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THE 6TH GRADUATE STUDENTS' WATER RESEARCH CONFERENCE IN ISRAEL

CONFERENCE ABSTRACTS

29/12/2024

TECHNION, HAIFA

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Under the guidance of **Prof. Eran Friedler**, head of the Grand Water Research Institute, Technion.

Abstracts are published in the authors' original version.

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Keynote lecture

Avoid, Shift, Improve: Insights from Research on Sustainable Consumer Choices

Atar Herziger

Dr. Herziger is an environmental psychologist whose research focuses on sustainable consumer behavior. She examines the psycho-social and contextual factors that motivate, hinder, and bias consumers' judgments and behaviors as they relate to sustainability. Her work examines a variety of behaviors, ranging from minimalism, through sustainable diets and second-hand consumption, to electric vehicle adoption. Her projects often employ an experimental or quasi-experimental approach and are conducted in both lab and field settings.

In this talk, Dr. Atar Herziger explores sustainable consumer behavior through the ASI (Avoid-Shift-Improve) framework, emphasizing the significant impact of household consumption on greenhouse gas emissions. She discusses effective marketing appeals that can promote positive behaviors and mitigate negative ones, highlighting the role of psychological mechanisms in influencing consumer choices. The presentation advocates for a holistic approach to marketing sustainability, integrating strategies across the entire product lifecycle to foster sustainable consumer practices.

Water and Wastewater Treatment (Hebrew)

Catalytic Decomplexation of Copper-Organic Chelates for the Selective Recovery of Copper from Industrial Wastewater and Contaminated Soils

Erez B. Ruck, Nitzan Rainer, and Youri Gendel

Interactions between dissolved metals and organic molecules in water form metal-organic chelate complexes. These complexes pose environmental risks due to their increased mobility and strong chemical stability, thereby reducing the treatment efficiency of conventional methods for metal recovery. We propose a novel electrocatalytic process which utilizes a bi-functional catalyst, hydrogen and aerial oxygen to decomplex copper-organic chelates and selectively recover copper as raw material without generating secondary waste. Recirculating the polluted water concurrent to hydrogen purging through a reactor loaded with platinum-decorated activated carbon promotes the spontaneous hydrogen oxidation and Cu(II) reduction reactions, resulting in copper electrodeposition (Figure 1; Step 1). The subsequent air supply triggers spontaneous oxygen reduction and Cu0 oxidation, achieving complete Cu(II) recovery (Figure 1; Step 2). In this study, we reveal the electrostatic governed mechanisms for selective separation of copper from EDTA and citric acid by experimental undertaking and PHREEQC simulations. Furthermore, results show that pre-charging the catalyst boosts selectivity and catalytic activity which correlates with the Electrochemical Promotion of Catalysis effect. Lastly, optimized process conditions were implemented on a real leachate solution obtained by a copper contaminated soil remediation process, achieving near complete decomplexation and over 90% copper recovery in 5 cycles.

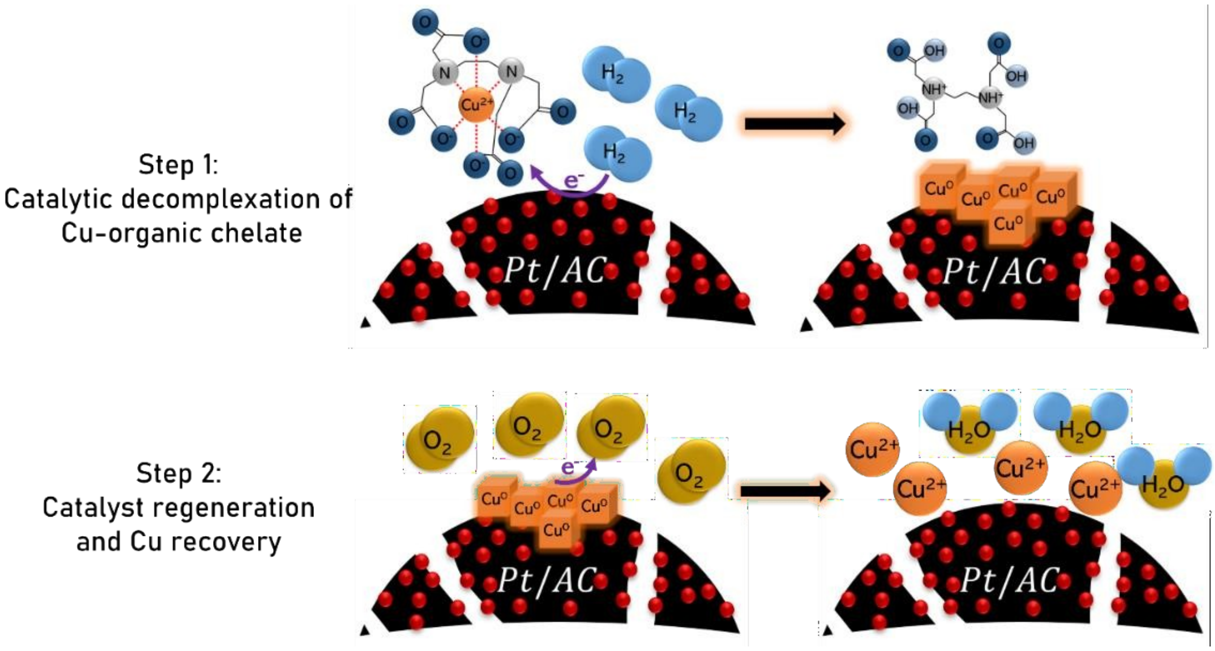


Figure 1: Illustration of the two-step process for the catalytic decomplexation of Cu-organic chelate and copper recovery using the platinum decorated activated carbon catalyst.

Water Decontamination through Sulfate-Radical Oxidation in a Nano-enabled Catalytic Filtration Process for Non-potable and Potable Water Reuse

Omer Yashar, Mohammad S. Khan, Yinon Yecheskel, Uwe Hübner, Benedikt M. Aumeier, Jörg E. Drewes, and Ines Zucker

Potable and non-potable reuse of appropriately treated wastewater can be an economically and ecologically viable option in regions with water shortages. However, effective removal of the multitude of microbial and chemical contaminations in treated wastewater is challenging and energy-intensive. In this study, we engineer, optimize and upscale an alternative treatment concept with a novel nano-enabled catalytic filtration process as the core element applicable for non-potable and potable water reuse applications. The nano-enabled catalytic filtration process generates sulfate radicals through catalytic decomposition of peroxymonosulfate (PMS) via MnO_2-based nanomaterials. Integration of such nanocatalysts in water reuse holds promise in inactivation of pathogens, removal of a variety of trace organic chemicals (TOrCs), and mitigating the spread of antibiotic microbial resistance (AMR) from municipal wastewater with high durability in long-term operation. Through immobilization of the nanomaterial onto a granular media and packaging of the resultant nanocomposite in a filtration unit, we allow efficient, sustainable, and practical use in reuse schemes at comparable costs to established processes. In addition, through both material design and process engineering, optimal deployment of such nano-based technology can be utilized in high efficiency while avoiding the limitations of currently available technologies.

As a part of the conference, I would like to present my work on the synthesis, characterization, and demonstration of the catalytic activity of MnO_2 on activated carbon (AC) and sand substrates. The catalyst is produced in hydrothermal synthesis procedure technique and shows nanowire structure, known as α phase MnO_2. Preliminary results indicated challenges in achieving uniform MnO2 coverage on AC substrate, possibly due to growth and deposition limitations. The adhesion between the substrate and the catalyst deposited layer should improve in order to avoid leaching of Manganese to the water and increasing the catalytic stability. Consequently, various pretreatment techniques for AC grains are investigated to enhance MnO_2 deposition, such as sonication, H_2SO_4 soaking, HNO_3 soaking and heating, UV/O exposure, TEOS molecules layer etc. In addition, different types of AC were tested as a suggested substrates for MnO_2 deposition. In parallel, synthesis of MnO_2@sand has been done in order to overcome the limited coverage and to examine the catalytic activity of the nanomaterial. Transforming of PMS to sulfate radicals ($SO_4{\cdot}^-$) and purification pollutants such as dye and trace organic contaminants has been examined. The results confirm the dominancy of catalytic activation of PMS by MnO_2@sand compared to adsorption or direct oxidation solely by MnO_2@sand or PMS, respectively.

The Effect of Free Ammonia, Free Nitrous Acid, Dissolved Oxygen and Salinity on Hypersaline Nitritation Stability

Samah Abasi, Sheldon Tarre, and Michal Green

Hypersaline (greater than 3% salinity) wastewaters from aquaculture, seawater flushing toilets and industrial sources are ever increasing and can contain high levels of ammonia that needs treatment before being released to the environment. After carbon removal, biological nitrogen removal in saline and non-saline wastewaters begins with nitrification, a two-step process consisting of nitritation where ammonia is oxidized first to nitrite by ammonia-oxidizing bacteria (AOB) and subsequently, nitratation where nitrite is oxidized to nitrate by nitrite-oxidizing bacteria (NOB). In conventional wastewater treatment, the nitrite and nitrate produced by nitrification is reduced to dinitrogen gas via denitrification by heterotrophic bacteria using organics as the energy source. Nitritation has recently received attention for its important role in replacing conventional biological nitrogen removal with low-carbon and energy-saving nitrogen removal processes. Nitritation-denitrification and partial nitritation-anaerobic ammonium oxidation (anammox) processes can reduce up to 60% of the required energy as compared to the complete nitrification-denitrification process. Despite the advantages, maintaining stable nitritation in anammox based systems poses significant challenges, especially in suppressing unwanted microorganisms such as NOB and heterotrophic denitrifying bacteria that compete with anammox for nitrite. While wastewaters with low organic matter limits competition from heterotrophic denitrification for nitrite, suppression of NOB remains a difficult challenge for the success of anammox based processes. NOB suppression can be achieved by manipulating reactor operational parameters to attain inhibiting concentrations of free ammonia (FA), free nitrous acid (FNA) and dissolved oxygen (DO). However, in spite of the reported effectiveness of these factors, various NOB species have shown the ability to overcome the negative effects of these inhibitors. Nitritation stability has been extensively investigated under non-saline conditions, however, few studies have addressed nitritation stability and NOB inhibition under saline conditions In order to treat hypersaline wastewater using partial nitritation-anammox or other nitrogen removing processes involving nitritation, it is essential to develop and investigate an efficient, stable, and reliable nitritation reactor specifically designed for hypersaline conditions. The purpose of this study is to investigate nitritation stability under hypersaline (4% salinity) conditions using FA, FNA and low DO concentrations as inhibitors for NOB activity and compare it to non-saline conditions. Furthermore, the effect of salinity greater than 4% on the inhibition of AOB and NOB activity were studied. In this research, continuous and completely mixed fixed bed reactors were used.

The results show that In short-term reactor operation, similar high nitritation rates of 2.6 g N/L-reactor/d were achieved under both hypersaline and non-saline conditions using high FA (2.6–6.5 mg N/L) to prevent NOB prolifereation. Long-term stable nitritation was maintained under hypersaline conditions using high FA concentrations (1–10 mg N/L). At low FA levels (less than 1 mg N/L), the NOB Nitrospina proliferated, and full nitrification was observed under both high and low DO conditions. Despite repeated cycles of nitritation and nitrification, nitritation consistantly recovered with a return to high FA. In contrast, under non-saline conditions and high FA, the NOB Nitrobacter appeared and nitritation recovery was not possible. Under non-saline conditions, FNA concentrations of 0.11 mg N/L effectively inhibited NOB growth, contrary to hypersaline conditions at the same FNA concentration, the NOB Nitrococcus proliferated. Salinity above 5% and without any other inhibiting parameter, was shown to selectively inhibit NOB proliferation without significantly impacting nitritation (AOB) performance. In summery, the results show that it is possible to achieve long term stable nitritation under hypersaline conditions, using FA as an inhibitor to NOB, in contrast to NOB proliferation under non-saline conditions using FA. The results of this study are useful for developing partial nitritation-anammox reactor systems for the removal of ammonium from hypersaline wastewater.

Mucin-Based Solutions for Water Decontamination

Shira Gavriely, Shachar Richter, and Ines Zucker

The increasing amounts of industrial wastewater and the ongoing necessity for clean, safe water call for more effective and sustainable solutions. Biomaterials have emerged in recent decades as an alternative set of materials that can be employed in various water treatments, avoiding the use of costly or toxic synthetic materials. One intriguing biomaterial that has not been utilized for environmental applications is mucin, a natural glycoprotein with the unique ability to filter substances in physiological processes in various living organisms, such as jellyfish and the human body. This renewable resource has the potential to adsorb and reduce heavy metals ions, while selectively attaching to different molecules. We evaluated mucin's effectiveness in removing contaminants through various tests, including adsorption kinetics and isotherms, ion competition under different environmental conditions, and even in the green synthesis of precious metals. Various techniques, like X-ray photoelectron spectroscopy, UV-visible and X-ray diffraction analyses, helped us understand how mucin interacts with and attracts different pollutants, revealing the mechanisms of removal. In addition, to use mucin in a practical and green fashion, mucin was processes into solid forms, such as nanofibers, and was also assessed in water decontamination tests, offering convenience and recyclability. In several cases the adsorbed contaminant, such as gold ions, could be retrieved and used in a secondary treatment to further eliminate organic pollutants. Overall, our studies have shown that mucin, as a biomaterial, holds significant potential for various water treatment processes, highlighting its exceptional natural abilities. These findings indicate the promising use of mucin as a green alternative for future water treatment applications.

Modified Clay Composites for the Removal of PFAS from Water

Tamir Zalmon, Adi Radian, Giora Rytbo

Per and poly fluoroalkyl substances (PFAS) are anthropogenic pollutants which gained the attention of scientists and decision makers due to their wide global occurrences and negative effects on human health and the environment. Potable water contamination by PFAS pose a major concern as these compounds are persistent in the environment, accumulative and highly soluble. Adsorption processes are considered as the most feasible approach for PFAS removal from contaminated water, however commercially available solutions demonstrate poor removal of short-chain PFAS. In this study, polymer modified clay composites were examined for PFAS adsorption, with focus on short chain species. An adequate sorbent for PFAS adsorption was developed by applying a specific clay-polymer combination. The capacity, kinetics and environmental conditions affecting PFAS adsorption to the chosen composite were studied, and the dominant adsorption mechanisms were established. Granulation procedure was adopted to obtain hydraulic properties that enabled application in column experiments. Groundwater contaminated with short-chain PFAS was successfully treated in a column experiment packed with granulated composites. Degradation of the adsorbed contaminants through Fenton heterogeneous reaction was also tested. Although degradation was not successful, The composite granules showed tremendous potential for PFAS adsorption, providing a cheap, safe and environmentally friendly solution to PFAS contamination.

Hydrology and Contaminant Treatment

A Facile activation of supported platinized catalyst: Implications to aqueous nitrate catalytic decontamination technology

Hailu Demissie Tulu, Erez Ruck, Youri Gendel

The pervasiveness of nitrate (NO_3^-) in the environment due to natural and human activities negatively impacts anthropogenic activities. Its intake triggers a notorious growing threat to public health and environmental hazards, given the rising interrogate for food and water. Groundwater is one of the most accessible freshwater sources for drinking though affordable desalination approaches are required to lower the NO_3^- content of typical brackish groundwater. Electrochemical reduction of nitrate, particularly with copper incorporated platinized activated carbon (AC) has emerged as an effective method for its removal from contaminated groundwater. However, the catalysis is hampered by the prevalent oxidation of copper by oxygen and chloride presence during the operation which negates its extended use. It compels the interruption of the denitration process to regenerate (reactivate) the catalyst. Regeneration methods of the catalyst reported yet are very cumbersome and expensive, making it difficult to adopt in large-scale treatment. In addition, the reported methods for coupling the secondary metal (copper) to the supported noble metal (Pt) catalysts attained by a combination of wet chemistry and heat treatment in special equipment. In this work, we demonstrate a completely new activation approach (hydrogen-induced galvanic deposition of Cu on Pt-AC) as a stable bi-functional catalyst for effective nitrate removal, which only consumes hydrogen (H_2), and or air if full recovery of the loaded Cu metal is needed. Batchwise use of the catalyst (enclosed in a glass column to avoid abrasion and loss of catalyst) in a wide range of nitrate concentration resulted in almost complete nitrate removal within 4 hours. The ease of catalyst activation, the control of Cu loss, and the NO_3^-removal performance maintenance over extended use augers well to promote the reuse of this catalyst for sustainable water treatment.

