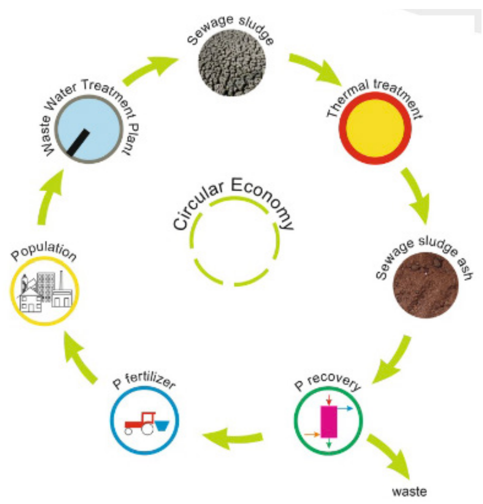
FROM MOLECULAR TO LARGE-SCALE PHOSPHOROUS RECOVERY FROM WASTEWATER USING COST-EFFECRVE ADSORBENTS: AN INTEGRATED APPROACH

In addition to being a pollutant, phosphorus is a valuable resource that gained a lot of attention in recent years. It is an indispensable nutrient for all living species; however, the reserves of phosphorus are limited.
Furthermore, phosphorus reserves are distributed within a small number of countries (e.g., Morocco, China, USA), additionally leading to geopolitical dependence of other countries and putting it on the list of critical raw materials.





Europe - invested & encouraged research: phosphorus recovery - high dependence on phosphorus imports. Much research is done in this area, contrasting results, efficiencies, as well as the cost of some solutions have made challenging the implementation of phosphorus recovery in full-scale WWTP.



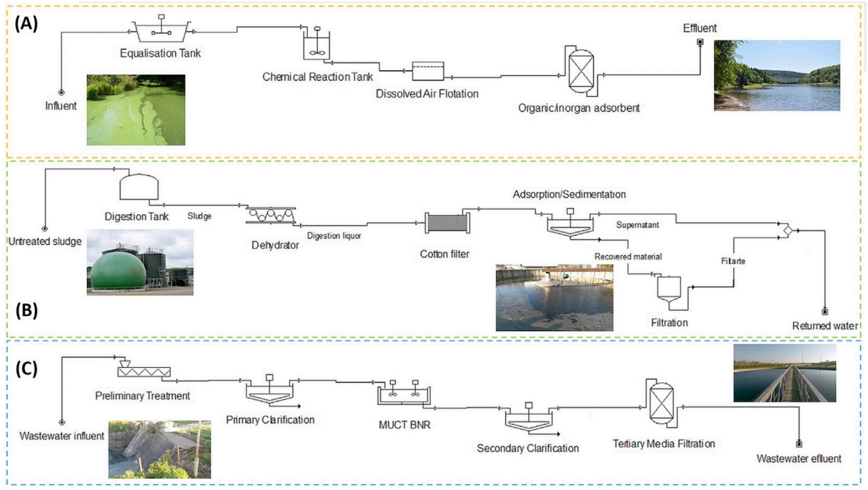
Over the last 10 years, the global price of rock phosphate has fluctuated by ~800% (~$50/t to ~$400/t) and is expected to increase exponentially in the next 20 years (Shepherd et al., 2016). Schröder, Smit, Cordell, & Rosemarin (2011) estimated that by 2035, global P demand will exceed supply.

This challenge could be mitigated (at least in part) by greater use and recovery of P from various waste streams (e.g., sewage sludge, solid waste, wastewater)

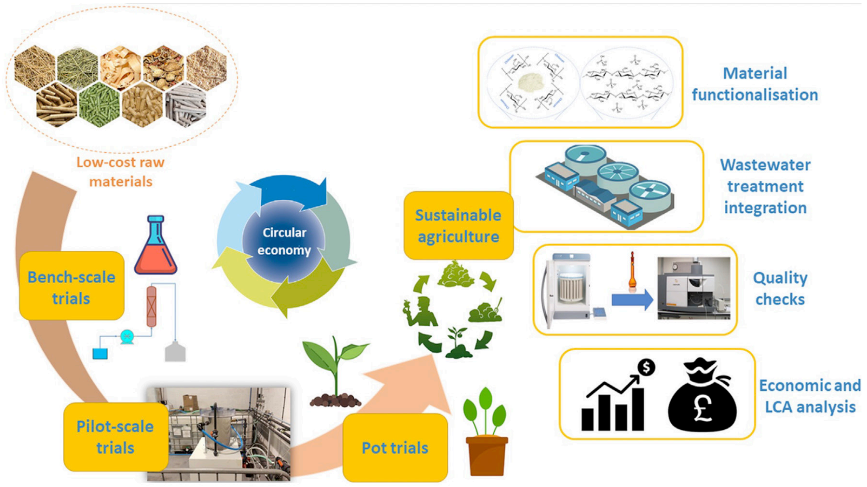
BUT

In many countries [i.e., in the European Union (EU)] this practice is restricted by legislation due to potential environmental risks posed by organic/inorganic pollutants and pathogens which may be present.

"Circular economy" based approach
Involving the utilization of waste wood brash (created following tree felling during peatland restoration) to create a biochar that could then be P-enriched and used as a fertilizer in new forestry (or remain as a soil C stabilizer)



Schematic diagrams showing integrated/hybrid P recovery processes:
(A) organic/inorganic hybrid adsorbent integrated with dissolved air flotation (An et al., 2019)
(B) sludge digestate treatment plant developed by Okano et al. (2016)
(C) MUCT BNR process with filtration media (Bashar, Gungor, Karthikeyan, & Barak 2018). BNR, Biological nutrient removal; MUCT, Modified University of Cape Town.)



Integrated P recovery from raw material, through to P recovery from wastewater, through to sustainable agricultural reuse.

Maja Turk Sekulić [1], Mark A. Taggart [2], Barbara Bremner [2], Sabolc Pap [1,2]

[1] Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad, Novi Sad, Serbia
[2] Environmental Research Institute, North Highland College, University of the Highlands and AU:1 Islands, Thurso, United Kingdom

WATER FOOTPRINT CONCEPT IN GERMAN SMEs

ANALYSIS AND OUTCOMES

Why is it important to measure SMEs water footprint?

Growing population, climatic change and global economic developments have resulted in freshwater scarcity issues, where the demand is more than sustainable supply. While large companies are scrutinized for their water consumption, SMEs who form more than 99% of the companies in Germany are less perused for their water usage. Additionally, traditional methods of measuring water use measures only direct consumption, whereas indirect consumption in supply chain is overlooked. SMEs have significant influence on environment, society and economy. To ensure a sustainable future, SMEs need to monitor their water status and take actions in the direction of responsible water use.

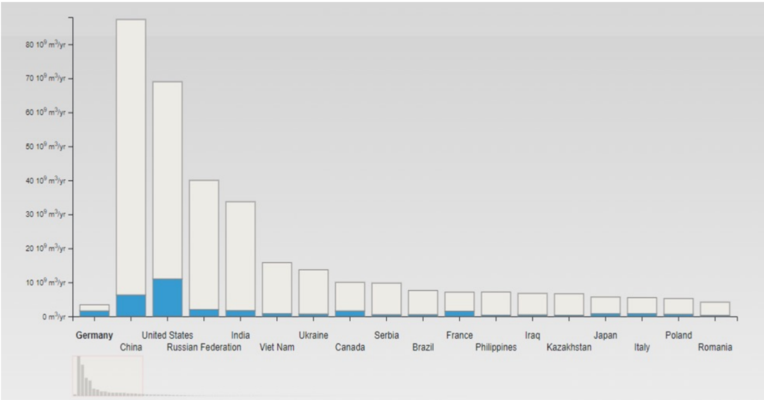


Fig. 1: Chart showing annual Blue and Grey water footprint of the industrial sector in Germany with respect to other countries (waterfootprint.org, ND).

How was the study conducted? – Approaches and tools

The study aimed to analyze the water consumption pattern in SMEs using water footprint concept on a sample of three German SMEs - Bildbrauerei UG (Videography Company), Sindbad GmbH (Food catering services) and Innofil GmbH (Dust collection equipment manufacturer), each involved in different line of work. The study attempted to account for both direct and indirect water consumptions to measure overall internal business water footprint. The data required for analyzing water footprint and social-economic aspects were obtained by conducting expert interviews with the considered SME heads. The water footprint data of both operation and supply chain were assessed for their sustainability stance using chain summation approach (CSA). Different dimensions of sustainability such as environmental, social and economic were evaluated using impact assessment concepts. Water risk to SMEs were examined using FMEA method. Furthermore, business management concepts such as SWOT analysis, PEST analysis and blue ocean strategy were used for social-economic evaluation.

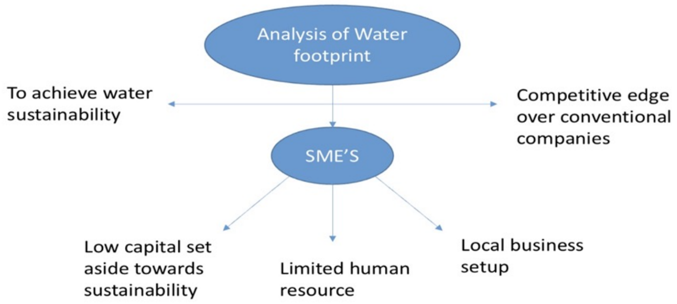


Fig. 2: Water footprint analysis in SMEs (by author)

What were the outcomes of the study?

The results of water footprint analysis from considered SMEs were tabulated and total business water footprint accounting was attempted by making certain assumptions. The results were assessed to determine the extent of sustainability. The internal indirect water footprint of Bildbrauerei, Sindbad and Innofil were found to be around 96 m3/month, 1371 m3/month and 9.6 m3/month respectively. Measures to offset negative impacts were suggested.

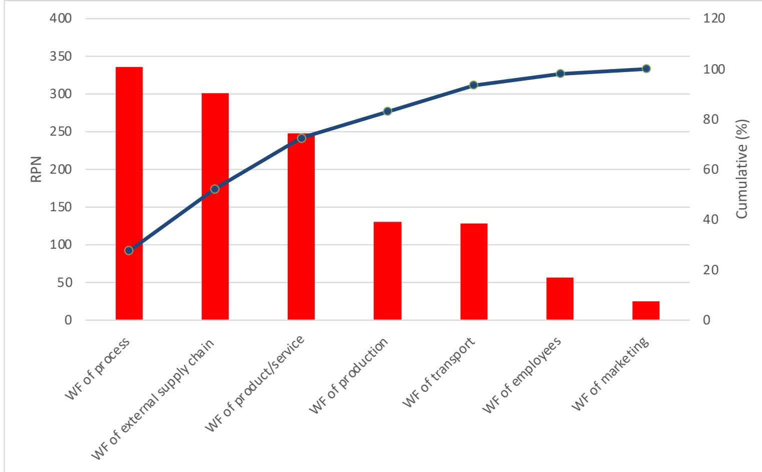


Fig. 3: Chart representing the variation in RPN of different WF steps (by author)

What does this mean for the SMEs?

While the considered SMEs showed certain sustainable characteristics, it was found that they were not water-neutral during the time of study. However, these SMEs did not import water in virtual form because they were mostly local businesses, received water from sustainable water source, had no emission of polluted water (grey water), promoted digital work environment and they embraced water conservation initiates. Additionally, the SMEs targeted to compensate their minimal consumption by taking actions that would positively contribute to nature and society in terms of water. The business tools highlighted that in modern market driven by eco-conscious customers, water sustainability aspect could provide a competitive edge for the organization equivalent to the price and quality aspects.

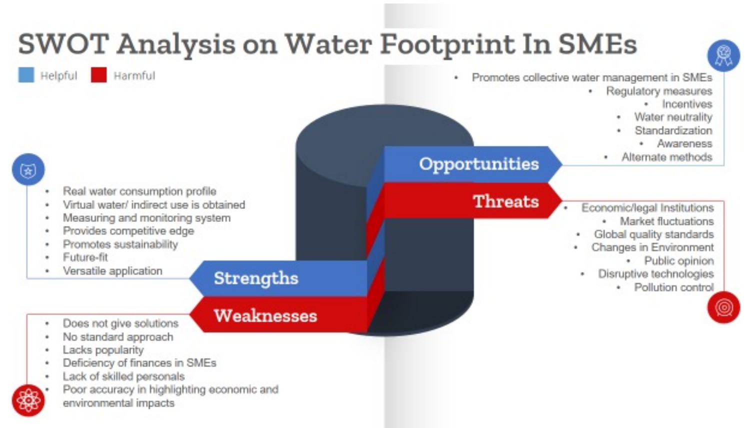


Fig. 4

The study also identified that the concept of WFA is not fully matured to be directly implemented in SMEs; the WF concept can be fully implemented in SMEs only when the primary data of water consumption that goes into each step of production and the water data from the vendors is specifically collected. Overall, it could be concluded that monitoring water footprint in SMEs and taking necessary actions is both ambitious and authentic in several ways.

Results from WFA of SMEs considered for this study. (Blue, green and grey water footprints were analyzed)	*Direct WF business M³/month*	*Indirect WF business M³/month*	*Total WF business M³/month (~)*
Bildbrauerei (Photography/Videography)	*0*	*96*	*96*
Sindbad Food GmbH (Food catering)	*1073⁺*	*1371*	*2444⁺*
Innofil GmbH (Dust collection systems)	*0*	*9.6*	*9.6*

REFERENCES

Arjen Y. Hoekstra, A. K. (2011). The Water Footprint Assessment Manual. Earthscan.

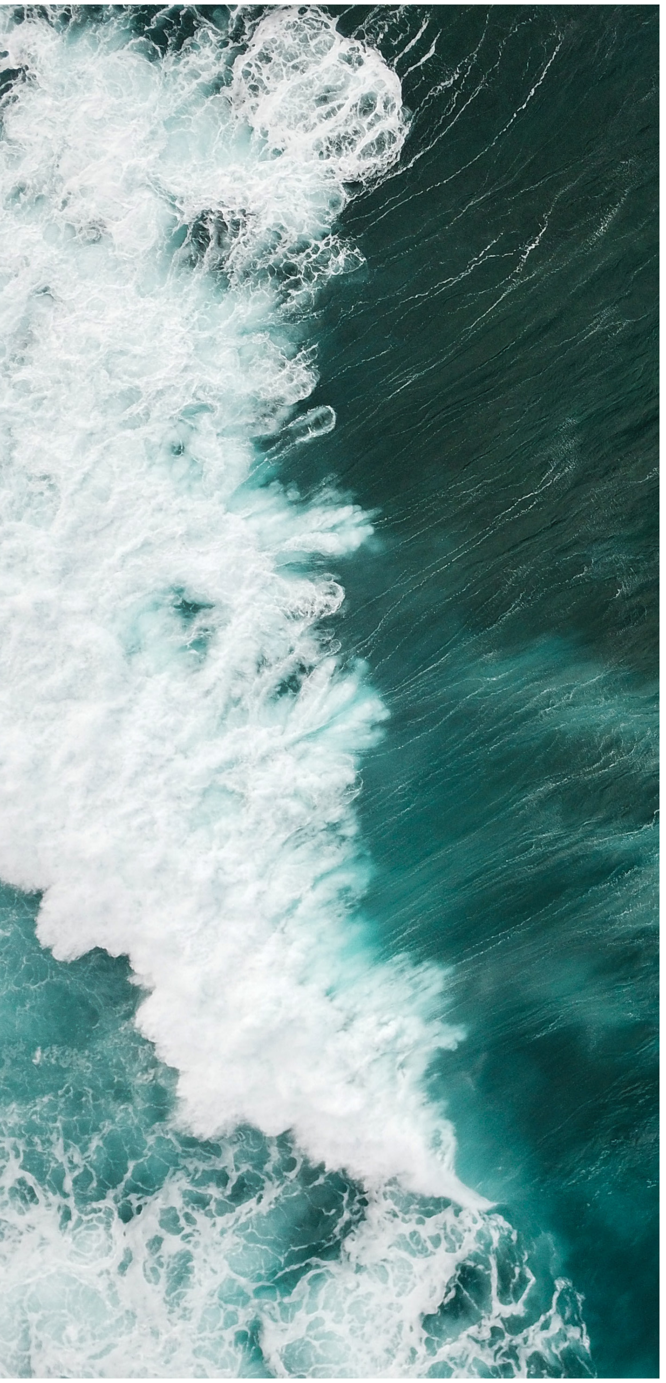
Fabricio Carlos Schmidt, R. R. (2018). Evaluation of Sustainability Practices in SMEs. MDPI,

https://futurefitbusiness.org/
https://waterfootprint.org/en/water-footprint/

Manoj Samuel Baptist
Under the guidance of - Prof. Dr. Ulrike Gayh and Dr. Torsten Seidel

SRH University of Applied Sciences Heidelberg, Germany

SEDIMENT FORMATION IN URBAN COLLECTOR SYSTEM



The collector (storm water collector) is small culvert for storm water (rainwater) or for removing the river (creek, stream, flow) under ground. Over 160 rivers in Moscow were removed in tubes because they flow near industrial and civil structures. The flows in collectors can be classified as two-phase (liquid phase - water, solid - sand, clay, stones, silt, etc.). If the flow rate is significant, then all solid particles move in the pipe, if not, they settle to the bottom of the pipe and sediment is formed. The sediment formation reduces efficiency of the system partially or completely. The deposition process and sediment formation are very complex. And calculation of sediment formation must rely on a variety of different factors.