On the transport and fate of heavy metals in calcareous soils—a spectral induced polarization study

Shany Ben Moshe and Alex Furman

The fate and transport of heavy metals in the soil have been intensively studied over the last decades due to its implications on public health and the environment. The mobility of heavy metals in the soil depends on the surface characteristics of the soil minerals and other solid components such as organic matter, the pore water pH and its composition, among others. Specifically, in calcareous soils, the introduction of heavy metals has been shown to induce dissolution of the calcite and formation of metal-based carbonate minerals. The study of such processes traditionally involves intensive sample collection and chemical analysis of multiple species. In this study, spectral induced polarization (SIP) was used to in-situ monitor the transport Cu and Zn through soils that contain calcite to different extents. In SIP, an alternating current in wide range of frequencies is injected, and the phase and amplitude difference between the injected and induced potential are measured and translated into a complex conductivity spectrum. These measurements are sensitive to both pore water characteristics and to surface processes. The experimental setup involves flow-through columns packed with natural soil, through which the inflow solution is passed. Electrical potentials are recorded at three locations along the column. The analyzed SIP measurements allow not only non-invasive, non-destructive monitoring of the metal progression through the soil but also deduction of its fate through combination with elemental analysis. The results show that the complex conductivity is sensitive to both the heavy metal adsorption to the soil and the subsequent calcite dissolution. The conductivity values at the peak polarization frequency over time depict the progression of the calcite dissolution 'front' along the soil profile, presenting a distinct conductivity decrease. Further, the dominance of the conductivity decrease was found to be proportionate to the calcite content of the different soils used and differs between the two metals.

Design an Adsorbent-Based Passive Sampler for Per- and Polyfluoroalkyl Substances (PFAS) Monitoring in Groundwater

Rachel Ben Efraim and Avner Ronen

The Jacob Blaustein Institutes for Desert Research, The Zuckerberg Institute for Water Research, Ben Gurion University of the Negev

Per- and polyfluoroalkyl substances (PFAS), widely used in industrial processes, have accumulated in landfills and wastewater treatment facilities, posing significant environmental and health risks due to their bioaccumulative nature. Short-chain PFAS, such as PFBA and PFBS, are increasingly recognized as potential health hazards, similar to long-chain PFAS (e.g., PFOA and PFOS). However, the adsorption and removal of short-chain PFAS are challenging due to their lower adsorption affinity and the difficulty in regenerating adsorbents. These challenges stem from the unique chemical properties of short-chain PFAS and their interactions in aqueous environments, underscoring the need to better understand the molecular interactions governing PFAS adsorption.

To address these challenges, we propose a novel approach using pristine and functionalized multi-wall carbon nanotubes (MWCNTs) combined with an externally applied electric potential. By investigating PFAS with different functional groups, we observed distinct adsorption behaviors: PFOA exhibited strong adsorption on fluorophilic MWCNTs-F, whereas PFBA adsorption was primarily driven by electrostatic interactions on amine-functionalized MWCNTs-NH2. Additionally, under applied potential, the modified electrode properties significantly influenced PFAS sorption mechanisms, particularly enhancing PFBA adsorption through intensified electrostatic interactions due to the high conductivity of MWCNTs.

This research provides critical insights into the adsorption mechanisms of PFAS, especially short-chain compounds, in systems incorporating external potential. These findings have important implications for developing efficient PFAS treatment strategies and advancing our understanding of PFAS contamination control.

Dynamic Coupling of Flow and Surfactant Adsorption at Interfaces in a Heterogeneous Pore Network

Debanik Bhattacharjee, Guy Ramon, and Yaniv Edery

Immiscible phase flow in porous media occurs in various applications, like unsaturated soil, non-aqueous phase (NAPL) remediation, and oil recovery. In these processes, an immiscible invading fluid displaces a defending fluid within the confines of a heterogeneous porous structure, yet the invasion pattern continuously evolves over time due to the chemical action of surfactants that alter the interfacial tension and surface wettability. The purpose of this study is to numerically investigate how the invasion percolation pattern continuously evolves due to surfactant adsorption from the bulk fluid to the fluid-fluid and fluid-solid interfaces, calculated by the Langmuir isotherm, for various heterogeneity levels. The porous medium heterogeneity level is set by the variance of the Gaussian distribution used to spatially distribute pore sizes within the pore network model. The numerical model shows that the invasion pattern evolution over time scales with the surfactant mass transfer and the network heterogeneity, as it follows the cumulative of the Gaussian distribution used to allocate the pores in the medium.

Use of Field-Scale Particle Tracking and Simulated Annealing in Contaminant Transport Inverse Modelling

Subhajit Dey and Scott K. Hensen

Groundwater is one of the purest natural water sources, often free from surface water contaminants. However, human activities—such as industrial processes, agricultural runoff, and improper waste disposal—have increasingly polluted groundwater, posing risks to ecosystems and public health. Managing these pollutants is challenging due to limited information on specific contamination details, like release points, timelines, and levels. This lack of data hinders the development of effective remediation strategies and complicates accurate risk assessments and management planning.

To address these challenges, Linked Simulation-Optimization (LSO) methods have emerged as effective tools for reconstructing the history of contaminant releases and identifying potential source locations. LSO combines the strengths of simulation models and optimization algorithms, allowing researchers to test various scenarios that match observed contamination data. In this poster, we present a promising application of LSO by integrating the Aurora groundwater particle-tracking model with the simulated annealing (SA) optimization algorithm. Aurora, a particle-tracking model that operates with MODFLOW using continuous-time random walk (CTRW) particle tracking, simulates contaminant flow in groundwater systems. Meanwhile, SA inspired by the metallurgical process of annealing, iteratively seeks optimal solutions by gradually "cooling" the system to minimize an objective function representing the contaminant release pattern. This study applies the Aurora-SA approach to a real-world contamination case at a Superfund site in Palm Bay, Florida, where Trichloroethane (TCE) polluted groundwater over several decades (1951–1992). Although the Harris facility in Palm Bay has nine identified potential contamination sources, the exact timeline and individual contributions of each site remain unclear. By using the combined LSO method with Aurora and SA, we successfully reconstructed the TCE release history at this facility, providing a clearer understanding of contamination sources and timelines. This approach highlights the potential of LSO methods to support effective contamination management, making a significant contribution to groundwater protection and environmental restoration efforts.

Innovation in Resource Management for Water and Agriculture

Synthesis of Polyamide Membranes with Ion-Specific Selectivity by Incorporating the Target Ion in the Polymerization Reaction

Aleksandr Ershov

Addressing global challenges like freshwater scarcity, resource shortages, and pollution requires advanced water treatment technologies. Although widely used, current polyamide (PA) membranes used in nanofiltration (NF) and reverse osmosis (RO) processes lack precise ion-specific selectivity. A promising strategy for enhancing solute-solute selectivity in PA membranes is applying coordination chemistry, which is based on the interactions between metal ions and ligands, forming highly specific complexes. Biological ion channels, like the potassium channel, offer an inspiring example of nature's ability to selectively transport ions by coordination chemistry, providing a selectivity of up to 104, which is markedly higher than the selectivity in current synthetic membranes. This research focuses on a novel approach to enhance the ion selectivity in polyamide membranes by applying salt-induced coordination chemistry during the membrane fabrication process. By incorporating metal coordination sites within the polyamide structure, the membrane could be engineered to form stable and specific bonds with the target metal ion. This membrane chemistry can potentially reduce the free energy barrier for the transport of the target ion, allowing it to pass through the membrane more readily than other ions. We utilized salt-induced coordination chemistry to synthesize NF membranes with coordination sites for Ca^{2+} ions (Figure 1). The synthesized membranes showed high selectivity towards calcium ions alongside the increased retention of monovalent ions and enhanced water flux. Notably, the resulting membranes that were fabricated in the presence of calcium ions exhibit reversed monovalent-divalent selectivity trend; that is, higher rejection of divalent ions compared to monovalent ions. By leveraging insights from natural ion transport mechanisms, we intend to create membranes that address current challenges in precise solute selectivity and contribute to the broader field of membrane technology by elucidating the fundamental mechanisms underlying ion transport under confinement.

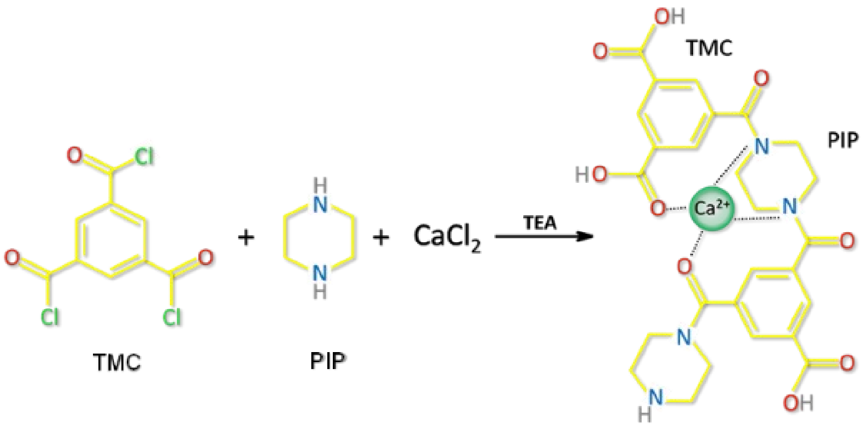


Figure 1: Schematic representation of an interfacial polymerization process between trimesoyl chloride (TMC) and piperazine (PIP) in the presence of Ca^{2+} *ions and catalyst (triethylamine, TEA) for preparing calcium-induced NF membranes. The chemical structure of the polyamide layer with calcium coordination sites is depicted.*

Release of iron nanoparticles from jellyfish-based hydrogel for fertilization use

Guy Avrahami

The aim of this research is to develop an innovative iron fertilizer by incorporating iron nanoparticles into a jellyfish-based hydrogel. The final product will be designed for use in agriculture in its dry form. Upon irrigation, the hydrogel will absorb water, swelling in the soil, and as it gradually releases the water, the embedded iron nanoparticles will be delivered to the plant roots. This approach has the potential to improve soil conditions, particularly in sandy soils with low water retention, by combining enhanced water retention with efficient iron fertilization.

The utilization of jellyfish in the formulation offers additional benefits. The hydrogel provides a source of organic matter, which can enhance soil health and contribute to the overall sustainability of the fertilizer. By transforming jellyfish into a renewable resource, the product not only supports plant growth but also contributes to a circular economy and reduces the environmental impact of conventional fertilizers.

The research focuses on understanding the release dynamics of the iron nanoparticles from the hydrogel under various conditions. In the first phase, the release is studied based on the physical properties of the hydrogel itself, which will help optimize the hydrogel synthesis protocol. The second phase of the study explores how environmental factors, such as pH and temperature, affect the release of iron nanoparticles. This step simulates various environmental conditions to assess how the fertilizer performs in different agricultural settings.

By investigating these release mechanisms, the study aims to provide a customizable solution for agricultural soils. The fertilizer can be tailored to meet the needs of specific soil types and environmental conditions, improving both water retention and nutrient delivery. This novel iron fertilizer has the potential to enhance soil quality, boost crop yields, and contribute to more sustainable agricultural practices.

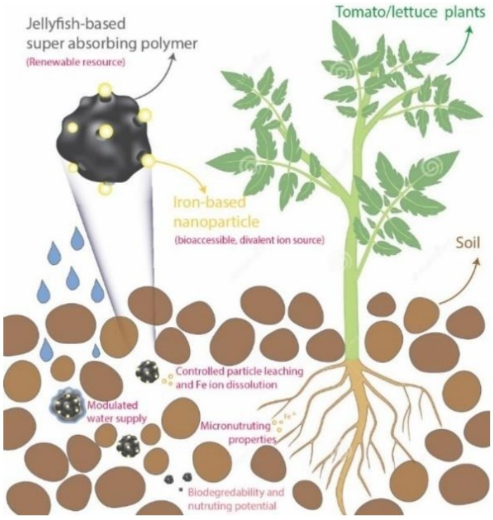


Figure 1: The final product in the soil. The hydrogel is placed in the soil near the plant and during irrigation iron particles are released and received in the roots.

Development of Water Treatment System for Removing Nitrate by Donnan Dialysis into a Bicarbonate Rich Stream

Tzah Ben Hamo

Nitrate pollution in ground and surface water is a significant global issue with serious implications for natural life and human health. The Ion Exchanging Membrane Bioreactor (IEMB) comprises Donnan dialysis with an ion-exchange membrane (IEM) and a stimulated anoxic bioreactor to remove target ions, such as nitrate, from contaminated water. Laboratory scale contactors using anion exchange membrane (AEM) remove the nitrate ions, which are concentrated in the receiving solution due to continuous diffusive transport affected by driving anions that are typically found in natural water sources and provided in excess at the receiving compartment side, still a commercial scaled-up version of a contactor, preferably a plate and frame design (which should be more easily cleaned), is yet to be developed. Here we show batch mode flat cell contactor experimental transport data of monovalent nitrate ions permeation from a $NaNO_3$ feed solution to a $NaHCO_3$/$KHCO_3$ receiver solution screened by two different AEMs—low resistance with high flux membrane (Fumasep FAD) and a very low resistance membrane with high selectivity (Fumasep FAS). Measurements show higher removal efficiencies for FAS membrane. The overall kinetic coefficients were also derived for both membranes. The nitrate dialysis data of the high selectivity membrane were found to be controlled by a diffusive process, while the data of the high flux membrane were found to be mass transfer controlled. Furthermore, a prototype multi-pair-plate continuous crossflow Donnan contactor, screened by the high selectivity membrane, was designed and will be studied in the scope of this work, proving cost-efficient feasibility to treat 10 L/h of nitrate laden water with high nitrate removal efficiencies of 90% in one pass. The nitrate-enriched bicarbonate waste stream can be recycled and reused in the Donnan dialysis contactor by the cultivation of cyanobacteria in the uptake stream to produce polysaccharide-rich cyanobacterial biomass, that can be used for soil quality improvement, facilitating wind and water erosion. In addition, the bicarbonate solution from which cyanobacteria consume the nitrate can then be recycled to the Donnan dialysis contactor.

Simplified soil dry density measurement

Yaron Franco, Itzhak Shmulevich, and Alex Furman

The soil's dry density is of crucial importance for many soil-related processes. Nevertheless, there is no direct and reliable method for its measurement. We propose a simple method for assessing the dry density based on time domain reflectometry (TDR) measurement of the bulk dielectric constant of the soil and the temperature, coupled with gravimetric water content measurement (a small disturbed soil sample of about 50 g). These measurements, supported by two parameters that can easily be approximated, yield a robust estimation of the dry density that is of comparable accuracy to other methods but is much more straightforward. The novelty of the proposed method lies in its foundation upon fundamental physics principles, minimizing soil disturbance. Its superiority over existing measurement techniques is underscored by several key advantages: no calibration requirement, independence from empirical relationships, immunity to operator skill variations, minimal soil disruption during measurement, and swift measuring procedure. Moreover, this method is adept at measuring soil density at depth, making it particularly suitable for limited access to narrow boreholes.

Airborne and Sedimentary Drift of Herbicides Using UAVs and Tractors Across Variable Operational and Meteorological Conditions

Neriya Perez Lapid, Yael Dubowski, Irina Kuzmenkov, Nura Azzam

Herbicides are a critical component in modern agricultural practices for effective weed management. However, their drift during application poses environmental risks and affects the precision of herbicide delivery, with implications for agronomic efficiency and environmental safety. UAVs, with their maneuverability and ability to operate at low altitudes, offer the potential for more economical and precise spraying, especially in complex terrains with limited ground accessibility. However, current data on agronomical efficiency and atmospheric drift during UAV applications is significantly lacking, which limits full leveraging of UAVs' capabilities, as well as the development of proper regulation for it.

Here we present a comparative analysis of herbicide drift when applied using Unmanned Aerial Vehicles (UAVs) under varying operational and meteorological conditions. The study assesses both airborne and sedimentary drifts, as well as their dependency on variables such as flight speed, height of application, and wind speed. Drift measurements were conducted using active air sampling in various heights, both beneath and above application point, and deposition assessments on water-sensitive paper at several distances downwind from the field edge (up to 15 m). Initial results show that airborne drift was detected at all sampling points, both below and above the spraying site. This suggests the potential for atmospheric drift. Typically, the highest concentration of herbicide was found at the lower sampler, indicating possible inhalation and dermal exposure risks. Interestingly there was no significant difference between UAV and tractor in term of airborne or sedimentary drift, and while UAVs are more sensitive to changing wind conditions, their superior flexibility in operational adjustments can provide an adaptable solution across diverse meteorological settings.

Aquatic Systems and Environmental Technologies

The rotation of fish eggs relative to the surrounding water and its implication to mass transfer

Maya van Gelder, Roi Holzman, and Uri Shavit

Pelagic fish eggs rely on mass transfer with the surrounding water for oxygen supply. Past studies assumed no relative motion between the egg and the surrounding water, implying that diffusion is the only process that governs oxygen transfer.

The distribution of density within fish eggs is non-uniform, with the heavy embryo at the bottom and light oil globule at the top. We hypothesize that this internal structure acts as an internal restoring moment that balances the external torque applied on the egg by the flow. This mechanism allows the egg to maintain a vertical orientation, while the water rotates around it, resulting in a relative motion between the egg and the surrounding water. This motion can enhance the flux of oxygen into the egg by stimulating advection mechanisms in addition to diffusion.