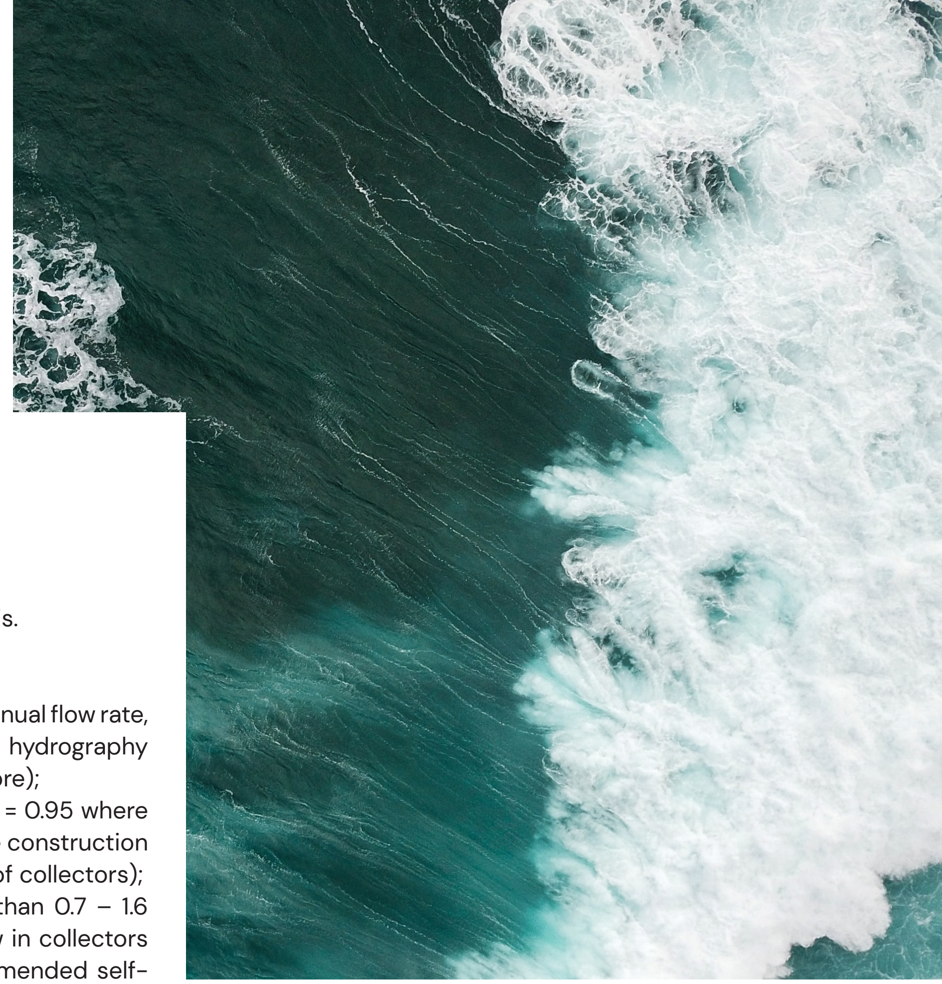
Storm water system is separated from sewer systems in Moscow and water in collector system must without sedimentation (deposition). The data base (DB, from official sources of Moscow engineering organizations) consists of hydraulic characteristics of 153 collectors, including more than 100 tubes with sediment formation. The cross section shapes and other characteristics of tubes were used for hydraulic calculations.

Collectors are used for:

- Storm water collection (to protect the territory from flooding)
- City's development (increasing the territory and district connection)
- Ecological goal (Reduced entering pollution from the water flows)

The Moscow city sewerage (urban) system appeared at the turn of the 19th-20th century. Most of now existing collector systems were built in period of 60-80 years of the 20th century.

Collector system is extensive net (network) of tubes (tree like), where tubes of smaller diameter are connected to tubes of large diameter. The flow is caused by the slope. The slope can be from 0.05% to 20%. Flows in collectors can be unsteady, irregular with variable roughness coefficient, two-phase with wide list of solid particles.



The design of:

- cross-sections of collectors,
- dimensions of chambers,
- nodes,
- inspection wells

were carried out on SNiP regulations basis.

The main principle of regulations basis:

1. flow rate $Q_{cal}=Q_{aver}*K$, where Q_{aver} annual flow rate, K - from 0.7 to 1.3 (but statistics and hydrography show that the flow rate varies much more);
2. depth of the flow (rate capacity) h / d = 0.95 where h - is depth of flow, d – diameter of the construction (this condition is only detected in 3% of collectors);
3. average flow velocity must be more than 0.7 – 1.6 m/s (self-cleaning velocity). If the flow in collectors has average velocity less than recommended self-cleaning velocity, solid particles will settle in the bottom of the pipe and the sediment is formed.

RESULTS

1. For the average annual flow rate (in the hole collector system of Moscow), estimated as 11.23 m^3/s and for particles brought into the collector system from the outside:
   - 97% of solid (silts) particles (diameter up to 5 mm), will settle to the bottom.
   - 87.6% of the suspended solids will settle to the bottom.

2. At a flow rate 4 times higher than the average annual flow rate (44.92 m^3/s):
   - 58.2% of solid (silts) particles (diameter up to 5 mm), will settle to the bottom.
   - 25.4% of suspended solids will settle to the bottom.

3. The estimation of the average annual weight of solid particles deposited at the bottom of the collector system of Moscow is 40.3 thousand tons (based on the average annual level of water consumption, pollution and deposition).

Lyudmila V. Volgina

Associate Professor of the Department of Hydraulics and Hydro Technical Engineering

WATER QUALITY CONTROL FOR SEMI ENCLOSED COASTAL WATERBODIES

ABSTRACT

The approaches to study water quality control for semi-enclosed coastal areas like harbours, and coastal protection structures area are analyzed. Analytical, numerical modelling and experimental study of the water quality in the semi-enclosed areas is the important subject of the water quality control. The new approaches focus on estimating the limitation of the low dimension's models of water quality. It's presented the method based on the numerical modeling of the processes for the forecasting and protecting of the sea water quality at the stage of design of the coastal constructions. The enclosed coastal water bodies are the areas of the intensive pollution and at the same time have the limited water exchange with the main water basin. The numerical modelling is presented by few examples. The protection of the water quality in the yachting ports is actual problem because the water quality is not only environmental but also the consuming property of the marinas. The study of simulation of the spread of an emergency spill of marine fuel has been carried out for the conditions of the yachting port "Grand-Marina Sochi", which is designed for seaport Sochi, Russian Black Sea coast.

Keywords: water quality, enclosed area water exchange, pollution of the coast, coastal protection structures, harbours, numerical modeling, experiments

1. INTRODUCTION

Waterbody of the seaport is extremely polluted area, and often it's sufficiently enclosed by shoreline and protected structures. The coastal water quality is a factor of a great importance in managing of coastal zone development. As an order, it must be included to consideration to decide the future development and improving of the coastal zone.

Enclosed basins in the coastal zone may be the natural ones like bays, lagoons, estuaries, and the artificial ones like marinas, coastal structure areas. They have much more water quality problems than the open sea since for the coastal enclosed areas water exchange is usually small. In enclosed basins, water exchange with main body (flushing) is an important factor in maintaining water quality.

Aqua area of the yachting port (marina) is extremely sensitive for incoming waves, and, as the result, normally it is sufficiently enclosed. And then, the problem of water exchange and water quality may be important for similar cases.

The various approaches to water exchange and water quality basing on the author´s research and experience are presented in the paper.

2. BULK (0-D) MODEL OF WATER EXCHANGE

The main assumption of the 0-D water exchange model is the following one: the fluctuations of water quality parameters over the water body is not larger, then the certain accuracy [1]. The general equation of the water quality evolution for water body may be written as:

$$\frac{d(CW)}{dt} + CA = G + Q_{in}C_{in} \quad (1)$$

where C is a parameter of water quality (substance concentration, bioconcentration of phytoplankton or zooplankton, etc.); W is the volume of water body; G is parameter, which does not depend on concentration of C and hydrological characteristics; A is parameter, which depends on the hydrological characteristics; Q_{in} is total inflow to selected water body through the boundaries; C_{in} is concentration of the interested parameter in the inflow. The last value may be obtained by summation over all inflows:

$$C_{in} = \frac{\sum Q_{in}C_{in}}{\sum Q_{in}} \quad (2)$$

where the numerator sum is the total substance inflow, and the denominator sum is the total water inflow.

Solution of generalized equation (1) may be presented as follows:

$$C = \frac{G}{A} + \left(C_0 - \frac{G}{A}\right) exp\left(-\frac{A\Delta t}{W}\right) \quad (3)$$

under the if all parameters don't vary over the time Δt, and $C0$ is the initial value of C. The solution (3) may be rewritten as:

$$C = \frac{\chi C_{in}+\zeta}{\chi+K} + \left(C_0 - \frac{\chi C_{in}+\zeta}{\chi+K}\right) exp[-\Delta t(\chi+K)] \quad (4)$$

where

$$\chi = \frac{Q_{in}}{W} \qquad \zeta = \frac{G}{W} \quad (5)$$

and K is chemical (biochemical) reaction rate coefficient.

Coefficient K presents the characteristics of the interesting water quality parameter (rate of phytoplankton biomass growing and death, decay rate of nonconservative pollution, etc.). Coefficient χ shows the intensity of water exchange, $1/\chi$ equals the period that needs for complete change of the water in box due the exchange through the box boundaries. For the chemical substances like nitrogen, phosphorus, organic pollutants, coefficient K presents the rate of chemical decay of substance. For phyto-zooplankton this coefficient includes the factors like: respiration, growth, death, and settling.

Coefficient ζ presents the internal source of pollution, which power does not influence by the concentration C. As an example, the fluxes of organic and biotic matters caused by the phytoplankton biomass decomposition, polluted flux from bottom deposition to water, and so on, may be considered. Using (4), the maximal source power by which the water quality is satisfied with the standard (normal) criterion, $c = c_{norm}$, i.e., pollution concentration is below a tolerable level may be found as:

$$\zeta_{max} = C_0(\chi+K) - \chi C_{in} + \frac{(C_{norm}-C)(\chi+K)}{1-\exp[-(\chi+K)t]} \quad (6)$$

It may be concluded that the 0-D model of water quality may be applied, if we know the fluxes passing the box boundary surface. And we must be sure, that the ideal mixing in the box is already happens and the parameter C is distributed uniformly over the box volume.

2.1 BULK MODEL LIMITS OF APPLICABILITY

Considering the mixing of pollutant in the coastal water body, it may be concluded, that the instantaneous mixing is not possible in the real conditions. There is certain time, during which the pollutant, emitted from the source inside the box is delivered over the water volume due the turbulent diffusion. Let place the source of substance in the certain point of the box, and the time after which the concentration became uniform over the water volume with the certain accuracy ε will be the interesting time, T_ε. It is time scale that satisfy the 0-D model, what means, that the averaged over the bulk concentration may be considered as the averaged over the time T_ε, only. For the smaller times the concentration may be differ sufficiently from the averaged over the bulk, and in this case the model of higher levels must be used.

To estimate time scale of 0-D model let's consider the 1-D water body with length L, at one boundary $(x=0)$ the permanent source of substance with concentration $C=1$ is placed, the second boundary $(x=L)$ is closed. The two directions of the current in the channel have the same probabilities. The propagation of the substance in the channel is expressed by the following diffusion equation:

$$\frac{\partial C}{\partial t} + \frac{\partial}{\partial x} D \frac{\partial C}{\partial x} = -KC \quad (7)$$

where K is a production (destruction) coefficient of substance, D is the turbulent diffusion coefficient.

2.2 CONSERVATIVE POLLUTANT

For the conservative pollutant the coefficient $K=0$ and solution of (7) is:

$$C(x.t) = 1 - \sum_{n=1}^{\infty} B_n exp\left[-\left(\frac{\pi n^2}{l}\right) Dt\right] \sin\left(\frac{\pi n}{l} x\right) \quad (8)$$

where $l=2L$ and

$$B_n = \frac{2}{\pi n}(1-\cos(\pi n)) \quad (9)$$

With the enough time t, the series expansion (8) is rapidly convergent, therefore only the first term of series of (8) may be estimated. It gives, that the time, after what for every coordinate x the difference between local concentration and 1 will be smaller than the certain accuracy ε, is expressed as:

$$\frac{4}{\pi} exp\left[-\left(\frac{\pi}{l}\right)^2 DT_\varepsilon\right] \le \varepsilon \quad (10)$$

what gives finally for T_ε the following expression:

2.3 NONCONSERVATIVE POLLUTANT

Let's consider the same problem with nonconservative pollutant. The steady-state ($\partial C/\partial t=0$) solution of the diffusion equation (7) may be obtained as:

$$C = \frac{e^{K'(L-x)} + e^{-K'(L-x)}}{2\cosh(K'L)} \tag{12}$$

where $K'=\sqrt{K/D}$. With diffusion coefficient D from (11), it yields for $x=L$:

$$C|_{x=L} = \frac{1}{\cosh r} \tag{13}$$

in which

$$r = \sqrt{\frac{K' T_\varepsilon \pi^2}{4\ln(4\pi\varepsilon)}} \tag{14}$$

The assumption on the complete mixing will be acceptable if

$$C|_{x=L} > 1 - \varepsilon \tag{15}$$

Have been applying (13) and (14), the next relation for the condition of complete mixing may be written:

$$\cosh r = \frac{1}{1-\varepsilon} \tag{16}$$

And the second-order approximation will give

$$\frac{r^2}{2} < \varepsilon \tag{17}$$

or, finally

$$KT_\varepsilon < \frac{8\varepsilon}{\pi^2}\ln\frac{4}{\pi\varepsilon} \tag{18}$$

what presents the limitation of substance change coefficient K, with which the application of the 0-D model is valid. If K does not satisfy to the relationship (18), the 0-D approximation can result in the unacceptable errors.

2.4 WATER EXCHANGE IN THE SINGLE GROIN AREA

Another situation relates with water exchange modelling for area of coastal structures. The traditional shore protection structures like groins, breakwaters, etc. can enclose the coastal area to weaken the water exchange with the main body. The factors of water exchange for coastal structures areas are the wind- and breaking wave-induced currents [2].

To estimate the time T_ε, the coefficient of turbulent diffusion is necessary. There were a lot of estimations of the turbulent diffusion coefficients, basing on theory, field, or laboratory investigations. One of them for on-offshore direction is [3]:

$$D = \frac{H_b X_b}{T} \tag{19}$$

where H_b, X_b are the wave height at breaking and distance of breaking point from shore, respectively, and T is the wave period. Assuming $X_b=L$, $H_b \approx d_b = L\tan\alpha$, d_b is the water depth at breaking, $\tan\alpha$ is the representative bottom slope in the surf zone, the diffusion coefficient may be rewritten as follows:

$$D = \frac{L^2 \tan\alpha}{T} \tag{20}$$

Substituting of D into (11) yields:

$$T_\varepsilon = \frac{4}{\pi^2}\frac{1}{\tan\alpha} ln\frac{4}{\pi\varepsilon} \tag{21}$$

or

$$\frac{T_\varepsilon}{T} = \frac{4}{\pi^2}\frac{1}{\tan\alpha}\ln\frac{4}{\pi\varepsilon} \tag{22}$$

Considering the following parameters: $\tan\alpha = 0.02$, $T = 5$ c, $\varepsilon = 0.1$, it is obtained $T_\varepsilon = 258$ c, what is about 50 wave periods, only. It may be concluded the absence of the serious limitations of the applying of 0-D model in considering aspect.

Typical shore protection structures are groins, offshore breakwaters, submerged breakwaters, and various combinations of them. Considering the groins, it may be noted, that circular current zones are created both at the upstream and downstream ends of a single groin under longshore current, as shown in fig.1. The longshore current velocity, the length of the groin, the mean water depth in the surf zone, and the volume of box affect the water exchange between the circular current zone and the transition zone in the presence of longshore current.

For detached offshore breakwater the onshore wave-induced drift interacts with breakwater units as a jet and the offshore compensate current is created in the area between the breakwater and the shore. By using shore protection structures with gaps, the water exchange in the protected area may be improved [4]. Groins with gaps result in sufficiently stronger water exchange under oblique incident waves.

Another design case is the normal to shore wave incidence. This case the drift current interacts with offshore breakwater as a jet again, but the jet discharge and current velocities are smaller. It can be assumed that inflow and outflow take place at the half cross sections of the opening. As the ratio of the width of the gap to the length of the breakwater decreases, inflow will take place at the center of the opening, and the reverse flow will take place at two sides of the opening.

Table 1 presents the relative water exchange intensities of shore protection structures due the longshore and onshore currents, obtained by 0-D modelling of water exchange, what may be called here «hydraulic approach».

3. NUMERICAL STUDY OF COASTAL PROCESSES IN GELENJIK BAY, EFFECT OF THE NEW PORT

3.1 SIMULATION OF CHARACTERISTICS OF WIND WAVES. EXTREME STORMS, 1990-2019 IN GELENJIK BAY

For the calculation of the characteristics of the waves on the approach and inside the Gelenjik Bay was used the SWAN [5.6] model. wind field for calculation is based on the NCEP/NCAR Reanalysis data wind fields during the period from 1989 to 2012 years involving for adjustments. refined date on satellite observations and measurements of the waves in the region.

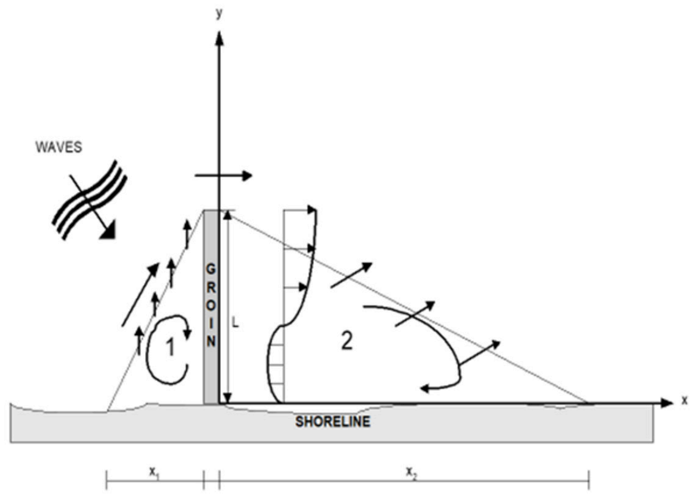


Figure 1. Water exchange in the single groin area

Structure	Camera	Water exchange due the longshore current	Water exchange due the onshore drift
Single groin	Front of single groin Behind single groin	0.18 0.07	1.00
Permeable single groin (10%)	Front of groin Behind groin	0.60 0.13	
Single T-groin	Front of groin Behind groin	0.07 0.05	0.84
Permeable single T-groin (10%)	Front of groin Behind groin	0.60 0.09	
Group of groins	Intergroin area	0.10	0.50
Group of T-groins	Intergroin area	0.05	0.25
Single breakwater	Protected area		0.84
Offshore detached breakwater	Protected area		0.29
Submerged breakwater	Protected area		0.25
Submerged breakwater with jetties	Area behind breakwater. between jetties		0.25

Table 1: Relative water exchange intensities of shore protection structures

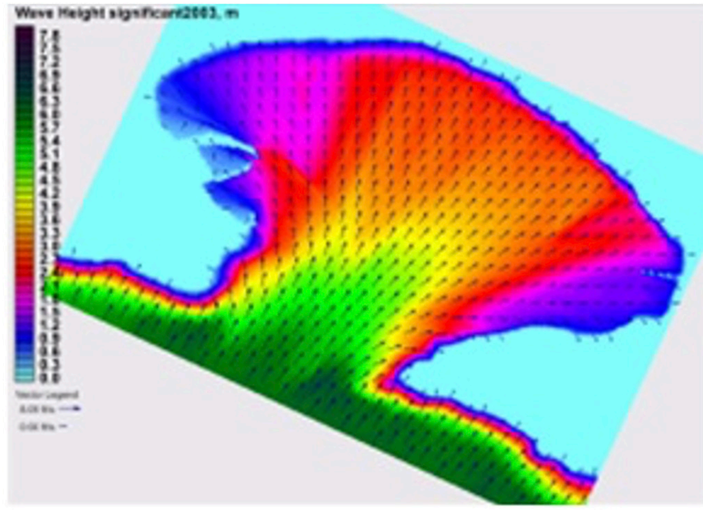


Figure 2. Field wind waves during the storm January 2003 in the Gelenjik bay, Black Sea

3.2 SIMULATION OF THE CURRENTS IN THE BAY

Model of currents calculation COASTOX-MORPHO is based on two-dimensional system equations. averaged over time, significantly exceeding the period of "short" waves (storm waves, swell) in long- wave (hydrostatic) approximation. These equations explicitly describe the tides and water level fluctuations associated with the wind-surge. Influence of short waves on the currents and the change in the average level parameterized in the equations by wave radiation stress. The settlement grid consists of 47625 nodes and 94414 elements (fig. 3).

According to results of simulations of the currents in the Gelenjiik Bay (fig. 4) it may be concluded construction of the port Gelenjik practically has no effect on the distribution of currents in the South-Eastern part of the Gelenjik Bay. Currents in the central part of the Bay are feeling the impact of the construction of the port. However. the characteristic pattern of currents after its construction does not change.

4. SOCHI. CONSTRUCTION OF MARINA IN THE RECONSTRUCTED PORT

4.1 MODELING OF THE CURRENT CONDITIONS

The study has been carried out for the conditions of the yachting port "Grand-Marina Sochi", what is designed for placing in the existing seaport Sochi, Russian Black Sea coast. Construction of the marine with a capacity up to 200 yachts with a technical zone is planned for the creation of the sea passenger and cruise traffic international center (fig. 5). The water area of marina is bounded by construction of the additional breakwater in the main seaport [7].

Calculations were carried out with application of modern hydrodynamic models. 3D circulation of the currents inside and in the gate of the marina is modeled by application of the SELFE-code [8] – the numerical solution of the hydrodynamic equations on the unstructured grids. To simulate the dynamics and evolution of the oil spill the 3D OILTOX-code is used. Both codes have been developed in Ukrainian Center of Ecological and Water Projects. The system dynamic model of the water quality evolution has been designed on the base of PowerSim model and applied to simulate the changes of the water quality parameters after sewage system damage.

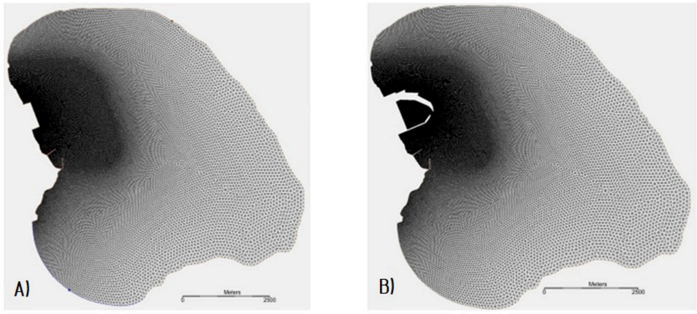


Figure 3. Computational grid: A) In existing conditions; B) After the construction of the port Gelenjik

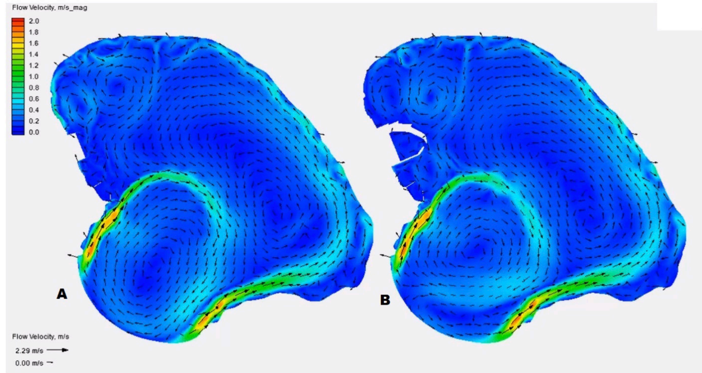


Figure 4. The established current field on the middle depth for a water area: A) In existing conditions; B) After the construction of the port Gelenjik

For the modeling of current field, the area with extension of 120 km along the coast and 50 km wide was chosen. The Sochi port is in the center of settlement area. Hydrodynamic calculations were made for two options: before and after port reconstruction. The open border in both cases coincides. The settlement grid consists of 12247 cells in existing conditions and 14148 in option after reconstruction. The sizes of the parties of cells vary from 10 m in a marine to 5 km on open deep-water borders. The sigma system of coordinates from 40 levels with a condensation at a surface was used. Calculations were carried out by the hydrostatic version of model with a temporary step 10c. In the model the k-ε model of the turbulence was used. On open borders radiation conditions were set.

4.2 SIMULATION OF THE SPREAD OF AN EMERGENCY SPILL OF MARINE FUEL

For the modeling of the accidence during the yachting port operational period "the worst scenario" was chosen. In this scenario there is a spill of diesel fuel in the port entrance as result of accident. and a wind directed to the marine. The total volume of the discharged oil is taking as 500 liters, the time of discharge is 10 minutes. The number of model Lagrange tracers is 6200. volume of each tracer is 0.008 liters, time step of model is 0.5 c.

The modeling results (fig.6) shows that the breakwater construction opposite to the marine entrance slows down the speed of oil products distribution for a little and changes a movement trajectory of a spot, but the pollution of the coast remains approximately identical. In all scenario's diesel fuel was completely washed ashore within two hours after the flood beginning. With a wind of 15 m/s, all diesel fuel appeared ashore, in 20 min in old configuration of port and in 30 min in the presence of a breakwater.

Consider the results of forecasting changes in water quality in the water area of the designed marina in the presence of a hypothetical emergency discharge of untreated wastewater during the operation period. considering the season. as well as the intensity of water exchange between the marina water area and the atmospheric sea [9].

The quality of sea water is approaching the chemical and biological specialties. Therefore, the parameters include parameters by which the state of the water area of the designed marina is assessed, especially phosphates, nitrates, nitrites, soluble oxygen and nitrogen, ammonium. Phosphates and nitrogen-ammonium are considered as pollutants entering the banks with domestic wastewater.

The estimated consumption of domestic wastewater in the water area of the designed marina is 162.9 m^3/day. and the volume of water in the water area is 632 199.4 m^3. The composition and quality of domestic wastewater are applied in accordance with the regulations.

Figure 5. The model of a new marine.

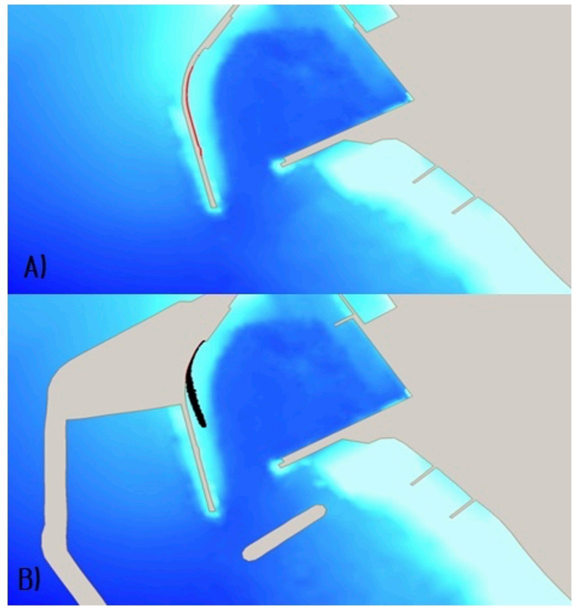


Figure 6. Distribution of a diesel fuel spot in 20 min after the flood beginning with a wind speed 15 m/c in: A) old port configuration B) new port configuration.

5. CONCLUSIONS

1. 0-D mathematical models of water exchange for enclosed or semi-enclosed coastal areas may be successfully apply in research and teaching in integrated coastal zone management, environmental issues. Particularly, this kind of model can give the comparative estimation of various typical coastal structure influences onto water exchange of protected areas with main body.
2. According to results of simulations of the currents in the Gelenjiik Bay it may be concluded construction of the port Gelenjik practically has no effect on the distribution of currents in the South-Eastern part of the Gelenjik Bay.
3. For the modeling of the accidence during the yachting port operational period “the worst scenario” was chosen. In all scenario’s diesel fuel was completely washed ashore within two hours after the flood beginning. With a wind of 15 m/s. all diesel fuel appeared ashore. in 20 min in old configuration of port and in 30 min in the presence of a breakwater. The estimated consumption of domestic wastewater in the water area of the designed marina is 162.9 m^3/day. and the volume of water in the water area is 632 199.4 m^3.

REFERENCES

1. Kantardgi I. (2003): Natural flushing of the coastal semi-enclosed areas. Models and model limitations. Proceedings of the Sixth Int. Conf. On Coastal & Port Engineering in Developing Countries. Colombo. Sri Lanka. Vol. 65
2. Kantardgi. I. (1996): Groin area water exchange. Journal of Hydraulic Research. 1996. 34. No.2
3. Inman. D.L., Tait. R.J. and Nordstorm. C.E. (1971): Mixing in the Surf Zone. Journal of Geophysical Research. 76
4. Kantardgi. I. and Dreizis. Y. (1995): Permeable Moles to Improve Marina Water Exchange. Second International Conference on the Mediterranean Coastal Environment. October 24-27. 1995. Tarragona. Spain. Proc. MEDCOAST 95. 3
5. Holthuijsen L. H. (2007) Waves in oceanic and coastal waters. -Cambridge University Press. 2007. -236 p.
6. Holthuijsen. L., Booij. N., Ris. R., Haagsma., I. G. Kieftenburg., A. Kriezi E. E. (2009) SWAN Cycle III version 40. 51 User Manual. Delft University of Technology. Department of Civil Engineering. The Netherlands.
7. Kantardgi. I. (2013). Kantardgi I., Maderich V., Terletskaya E., Brovchenko I., Prokhoda-Shumskikh L.Water quality protection: Grand-Marina. Sochi. Proceedings of the Global Congress on ICM: Lessons Learned to Addressed New Challenges. EMECS 10- MEDCOAST 2013. 30 Oct-03 Nov. Marmaris. Turkey. vol. 1. pp.989-1001
8. Brovchenko I.A., Maderich V.S. Chislennyy lagranzhevyy metod modelirovaniya rasprostraneniya poverkhnostnykh pyaten nefti [Numerical Lagrangian Method for Modeling the Spread of Oil Slicks]. Prikladnaya gidromekhanika. [Applied hydromechanics] 2002. 4 (76). vol. 4. pp. 23-31.
9. Kantardgi. I. & Maderich. V. (2013). Water quality protection in the coastal artificial water areas. Magazine of Civil Engineering. 37. 75-80+125. 10.5862/MCE.37.11.