Here, we measured the orientation of fish eggs under increasing rotational velocities, which applied external torque on the egg in the range experienced in the ocean. We show that eggs maintain a constant orientation within each rotational velocity, while the water rotates around them. Eggs inclined further towards a horizontal orientation as the velocity increased, up to a critical velocity in which they started tumbling. A theoretical model we developed shows that this behavior can result from the non-uniform distribution of the mass within the eggs under increasing torque.

The relative motion of the eggs under waves and turbulence was not considered nor implanted in previous models of oxygen transfer rates into fish eggs, thus, likely been underestimated.

Micritization in the Persian Gulf—Abu Dhabi: Chemical precipitation or physical boring activity?

Almog Ash, Adi Torfstein, Gilad Antler, Tianyu Cao, Tanya Rivlin, Mohammad Alsuwaidi, Sadoon Morad, Boaz Lazar, and Mordechai Stein

The solidity and porosity of calcium carbonate rocks are of great interest in fields such as reservoir evaluation, geological history reconstruction, groundwater flow, civil engineering and mining. On a geological timescale these rocks (limestones and dolostones) have been a huge reservoir. In their absence, the carbon they hold would reside in earths atmosphere, converting it to a hot, Venus type planet. Micritization is an early diagenetic process, during which biogenic calcium carbonate particles and ooids are converted to micro-grained carbonate sediment, an initial stage in the evolution of many types of carbonate rocks. Despite the importance of the micritization process in the production of carbonate sediments, its exact mechanism and the controlling environmental factors are poorly understood. An excellent environment to investigate modern micritization processes and the formation of fine carbonate sediments is the coastline of the Persian Gulf at Abu Dhabi. These types of sediments are ubiquitous in a variety of shallow environments along this coast. These depositional environments resemble the low angle calcium carbonate ramps that were widespread in epeiric seas during the geological past. Our study aims to explore several calcium carbonate depositional environments on the coast of Abu Dhabi as "natural laboratory" to investigate the micritization process and gain insight to the early stages of formation of ancient carbonate rocks. To do this, we sampled sediment cores from various depositional environments, e.g., mangrove forests, tidal channels, sabkhas and offshore locations. We study the micritization process by examining the temporal, spatial chemical and structural characteristics of the modern sediments and their porewater. We are employing geochemical analyses (e.g. porewater analysis, stable isotopes, XRD minerology) in combination with sedimentological methods (e.g. SEM, microprobe, MC-ICPMS). Preliminary results show that most of the calcium carbonate mud is composed of low-magnesium calcite, with little to no aragonite. This finding contrasts with other studies on calcium carbonate ramps, in which the mud is comprised of high-magnesium calcite. The degree of micritization in the core seems to increase with depth (distance below the sediment surface). This trend is steepest within tidal channels. Microprobe observations indicate that substantial amount of micrites are formed by bioerosion. Boring holes are ubiquitous in core allochems, and most of the micritic envelopes of the particles have an uneven surface and appear alongside boreholes. The crystal structure of the allochems in the sabkha suggests that chemical precipitation is more pervasive in that environment. The porewater in all studied environments shows a distinct DIC to alkalinity slope of 1, suggesting that chemical processes such as calcium carbonate precipitation/dissolution in an open system, sulfate reduction/sulfide oxidation etc., are occurring alongside the physical bioerosional (boring organisms) activity. Mass balance and thermodynamic simulations are conducted to identify and quantify the possible geochemical processes.

Life Cycle Assessment of a Novel Photocatalysis Process for Micropollutants Treatment: Impact Reduction Potential in the Transition from Lab to Pilot Scale Setup

Rajhans Negi

The micropollutants present in the water matrix can pose serious health problems and limit the circular economy prospects in water systems. Strict standards are being drafted in many countries for micropollutant which has led to development in advanced oxidation processes. However, there are limited studies available to assess the environmental feasibility of the oxidation processes for its widespread adoption and integration.

In this study we assessed the environmental impacts of the CatMemReac technology through life cycle assessment framework. The CatMemReac is based on photocatalysis through metallic foam used as a substrate. The study details the impacts for the lab scale (100 ml capacity) as well as pilot scale setup (3 liters capacity) developed onsite in Tel Aviv University. Carbamazepine (CBZ), a pharmaceutical drug found was the targeted pollutant, and it was reduced to below 1 ppb from the initial concentration of 1000 ppb and 20 ppb. The functional unit of the assessment was 1 m3 of water treated by CatMemReac technology. The system boundary included the operational phase electricity and chemical inputs in setup components such as pumps, nickel foam, electrophoretic deposition, and light emitting diodes (LEDs). The LCA was performed in the openLCA 2.0.0 software with ecoinvent database (ecoinvent 3.9.1). Most of the foreground operational data collected was primary in nature while the background data inventory was adopted from the ecoinvent database. The life cycle impacts were determined using the ReCiPe 2016 v1.03, a mid-point approach.

Results show that the environmental impacts were reduced for the pilot scale setup compared to the lab scale CatMemReac setup. The global warming potential (GWP) for the pilot scale was 40 times less compared to the lab scale in all the concentrations of CBZ analysed. Similar reductions were found in all the other impact categories as shown in Figure 1. The reductions were attributed to the change in design parameters of the pilot scale setup including the surface area for the metallic foam. The most contributing flow to the impact categories in the lab as well as pilot scale setup was electricity while the other consumables in the metallic foam and electrophoretic deposition setup contributed insignificantly. The uncertainty and sensitivity analysis were performed to enhance the robustness of the calculated environmental impacts. The study presents the potential of impact reduction while developing photocatalysis technology from lab to pilot scale and helps in analyzing the scaleup feasibility of CatMemReac to contribute towards water security and wastewater reuse.

This project was funded by the BMBF–MOST program in collaboration between Tel Aviv University and Fraunhofer Institute for Interfacial Engineering and Biotechnology IGB.

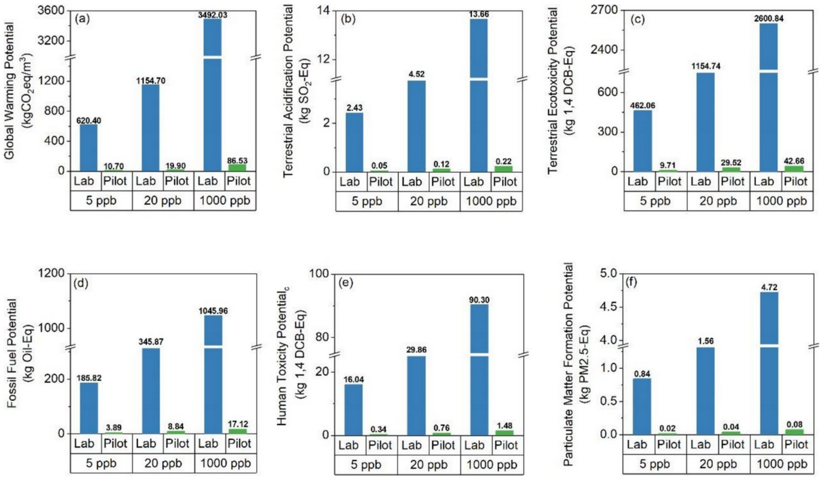


Figure 1: The variations in the magnitude of different environmental impacts for lab and pilot scale CatMemReac setup operated in different CBZ concentrations.

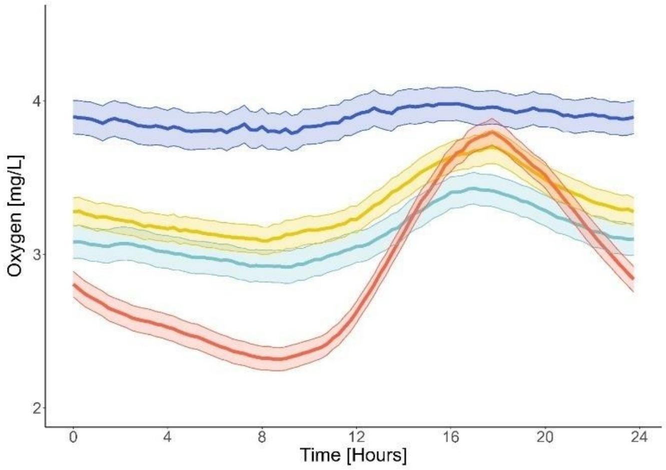
דינמיקה של איכות מים בנחל ים-תיכוני בסביבה עירונית

טל גודינגר, צפריר אדר, יותם סבוראי, גולן בל, שי ארנון

ניטור איכות המים בנחלים מאפשר מעקב אחר מצב ותפקוד המערכת האקולוגית ומהווה בסיס לקביעת רגולציה לשימוש במים כמשאב. יתרון מדידה רציפה באמצעות חיישנים הוא בהתאמת הרזולוציה לתהליכים הידרולוגיים וביוגאוכימיים המווסתים או פוגעים בתפקוד המערכת האקולוגית. נחלים באקלים הים-תיכוני השורר בישראל נבדלים מאלו באזורי אקלים אחרים במשטר הזרימה בהם, בתקופה ממושכת בשנה בה הזרימה איטית במקביל לקרינת שמש גבוהה וכן באוכלוסייה הצפופה השוכנת באזורים אלו. כדי להעמיק את הידע.

וההבנה על הדינמיקה באיכות המים ותהליכים המשפיעים ומושפעים ממנה כגון מטבוליזם, הוקמה תחנת מחקר בנחל הירקון ביולי 2019. התחנה מכילה חיישני: חמצן, פחמן דו חמצני, חנקה, חומר אורגני, כלורופיל, עכירות, ערך הגבה, מוליכות חשמלית, מפלס המים וקרינת שמש. מניתוח ארבע שנים של מדידה ניתן להסיק כי בעוד ההשתנות העונתית של מומסים כגון חמצן, פחמן דו-חמצני, חנקה ו-cDOM קיימת אך אינה ברורה לעין, היא הופכת ניכרת ברמה היומית. לדוגמה, עבור חמצן ההשתנות היומית הגיעה לכ-30% בחודשי הקיץ, לעומת החורף בו ההשתנות היממתית היא כמעט אפסית (איור 1). הקשר בין ריכוז המומסים לספיקה בזמן שיטפונות מצביע על מיהול בזמן השיטפון (מלבד חמצן) ושטיפה אל המורד. ככלל, רוב הזמן המערכת האקולוגית בנחל נוטה לצריכה על פני יצירת חמצן. כמו כן, מהתפלגות ריכוזי החמצן נראה בבירור כי היפוקסיה היא תופעה רווחת בנחל (הסתברות של כ-12% מהזמן בקיץ וכ-4.5% מהזמן בחורף) ומהווה חסם משמעותי לקיום מערכת אקולוגית נחלית בריאה. מחקר באמצעות חיישנים של איכות המים ומטבוליזם בנחלים ים-תיכוניים הוא נדיר ולכן לא ברורה לגמרי ההתנהגות של הנחל בסקאלות זמן שונות (שעות-שנים). עבודה זו מספקת מבט כולל על מצב איכות המים והמערכת.

האקולוגית בנחל ים-תיכוני ויכולה לסייע בעתיד במאמצי שיקום והבנת תהליכים המתרחשים בנחל כתוצאה משינויי אקלים.



איור 1: השתנות לאורך היממה של ריכוז החמצן במהלך החורף (כחול), אביב (צהוב) קיץ (אדום) והסתיו (טורקיז) לתקופה יולי 2019 – פברואר 2024. לכל עונה, הקו מסמן את ממוצע הריכוזים וההצללה שתי שגיאות תקן

OS-BREEZE: Oil Spills Boundary Red Emission Zone Estimation Using Unmanned Surface Vehicles

Oren Elmakis, Semion Polinov, Gabi Gordon, Tom Shaked, Amir Degani

This research project presents the system and set of algorithms for autonomous detection and tracking of oil spills accidents in the port area using an RGB camera on a drone. The algorithms create a contour line on the border between clean and polluted water, enabling a quick and efficient assessment of the size of the spill. The testing of algorithm takes a place in controlled environments of the CAMERI pool in Technion with model of Haifa port 1:120. The advantage of using this algorithm is the minimization of assessment time, providing a rapid response to oil spill incidents. The system's performance was evaluated through experiments in simulated oil spill scenarios, demonstrating its effectiveness in accurately detecting and tracking the oil spills. This research provides a promising approach for automating oil spill detection and response, potentially reducing the negative impacts of oil spills on the environment and society.

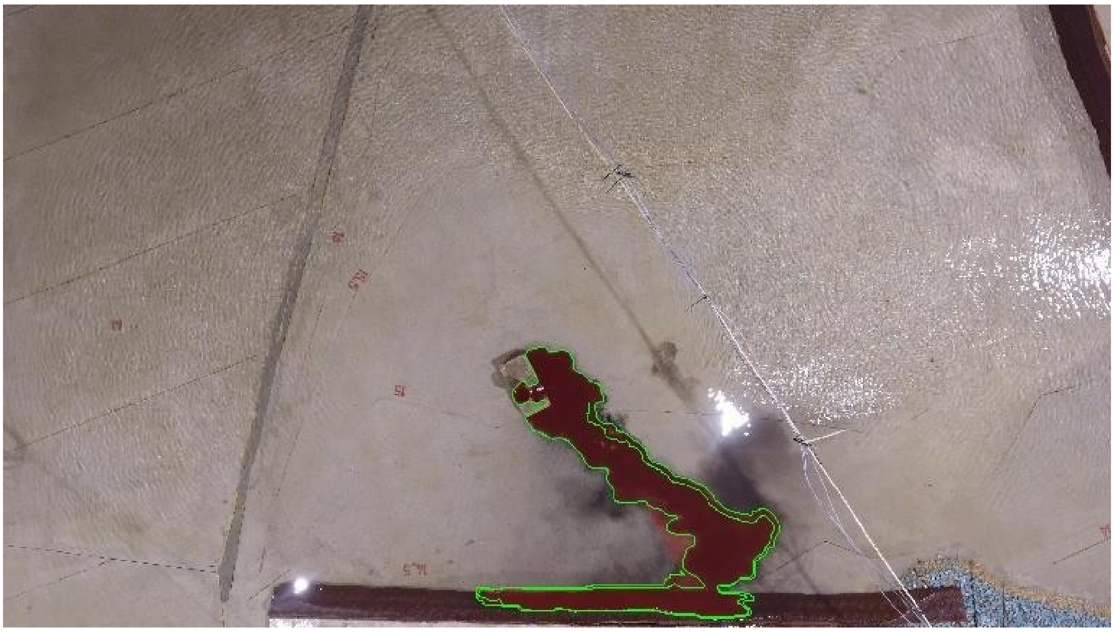


Figure 1: WBreeze algorithm's result of detection and tracking the oil spill during the testing in the CAMERI pool.

Data-Driven Approaches in Water Systems

Graph Neural Networks and Random Forests for Report-Based Failure Prediction in Sewage Pipes

Ofek Aloni, Barak Fishbain

Maintenance of sewage networks is costly, and the funds required will only increase with population size and pipe aging. Smart tools for future planning can help reduce costs and focus repairs on the pipes that need them most, preventing failures. Early research shows promise of Machine Learning (ML) models such as Random Forests (RF) in predicting the evolution in time of the structural state of pipes. We take a different approach, using ML models to directly predict pipe failures. Training data utilizes past reports of pipe failures, combined with GIS data with pipe parameters. This makes it immediately applicable to many municipalities, as this data is often available. This is especially relevant in Israel, as CCTV inspections assessing the structural condition of sewage pipes are still relatively scarce.

Data were obtained from both Mei Netanya and Maayanot Hasharon. GIS data of about 30,000 sewage pipes was obtained from each, containing pipe location and length, as well as pipe properties, such as pipe age, material, and diameter, among others. The other set of data supplied is report data. Maayanot Hasharon supplied 11,000 reports of sewage malfunctions, collected from 2013 to 2024. Netanya offered total 25,500 reports from the years 2015–2024. The tabular reports were filtered to exclude reports that do no necessarily indicate failures, e.g. complaints of smell, or misplaced manhole covers. Remaining reports were geolocated and matched to adjacent pipes. Analysis of the reports was performed, such as investigating the number of recurring reports in each pipe, monthly distribution of reports, and more. Temporal analysis using transition matrices indicates that past reports have significant influence on the likelihood of future reports in the same pipe, giving a concrete basis for utilizing past reports as features in the training data.

A Random Forest model will be used as the baseline for prediction, as it was found effective in similar applications. Thanks to the simplicity of applying a RF model, early results for prediction in the Netanya dataset were already obtained, showing promise. However, since RF accepts tabular input only, we aim to train a Graph Neural Network (GNN) on the data, to leverage the spatial structure of the network. Such models were found to outperform tabular ML models in tasks such as missing data imputation, but further investigation is required on GNN applications for predictive maintenance of sewage pipes.

The research is conducted as part of the Data-Driven Sewer Asset Management (DASAM) collaboration, including Kompetenzzentrum Wasser Berlin (KWB) and Berliner Wasserbetriebe (BW), as well as the Technion.