Izmail Kantarzhi (Dr., Prof.), Alexander Kuprin (PhD student)

National Research Moscow State Civil Engineering University

OPERATIONS RESEARCH CASE STUDIES FOR CONFLICT MANAGEMENT

Operations Research (OR) offers general methods for optimizing the production, mixing, allocation, or distribution of goods, services or resources in terms of revenue, profit or utility. This typically requires maximizing the output of a process, project, or enterprise, and is shadowed by the "dual" problem of minimizing the amount of needed inputs and costs. The latter task can include avoiding permanent losses of resources and even human lives in conflict situations, which reminds of the fact, that quite a few methods of OR were developed at times of war.

More specifically OR uses methods and algorithms for linear optimization, a.k.a. linear programming (LP), as well as for dynamical and nonlinear optimization. These are helped by graph-theoretical and probabilistic approaches like simulations, and by special disciplines like decision theory or game theory. The oral presentation discussed a few made-up case studies, illustrating some of the pervasive principles of OR.

Transportation problem

In a first such case it was shown that the overall transportation costs of resources like a supply of water by two different providers to two different places of demand in a desert environment cannot always be optimized in a "greedy" way. This approach would for once favor the lowest-cost combination of supply and demand, but leave the costliest transport for the remaining supply and demand combination, only. A better solution for this 2x2 matrix situation chooses the second- and third-cheapest venues and leads to the least overall costs. Of course, in a real- world situation the outcome of a scenario like this would be depending on whether the different customers would be stiffly competing or, on the other hand, be willing to cooperate.

Maximum throughput

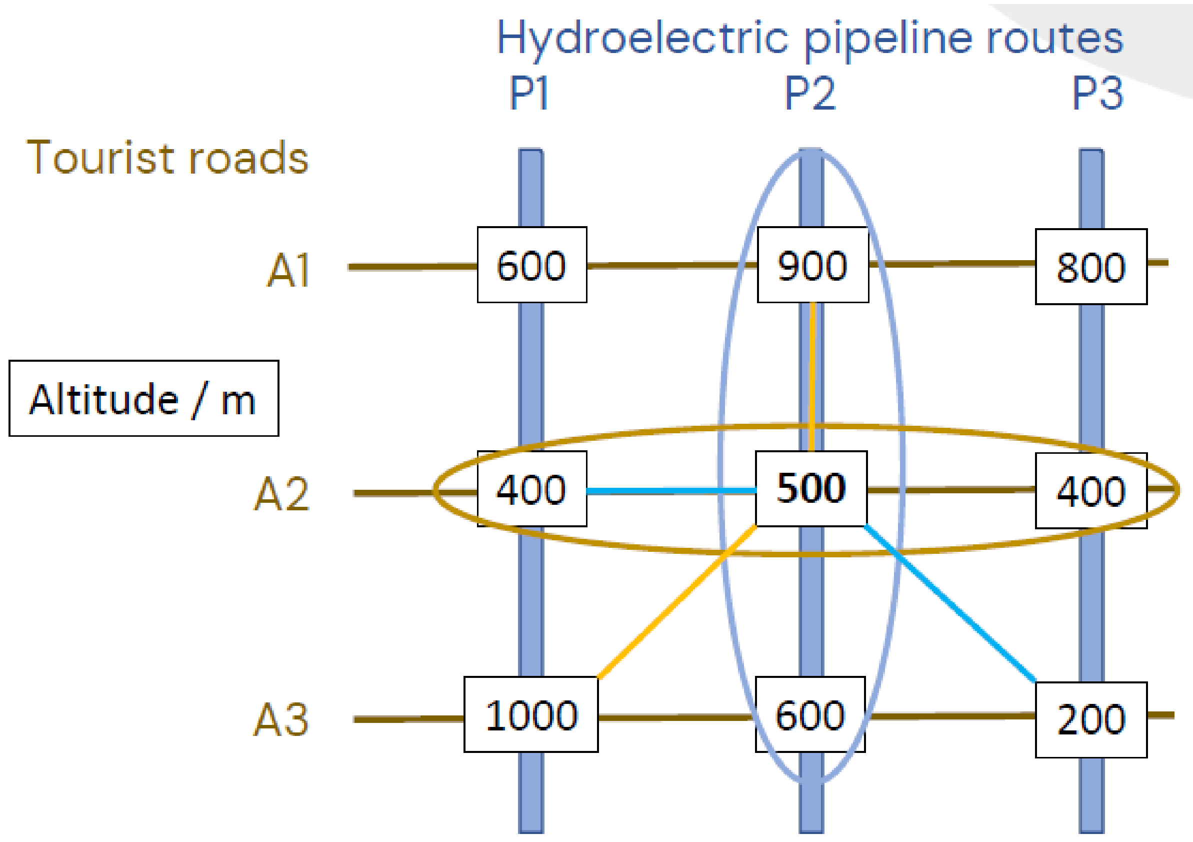
A second case, on the contrary, showed an instance, when greedy solutions will be optimal, though. Specifically, the algorithm by Ford & Fulkerson will provide for maximal throughput of water from reservoirs to a big city in a system of waterways and pipelines with differing capacities. Artificially breaking or inactivating one of the interconnected pipelines was shown to be followed by a loss of only half of its respective capacity in overall throughput, because the algorithm redirects the flow accordingly.

Game theory cases

It is well known, that "gamification" of real life situations can also improve solutions. Game theory is the mathematical field which addresses some of this in more formal terms. Two-person zero sum games present a simple model for conflict management.

In a sample scenario, fictitiously located in the Ural Mountains, a hydroelectric power company has singled out three possible pipeline routes as alternative strategies for decision and would prefer the highest possible location for the reservoir, whereas the tourism board can build one of three alternative access roads and opts for the lowest possible location to avoid cold weather. Given the following network of the nine intersections with altitudes, it becomes clear that a greedy strategy from either "player would result in a solution at the highest possible altitude of 1000 meters, thus frustrating the tourism board.

In cases like these it is sometimes worthwhile to follow a less aggressive venue, the so called minimax strategy. In the given example case, the power company determines the maximum altitude along each of its three pipeline routes and then singles out the minimum of these. The tourism board looks for the minimum altitude for each of the three access road alternatives, and then decides to accept the maximum among these. It can be seen, that both individual decisions "meet" at a saddle-point in topography. Such a cooperative solution is generally considered a game's saddle-point for any other numerical matrix of payoffs.



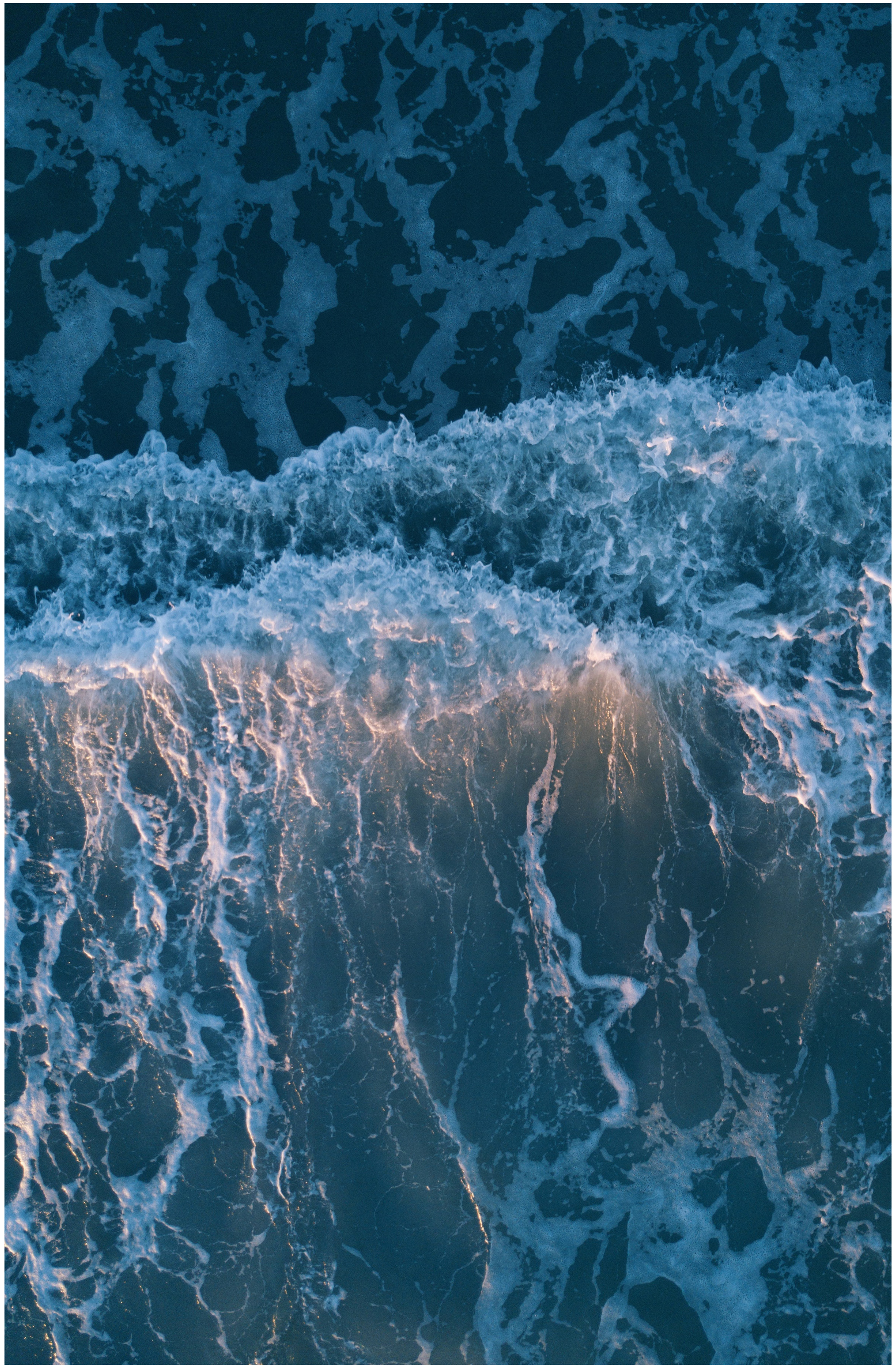
Not every such game has a saddle point. However, a choice of mixed strategies can produce it, which makes sense only when both players will do this in a rational way. Given two strategic alternatives for each player, their respective mixing ratio of strategies could be 1:2 for player A and 1:1 for player B, e.g. Whether the game requires only a single decision or many if going to be repeated, these probabilities would best be attained at random by rolling a dice for player A and allocating two of its results to the first and the four others to the alternative strategy. For player B it suffices to toss a fair coin with each face good for one of the alternatives.
For the East-West-Dialogue a fictitious conflict between two neighboring countries, both being able to block the use of a dammed hydroelectric reservoir along a common border, was plugged into a mixed strategy approach, which on the average resulted at least in a basic amount of water or electricity for each.

Nash equilibrium

Sometimes, adding a new and often costly alternative to an existing situation, e.g., a new piece of infra-structure will not improve the overall outcome, because all participants will try to use it for themselves, but generate blockages of sorts this way. A situation, where any change of strategy worsens the total payoff is called Nash equilibrium in game theory. It was exemplified by the effect of adding a quite expensive street tunnel to a certain grid of mountain roads.
Examples like these merit further elaboration in order to make them useable in conflicts for water or other resources, as otherwise rational and cooperative solutions will often be missed.

Elmar Schmidt (retired)

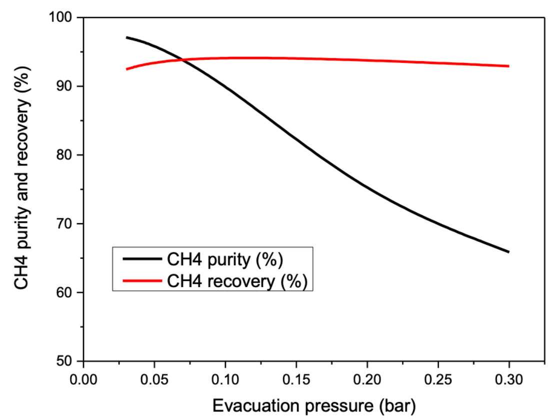
SRH University of Applied Sciences Heidelberg, Germany



SIMULATION OF A PRESSURE SWING ADSORPTION PROCESS FOR BIOGAS UPGRADING

Biogas is a renewable gaseous fuel produced by the anaerobic digestion of organic substrates such as animal manure, sewage sludge (by-product of wastewater treatment processes), the organic fractions of household and industry waste, and energy crops. Biogas recovery from wastes is gaining increasing attention globally due to the rising cost of conventional energy and growing attention to renewable and sustainable energy generation. The gas contains volume fractions of 55 - 65% methane (CH4) and 30 - 40% carbon dioxide (CO2). Biogas can be upgraded to natural gas quality by removing its significant non-combustible CO2 content. This improves the energy density and calorific value of the gas and is considered a very important step in the development and utilization of biogas energy.

In this study, the pressure swing adsorption (PSA) separation technique was used to study the removal of CO2 from biogas by means of computer simulations. In the biogas PSA process, the CO2/CH4 mixture is passed under pressure through a column packed with a CO2 selective adsorbent material that attracts CO2 more strongly than it does CH4, hence, the gas coming out of the column will be enriched in CH4. After a prescribed time, the column pressure is reduced to desorb the CO2 to make the adsorbent bed available for the next cycle of operation. Several intermediate steps can be incorporated to optimize the separation efficiency.



Effects of Desorption Pressure on CH4 Purity and Recovery. Adsorption pressure = 2 bar; Adsorption step time = 60s; Feed composition = 60% CH4/ 40% CO2.

The PSA process adopted consists of two adsorber columns packed with carbon molecular sieve adsorbent and undergoing the distinct cycle steps of pressurization with feed, adsorption, pressure equalization, vacuum evacuation, and counter-current purge. A non-isothermal, non-adiabatic PSA model was developed in the commercial Aspen Adsorption simulator to predict the performance of the PSA cycle. Adsorption equilibrium data measured by (Rocha, Andreassen and Grande, 2017), fitted to the Dual-site Langmuir model were used determine the amounts of CH4 and CO2 adsorption in the simulation. With adsorption pressure of 2 bar and a mixture 60% CH4 and 40% CO2, the simulations predicted a biogas product with CH4 purity of about 96% and a recovery of 94% at desorption pressure of 0.05 bar. By fixing adsorption step time, CH4 purity increased with decreasing desorption pressure while recovery remained almost constant. As the desorption pressure decreases, the bed is more cleaned for more CO2 adsorption resulting in less CO2 in the effluent of the column to dilute the CH4 product.

Future work will explore different cycle designs and operating strategies to help identify optimal design and operating window and calculate other performance variables such as energy consumption and productivity. This will enable effective scale up of the process and techno-economic assessment of the process.

REFERENCES

Rocha, L. A. M., Andreassen, K. A. and Grande, C. A. (2017) 'Separation of CO2/CH4 using carbon molecular sieve (CMS) at low and high pressure', Chemical Engineering Science, 164, pp. 148–157.

Augustine Ntiamoah, Nana Yaw Asiedu

Department of Chemical Engineering, Kwame Nkrumah University of Science & Technology, Kumasi- Ghana.

EVALUATING PROCESS OF LOW-COST DEVICES AND THEIR EFFICIENCY FOR AIR QUALITY MONITORING

Data calibration of four low-cost sensors (LCS) by performing collocation of LCS with reference monitoring station (RFS).

LCS performance evaluation was conducted in order to examine accuracy, error, and precision of measuring PM2.5 in ambient conditions and examine efficiency of the calibration process.