Identifying the Optimal Type and Locations of Natural Water Retention Measures Using Spatial Modeling and Cost-Benefit Analysis

Merav Tal-Maon, Michelle E. Portman, Dani Broitman, Mashor Housh

Water management has shifted from solely technical and engineering approaches towards nature-based solutions (NBS), like natural water retention measures (NWRM), which offer benefits beyond hydrology, including improved well-being and biodiversity conservation. Determining the best type and location of these measures is challenging due to diverse options with varying benefits and effects depending on measure type and location characteristics. While most studies regarding the optimal allocation and implementation of NBS focus on the urban environment, this study presents a methodology for decision-makers focusing on inter-urban regions with limited data on NWRM implementation. Through hydrological modeling and cost-benefit analysis (CBA), we identify Pareto optimal NWRM sites and types, considering water quantity and quality alongside economic, environmental, and social objectives. We defined optimal locations that seek the most significant reduction of runoff, sediment and pollutants, whilst optimal NWRM types are defined to seek the most cost-effective measures based on hydrological, ecological, and social criteria. Using the Open Non-point Source Pollution and Erosion Comparison Tool (OpenNSPECT), we simulated increased infiltration in different inter-urban areas and identified the optimal placement. The criteria for selecting suitable NWRM types for the identified areas are derived from the EU Directorate General for the Environment (DG-ENV) NWRM database. The results show different effective areas for reducing runoff, sediment, and pollutants. While one NWRM (natural bank stabilization) was identified as most beneficial for reducing sediment, several measures were selected for runoff reduction. Interestingly, measures with high potential for pollutant reduction seem to offer limited social and biodiversity benefits, suggesting conflicting objectives and highlighting the importance of accounting for multiple criteria. By employing simplified models and qualitative benefit assessments, this paper presents a practical decision-making approach to facilitate NWRM implementation in data-scarce areas.

WaCSim: A Water and Cyber Simulation Tool for Enhancing Cyber Security in Smart Water Systems

Stav Cohen, Mashor Housh, Barak Fishbain

Smart water systems are vulnerable to cyber-attacks due to increased connectivity. Current simulation tools often lack full integration of cyber layers or fail to accurately represent real-world configuration of the cyber-physical layers. We present WaCSim, an advanced simulation tool providing cyber-physical modeling for WDSs. Building on the open-source foundation of DHALSIM, WaCSim offers two primary enhancements: First, WaCSim expands cyber-network configurations by incorporating three architectures: (a) PLC Control that simulates decentralized operations where programmable logic controllers (PLCs) communicate with each other over the network, sharing sensor data to operate collaboratively without central SCADA intervention; (b) SCADA Control that simulates the SCADA system as the central controller, receiving data from all PLCs and invoking commands; (c) Hybrid Control that allows PLCs to receive data from other PLCs and from SCADA. These three schemes enable the simulation of different configurations ranging from fully decentralized to fully centralized control schemes. Second, WaCSim provides a user interface for integrating customizable Python-based algorithms. Users can implement Conflict Resolution Algorithms (CRAs) to handle discrepancies between PLC and SCADA commands, as well as algorithms for anomaly detection, optimization, and system control. This enables users to assess the impact of cyber-attacks and their mitigations within the simulation tool. We present case studies demonstrating how WaCSim can simulate cyber-attacks on different architectures and evaluate different mitigation strategies. These examples highlight WaCSim utility in enhancing the resilience, security, and operational efficiency of water distribution networks. securing these systems.

Oral presentation attendees will gain insight into WaCSim's capabilities by learning how it simulates cyber-physical interactions in water distribution systems. They will explore the three control architectures within WaCSim: PLC Control, SCADA Control, and Hybrid Control modes to understand how each mode functions and can be applied. Additionally, participants will discover how to implement customizable Python-based algorithms for conflict resolution and anomaly detection. By analyzing cyber-attack case studies, they will review examples demonstrating attacks and mitigation strategies using WaCSim, enhancing their understanding of cyber-security in smart water systems.

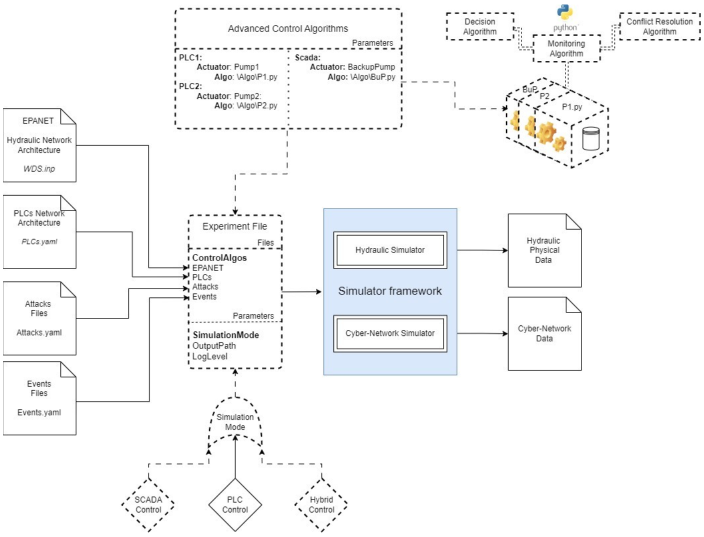
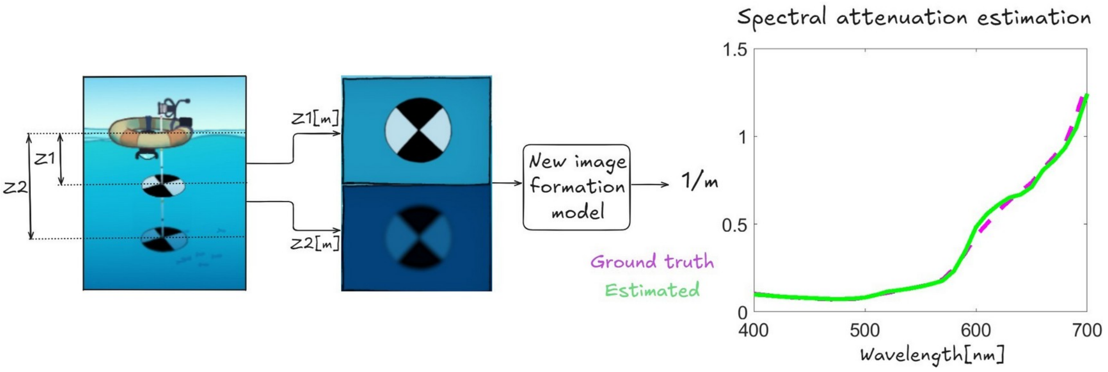


Figure 1: The WaCSim Simulator Diagram

Secchi Disk Meets Underwater Computer Vision: Advancing Theory and Method

Amir Hadad and Derya Akkaynak

Underwater visibility has long been a subject of interest for sailors, fisherfolk, coastal navigators, and scientists, who, over time, have developed various tools for its measurement and prediction. Among the most enduring is the Secchi disk, a simple white disk lowered into the water using a marked line, whose depth of disappearance serves as a proxy for vertical visibility. Although the theory behind Secchi disk visibility (i.e. Secchi disk depth, Z_{SD}) was formulated in the 1950s and has undergone several revisions since then, the current model still omits important factors regarding the visual perception of the observer, physical characteristics of the disk, and the effect of dynamic environmental conditions. Here, we propose the next step in Secchi disk visibility theory that bridges these gaps, leveraging advances in physics-based underwater computer vision. First, we modernized the method itself, automating the lowering of the disk using an Arduino micro-controller, and by replacing the human observer with a camera submerged just under the sea surface. In addition, we incorporated a pressure sensor into the disk itself, synchronized with the camera, to acquire accurate depth readings. Then, we formulated a Secchi disk-specific inverse image formation model that accounts for the characteristics of the observer's visual system and viewing geometry. Our modernized method requires only two images taken at any two depths to estimate Z_{SD}. A direct outcome of our methodology is the ability to estimate spectral attenuation coefficients from RGB photographs, providing objective and actionable data for scientists, citizen scientists, and coastal communities.



CEcBaN: A Tool for CCM-ECCM Bayesian Network Causal Analysis of Ecological Time-Series

Sabrin Hilau Isakov, Amitai Y., and Tal O.

In ecological systems, such as freshwater lakes, multiple biotic and abiotic factors interact to create a complex environment. One of the major challenges for ecologists is to define the interactions between the ecosystem components. The concept of causality allows us to understand the relationships between causes and their effects. In environmental and ecological research, understanding causal relationships is crucial for identifying factors that influence ecosystem dynamics and for better management decisions. However, correlation and causation are different concepts. Correlation refers to a statistical association between two variables, but it does not imply that one variable causes the other. Two variables may be correlated due to confounding factors or because they are both influenced by a common cause. In contrast, causation implies the influence of one variable on another. Revealing the causal relationships within the system is essential for understanding the dynamics and mechanisms driving the system and predicting responses to environmental change. The Convergent cross mapping (CCM) method was presented in 2012 by Sugihara et al. CCM method aims to detect cause-and-effect relationships in nonlinear dynamics systems with non-separatable variables, based on state space recognition. CCM extension, extended CCM (ECCM) was proposed to validate and clarify CCM ambiguous results. Indeed, these techniques and others have been successfully employed to identify causality in complex ecological systems. However, using these advanced methods may be challenging for ecologists, due to technical complexity and lack of computational background and coding expertise.

Here we present CEcBaN tool, which is an intuitive platform that integrates advanced causal discovery techniques within a user-friendly interface, and follows the approach presented by us previously. CEcBaN takes as input a multivariate ecological time series and generates the following outputs: (1) CCM results for all possible interactions between the input variables and a selected target variable, calculated based on user-selected parameters; (2) CCM results for all possible interactions between the causal variables identified in step 1; (3) ECCM results for the suggested causal interactions from steps 1 and 2; (4) statistical analysis using comparison to surrogate results; (5) a DAG of the causal network, constructed based on user-selected conditions; and (6) a Bayesian network (BN) model, including mean scenarios that describe the dynamics leading to higher or lower target values. This allows to perform a complete causal analysis and automatic BN mode construction and scenarios analysis of complex ecosystems.

Water and Wastewater Treatment (English)

New Approach for Rb^+ Separation from Brines Using Prussian-Blue Analogue (PBA) Ion-Chromatography

Chen Dagan-Jaldety, Paz Nativ, and Ori Lahav

Belonging to the alkali metals group, rubidium (Rb) is noteworthy for its heightened reactivity, attributed to being the second most electropositive element and possessing low ionization energy. Despite ranking as the 23rd most abundant mineral in Earth's crust, the global production of Rb compounds remains limited (2–4 tons/year), primarily due to the scarcity of easily extractable Rb-rich minerals. This rarity, coupled with substantial demand, results in rubidium being a costly commodity (~$18,000/kg as metal and ~$8,000/kg as RbCl salt on a metal basis).

The present study introduces a novel method for effectively isolating pure RbCl(s) salt from solutions abundant in Na^+ and K^+. this approach relies on the ion exchange properties of self-synthesized PES coated Zn-Hexacyanoferrate material, enabling Rb^+ adsorption. The process initiates by passing Rb^+ containing brines through an ion exchange column. Once the adsorbed Rb^+ surpasses the specified threshold (>8%), a chromatography-based separation between Rb^+ and Na^+/K^+ is executed using a second column, entirely pre-adsorbed with NH^+. In the initial stage, a 0.05M NH^+-solution is employed to extract Na^+ and K^+ from the first column, retaining a small Rb^+ mass, partly re-adsorbed in the second column, while Na^+/K^+ remain unaltered. After ensuring the eluent solution is free from competing ions, a 1M NH^+ solution extracts all remaining Rb^+ into the regeneration solution. This solution then undergoes water evaporation and NH_3/HCl sublimation, resulting in the production of a pure $RbCl_{(s)}$ product. The research employs theoretical simulations validated by empirical results and cost assessments to demonstrate the feasibility of the proposed method.

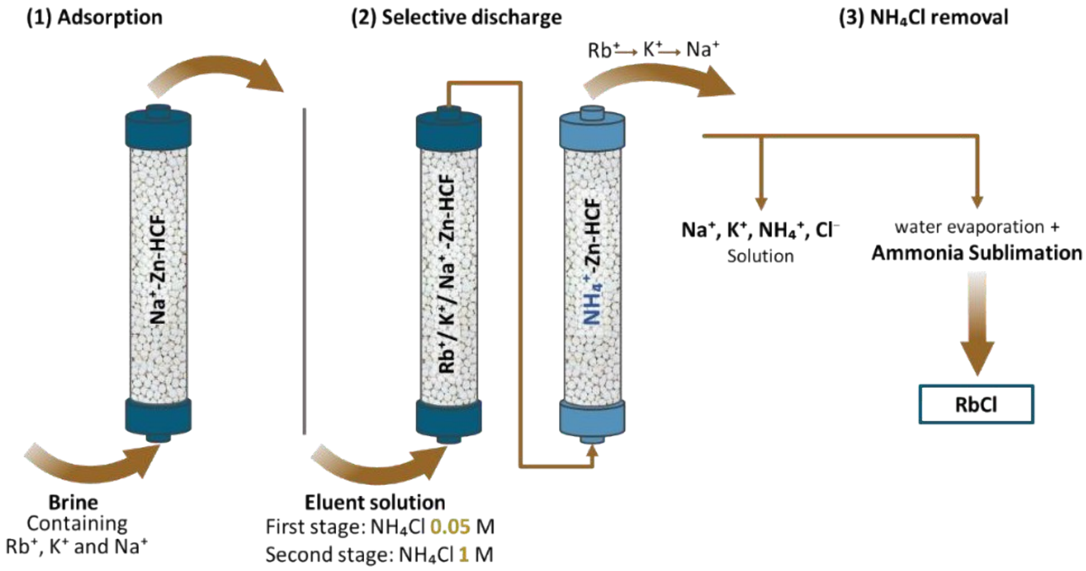


Figure 1: Schematic of the overall process of separating RbCl using a two-column PES-Zn-HCF setup. Following the adsorption step, the first column is saturated with a mixture of Na^+, K^+, and Rb^+ (>8%, eq/eq) ions. The 2nd column is preloaded with NH_4^+. The result of the operation is a time-based separation between the cations, followed by NH4+/HCl sublimation.

The Effect of Biomass Properties on Membrane Biofouling in a Mesophilic Anaerobic Membrane Bioreactor Treating Low-Strength Domestic Wastewater

Mor Shental-Isaacs, M. Herzberg, R. Biton, M. Zaiden

Anaerobic Membrane Bioreactors (AnMBR) offer a sustainable alternative to conventional activated sludge (CAS) systems for domestic wastewater treatment. By integrating anaerobic digestion with membrane filtration, AnMBRs facilitate the conversion of organic matter into methane-rich biogas while retaining biomass through filtration. This approach not only reduces energy consumption and sludge production but also generates high-quality effluent suitable for reuse and nutrients recovery. However, membrane fouling remains a critical challenge that limits the operational stability and increases the operational cost of AnMBR technology. This study aims to advance the maturation of AnMBR systems by elucidating the mechanisms of membrane fouling through a novel, integrated approach to biomass (mixed-liquor sludge) characterization. Our research was conducted at the Shafdan Wastewater Treatment Plant in Israel, where we operated an 8 m^3 AnMBR pilot processing raw domestic wastewater from a local municipality. We examined the reactor biomass under varying conditions, specifically focusing on the effects of increased organic loading rate (OLR). To characterize the biomass, we employed advanced methodologies, including quartz crystal microbalance with dissipation monitoring (QCMD) coupled with localized surface plasmon resonance (LSPR). The QCMD-LSPR method utilizes a membrane-mimetic sensor to analyze the interaction of extracellular polymeric substances (EPS) with the membrane surface and provides information on the EPS' viscoelastic and hydration properties. This data is highly significant, as the EPS acts as a biological scaffold, serving as the backbone of the biomass floc and enhancing its mechanical strength. Additionally, we used oscillatory rheometry to evaluate the mechanical stability of the biomass flocs on a macroscale level, while Sludge Volume Index (SVI) and capillary Suction Time (CST) analyses were employed to characterize the biomass' dewaterability properties. Our findings revealed that increasing the OLR induced significant changes in the properties of the EPS, which, in turn, reduced the mechanical stability of the biomass flocs and adversely affected dewaterability. Scanning Electron Microscopy (SEM) and Energy Dispersive X-ray (EDX) analyses indicated a decrease in calcium levels, contributing to floc instability. Furthermore, in-situ monitoring of transmembrane pressure (TMP) confirmed an increase in fouling propensity, supported by ex-situ fouling experiments conducted using Optical Coherence Tomography (OCT) visualization. In conclusion, this work enhances the understanding of the relationships among operational parameters, biomass properties, and fouling propensity in AnMBR systems for domestic wastewater treatment. By employing innovative biomass characterization methods, we provide critical insights into fouling mechanisms that inform the development of effective fouling mitigation strategies for improved performance and reduced operational expenditures.

Molecular Layer Deposition (MLD) as a Versatile Platform for Water Treatment: Precise Engineering of Dense Membrane

Ruoke Cai, Brian Welch, and Tamar Segal-Peretz

The advancement of next-generation desalination membranes is essential for tackling the growing global challenge of water scarcity, driven by increasing demand for clean water and the depletion of freshwater resources. The current state-of-the-art of membrane film is based on interfacial polymerization (IP) of aromatic polyamide (PA), which uses environmentally harmful solvents and results in inhomogeneous films. In this work, we present MLD as a novel and versatile technique for fabricating dense membranes (i.e., reverse osmosis (RO) and nanofiltration (NF) membranes) with precisely controlled thickness and composition. Unlike conventional IP techniques, MLD is a solvent- free, cyclic deposition technique for organic materials under vacuum. With each exposure, vapor- phase precursors form covalent bonds via polyaddition reactions with the sublayer, creating one layer at a time. This process offers molecular-level precision, enabling the creation of ultrathin, ultrasmooth, and defect-free selective layers.

Our research aims to develop PA MLD on commercial ultrafiltration membrane (UF) support for thin-film composite (TFC) membranes, to achieve high-performing, high-stability membranes. We investigated the MLD deposition cycles by tuning the thickness of the membranes, and evaluated their performance (i.e., permeability and salt rejection) through a cross-flow system. We found that

~7nm PA thin film is a critical thickness on UF to achieve state-of-the-art desalination rejection, as shown in Figure 1. The synthesized PA layers were characterized with attenuated total reflection—Fourier transform infrared (ATR-FTIR) spectroscopy, spectroscopic ellipsometry, atomic force microscopy (AFM) and quartz crystal microbalance (QCM), to determine the chemical composition, thickness, roughness and growth rate of each layer, respectively. In addition, the nanoscale morphologies and structures over the UF membrane were investigated via scanning electron microscope (SEM) and high-resolution cross-section transmission electron microscopy (TEM). This approach provides a unique platform that enables us to fabricate dense membranes with precise molecular-level control, and opens up new possibilities for optimizing membrane properties.

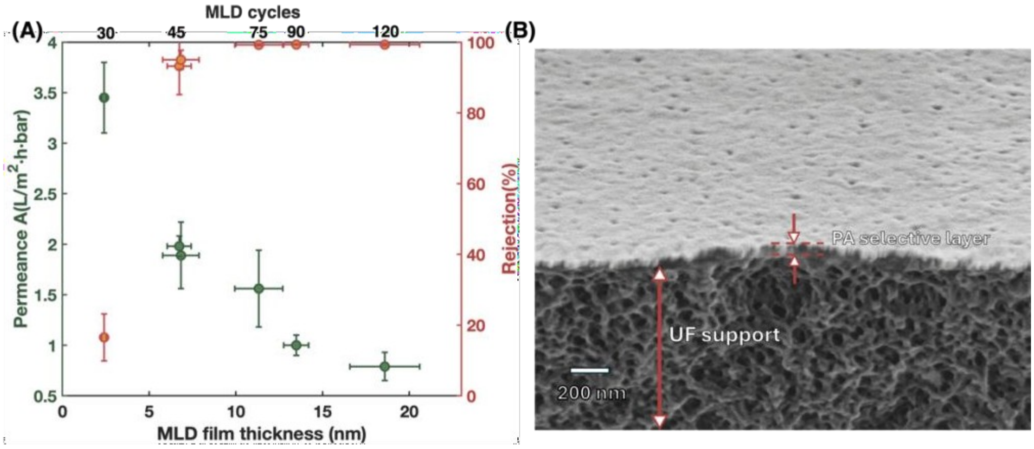


Figure 1: (A) Performance of TFC membranes with TMC-MPD MLD film on UF membrane; (B) SEM image of TFC membranes as an example.

Minimizing Nitrous Oxide Emissions in Single-Stage Partial Nitritation and Anammox Reactors Under Hypersaline Conditions

Lin Gao

One of the negative consequences of biological ammonia removal from wastewater is the emission of nitrous oxide. Nitrous oxide (N_2O) is a potent greenhouse gas and even though its emissions are much less than CO_2, its global warming potential (GWP) is calculated to be approximately 300 times more than CO_2. N_2O emissions from wastewater treatment are mainly due to incomplete nitritation and denitrification by ammonia oxidizing bacteria (AOB) and heterotrophic denitrifying bacteria, respectively, and has been shown to occur mostly under conditions of low dissolved oxygen (DO) and the presence of nitrite. Paradoxically, these conditions exist in newer partial nitritation—anammox (PN/A) processes employed to reduce energy consumption and CO_2 emissions during nutrient removal.

As PN/A technology becomes more widespread, monitoring and controlling nitrous oxide (N_2O) emissions from PN/A processes has become an important objective. Here, N_2O emissions from single-stage PN/A reactors for nitrogen removal under hypersaline conditions (4%) were investigated. The reactors were operated with continuous feeding and reactor recirculation (fixed bed reactor) and intermittent mixing (suspended reactor) to ensure mixed conditions and constant ammonium concentrations and aeration to avoid dynamic changes found in previous works using sequential batch reactor (SBR) systems. The reactors were operated first with no organic addition to isolate N_2O emissions from nitritation while keeping denitrification to a minimum. Subsequently, acetate addition to the reactor feed was used to minimize N_2O emissions via denitrification. Results show that N2O emissions in fixed bed and suspended PN/A reactors ranged from 0.08% to 1.0% and 0.09% to 1.5% of ammonium removed, respectively. Bulk ammonium and nitrite concentration were shown to be the main controlling factors for N_2O emissions. The addition of acetate to both suspended and fixed bed reactors reduced N_2O emissions by 52.5% and 72.4%, respectively. Quantitative PCR results showed an increase in the functional genes related to denitrification (nirS, nirK and nosZ) with the addition of acetate, however deammoniafication was not significantly affected. The ammonia oxidizing bacteria and anammox bacteria identified in both PN/A reactor systems were from the genus Nitrosomonas and genus Candidatus Scalindua, respectively. The significance of this research is two-fold, (1) to show the importance of bulk ammonium and nitrite concentrations in controlling N_2O emissions in PN/A reactors under hypersaline conditions, and (2) the possible implications for operational strategies to minimize N2O emissions in PN/A reactors.

Impact of Adsorbent Surface Properties on the Adsorption and Desorption Kinetics of PFAS: Insights from QCM Measurements and their Implementations

Olanrewaju Eunice Beyioku, Avner Ronen

Per- and polyfluoroalkyl substances (PFAS) are persistent synthetic micropollutants with bio-accumulative tendencies and pose significant environmental and health risks due to their widespread distribution and resistance to degradation. This study investigates the adsorption and desorption characteristics of long-chain (e.g., PFOA) and short-chain (e.g., PFBA) PFAS on quartz crystal microbalance (QCM) sensors with various surface coatings, focusing on surface properties such as hydrophobicity, surface area, and surface charge. The sensor's properties were selected to mimic surfaces used in PFAS-contaminated water treatment technologies, such as hydrophobic polyethersulfone (PES) for membrane filtration, hydrophilic SiO_2 for media filters, positively charged 3-amino propyl tri ethoxy-silane (APTES) mimicking ion exchange resins, and carbon nanotube (CNT)-coated surfaces representing carbon-based adsorbers (Figure 1).

The results demonstrate that PFOA is strongly adsorbed onto hydrophobic surfaces (e.g., PES, APTES, and CNT), driven primarily by hydrophobic interactions, while PFBA exhibited significantly higher adsorption onto CNT and APTES surfaces, highlighting the crucial role of surface area and electrostatic interactions. Kinetic analysis revealed a two-stage adsorption process for PFOA on PES, with an increased rate in the second stage likely due to hemimicelle formation. For PFBA, higher initial adsorption rates were observed on CNT-coated sensors, followed by a decline due to diffusion limitations within CNT's micropores. The positively charged APTES surface demonstrated about 60% higher adsorbed mass of PFBA compared to PES, highlighting the significant influence of electrostatic interactions on short-chain PFAS. Desorption studies showed low release rates for both PFOA and PFBA from PES, suggesting strong retention due to hydrophobic interactions. PFBA desorbed more slowly from APTES due to stronger electrostatic retention, while CNT surfaces displayed an initial rapid release driven by concentration gradients, followed by a slower, diffusion-limited phase.

This study highlights the critical role of surface properties in the adsorption and desorption of PFAS and suggests that combining high surface area with positive surface charges can significantly improve the removal of both long-chain and short-chain PFAS, providing important insights for designing more effective PFAS treatment systems in environmental remediation.

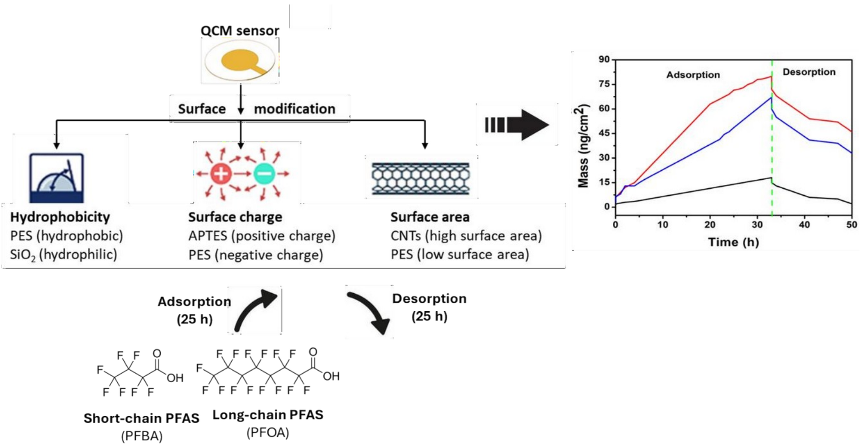


Figure 1: Representative figure of the modified sensors and adsorption and desorption stages.

Poster presentations

Achieving charge reversal of polyamide nanofiltration membranes using multivalent cations

Siyu Pan

As a membrane technology, Nanofiltration (NF) requires lower operating pressure and energy consumption compared to reverse osmosis (RO) in the expense of lower salt rejection. Typically, NF membranes are composed of a polyamide active layer and a polysulfone support layer, which provides mechanical strength. The principle of solute rejection in the polyamide layer is based on size and charge effects among other mechanisms. Due to its lower salt rejection compared to RO, NF shows higher ion-ion selectivity and is therefore a promising membrane process for separating between solutes, such as monovalent and divalent ions. For instance, it can be used for recovering Li^+ by separating Li^+ from Mg^{2+} in brine lakes with high Mg^{2+}/Li^+ ratio. Notably, a recent study showed that the divalent ions (e.g., Ca^{2+} and Mg^{2+}) can be adsorbed by the negatively charged carboxylic groups in the polyamide active layer of the membrane, which affects the membrane surface charge. NF membranes at neutral pH are typically negatively charged, however, the membrane may become positively charged with adsorption of divalent ions, which is known as charge reversal. Charge reversal is helpful for Mg^{2+} rejection due to repulsion of co-ions, increasing the selectivity of Li^+/Mg^{2+}.

In this study, we explore the possibility to obtain charge reversal of polyamide NF membranes using divalent ions and altering the pH of the solution. The latter affects the membrane surface charge due to the nature of the functional group on the active layer (i.e., the pK_a values of carboxylic and amine groups are around 4.5 and 8, respectively). Specifically, we used KCl and $MgCl_2$ as electrolyte solutions, and evaluated the surface charge of the membranes using zeta potential measurements. The concentration of electrolyte solutions was set from low to high and the pH was altered from 9.0 to 2.5. As shown in Figure 1, when the concentration of electrolyte solution increases, the zeta potential also increases, which means that the membrane becomes less negatively charged. Nonetheless, the charge reversal is achieved only at acidic pH (<3.5). Hence, the plan for next step is testing possibilities to obtain charge reversal at neutral pH.

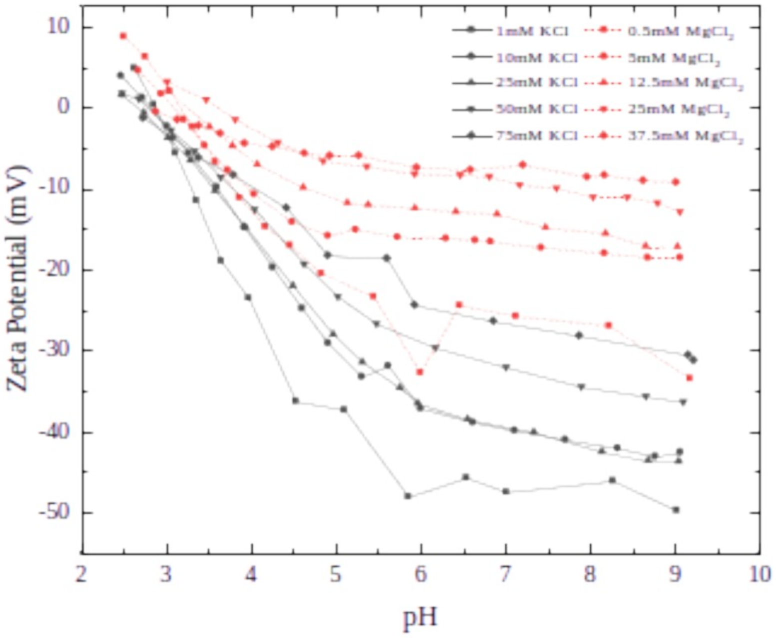


Figure 1: Effect of different electrolyte solutions and pH on the zeta potential of the NF270 membrane.

Advancing Marine Carbon Dioxide Removal through Electrochemical Alkalinity Enhancement and Mineralization

Noam Karo, Or Mayraz, Charlotte Vogt

Capturing and sequestering CO_2 at the necessary scale to stay below a 2°C average global temperature increase by 2050 requires solutions that align with energy and cost-efficiency goals. Direct air capture (DAC) technologies aim to concentrate atmospheric CO_2 but suffer from low efficiencies and face great challenges in scaling up. Moreover, the financial cost of separation processes scales inversely to the initial concentration, meaning that sources with higher CO2 concentrations—such as seawater—offer more cost-effective pathways. Oceans contain approximately 140 times more carbon than the atmosphere. This makes marine carbon dioxide removal (mCDR) technologies an attractive solution. Electrochemical methods to increase seawater alkalinity, and thus CO_2 absorption, have gained attention due to their scalability, operability at ambient temperatures and pressures, and potential to be powered by renewable energy. Moreover, these methods offer a promising pathway for long-term, safe and stable carbon storage, in addition to new opportunities for sustainable mineral mining. However, experimental data is limited.

Our research investigates the potential and challenges of electrochemical mineralization experimentally, theoretically and techno-economically. We propose an experimental setup designed to decouple alkalinity enhancement from mineralization via an electrochemical membrane cell and a mineralization cell, in which precipitation is induced. Utilizing real seawater, we explore the effects of pH swings (up to pH ~10), calcium carbonate precipitation and further dissolution of $CO_{2(g)}$ on the ocean chemistry (e.g., pH, dissolved inorganic carbon [DIC], and alkalinity). We perform a combination of empirical measurements and comprehensive geochemical simulations using PHREEQC to conduct the analysis. Thereby, we provide further insight into the dynamics of the carbonate system and the energy consumption required to reach different pH values. Lastly, we visualize a pH-DIC-alkalinity space to map potential mCDR pathways.

Our results show that electrochemical mineralization can potentially be a carbon negative process, even when carbon emitting fuel (i.e., fossil fuels) is the energy source. In addition, we show that Mg^{2+}, due to its high concentration relative to other cations, is a key factor influencing the energy needed to reach certain pH levels required for effective $CaCO_3$ precipitation. Ultimately, we suggest a two-step approach for optimizing carbon removal and sequestration as DIC and carbonate minerals. These steps include a carbon uptake capacity enhancement step and a controlled mineralization step. We conclude that, although electrochemical mCDR presents challenges, electrochemically inducing ocean alkalinity to enhance DIC uptake and facilitate carbonate mineralization is a feasible, low-energy pathway to scalable CO_2 removal.

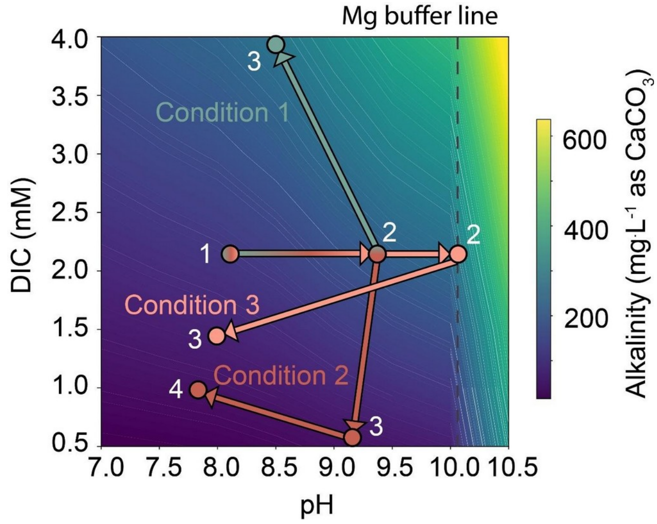


Figure: A 3D representation of the relationship between dissolved inorganic carbon (DIC), pH, and alkalinity for RSW, extrapolation based on PHREEQC simulation and speciation at different DIC molar concentrations: 0.0005, 0.001, 0.0015, 0.002, 0.003, 0.004, 0.005, 0.006, 0.007, 0.008, 0.009, 0.01 M.