- Collocation process implied RFS and LCS to operate at the same time and place under real-world conditions for certain evaluation period, to calibrate 1h and 24h data.
- Each sensor was placed next to the other in the vicinity of RFS at a distance of 2.5 m and height of 1.2 m, for 14 days (Pict. 1-2).

Pic. 1

Pic. 2

RESULTS:

- A review of collected data after the evaluation period, showed a few outliers present in all four LCS data sets, more extreme in case of 1h frequency measurement, but also sudden changes in a sensor's response over the evaluation period in the form of higher or lower $PM_{2.5}$ concentrations comparing to RFS data.

1h frequency measurement (Table 1):

- Determination coefficient (R2) values were in range 0.79 – 0.82 (e.g. LCS1, Figure 3).
- Mean absolute error (MAE) and relative error (RE) values were in the range 2.33 - 2.70 μg/m³ and 25.9 – 40%.
- Mean and standard deviation (SD) values of RFS data were 7.90 and 3.84 μg/m³ and for LCS1-4 were in range 6.39-8.84 and 5.21 – 6.35 μg/m³.

24h frequency measurement (Table 1):

- R2 (e.g. LCS1, Figure 4), MAE and RE values were in range 0.84-0.85, 1.38-1.85 μg/m³ and 17-25%.
- Mean and SD values from RFS were 8.05 and 2.3 μg/m³, and for LCS1-4 were in range 6.59-8.98 and 3.35-4.33 μg/m³.

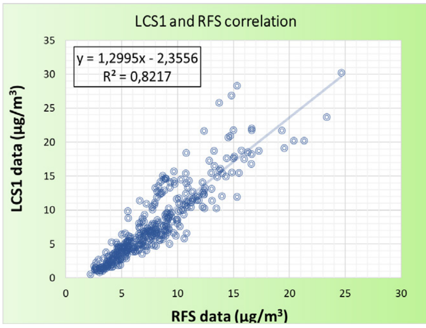


Fig. 3

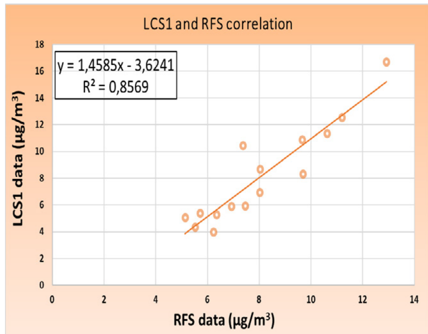


Fig. 4

Device & frequency	Mean (μg/m³)	SD	MAE	RE (%)
RFS 1h	7.9	3.8	-	-
LCS1	7.9	5.5	1.8	25.9
LCS2	8.8	6.3	2.2	27.9
LCS3	6.4	5.2	2.5	39.0
LCS4	6.9	5.7	2.4	40.0
RFS 24h	8.1	2.3	-	-
LCS1	8.1	3.6	1.4	17.0
LCS2	9.0	4.3	1.7	18.5
LCS3	6.6	3.4	1.9	25.8
LCS4	7.2	3.7	1.8	24.3

- R2 indicates a strong correlation of LCS data with RFS data.
- LCS provide good insights into $PM_{2.5}$ pollution trends in the form of a decrease or increase of PM2.5 concentrations (e.g. LCS1, Fig. 5 and 7) .
- The precision of the LCS is relatively low, since SD values of LCS data showed high dispersion of a data set relative to its mean.
- The measurement accuracy for both LCS data frequencies was moderate, comparing to RFS measurement.
- Slope and intercept values are further used for LCS 1h and 24h data calibration by applying inverse linear regression to increase the accuracy of the LCS data.

Calibration efficiency:

- MAE and RE values for 1h data were in the range 1.2 – 1.3 μg/m³ and 16-20% (Fig.6)
- MAE and RE values for 24h data were in the range 0.7-0.77 μg/m³ and 9-10% (Fig.8)
- The efficiency of applying LCS in PM2.5 pollution monitoring is modest.
- Basic data analysis results confirm that periodic calibration of LC devices and data is critical in reducing the error of sensor measurements and in characterizing and mitigating long-term sensor performance issues.

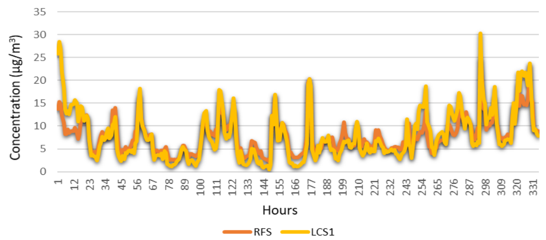


Fig. 5: "1h comparison graph before calibration"

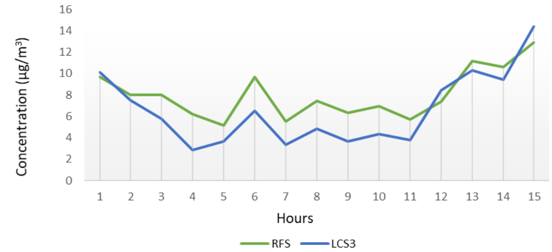


Fig. 7: "24h comparison graph before calibration"

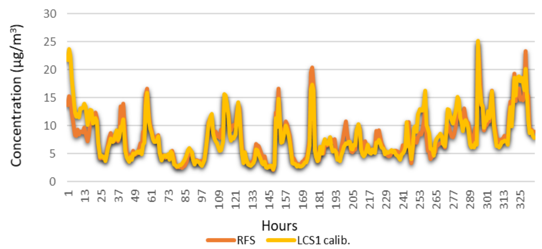


Fig. 6: "1h comparison graph after calibration"

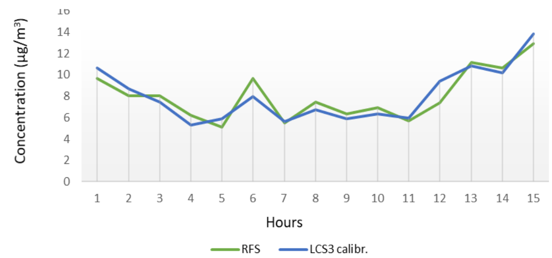


Fig. 8: "24h comparison graph after calibration"

Sonja Dmitrašinović, Jelena Radonić

Department of Environmental Engineering and Occupational Safety and Health, Faculty of Technical Sciences, University of Novi Sad

Acknowledgment
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".

DEVELOPMENT OF SLUDGE WASTE MANAGEMENT MODELS IN SERBIA

IN COLLABORATION WITH SRH HOCHSCHULE HEIDELBERG & UNVERSITY OF NOVI SAD AS A PART OF EU ERASMUS FUNDING PROGRAM

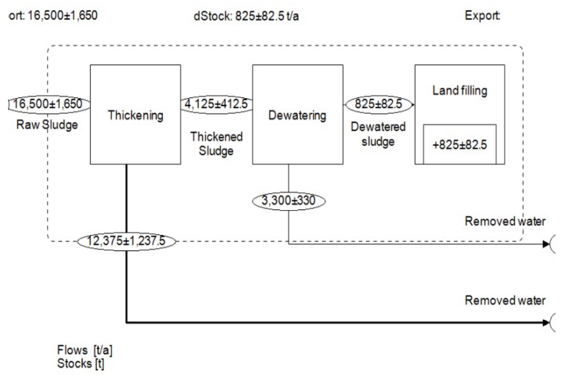
- Sludge is resource not a waste.
- Every resource must be used to attain a sustainable environmental future.

RESEARCH BOUNDARY
Sludge managment is at the primary level in Serbia.

Most of the sludge generated is directly land filled.

The models are developed for the Northern Part of Serbia (AP Vojvodina).

STAN (Substance Flow Analysis) software is used for model development



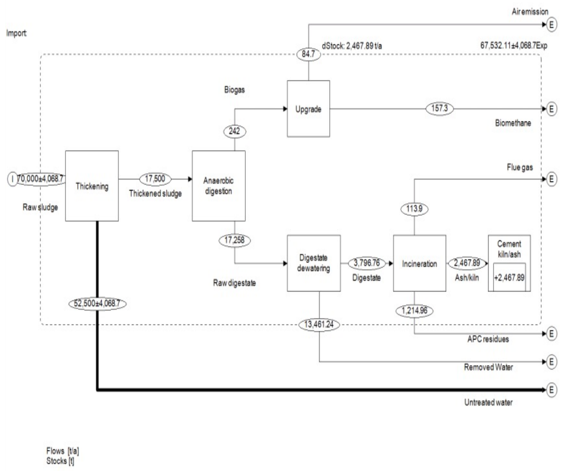
MODEL DEVELOPMENT
Different scenarios were developed.

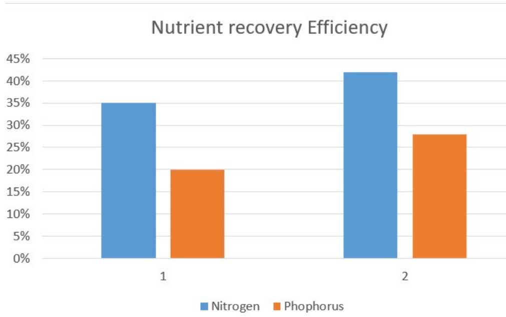
1 – combining composting with the existing methods and landfilling.

2 – combining incineration in cement kilns with the existing methods.

3 – combing anaerobic digestion and biogas upgrade with existing methods

4 – the combination of anaerobic digestion, biogas upgrading, and incineration.



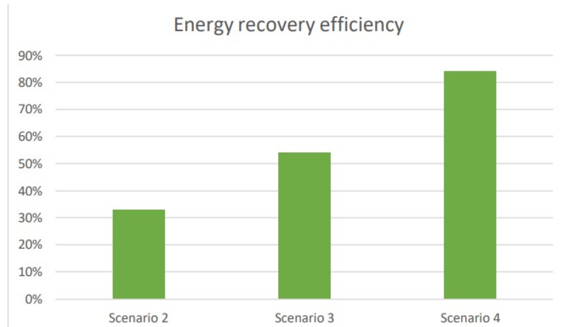


RESOURCE MANAGEMENT
All the models and calculations and models were developed abiding EU wastewater and sludge management regulations.

Based on these models, nutrient and recovery efficiency are calculated.

CONCLUSION
The nutrients recovered can be useful for other purposes.

For any person, every resource is important as long as we find other ways to use it.



Presented by Uday Kumar Batta

Supervised by Prof Dr Ulrike Gayh (SRH) &
Prof Dr Nemanja Stanisavljevic (Novi Sad)

IMPROVEMENT IN PERFORMANCE OF ANAEROBİC DIGESTION VIA CONDUCTIVE MATERIALS; GRANULAR ACTIVATED CARBON & HEMATITE

CONVENTIONAL ANAEROBIC DIGESTION (AD) IS A WIDELY USED PROCESS FOR THE TREATMENT OF WASTES AND TO GENERATE METHANE FROM WASTES. LOW METHANE YIELD, LOW ORGANIC REMOVAL AND LOWER RATE ARE DRAWBACKS FOR AD SYSTEMS 1,2.

- **CONDUCTIVE MATERIAL (CM) CAN IMPROVE PERFORMANCE OF AD BY DIRECT INTERSPECIES ELECTRON TRANSFER (DIET)**
- **LAG TIME CAN BE REDUCED BY CM**

Parameter	Inoculum	Substrate
pH	7.5	7.8
Total solid (%)	3.34 ± 0.01	12.18 ± 0.06
Volatile solid (%)	1.76 ± 0.01	9.45 ± 0.05
Volatile solid/Total solid (%)	52.68 ± 0.39	77.55 ± 0.04
Chemical oxygen demand (mg COD/L)	30,027 ± 61	151,743 ± 6446
Phosphorus (mg PO4/L)	-	35.3 ± 1.6
Ammonia (mg NH3-N/L)	-	1897 ± 117

Table 1: Inoculum and sustrate characterization

Aim of the Study

In this study, we aimed to increase the performance of AD for cattle manure digestion by supplementation of two different conductive material, hematite (Fe_2O_3) and granular activated carbon (GAC) and to investigate the effect of CM amount.

Reactor	Inoculum	Substrate	Conductive material (GAC/Fe_2O_3)
Blank	+	-	-
AD	+	+	-
GAC-20	+	+	GAC (20 g/L)
GAC-40	+	+	GAC (40 g/L)
GAC-60	+	+	GAC (60 g/L)
Fe-20	+	+	Fe_2O_3 (20 mM Fe)
Fe-50	+	+	Fe_2O_3 (50 mM Fe)

Table 2: Experimental Design

Methodology

Inoculum: Anaerobic digester seed
Substrate: Cattle manure from a biogas plant

Diffferent GAC concentration

- 20 g/L GAC
- 40 g/L GAC
- 60 g/L GAC

Different Fe_2O_3 concentration

- 20 mM Fe
- 50 mM Fe

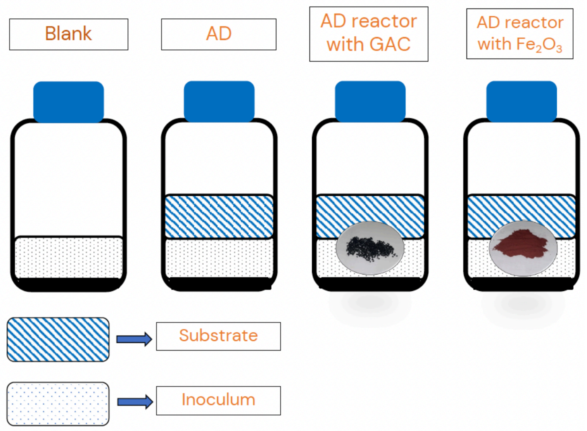


Figure 1: Representation of experimental design

RESULTS

- 30% higher cumulative CH_4 production in all GAC reactor than conventional AD reactor
- 21% higher CH_4 yield (ml CH_4/g VSremoved) in all GAC reactor than conventional AD reactor
- 11% higher cumulative CH_4 production in Fe-50 reactor than conventional AD reactor
- 17% decrease in lag time in GAC-40 with respect to conventional AD reactor
- 1.48 times higher CH_4 production rate in GAC-60 reactor and 1.33 times higher CH_4 production rate in Fe-50 reactor

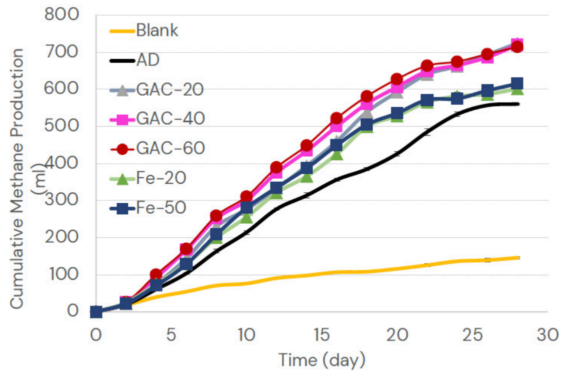


Figure 2: Cumulative CH_4 production

CONCLUSIONS

- Application of conductive material (GAC and Fe_2O_3) enhanced
- CH_4 production with respect to conventional AD reactor
- Lag time for the digestion decreased by the supplementation of conductive material
- No significant difference among GAC reactors in cumulative production
- Conductive material is a promising approach to improve the performance of conventional AD process

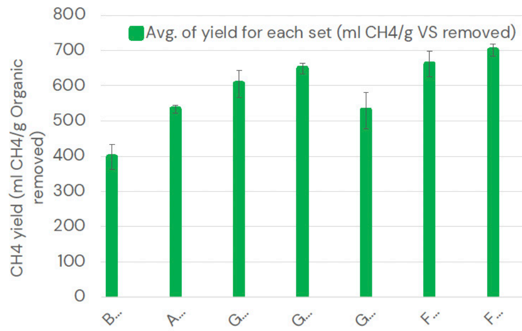


Figure 3: CH_4 yield (ml CH4/g $VS_{removed}$) removal for each set

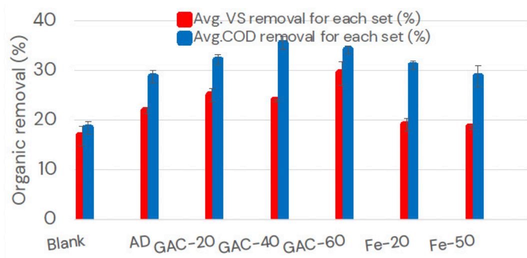


Figure 4: VS and COD removal for each set

	AD	GAC-20	GAC-40	GAC-60	Fe-20	Fe-50
P (ml)	671	828	777	767	657	648
Rm (ml/d)	27	36	38	40	34	36
λ (d)	2.4	2.5	2.0	2.1	2.5	2.5

P: Methane production potential (mL) ;
Rm: Maximum methane production rate (mL/d);
λ: lag-phase time (d)

Table 3: Modified Gompertz fitting parameters

REFERENCES

1. Johnravindar, D., Liang, B., Fu, R., Luo, G., Meruvu, H., Yang, S., Yuan, B., & Fei, Q. (2020). Supplementing granular activated carbon for enhanced methane production in anaerobic co-digestion of post-consumer substrates. Biomass and Bioenergy, 136, 105543.