Steps along the different experimental conditions employed in this work are depicted on the DIC-pH-Alkalinity space for Condition (1) (increasing pH to 9.5 and sparging with synthetic air), Condition (2) (increasing pH to 9.5, allowing mineralization and subsequently sparging), and Condition (3) (increasing pH to ~10 and simultaneously sparging and mineralizing).

Air-SAT: Active Air Injection for Enhancement of Efficiency in Soil Aquifer Treatment—Field Scale Exploration

Natasha Katsevman, Noam Weisbrod, and Alex Furman

Soil aquifer treatment (SAT) is a well-established method for the tertiary treatment and storage of secondary treated wastewater (TWW). During TWW infiltration into the subsurface, biogeochemical processes, which predominantly require oxygen, occur. Consequently, SAT operational cycles include drying periods, reducing the economic and environmental efficiency in densely populated areas with high wastewater discharge rates. Building on successful laboratory experiments conducted by Arad (2022) that aimed to improve water quality and system capacity, we expanded the research to a field-scale experiment. At an actual SAT site in southern Israel, we installed an air injection system that provides pulses of air into subsoil regularly flooded with TWW. The aim of the air pulses is to limit and even eliminate the drying periods. The soil conditions are monitored using water content, temperature, and redox potential sensors. Water quality parameters examined include dissolved organic carbon, nitrogen species, major ions, and three emerging contaminants: ibuprofen, carbamazepine, and 1H-benzotriazole. The extensive placement of sensors and water sampling devices over a 20x20x1.2-meter range helps us build a comprehensive picture of the experiment and optimize the process through efficient work cycles. Although the experiment is in its early stages, we can provide an initial overview of the hydrogeological and biogeochemical conditions of the site with and without air injection, assessing its relative efficiency in terms of water quality and increased infiltration quantity. The goal of Air-SAT research is to reduce pollution caused by excessive TWW disposal into water reservoirs, provide higher-quality tertiary wastewater, and optimize the land area used by SAT systems.

Figure: Installation of a piping system

Analyzing The Secondary Wastewater-Treatment Process Using Faster R-CNN and YOLOv5 Object Detection Algorithms

Offir Inbar, Moni Shahar, Jacob Gidron, Ido Cohen, Ofir Menashe, Dror Avisar

The activated sludge (AS) process is the most common type of secondary wastewater treatment, applied worldwide. Imbalances between the different types of bacteria may occur and disturb the process, with pronounced economical and environmental consequences. Microscopic inspection of the morphology of flocs and microorganisms provides key information on AS properties and function. This is a time-consuming, highly skilled, and expensive process that is not readily available in all locations. Thus, most wastewater-treatment plants do not carry out this essential analysis, resulting in frequent operational faults. We develop a novel deep learning (DL) object detection algorithm to analyze and monitor the AS process based on a unique microscopic image database of flocs and microorganisms. Specifically, we applied YOLOv5 and Faster R-CNN algorithms as tools for segmentation and object detection to analyze the wastewater. The mean average precision (mAP) of the YOLOv5 was 0.67, outperforming the Faster R-CNN by 15%. Histogram equalization preprocessing of both bright-field and phase-contrast images significantly improved the results of the algorithm in all classes. In the case of YOLOv5, the mAP increased by 16.67%, to 0.77, where the AP of protozoa, filaments, and open floc classes outperformed the previous model by over 20%. These results demonstrate the potential DL algorithms to enhance the analysis and monitoring of WWTPs in an affordable manner, consequently reducing environmental pollution caused by contaminated effluent. The fundamental challenge addressed herein has important global relevance, especially in an era in which the demand for high-quality wastewater reuse is expected to increase dramatically.

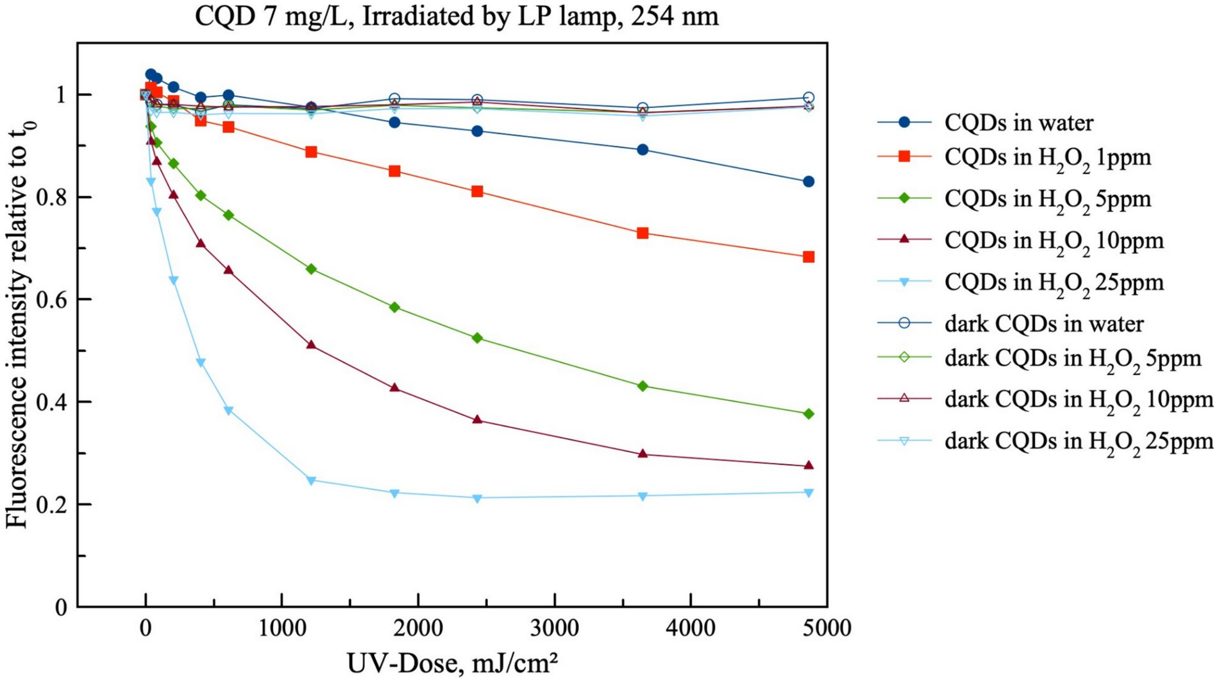
Carbon Quantum Dots as Components of a UV Detection System for Water Treatment Applications

Roman Belykh

The emergence of UV LED technology has revolutionized water disinfection systems, necessitating new methods for precise efficiency monitoring. This study investigates Carbon Quantum Dots (CQDs) as potential actinometric indicators for UV detection and advanced oxidation systems.

CQDs synthesized via microwave heating from citric acid and ammonium phosphate demonstrated favorable optical properties, exhibiting emission and excitation peaks at 420 nm and 330 nm, respectively. The synthesized CQDs showed remarkable stability across diverse conditions, maintaining integrity at temperatures up to 100°C and pH values ranging from 2 to 9, aligning with previously reported characteristics.

While aqueous CQD solutions exhibited minimal photodegradation under broad-spectrum UV exposure, a significant exponential decrease in fluorescence was observed under UV-C irradiation in the presence of H_2O_2, attributed to radical-mediated degradation mechanisms. These findings suggest the potential development of a dual-component UV detection system incorporating CQDs and radical generators such as H_2O_2 or TiO_2 photocatalysts. This approach could provide a method for monitoring UV disinfection efficiency in water treatment applications.



Climate Change Impact on Urban Runoff in the Eastern Mediterranean

Raz Nussbaum, Efrat Morin

In urban environments, excess runoff can cause urban flooding—an impactful disaster that could result in severe outcomes, including loss of life and extensive damage to property and infrastructure. Climate change and urbanization are the main factors contributing to increasing the frequency and intensity of flooding in urban areas. Yet, effectively modeling the intricate and heterogeneous nature of an urban area and understanding the rainstorm and surface properties that impact runoff formation is still a challenge. In addition, there is a lack of research on the interaction between climate change and urban runoff in the Eastern Mediterranean region particularly. We employed high spatiotemporal rainstorm and surface data of the Nahal Ra'anana basin (13 km^2) located on Israel's coastline to develop a comprehensive and sufficiently accurate urban rainfall-runoff model. This model, based on the hydraulic-hydrological SWMM model, was refined using data collected from 26 distinct storms, capturing a diverse range of precipitation patterns and intensities. The developed SWMM-based model effectively represents Nahal Ra'anana basin's hydrological response, with KGE values of 0.66 for peak flow and 0.88 for total volume, indicating satisfactory performance. By employing this model, we are currently investigating various factors influencing urban runoff characteristics, including rainstorm properties associated with climate change and land use changes resulting from urbanization. The findings derived from this research will contribute significantly to the enhancement of flood risk management strategies in future urban environments.

Emission Mechanism and Atmospheric Distribution of Airborne Marine Viruses

Jonathan Blaustein, Naama Lang-Yona

Marine viruses play a crucial role in regulating nutrient cycles, climate processes, and marine biodiversity. Traditionally considered confined to aquatic environments, recent studies suggest that marine viruses can also be aerosolized, impacting atmospheric and ecological systems. However, the mechanisms and extent of this aerosolization remain poorly understood, particularly regarding how environmental factors influence viral emissions.

This research aims to investigate the emission mechanisms and atmospheric distribution of airborne marine viruses in the contrasting environments of the Red Sea and the Mediterranean Sea. The Red Sea, characterized by high temperatures and salinity, offers a distinct setting compared to the Mediterranean, which experiences more pronounced seasonal temperature variations and lower salinity. These differences provide a unique opportunity to explore how factors such as the sea surface microlayer (SML) composition, meteorological conditions, and seasonal dynamics affect viral aerosolization.

We hypothesize that the efficiency of marine bioaerosol emissions, particularly viruses, differs significantly between these regions, influenced by environmental conditions. To test this, we focus in this study on the diatom Chaetoceros tenuissimus and its pathogenic virus, CtenDNAV, both of which commonly bloom during seasonal transitions in the Red Sea and Mediterranean Sea. Diatoms are critical to oceanic food webs and carbon cycling, contributing up to 25% of global primary production and 40% of marine primary production. Their role in mitigating climate change and supporting biodiversity highlights the importance of understanding factors that may influence their bloom dynamics.

This research suggests that variations in environmental factors between these regions may significantly impact the aerosolization of viruses associated with diatom blooms, potentially affecting marine microbial communities, ecosystem health, and biogeochemical cycles. Future findings from this study may offer valuable insights into the ecological and atmospheric significance of airborne marine viruses.

This research is supported by the Interuniversity Institute for Marine Sciences (IUI) Graduate Student Grant.

Extracellular Polymeric Substances Attribute to Biofouling of Anaerobic Membrane Bioreactor: Adhesion and Viscoelastic Properties

Kbrom Mearg Haile, Mor Shental-Isaacs, Moshe Herzberg

Membrane fouling is the bottleneck for the anaerobic membrane bioreactor (AnMBR) robust continuous operation, primarily caused by the mixed liquor suspended solids (MLSS) characteristics formed by aggregated flocs and a scaffold of microbial self-produced extracellular polymeric substances (EPS), which dictates the flocs integrity. Accordingly, the adhesion of EPS to the membrane surface versus their role in forming firm, elastic, and mechanically stable flocs under the reactor's hydraulic shear is critical for minimizing interactions between EPS and colloids, originating from the MLSS flocs, with the membrane. This study aims to gain insight and investigate the effect MLSS flocs properties, EPS adhesion and viscoelasticity, viscoelastic properties of the sludge, and membrane fouling propensity.

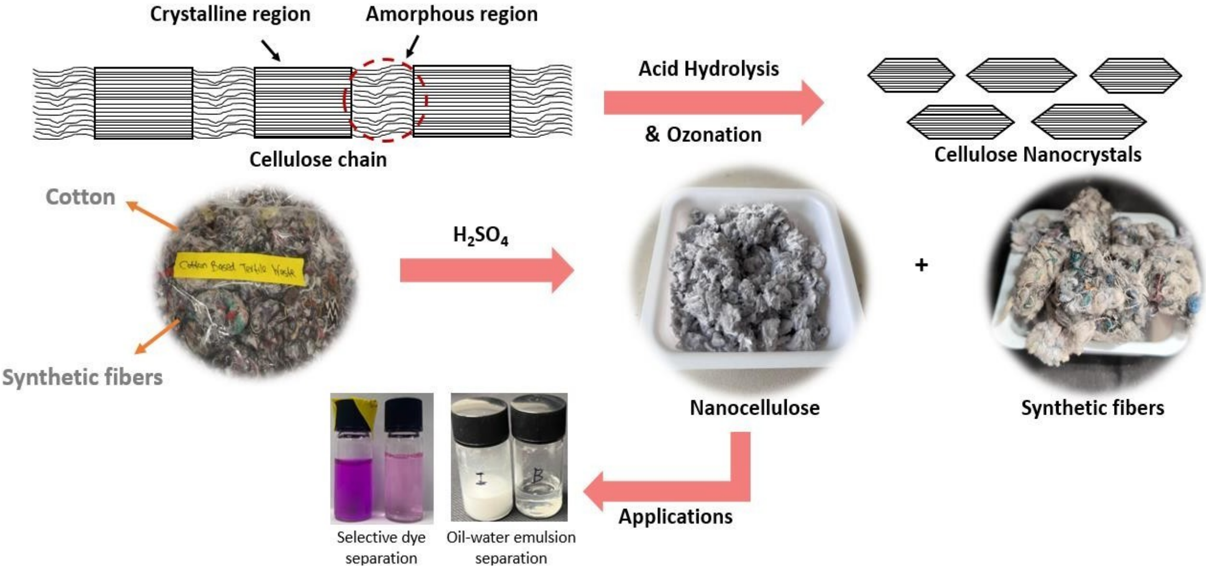
As a working hypothesis, to alter the aforementioned flocs' and EPS's properties, the addition of either coagulant or surfactant was carried out during the AnMBR operation. In the AnMBR, two flat-sheet 300 kDa pore size polyether sulfone (PES) membranes with a total filtration area of 352 cm^2 were immersed in the AnMBR system treating municipal wastewater of Midreshet Ben-Gurion village at the Negev highlands, Israel. The system temperature, pH, biogas recirculation, and hydraulic retention time were regulated. TMP fluctuations during a 30-day experiment were recorded under three operating conditions: Baseline (without addition of coagulating or dispersing agent); coagulant addition ($FeCl_3$), and surfactant addition (sodium dodecyl sulfate). At the end of each experiment, EPS were extracted from the MLSS and from the fouled membrane, characterized for their protein, polysaccharides, and DOC contents, and correlated with the fouling tendency of the submerged UF membrane. The EPS adherence and viscoelastic properties were revealed using QCM-D via the PES-coated gold sensor used as a membrane-mimicking surface providing a detailed real-time EPS adhesion. The associated shifts in the resonance frequency and dissipation at different overtones were further modeled using the Voigt-based viscoelastic model (using Dfind software, Q-Sense Biolin Scientific) in which the thickness, shear modulus, and shear viscosity values of the adsorbed EPS layers on the PES coated sensor were calculated.

The observations obtained from the QCM-D analysis indicate a greater decrease in the frequency shift for the elevated membrane fouling scenarios, likely due to an observed decrease in the calculated shear viscosity and shear modulus of the EPS adsorbed layer, coupled with an increase in EPS layer hydrated thickness and fluidity ($\Delta D/\Delta f$ slopes). Further analysis is being conducted for the three major operating conditions-analyzing their effects on sludge rheology, dewaterability (capillary suction time-CST), and settleability (SVI). The biofouling layer is further characterized microscopically using a confocal laser scanning microscope (CLSM) and scanning electron microscope (SEM), for analyzing the consistency of the development of the biofouling layer with sludge characteristics, i.e., thicker biofouling layer on the membrane surface when operated with surfactant addition, due to flocs with reduced integrity and availability of EPS/colloids to the membrane. Conversely, a thinner layer when operated with coagulant compared to the baseline experiment, due to elevation in flocs integrity.