2. Liu, Y., Li, X., Wu, S., Tan, Z., & Yang, C. (2021). Enhancing anaerobic digestion process with addition of conductive materials. Chemosphere, 278, 130449. https://doi.org/10.1016/j.chemosphere.2021.130449

Yasin Odabaş, Yasemin Dilşad Yılmazel

Department of Environmental Engineering,
Middle East Technical University

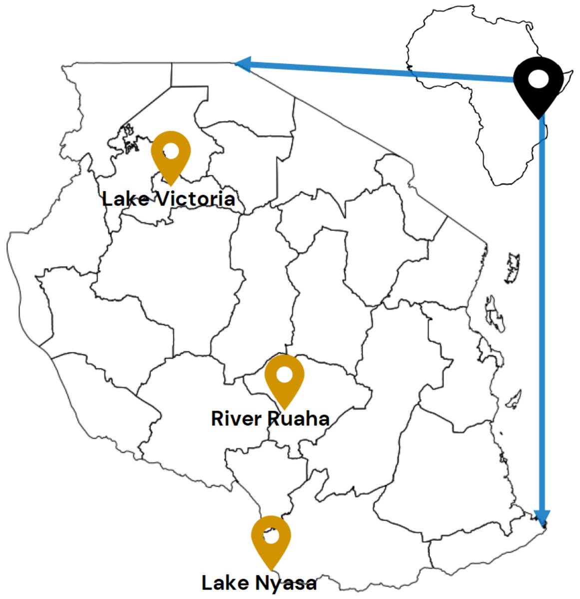
WATER POLLUTANTS IN AQUATIC ENVIRONMENT, TOXICITY POTENTIAL ON WATER QUALITY

A CASE STUDY OF TANZANIA

INTRODUCTION

Different water bodies have different water qualities depending on factors such as the sources of water, industrial and human activities surrounding the specific water bodies etc. The study was done on three different water bodies in Tanzania with the following objectives

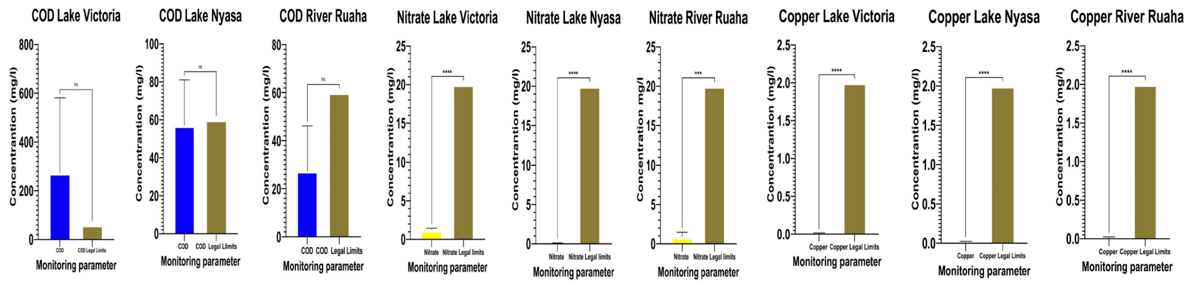
- Determination of the **toxicity levels** on Water **Quality for specific water bodies** and how the **toxicity levels** will affect different water users.
- Compare different toxicity levels against the permissible **limits**
- Identifying critical parameters and prioritizing for **regulatory monitoring**



MATERIALS AND METHODS

- Samples were collected from Lake Victoria, Lake Nyasa and River Ruaha.
- The samples were sent to Mwanza Zonal Water Quality L aboratory of for the analysis.
- The data was analyzed using a student t test in Graphpad prism 9 to determine significance of the data.

RESULTS



P is significant at $P < 0.05$:

1. There were significant COD concentration values in Lake Victoria as compared to the permissible limits ,P =0.43 (ns).
2. There were no significant Nitrate concentration values for all the three water bodies compared to permissible limits (***) P<0.0005.
3. There were no significant Copper concentration values for all the three water bodies compared to permissible limits , P<

CONCLUSION

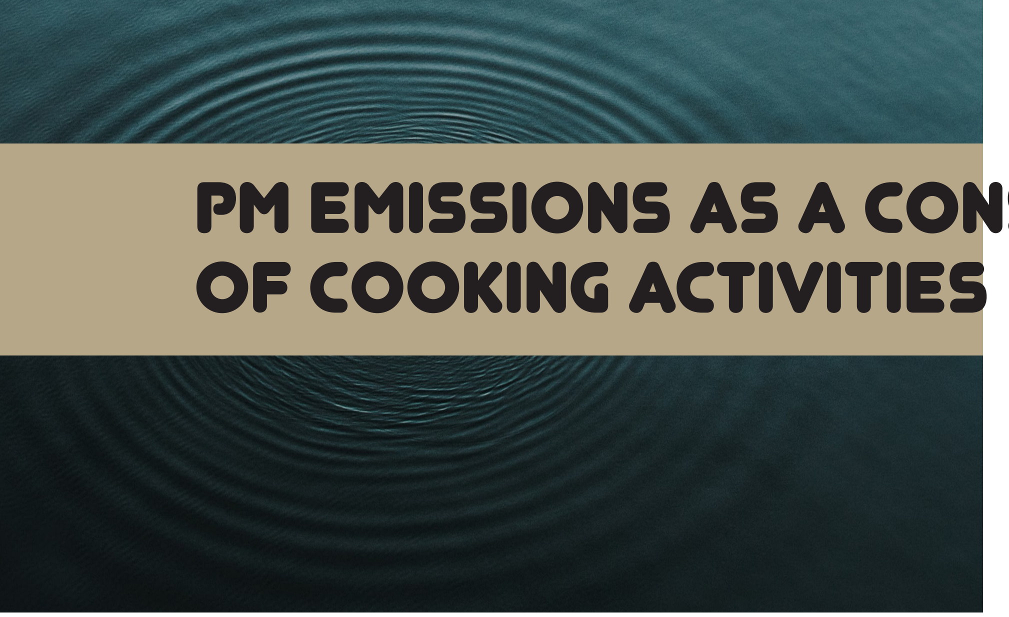
1. There were significant differences between the COD levels in lake Victoria in comparison to permissible levels due to industrial activities .
2. There were low Nitrate and Copper concentrations for all the three water bodies in comparison to the permissible levels.
3. COD monitoring especially for Lake Victoria was observed to be critical and should be of the highest priority.

REFERENCES

1. Harieth , K. (2017). Another decade of water quality assessment studies in Tanzania: Status, challenges and future prospects. African Journal of Environmental Science and Technology , 11(7), pp.349 360.
2. Hawkins, P. (2010). National Water Quality Management and Pollution Control Strategy . Ministry of Water and
3. Ministry of State and Environment (2007). Environmental Management (Water Quality Standards) Regulations, 2007 . Available at: http://extwprlegs1.fao.org/docs/pdf/tan151541.pdf
4. Mohammed, Salim.M . (2000). The Assessment of Water Quality and Pollution in Tanzania.

Submitted by: John Lugongo.

Supervisors: Dr. Kenneth Bedu Addo, Prof.Dr. Ulrike Gayh.



PM EMISSIONS AS A CONSEQUENCE OF COOKING ACTIVITIES

Data obtained from numerous studies show that people spend almost 90% of their time indoors. However, many studies are based on examining pollutants present in the external environment and originate from various human activities: traffic in urban areas, heating with biomass, and fossil fuels in rural areas. Therefore, it is essential to examine human health due to exposure to pollutants resulting from indoor activities. The primary sources of indoor air pollution are the most common activities related to maintaining home hygiene, such as vacuuming, burning incense, incense sticks, air fresheners, using chemicals for maintenance, and human activities such as smoking or cooking. As at least one meal is prepared in homes every day, frying is a commonly used method for food preparation. This research focuses on measuring the emission of particulate matter released when frying meat in fluid at different temperatures.

INTRODUCTION

Aerosols, black carbon, carbon dioxide, polycyclic aromatic compounds, formaldehyde, suspended particles, and other aero pollutants are released during the food preparation process. Exposure to particles can lead to severe health damage. The particles released during the food preparation process are inhaled into the respiratory system and deposited in the airways. In addition, numerous consequences occur in contact with other organs. Acute exposure to particulate pollution can lead to pneumonia, while long-term exposure can lead to cancerous diseases. Frying meat at high temperatures is dangerous to people who perform this activity. In addition to the negative impact on directly exposed people, PM particles emitted during frying also harm people in the immediate environment.

Particle concentrations in the air vary due to different food preparation methods and ventilation characteristics. In most homes in Serbia, natural ventilation is most often used to ventilate the space. Kitchen hoods are also in use. Insufficient capacity is a common problem with aspirators, but to some extent, they reduce exposure to pollutant that occur in food preparation.

This paper aims to determine, based on experimental results, the optimal method of food preparation and the method of ventilation from exposure to PM particles, which has the most negligible harmful impact on the health of the exposed.

MATERIAL AND METHODS

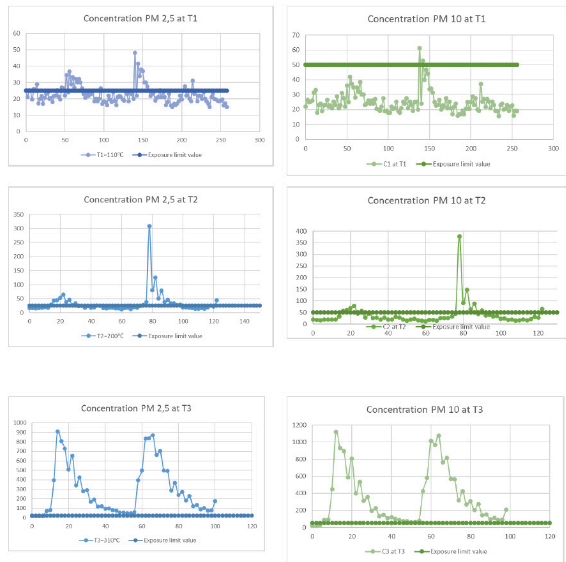
The experiment was performed in the summer, for three days, in a household located in a rural environment. The house is built traditionally. The room volume in which experiments were performed is 82.5 m3, and only kitchen furniture is placed in the room. No internal activities other than frying meat were performed during the investigation. Ventilation that was practiced during the experiments is natural. The doors of the adjoining rooms were closed during the experiment to quantify the concrete contribution of PM emissions in the frying process.

For the research, pork was used, which is the most often used kind of meat in nutrition, in the Republic of Serbia, and the most commonly used fluid was lard.

The exact amount of meat, 100 g, and the same amount of fluid, 100 ml, were always used. The meat was fried in a pan with a diameter of 30 cm on a Teflon surface. The pan was placed on a heating surface with a diameter of 30 cm, and an electric stove was used. The meat was fried at 3 different temperatures T1=110°C, T2=200°C and T3=300°C. Temperatures were measured with a thermocouple and a thermal imaging camera.

The sensors used for the measurement belong to thegroup of low-cost sensors, which can provide interesting complementary data. Sensors for measuring PM10 and PM2.5 were set at two different heights, at 1.7 m, which represents the average human breathing zone, and at the height of 1.5 m, and sensors recorded results every 2 minutes. Data processed using both sensors were used to process the results to obtain representative exposure results.

Each experiment started with a zero measurement to determine the background concentrations. During the meat frying, the sensors collected data on the emissions of the two fractions of suspended particles, PM10 and PM2.5. Before frying, the meat was thinned to a thickness of 0.5 cm, and no spices were added to the meat. The pan was placed on a heating surface that was heated to constant temperatures T1, T2 or T3, and after one minute, the meat was placed in the fluid. Frying was carried out until the steak was fried.

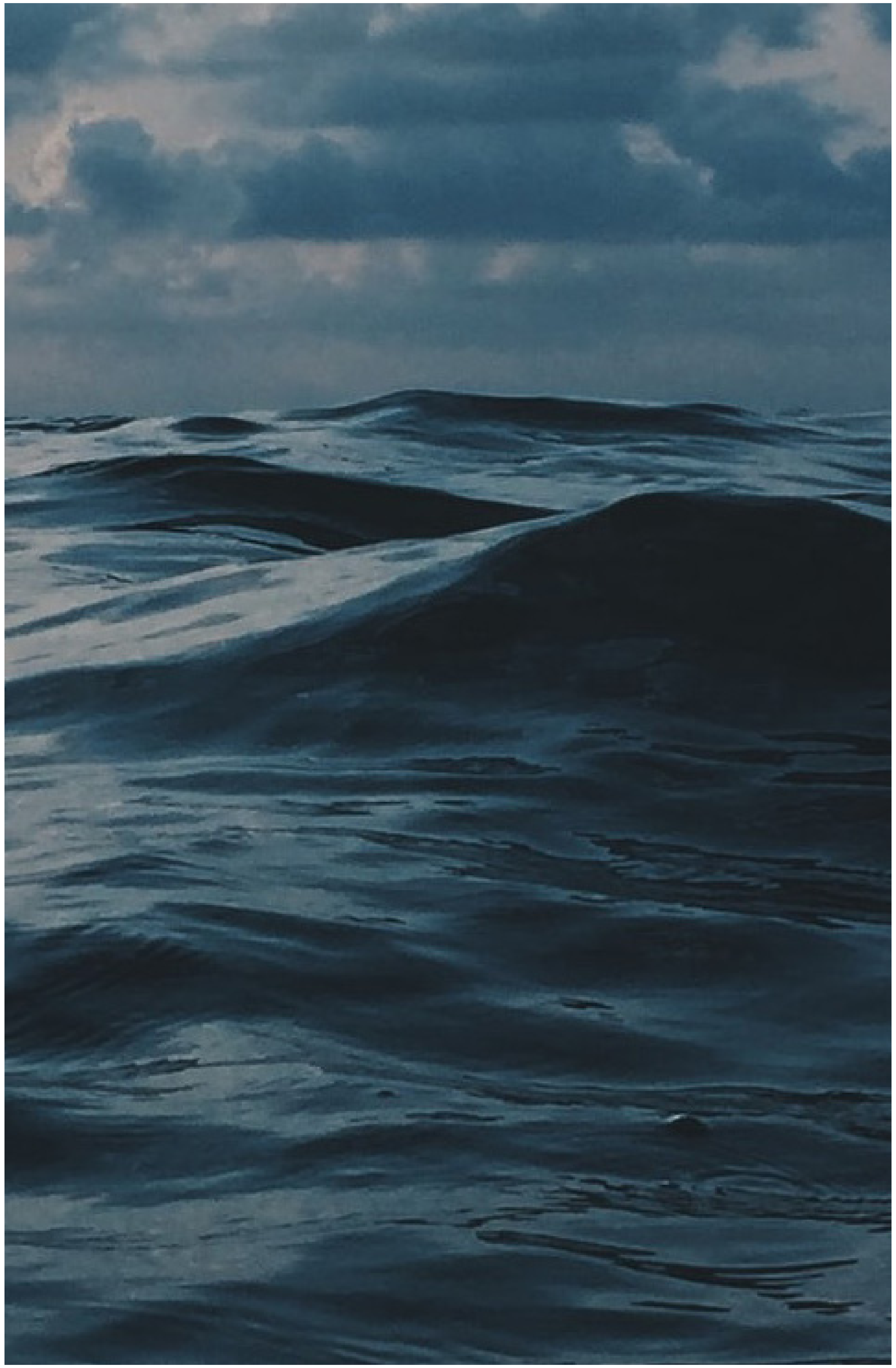


RESULTS AND DISCUSSION

As we can see from the figure, the concentration of suspended particles at temperatures T1 and T2 is around the limit value set by the WHO, with minor deviations at several points. However, frying meat at high temperatures, such as temperature T3, contributes to a significant increase in concentration. Furthermore, the concentration values deviate significantly from the limit values, so the risk of disease increases. One of the ways to reduce the risk is to combine the types of ventilation, natural ventilation, and use of kitchen aspirators, changing the method of food preparation, which means preparing food at lower temperatures or preparing food using water.