Extraction of Cellulose Nanocrystals from Cotton-Based Textile Waste and its Application in Water Treatment

Tian Qiu, Alona Maslennikov, Barak Halpern, Manohara Halanur Mruthunjayappa, and Hadas Mamane

Cellulose, a renewable natural fiber, has attracted significant research interest as a promising alternative to synthetic non-biodegradable fibers. Nanocellulose has shown vast potential in applications across the energy, environmental, and health sectors. Each year, an estimated 10^{10} to 10^{11} tons of cellulose are synthesized and degraded worldwide, emphasizing the importance of recycling over disposal to adhere to green chemistry principles and conserve trees and plants. The fashion industry alone produces approximately 150 billion garments annually, contributing to 92 million tons of textile waste, 85% of which ends up in landfills or incinerated. Despite this, only 15% of textile waste was recycled in 2015, with significant losses during the process. In this study, post-consumer cotton-based textile waste was shredded, collected, and processed through sulfuric acid hydrolysis and optimized the condition to produce pure nanocellulose (NC). The top-down method achieved a yield of around 47%, confirmed by COD and quantitative analysis. XRD, FTIR and XPS analyses characterized the extracted cellulose nanocrystals (CNCs), while SEM imaging and DLS revealed uniform rod-like particles with a size distribution of 66.46 to 124.4 nm, consistent with CNCs. Further, we have demonstrated their application as robust adsorption filter for selective dye separation and oil-water emulsion purification. The utilization of CNCs from textile waste provides a sustainable approach to waste and water management, supporting circular economy initiatives and promoting a greener future.



From Traditional Simulation to Machine Learning: Comparing EPANET-MSX and Physics-Informed Neural Networks in Water Quality Modeling

Raghad Shamaly, Gopinathan R. Abhijith, and Avi Ostfeld

Water distribution systems (WDS) are critical for delivering safe drinking water, and accurately modeling water quality dynamics is essential for ensuring public health and system efficiency. Conventional tools like EPANET-MSX are extensively used to simulate water quality by accounting for intricate chemical interactions and stoichiometric relationships. However, recent advancements in machine learning, specifically Physics-Informed Neural Networks (PINNs), offer a promising alternative for modeling these interactions with greater flexibility and potentially enhanced predictive accuracy.

This study presents a comparative analysis of EPANET-MSX and PINNs for modeling water quality variations and chemical-stoichiometric processes within the WDS domain. The investigation includes simulations of water quality responses in nonchlorinated, chlorinated, and chloraminated systems to arsenic contamination, perfluorooctanoic acid (PFOA) and perfluorooctanesulfonic acid (PFOS) degradation, chlorine decay, total organic carbon (TOC) degradation, bacterial regrowth, and trihalomethane (THM) formation. The results highlight key differences between EPANET-MSX, which relies on well-established chemical models, and PINNs, which can capture complex, nonlinear interactions with minimal prior assumptions.

By streamlining water quality modeling, this study contributes to more efficient management of WDS, offering insights into the computational efficiency, accuracy, and applicability of traditional versus machine learning-based approaches. These findings provide valuable guidance for the development of future water quality management tools, supporting the next generation of researchers and professionals in addressing emerging challenges such as climate change, contamination, and public health risks.

Growing Black Soldier Fly Larvae on Sewage Sludge and Other Organic Wastes to Produce Valuable Products

Maria Khoury, Adi Jonas-Levi, Yoram Gerchman, and Hassan Azaizeh

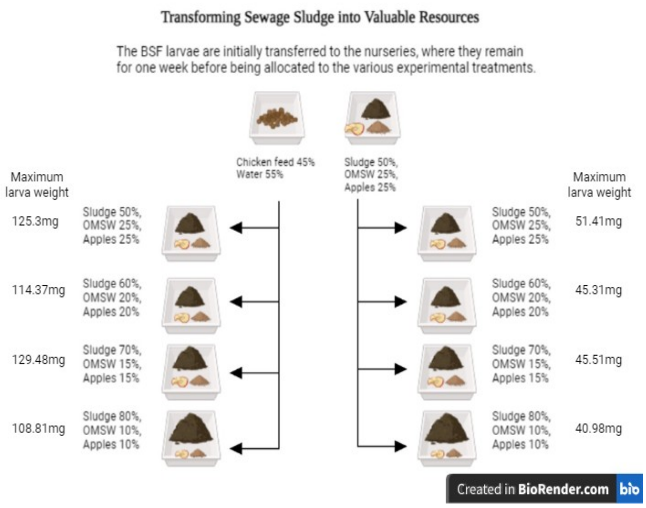
Sewage sludge is a byproduct of wastewater treatment and is produced in large quantities. Current sludge management includes anaerobic digestion for biogas production and/or composting, but these practices pose a significant challenge due to increasing urbanization, necessitating innovative and sustainable solutions. Our research investigates the potential of using black soldier fly (*Hermetia illucens*) (BSF) larvae for the conversion of sewage sludge into valuable resources. Our study focuses on the efficiency of BSF larvae in transforming sewage sludge into BSF biomass rich in fatty acids for biodiesel production. We investigate the dynamics of growth and fat accumulation in BSF under varying ratios of sewage sludge, apple waste, olive mill solid waste and others.

The larvae were reared at a controlled temperature of 30°C with substrate humidity maintained between 55-65% to support optimal growth conditions. Individual larvae samples were washed, dried, and weighed to accurately assess biomass. The lipid extraction and quantification were conducted by mixing BSF larval powder with a Methanol, i.e., MTBE solution, processing via vortexing, sonication, and shaking, and then centrifugation. The resulting supernatant consisted of the lipids, which were transferred to vials, dried and weighed, and the residual material was measured relative to the initial sample weight.

The findings indicate a significant difference in the nursery stage mix 50 vs. Chicken feed diet composition on the final larvae biomass (51.41±11.79 mg vs. 125.3±18.86 mg, respectively), highlighting the critical role of early food composition. The lipid content also depended on the growing conditions in the nursery where chick feed resulted in approximately twice that of the substrate mixture.

In summary, the findings suggest that sewage sludge can be used as cheap biomass for BSF feed, resulting in effective growth and oil accumulation, although optimization is still needed. The significance of this research lies in its contribution to circular economy principles, effective resource utilization, and improved environmental outcomes, utilizing sewage sludge to produce an economic product—BSF oil. By proposing a novel approach to sewage sludge management, this project has the potential to align with global sustainability goals and promote a greener future.

It's worthwhile to explore economically valuable methods for converting various wastes into valuable resources like biofuels and organic fertilizers. Ultimately, this work aims to foster collaboration, drive policy change, and inspire further research in sustainable waste management.



How Much the Diffuse Recharge is Really Important in the Chalk Aquifer Under Desert Conditions?

Hala Jmili, Noam Weisbord and Tuvia Turkeltaub

As aridity increases, the importance of focused groundwater recharge becomes more significant. It is well established that groundwater recharge in arid areas primarily occurs during intense rainfall events and flash floods in ephemeral streams. However, earlier studies indicate that diffuse recharge—spatially distributed recharge derived from precipitation or irrigation—may also contribute significantly to groundwater replenishment. This study aims to quantify the diffuse groundwater recharge component in the Chalk aquitard under the arid conditions of the Negev desert.

Three types of models were evaluated to explain the diffuse groundwater recharge in the fracture chalk aquitard of the Israeli Negev; data specifically were taken from boreholes in the Ramat Hovav area: the Richards equation, the dual porosity model, and the dual permeability model. Climate data from a nearby meteorological station and tritium concentrations in the rain collected between 1960 and 1995 were used as the atmospheric boundary conditions. The performance and uncertainties of these models were assessed using tritium profiles previously obtained from concentration measurements in unsaturated soil profiles of the Ramat Hovav region. The calibration process involved running multiple simulations, incorporating 800 combinations of hydraulic parameters generated by the Latin hypercube sampling method. Model selection and performance were evaluated using statistical metrics, including reduced root mean square error (RRMSE) and the Akaike and Schwarz information criteria. Based on the simulation results, the dual porosity model significantly fit the observed tritium concentrations better than the dual permeability model and Richards equation. This demonstrates that water flow occurs exclusively within fractures without simultaneous flow in the matrix while highlighting the exchange of water and solutes between the fractures and the chalk matrix in the arid environment of the Israeli desert. In the near future, we will test the critical size of rainstorms that produce the diffuse groundwater recharge component at our site.

Investigate Tradeoff Between Permeability and Ion-Ion Selectivity in Polyamide Membranes

Bangxing Jian

Due to their high salt rejection and excellent water permeability, reverse osmosis (RO) membranes are usually applied to desalination processes. The dense top layer of RO membranes made of a polyamide often exhibits the so-called permeability-selectivity tradeoff; that is, the higher the water permeability of the membrane, the lower its water-salt selectivity (i.e., salt rejection). This common observation is due to steric effects that hinder less the transport of water molecules compared to the larger hydrated salt ions. In this research, we hypothesize that a similar tradeoff exists between membrane permeability and the selectivity between two ions due to steric effects. Namely, in a more permeable membrane, the selectivity between two ions will decrease and vice versa. In the case of ions, however, steric effects are more complex and associated with the dehydration phenomenon. Specifically, relatively high energy barriers are expected for ion permeation that involves partial removal or rearrangement of the water shell when a hydrated ion enters a nanostructure smaller than its hydration shell. Hence, membranes with larger pore size will impose lower energy barriers for ion transport and show high permeability. Therefore, the permeability-(ion-ion) selectivity trade-off can be investigated using membranes with systematically different pore size, where all other properties remain constant. To test our hypothesis, we will use a systematically set of membranes treated by different concentration of hypochlorite, as the aromatic polyamide layer is sensitive to the chlorine species; thus, the chlorination will hydrolyze the C-N bond, making the membrane more permeable and decreasing salt rejection. In general, chlorination, which leads to the amide bond hydrolysis, is more effective at high pH. Therefore, in our experiment, we placed the commercial SW30 RO membrane into 0 ppm, 1200 ppm, and 2400 ppm hypochlorite solution at pH 9 to make the membrane more porous for further investigation. Membrane coupons are immersed in beakers which are wrapped with aluminum foil containing the NaClO solution and are consistently shaken at room temperature overnight. After the chlorination of the membrane, the laboratory-scale high-pressure crossflow filtration system is used to measure the water permeability and ion rejection of untreated and chlorinated membranes for a mixed salt solution. The gravimetric approach is used to measure the permeate water flux and ion chromatography is used to measure and calculate ion rejection and selectivity. Our preliminary results support our hypothesis, showing that in a more permeable membrane, the ion-ion selectivity decreases (Figure 1).

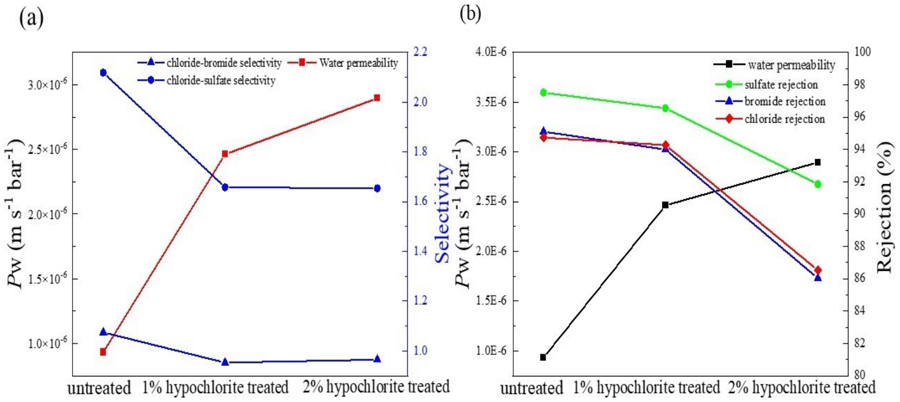


Figure 1: (a) Ion selectivity and water permeability for different treated membranes (b) Ion rejection and water permeability for different treated membranes. As the concentration of hypochlorite increases, membranes become more open; thus, the rejection of anions decreases and water permeability increases. Notably, as water permeability increases, the decrease in the rejection of divalent anions is greater than that of monovalent anions, resulting in reduced monovalent-divalent selectivity.

Nitric Acid-Treated Carbon Felt as a Cathode for Generation of Hydroxyl Radicals via Electro Fenton for Water Treatment

Yarden Maor and Daniel Mandler

Organic micropollutants present at deficient concentrations (ppt to ppb) in water can negatively affect living organisms. This project aims to degrade micropollutants from recycled water via the electro-Fenton process. In this process, oxygen is reduced to hydrogen peroxide (H_2O_2) and further reduced to hydroxyl radicals (OH). The latter is a strong oxidizing agent that can efficiently oxidize a range of organic molecules and, in some cases, result in complete mineralization. OH radicals are detected by fluorometry upon reaction with terephthalic acid (TPA) to give 2-hydroxyterephthalic acid (HOTPA).

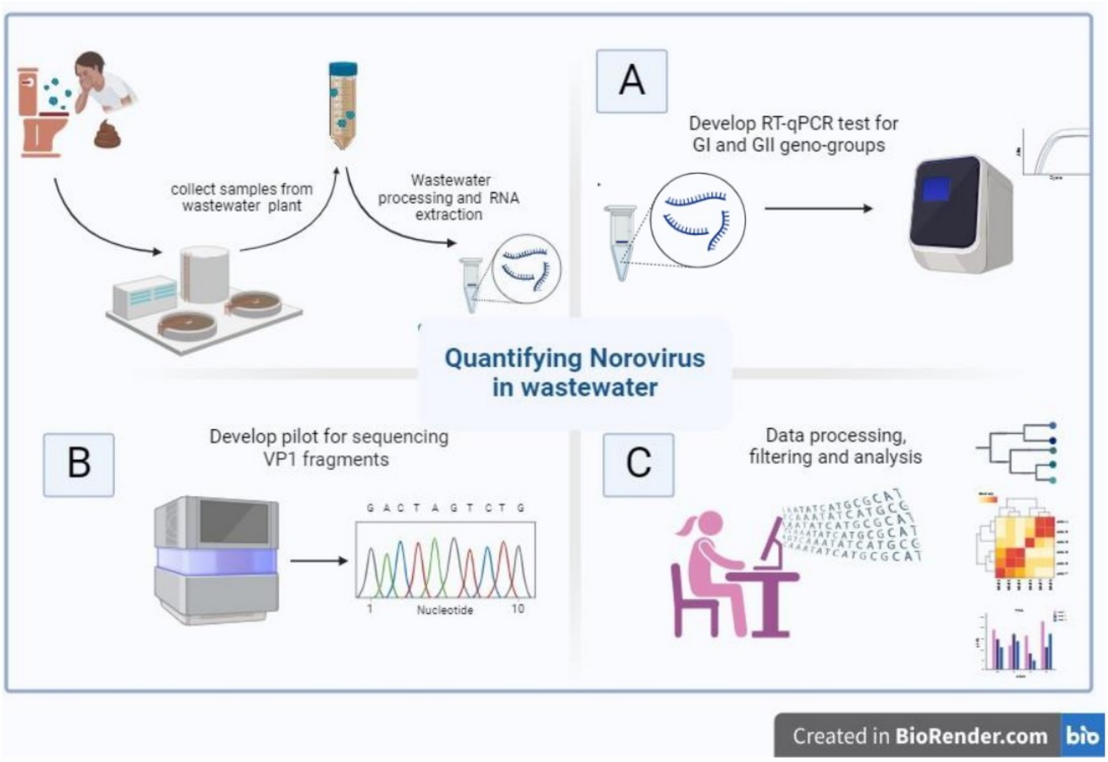
We are currently examining the electrochemical formation of OH radicals and H_2O_2 in artificial drinking water (containing $CaCl_2$ and $NaHCO_3$). An H-shaped three-electrode static electrochemical cell was assembled where the cathode, our working electrode, is made of carbon felt (CF). The CF was thermally treated with nitric acid to remove heavy metals. We obtain high concentrations and faradaic efficiencies for H_2O_2 and OH generation with the treated CF. Our goal is to find efficient heterogeneous catalysts that will be attached to our CF cathode and increase the ratio between the OH to H_2O_2 formation.

Norovirus Dynamics in Israel through the Lens of Wastewater-Based Epidemiology

Tal Maoz, Neta Zuckerman, Itay Bar-Or, and Yaniv Lustig

Norovirus is a leading cause of acute gastroenteritis transmitted via the fecal-oral route, particularly affecting young children. Norovirus has ten different genogroups, but only GI, GII, and GIV are human pathogens. Noroviruses are responsible for up to 200,000 deaths annually and contribute significantly to the global economic burden.

Noroviruses are highly resistant and can survive in a variety of environmental conditions. Studies in various countries indicate a seasonal pattern in virus outbreaks, a phenomenon that remains untested in Israel. Because most infected individuals do not seek hospital care, clinical epidemiological surveillance is ineffective. Therefore, monitoring norovirus in wastewater can provide insight into its spread across different regions. As there is no norovirus monitoring in Israel despite its importance, we developed an applied test for monitoring norovirus in wastewater in Israel. We examined norovirus prevalence in 13 sampling areas in 2022, these samples past processing and RNA extraction and stored in -80˚. These sites represent various demographic and environmental regions which can help us understand the dynamics and the virus strains circulation in Israel. Norovirus monitoring can assist decision makers in promoting better hygiene and social isolation measures within targeted communities when necessary. Furthermore, a several vaccines are in development, Understanding the seasonal and geographic patterns is important for the potential of the vaccine, as is the timing of the vaccine administration.