CONCLUSION

This study implemented a controlled experimental protocol to estimate the emissions of particles emitted during the frying of pork meat. This research found that the emission of particulate matter during frying is highly diverse, depending on the frying oil, frying temperature, frying method, frying style, and other factors. This diversity means that prediction and evaluation of the frying aerosol are challenging, although the characteristics of the cooking source are well known. Keeping in mind many factors that influence the generation of particulate matter, further research will be focused on defining the optimal conditions of food preparation to minimize the generation of harmful pollutants during the food preparation process.



ENHANCED REMOVAL OF CIPROFLOXACIN USING HUMIC ACID MODIFIED HYDROGEL BEADS

Widely present Fluoroquinolones (in wastewater, due to their high production and incomplete metabolization, provoke antibiotic resistant bacteria resulting in various health disorders.
We prepared an adsorbent for ciprofloxacin by incorporating humic acid on powder biochar (to add more functional groups) followed by encapsulation in chitosan to covert it into beads which are stronger, separable and recyclable Biochar (has wide range of applications in environmental remediation, and many studies have confirmed that its surface modifications can enhance its sorption capacity.

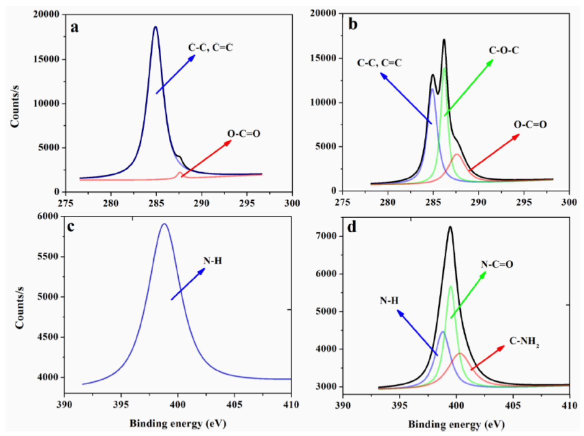


Fig. 1: C 1s and N 1s core spectra of HBCB pre and post adsorption

Both C1s and N1s core spectra of adsorbent (post adsorption) of CIP indicates generation of new peak at 286 2 eV (C-O-C), 399.5 eV (N-C=O) and at 400.3 eV (C-NH_2).
Adsorption capacity of 154.89 mg/g in first cycle was still enough 60 mg/g) after 4 th regeneration cycle.
Therefore, HBCB can be an economical adsorbent for the removal of CIP from wastewater.

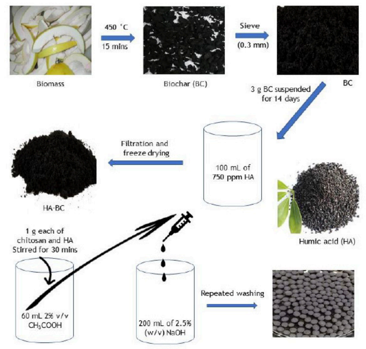


Fig. 2: Flow chart of adsorbent (HBCB) preparation.

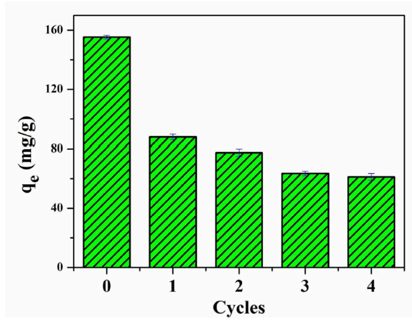


Fig. 3: Adsorption capacities of HBCB in different regeneration cycles

Presence of two Raman peaks at 1360-1380 cm^{-1} and 1570-1590 cm^{-1} correspond to the D-band and G-band of sp^2 type carbon. Increase in Id/Ig ratio from 0.6318 (BC) to 0.7597 (HA BC) reflects a decrease in the average size of sp^2 domains and increase in number of functional groups and creation of new graphitic domains of a smaller size and higher frequency.
Broad XRD peaks at 23° and at 43° are considered characteristic peaks of graphitic carbon, and at 9° indicates presence of oxygen containing functional groups and interspersed water molecules.
Increase in intensities of peaks after incorporation of HA indicates enhancement of functional groups already present on BC.

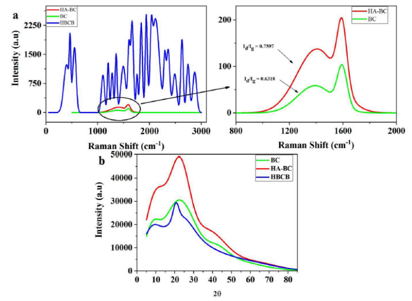


Fig. 4: (a) Raman spectra and (b) XRD spectra of BC, HA-BC, and HBCB (before adsorption).

Humic acid (HA) has a complicated macromolecular structure, with many hydrophilic groups (including carboxyl, hydroxyl, phenolic, alcoholic, amide and amine) covalently bonded to hydrophobic groups (including aliphatic, aromatic and heterocyclic structures.
Therefore, modification of BC with HA looks very promising approach.
At the same time, due to difficulty in separation of the composite from suspension, there is an urgent need to assemble an effective three dimensional structure with th composite material, for sustainable use.

Muhammad Zaheer Afzal,
Rengyu Yue, Xuefei Sun,
Chao Song, Shuguang Wang

CLEAN WATER AND SANITATION FROM THE ASPECT OF THE COVID-19 PANDEMIC

INTRODUCTION

Shortly after the COVID-19 outbreak, most countries took active measures in response to the emergency [1]. Frequent and proper handwashing is the most basic frontline defense against the spread of COVID-19 as an inexpensive, widely applicable response measure [2]. The contribution of water supply, sanitation and hygiene (WASH) to the COVID-19 response has therefore been central, primarily by promoting good hygiene, and particularly, by ensuring frequent and proper handwashing [3,4].

FEEDBACK LOOP: CLEAN WATER AND SANITATION – COVID-19

Access to the levels of water supply that support good hand hygiene and access to soap are deficient, particularly in low- and middle-income countries [2,4]. UNICEF/WHO Joint Monitoring Programme (JMP) estimates that only 71% of the global population (5.3 billion people) use a safely managed drinking-water service – that is, one located on premises, available when needed, and free from contamination [5]. The same data however shows that over one-quarter of the global population still uses water collected from off-premises water sources that are often shared between households, including 144 million people who are dependent on untreated surface water [5]. Reliance on such sources poses two challenges to the pandemic response: water for handwashing may not be available and physical distancing may be impractical for those who rely on fetching or sharing water, increasing the risk of transmission due to interhousehold contact [1,2,5].

IMPLEMENTATION OF COVID-19 WASH RESPONSES

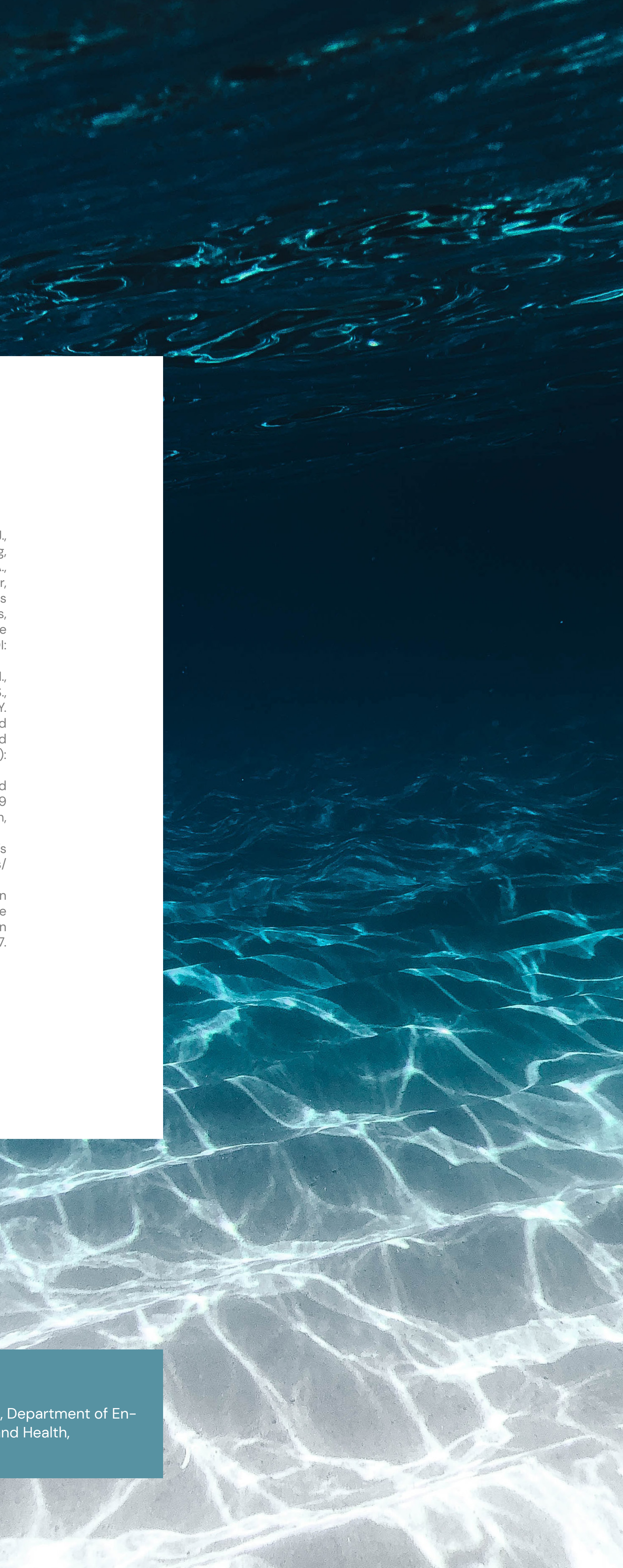
The framework that allows a structured analysis of the response is based on five target areas, classified into two key response blocks (Fig. 1). The framework was guided by UNICEF COVID-19 programming documents, and subsequently validated by selected WASH experts and stakeholders – mainly from UNICEF –, through different rounds of consultations [1].

CONCLUSION

Initiatives that relate to the intensification of behaviour change and awareness-raising campaigns for the promotion of handwashing and other IPC measures are widespread and have been widely adopted [1]. Many countries have also implemented a combination of technical and financial measures to ensure basic WASH needs for vulnerable groups and in key institutions, but they will not suffice to reach all population in need. With few exceptions, the rural areas and informal settlements received less attention [1,3]. In addition, sanitation has been rarely included in the response plans, placing certain groups of society at high risk of infection. Likewise, a general lack of support to service providers is challenging the capacity of both urban and rural operators to continue delivering services [1]. They might face serious problems, even in the short to medium-term, if technical and financial support is not scaled up soon.

Key response blocks	Target intervention areas
Measures and approaches to ensure access to a minimum daily volume of drinking water, basic sanitation and enhance safe hygiene behaviour for all – with a focus on the consumer (people and institutions).	1. Intensify behaviour change population-wide initiatives and awareness-raising campaigns for hand washing at the household level. 2. Strengthen infection prevention and control (IPC) at the household and in institutions. 3. Preserve the ability of all people, including the most vulnerable, to meet their basic needs in relation to water and sanitation during the crisis.
Measures to secure the continuity and affordability of WASH services and products – with a focus on the service providers.	4. Secure the continuity, affordability and quality of water and sanitation services as well as proper waste management practices. 5. Ensure technical and financial support to service providers.

Fig. 1: Study analytical framework of implementation of COVID-19 WASH responses [1]



REFERENCES

(1) Giné-Garriga, R., Delepiere, A., Ward, R., Alvarez-Sala, J., Alvarez-Murillo, I., Mariezcurrena, V., Göransson Sandberg, H., Saikia, P., Avello, P., Thakar, K., Ibrahim, E., Nouvellon, A., El Hattab, O., Hutton, G., Jiménez, A. 2021. COVID-19 water, sanitation, and hygiene response: Review of measures and initiatives adopted by governments, regulators, utilities, and other stakeholders in 84 countries. Science of the Total Environment, 795 (2021): 148789, DOI: 10.1016/j.scitotenv.2021.148789.

(2) Howard, G., Bartram, J., Brocklehurst, C., Colford Jr., J.M., Costa, F., Cunliffe, D., Dreibelbis, R., Eisenberg, J.N.S., Evans, B., Girones, R., Hrudey, S., Willetts, J., Wright, C.Y. 2020. COVID-19: urgent actions, critical reflections and future relevance of 'WaSH': lessons for the current and future pandemics. Journal of Water and Health, 18 (5): 613–630, DOI: 10.2166/ wh.2020.162.

(3) Stoler, J., Jepson, W.E., Wutich, A. 2020. Beyond handwashing: water insecurity undermines COVID-19 response in developing areas. Journal of Global Health, 10 (1): 010355, DOI: 10.7189/jogh.10.010355.

(4) World Health Organization. 2020. Timeline: WHO's COVID-19 response. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/interactive-timeline.

(5) Joint Monitoring Programme. 2019. Progress on Household Drinking Water, Sanitation and Hygiene 2000–2017. Special Focus on Inequalities, Progress on Drinking Water, Sanitation and Hygiene 2000–2017. Geneva.

K. Antić, M. Turk-Sekulić, M. Stošić, J. Radonić

University of Novi Sad, Faculty of Technical Science, Department of Environmental Engineering and Occupational Safety and Health, Dositej Obradović Square 6, 21101 Novi Sad, Serbia

CREATING INTERACTIVE POSTERS WITH AUGMENTED REALITY

The term Augmented Reality (AR) is used to describe a combination of technologies that enable real-time mixing of computer-generated content with live display. In short, AR is a digital medium that allows you to overlay virtual content such as videos, photos, 3D models, into the physical world in a way that makes it seem like the content is physically there.

AR generally works by identifying a target and a tracker. It uses computer vision, mapping as well as depth tracking in order to show appropriate content to the user. This functionality allows cameras to collect, send, and process data to show digital content.

VIRTUAL REALITY

The focus of virtual reality is on simulating the vision. The user needs to put a VR headset screen in front of his/her eyes. Therefore, it eliminates any interaction with the real world.

MIXED REALITY

Mixed reality (MR) is the merging of real and virtual worlds to produce new environments and visualizations, where physical and digital objects simultaneously exist and interact. Mixed reality takes place in neither the physical world nor virtual world, but is a hybrid of reality and virtuality.

DIFFERENCES BETWEEN AR AND VR

VR is an artificial digital environment that completely replaces the real environment or the so-called "real world". The main difference is that AR is "layered" on top of the real world that can have many shapes and forms, but the most common ones are videos, images, and other interactive data types. AR can be used to enrich the real-world experience of the user. Another key differentiation between AR and VR is that one does not necessarily need a headset. AR can be delivered through smart glasses, headsets, and portable devices such as our smartphones.

- AR augments the real-world scene whereas VR creates completely immersive virtual environments.
- AR is 25% virtual and 75% real while VR is 75% virtual and 25% real.
- In AR no headset is needed.
- With AR, end-users are still in touch with the real world while interacting with virtual objects nearer to them, but by using VR technology, VR user is isolated from the real world and immerses himself in a completely fictional world.

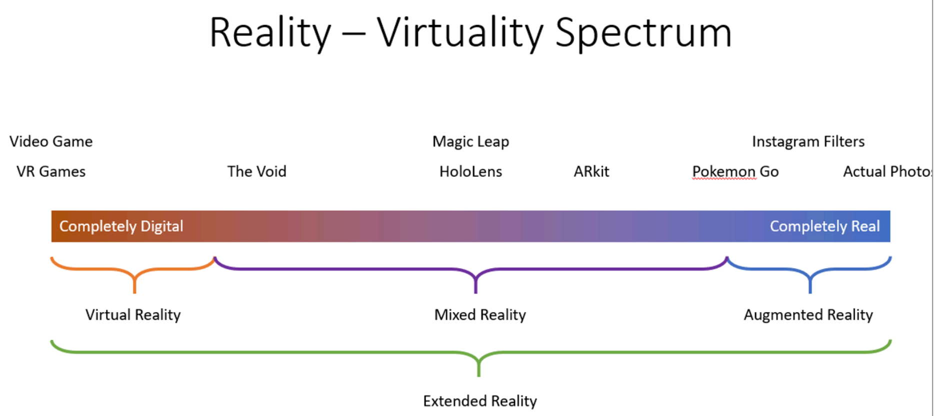


Fig. 1: Reality — Virtuality Spectrum. Credit: Hacker Noon

Augmented Reality is emerging as one of the key drivers of the tech economy. The total value of the AR market will reach about $300 billion in one year. AR technologies will impact deeply every single industry and market, including commerce, travel, healthcare, manufacturing, gaming, entertainment, and military.

GAME ENGINES

The main development tools in the AR space are the game engines like Unreal Engine and Unity. It is important to note that these are not strictly AR tools. Initially these software platforms were built to develop 3D video games. However since developing for VR (and AR) shares lots of similarities with game development, these game engines were adopted by the AR communities. They are used to build many of the biggest games on the market. For AR Apps one needs 3D models that make a virtual space possible. It is more common to create 3D models in other applications, like Maya, 3D Max, or Blender, and import them for use within Unreal or Unity.

AR POSTERS

In today's digital world, finding new ways to engage learners is more difficult. When home technologies such as mobile phones, tablets and games consoles are highly advanced, finding educational engagement with technology can be even harder. On the other hand, with advances in new technologies, education is rapidly taking off in new directions.

When presenting a poster at conferences, the ability to understand the project can be lost in a wall of text and static data. Augmented Reality can enhance and highlight the project with movement and sound. AR content furthers their understanding through visuals and audio on a digital interface. These visuals draw the viewer's attention actively as they see their screens.

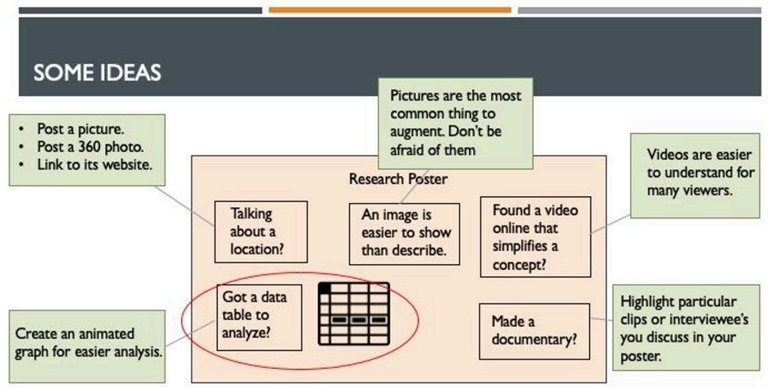


Fig. 2: Enriching Presentations with AR technologies

Enis Yazici
SRH Hochschule Heidelberg

DIGITAL CITY RALLY HEIDELBERG: WATER AND ARCHITECTURAL HIGHLIGHTS OF THE CITY

PROBLEM
The corona crisis has had a major impact on the event industry. Many events cannot take place as usual because the participants are not allowed to gather at the venue. However, the events industry is already developing digital concepts. The greatest challenge will be to make these concepts attractive, informative and motivating.

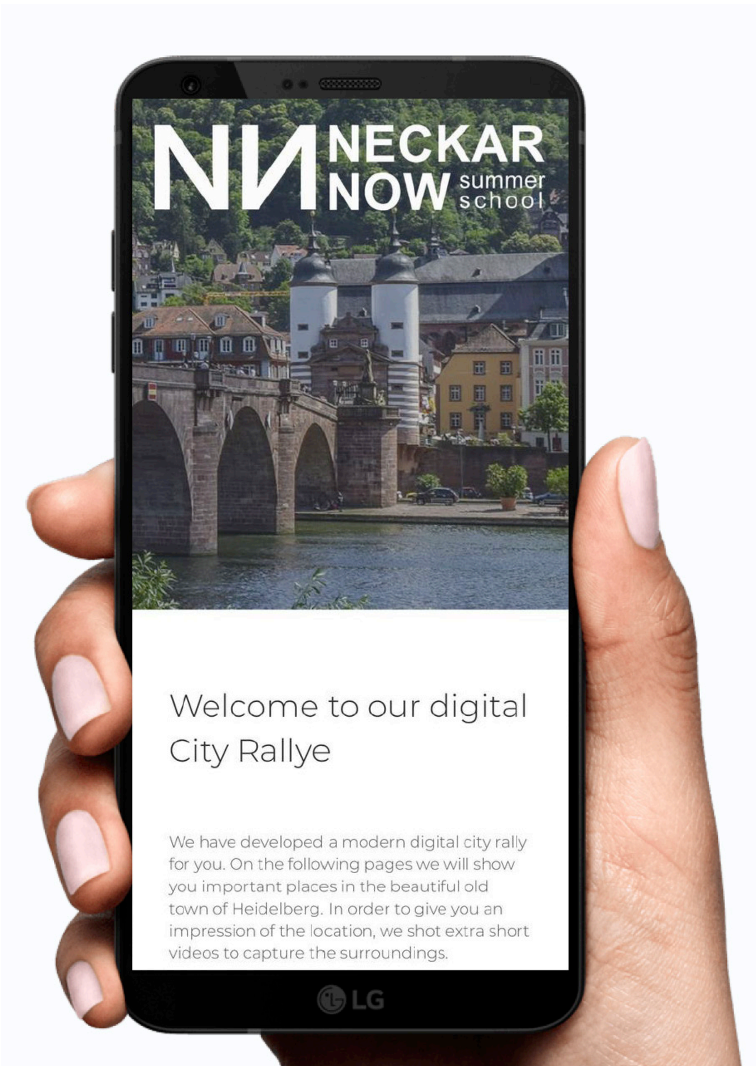
SOLUTION
Digital concepts have almost no barriers when it comes to participation compared to local events. However, digital events should be gamified in order to motivate and fascinate the participants. In order to convey the ecological topics of Democratia in an exciting and sustainable manner, a web-based rally is a suitable format for students to participate in, wherever they may be in the world.

MILESTONES
- Project meeting with the organizers of Democratia
- Evaluation of the Budget
- Content Research

TARGET GROUP
Students who study
water technology

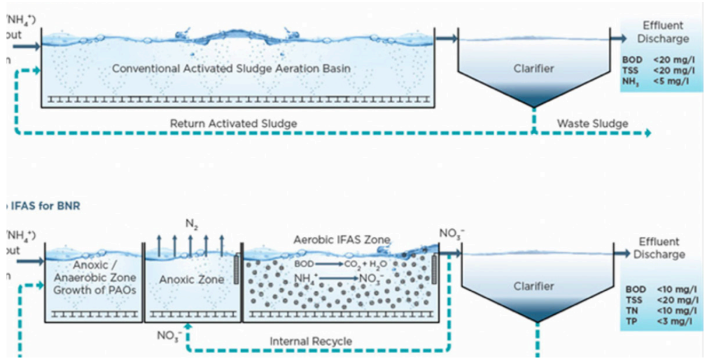
VISION
Our vision is to set up an immersive digital rally where the participants learn about different water projects all around the globe.
The narrative is "to be a world journey" where all participants travel together at the same time to the next destination.

In addition to the various technological projects and institutions, cultural characteristics typical for the respective country should be conveyed. Therefore, every country will have its own ambassador/moderator.



POSSIBLE CONTENT
New Novi Sad Waste Water Treatment Plant

A modern digital city rally has been developed. The rally shows the important places in the beautiful old town of Heidelberg. In order to give an impression of the location, short videos to capture the surroundings have been shot. While discovering the city, the participants obtain more important information from the host and at the same time learn something about how water was transported and used in Heidelberg in the past.



Oliver Schlenker

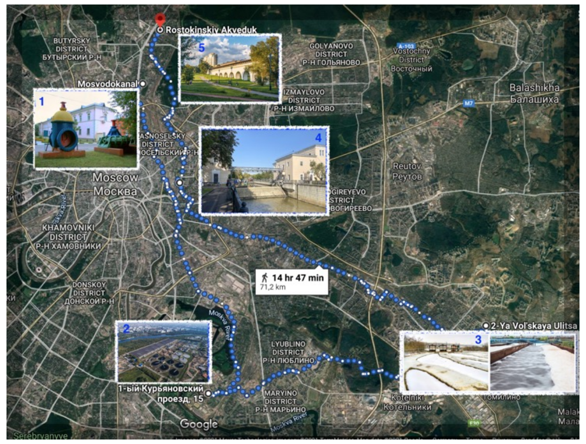
SRH Hochschule Heidelberg, Germany

DIGITAL RALLY ON NOVISAD, ANKARA & MOSCOW

The digital rally on Novi Sad and Ankara was conducted on 24.09.2021 and the digital rally on Moscow was done on 8.10.2021, platform provided by Digital Conference East Western Dialogue organized by Democratia-Aqua-Technia.

Novi Sad lies on the banks of the Danube River, and it is a home of the famous EXIT music festival, one of the best in Europe. Our first stop for the rally is the Petrovaradin Fortress, which means "the city on a rock strong as faith". It was a significant military fort of the Austrian rulers who, at the time of Napoleon's conquests, hid their treasures here. The second stop is Vodovod i kanalizacija, which is the public utility company for Waterworks and Sewerage. Its main objective is production and distribution of drinking water, as well as wastewater disposal. The third stop is International Association of Water Supply Companies in the Danube River Catchment Areas (IAWD), which was established in 1993. IAWD has built a strong network of cooperation in the region's water sector, which goes beyond national, cultural, and linguistic borders. It facilitates the voice of water utilities in the Danube region by acting as a regional platform for information exchange, peer to peer networking and knowledge sharing. The final stop is a new main pumping station NGC1, the most significant and most expensive investment in the city's history, planned for 2021. It will be equipped with double gratings, coarse and fine, so that all solid particles with a diameter of more than 6 mm will be removed.

Ankara, formerly known as Angora, sits in the country's central Anatolia region. For the digital rally, our first stop is Anıtkabir. Anıtkabir is the mausoleum of Mustafa Kemal Atatürk, the leader of the Turkish War of Independence and the founder and first President of the Republic of Turkey. The four main parts to Anıtkabir: the Road of Lions, the Ceremonial Plaza, the Hall of Honor, and the Peace Park. The second stop is ASKI (Ankara Municipal Water Authority), which serves more than 4 million customers with water in Ankara. There are total of nine water treatment plants feeding Ankara city center and district centers. Talking about the ivedik Drinking water Treatment Plant. It is the Turkey's largest water treatment plant, it was built to meet Ankara's drinking water, utility water and industrial water needs until 2070. Ayaş Wastewater Treatment Facility is our next stop, which was built to treat the wastewater of Sinanlı and its neighborhoods, together with the district center. The facility has been designed as an "Advanced Biological Treatment System" with a capacity of 6.172 m^3/day for an equivalent population of 26,167 people. The next stop is the Ankara Central Wastewater Treatment Plant which was commenced on 5 June 1992. It serves for an equivalent population of approximately 4 million with a capacity of 765.000 m3/ day and now expand to full average capacity of 1,380,000 m^3/d. The concept of the plant allows for extension of advanced technology for nitrogen and phosphorus removal. Then the next stop is Museum of Anatolian Civilizations (Turkish: Anadolu Medeniyetleri Müzesi) which is located on the south side of Ankara Castle. It consists of the old Ottoman Mahmut Paşa bazaar storage building, and the Kurşunlu Han. The final stop is Ankara Castle, which is one of the Turkish capital's oldest sights. There are cannons, various weapons, ammunition and 600 houses inside the inner castle. The inner castle is surrounded by a second series walls. There is a third outer wall on the slopes of the mountain.



The city of Moscow is situated on the watershed of the Volga and Oka rivers. The first centralized water distribution system in Moscow was launched on 28 October 1804, 25 years after Catherine II signed a corresponding executive order. For the digital rally, the first stop is Museum of Mosvodokanal. The significant of the museum is that the first section is dedicated to the history of construction of facilities of water supply and sewage system. The second section is dedicated to designs and functions of modern water supply and sewage systems. Our second stop is JSC "Moscodokal" Pleteshkovskiy Pereulok, which is the largest water company in Russia. The company provides high-quality drinking water and a reliable sewage system to 15.1 million residents of the Moscow metropolis through its water treatment stations: Lyubertsy Wastewater Treatment Plant (largest in Europe), Kuryanovskiy sewage treatment plant, Wastewater treatment plant „Yuzhnoye Butovo" and Wastewater treatment plant in Zelenograd. Then our next stop is the waterworks facility of the Yauza that was construction to create the Moscow water ring. It's major significant of the Yauza is to provide water supply, protect the territory above it from floods, and storm water. Lastly, we stop at Rostokino Aqueduct, which has a unique structure with 21 arcs over the Yauza River, which is one of the five aqueducts of the Mytishchi water pipeline that has survived to this day.

The digital rally on Moscow, Ankara and Novi Sad expresses us about the interesting facts of the city including its history, architecture, and highlights of the waterworks of the city. The rally is designed in such a way that participants can learn the background of the cities and engaged themselves into facts with information, referenced videos and quiz session for better understanding.

Sonam Gyaljen Tamang

SRH University of Applied Sciences Heidelberg, Germany

WHAT DO YOU ASSOCIATE WITH THE INITIATIVE DEMOCRATIA-AQUA-TECHNICA?

research and education
water insufficiency
water management
digital cooperation
resource recovery
communication
technology
research water technology
water managament
water technology
student integration
water shortage
exploration
solutio
water pollution
serbia
water wars
equitable water use
international cooperation
multidisciplinarity
water quality
cooperation
informative
peace
wastewater
innovative ideas
daad
water conflicts
collaboration
sustainability
srh university
water-friendly
new ideas
digital
solution
water improvements
international exchange
diversification
networking
water solutions
water footprint reduction
micropollutants removal
social topics discuission

PARTNER

The summer school was organized and carried out by Prof. Dr. Ulrike Gayh, Prof. Dr. Elena Gogina, Prof. Dr. Maja Turk Seculic, Prof. Dr. Yasemin Dilsad Yilmazel

srh

UNIVERSITAS STUDIORUM NEOPLANTENSIS

1921-2021 MGSU

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Funded by the DAAD from funds of the Federal Foreign Office:

DAAD Deutscher Akademischer Austauschdienst
German Academic Exchange Service

Federal Foreign Office

With the support of:

bildbrauerei VIDEOPRODUKTION

Schulz Schramm Das Gestalter-Gespann

NECKAR ORTE

INNOVATE! WORKSHOPS AND TRAININGS FOR INNOVATION AND CHANGE

ENMAZE LIVEGAMES

E-PUB
ISBN: 978-3-9822521-5-5