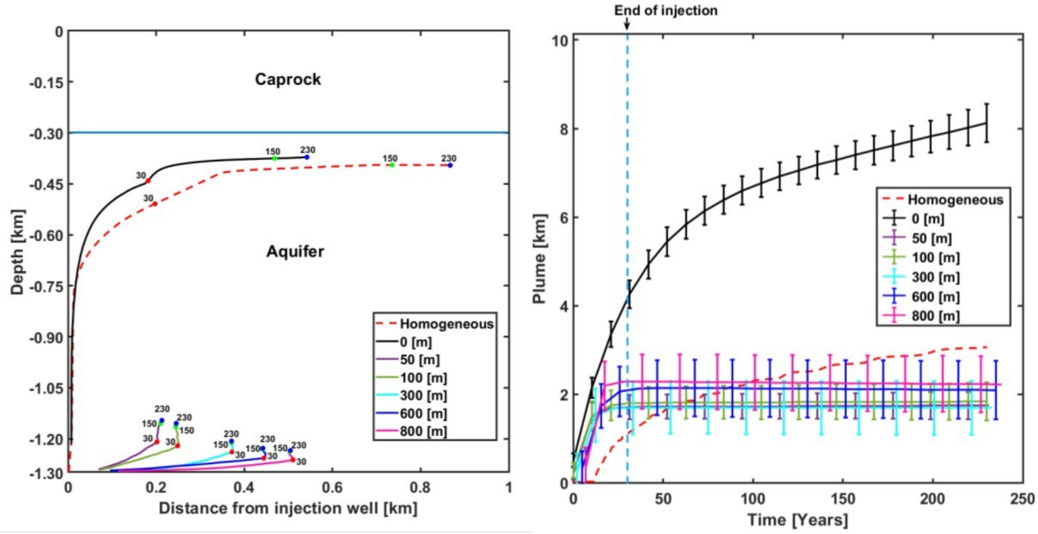


Numerical Analysis of CO_2 Migration and Trapping in the Heterogeneous Jurassic Saline Aquifer, the Negev Desert, Israel

Prince Kumar, Evyatar Cohen, Ran Holtzman, Ran Calvo, and Ravid Rosenzweig

The sequestration of CO_2 in saline aquifers represents a viable strategy for mitigating atmospheric CO_2 emissions. Many studies show that CO_2 storage efficiency and plume movement are significantly influenced by aquifer heterogeneity, including variations in permeability, porosity, and stratigraphy. However, the influence of permeability heterogeneity across various correlation lengths with multiple independent realizations and the role of horizontal injection wells in CO_2 storage remains largely unexplored. Our study investigates numerically the migration and trapping of injected CO_2 into a 2D heterogeneous model, using properties of the Jurassic aquifer of the Negev Desert, Israel. We consider uncorrelated and spatially-correlated heterogeneity in permeability and capillary pressure-saturation relationships, with correlation lengths of 50, 100, 300, 600, and 800 m, averaging over 15 realizations for each length. The simulated scenario is 30 years of supercritical CO_2 injection at a constant rate through a horizontal well placed at the bottom of the aquifer, examining spreading and trapping over a period of 200 years after injection stopped. We used the TOUGH2 reactive flow simulator with the ECO2N equation of state module.

We found that spatially-correlated structural heterogeneity inhibits CO_2 spreading and leakage into the caprock. In all cases, no mobile CO_2 is found in the caprock at the end of the simulation. In the uncorrelated (random) heterogeneity or homogeneous cases, where the center of mass of the CO_2 plume reaches the caprock negligible amounts of residually-trapped and dissolved CO_2 are found in the caprock plumes generate irregular shapes and reside at the aquifer's bottom, thus improving storage safety by limiting CO_2 penetration into the sealing layers.



(a) (b)

Figure 1: a) Evolution of CO2 plume center of mass over time (after 30, 150 and 230 years); b) Horizontal extent of the CO2 plume over time, comparing homogeneous, uncorrelated (random disorder, correlation length = 0) and correlated cases (correlation length of 50, 100, 300, 600 and 800 m).

Ozonation as an Effective Pre-treatment for Enhancing the Biodegradation of Membranes

Manohara Halanur, **Barak Helpern**, Vered Cohen-Yaniv, Ofir A. Menashe, Cliff Shachar, and Hadas Mamane

The widespread use of polymer membranes poses emerging environmental concerns, necessitating sustainable alternatives beyond land disposal. While biodegradation offers a green solution, its time-consuming nature prompts exploration of more efficient techniques. Present study investigated the use of low-dose ozonation as a pre-treatment before biodegradation for the demineralization of polymer membranes. Initially, ozonated membranes were characterized using various analytical techniques such as scanning electron microscopy (SEM), X-ray diffraction spectroscopy (XRD), surface zeta potential and mechanical strength analysis to examine changes in their physio-chemical properties. These changes suggest a disruption in the structure of complex polymer compounds and reduced mechanical strength, making them more biocompatible. Post ozonation, biodegradation was carried out using the commonly used microorganisms such as fungi *Trametes versicolor* and bacterium *Escherichia coli* MG1655 in anaerobic conditions. Complete degradation in cellulose acetate (CA) and polycaprolactone (PCL) based mixed matrix membranes, consumed 6.38 g ozone/gmem.L during ozonation, followed by fungi-assisted biodegradation within 30 days. The combined process resulted in 39.4±2.8% degradation with E. coli MG1655-assisted biodegradation. This study highlights the effectiveness of low-dose ozonation followed by biodegradation as an eco-friendly, scalable with minimal environmental impacts approach for polymer membranes demineralization.

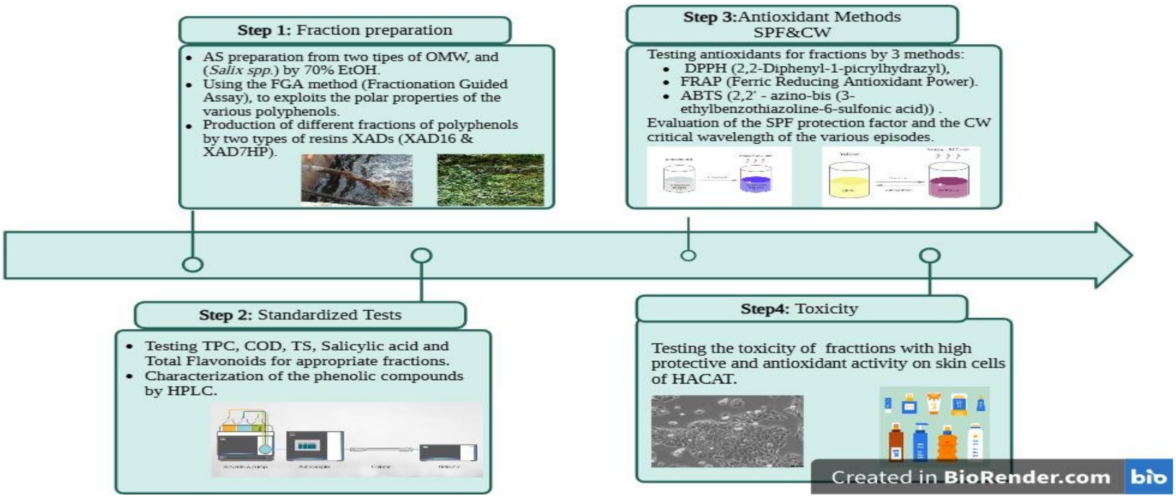
Polyphenolic Fractions From Olive Mill Wastewater and Willow Plants with High Sun Protection Factor to Protect Skin Cells From UV

Adala Ghadira, Manal Haj-Zaroubib, and Hassan Azaizeha

Olive mill wastewater (OMW) contains a high concentration of polyphenols, up to 30 g/L, which are known for their natural antioxidant, antibacterial, antiviral, and antifungal properties. Despite the environmental challenges posed by OMW, its polyphenolic compounds hold significant value for medical and cosmetic applications. Willow (Salix spp.) is also valued for its medicinal properties, primarily due to salicin—an anti-inflammatory compound and precursor of aspirin—as well as other phenolic and antioxidant compounds. Secondary metabolites in willows are primarily composed of phenols and phenolic glycosides. This study aims to extract polyphenolic fractions from OMW and willow foliage to evaluate their potential in sun protection formulations, leveraging their high polyphenolic and antioxidant content.

Polyphenolic fractions were extracted from OMW and willow foliage using chemical and physical methods designed to enhance sun protection efficacy. Chemical extraction employed organic solvents of varying polarity, while physical extraction utilized XAD7HP and XAD16 resins. The sun protection factor (SPF), critical wavelength (CW), total polyphenol content, and sugar content of the extracts were assessed. Additionally, phenolic profiling and quantification were conducted using HPLC. Antioxidant capacity was measured via DPPH, ABTS, and FRAP assays, and toxicity was evaluated on HaCaT skin cells using the MTS assay.

Preliminary results revealed antioxidant activity in OMW fractions, with a reduction in polyphenol concentration in less polar fractions, indicating selective extraction based on solvent polarity. Willow foliage extracts demonstrated high polyphenol and salicylic acid content, potent antioxidant activity, and elevated SPF and CW values. Combining OMW fractions with willow foliage extracts could result in an economical, natural organic formulation for protecting skin cells from UV radiation.



Step 1: Fraction preparation

- AS preparation from two tipes of OMW, and (*Salix spp.*) by 70% EtOH.
- Using the FGA method (Fractionation Guided Assay), to exploits the polar properties of the various polyphenols.
- Production of different fractions of polyphenols by two types of resins XADs (XAD16 & XAD7HP).

Step 2: Standardized Tests

- Testing TPC, COD, TS, Salicylic acid and Total Flavonoids for appropriate fractions.
- Characterization of the phenolic compounds by HPLC.

Step 3: Antioxidant Methods SPF&CW

Testing antioxidants for fractions by 3 methods:

- DPPH (2,2-Diphenyl-1-picrylhydrazyl),
- FRAP (Ferric Reducing Antioxidant Power).
- ABTS (2,2' - azino-bis (3-ethylbenzothiazoline-6-sulfonic acid)) .

Evaluation of the SPF protection factor and the CW critical wavelength of the various episodes.

Step4: Toxicity

Testing the toxicity of fracttions with high protective and antioxidant activity on skin cells of HACAT.

Studying the Effect of Salt Ions Introduced during Synthesis of Nanofiltration Membranes on the Charge and Pore Structure of the Membranes

Noa Bachinsky

Nanofiltration (NF) membranes are essential in water treatment due to their ability to selectively filter ions and small molecules, thereby enhancing water quality. The performance of NF membranes is assessed by its capacity to reject unwanted solutes, while allowing high permeability for water and other desired molecules. The pore size of NF membranes is relatively larger compared to that in reverse osmosis membranes, enabling the separation of particles through mechanisms like size and Donnan (charge) exclusion. For example, NF membranes can effectively separate monovalent ions from divalent ions based on differences of size and charge. However, achieving selectivity between ions of similar size and valence remains challenging. Developing membranes that can distinguish between ions of the same valency would significantly advance specialized water treatment processes and resource recovery technologies. The active polyamide layer of NF membranes is usually synthesized by the interfacial polymerization (IP) technique. IP is a chemical reaction that occurs at the interface between two immiscible phases usually between a water and an organic phase, where two monomers react to form an ultra-thin polymer layer on a porous ultrafiltration support. IP features complex reaction mechanisms with limited control, influenced by factors like monomer concentration, polymerization time, temperature, and additives.

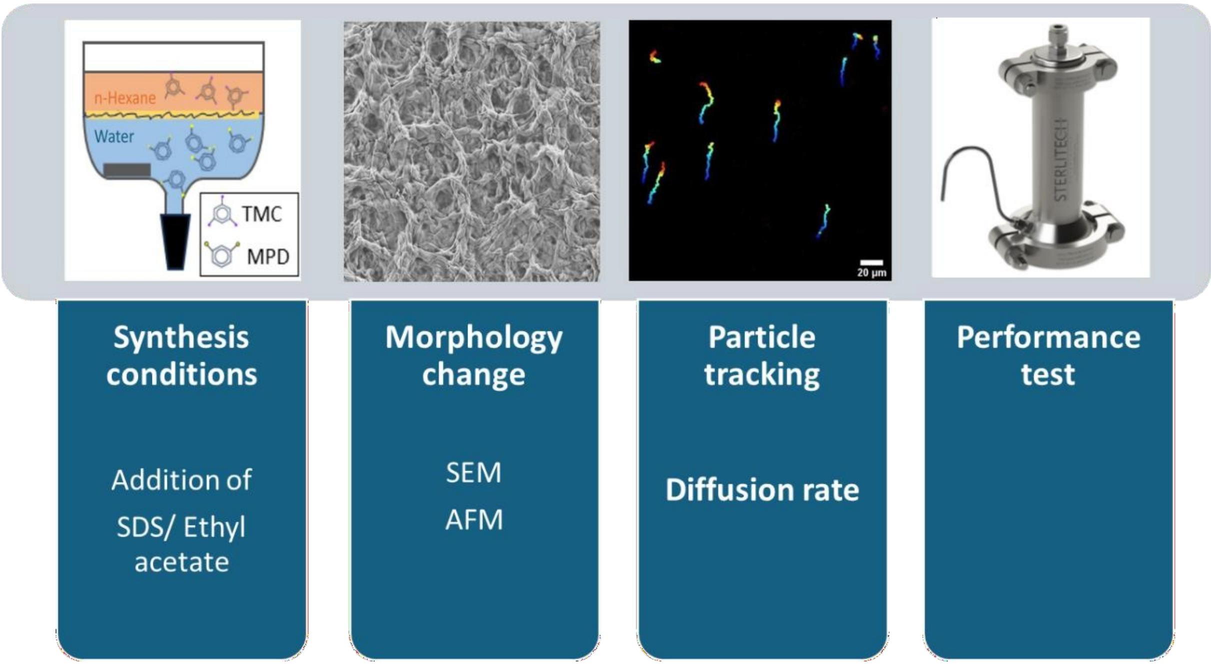
Considering the complexity of this process and the various influencing factors, there is a need for a deeper understanding of the mechanisms that govern solute transport in the nano and sub-nano pores of these membranes to develop membranes with precise selectivity. This study aims to investigate how the incorporation of inorganic salts, such as LiCl and $CaCl_2$, during membrane synthesis actively modifies surface charge and pore structure. Through a combination of membrane synthesis with different salts, zeta potential analysis, and nanofiltration experiments, this research aims to better understand the mechanisms of molecular membrane formation, with the purpose of developing membranes that exhibit enhanced selectivity for water treatment applications. Specifically, we hypothesize that metal salt ions, such as lithium and calcium, influence the surface charge and pore structure of the polyamide layer; this effect is attributed to the high charge density of lithium ions and the cross-linking potential of calcium ions. Our preliminary zeta potential results indicate that, when synthesizing membranes at varying concentrations of LiCl, the functional groups on the membranes exhibit trends distinct from those of the control membrane. Specifically, while low concentrations of LiCl did not produce a consistent effect on the functional groups, higher concentrations led to a more pronounced negative surface charge. As a next step, we seek to understand the effect of calcium on membrane structure with the overarching goal to deepen our understanding of chemistry and performance of membranes fabricated in the presence of salt.

Synthesis-Morphology-Performance of polyamide membranes with controlled reaction conditions

Noa Ram, Adi Ben-Zvi, Guy Ramen, Tamar Segal-Peretz

The research goal is to investigate a specific physical attribute that influences the interfacial polymerization (IP) reaction and examine its impact on membrane morphology and performance. m-phenylene diamine (MPD) diffusion is a key factor in the IP reaction, primarily controlled by the rate at which MPD diffuses into the organic phase. To isolate the effect of MPD diffusion, we selected reaction conditions where the interfacial tension was identical across both systems. This ensured that the susceptibility to film deformation and the energy barrier for MPD transfer to the organic phase were similar. In one system, we used a co-solvent, and in another, a surfactant.

The co-solvent is known to increase MPD diffusion into the organic phase and reduce interfacial. A surfactant also reduces interfacial tension and enhances MPD partitioning into the organic phase. By adjusting the amount of these additives to equalize the interfacial tension (thus ensuring equal susceptibility to instability), the effect of MPD diffusion on the reaction-specifically the increased polymerization rate-becomes evident and is amplified in the system containing the co-solvent, The polyamide membranes were fabricated using the SFIP technique to eliminate any destabilizing effects of the support layer on interfacial polymerization. The diffusion rate of MPD was measured by spectrophotometer and is demonstrated by the motion of fluorescent microparticles in the aqueous phase, tracked in real-time using confocal microscopy. Additionally, the resultant film morphology is characterized using scanning electron microscopy (SEM) and atomic force microscopy (AFM). The membranes overgo performance tests in a dead-end cell. This study focuses on isolating the impact of MPD diffusion on the resulting film morphology and membrane performance, aiming to better understand the synthesis-morphology-performance relationship in polyamide membranes.



The Effect of Alternating Electric Fields on Membrane Colloidal Fouling

Elina Yachnin, D. Jassby, T. Segal-Peretz, and G. Z. Ramon

Colloidal fouling, where micro particulates are deposited on the membrane surface, often leads to reduced membrane performance and increased operational costs. Previous studies have shown that electric fields (EF) can reduce foulant accumulation near membrane-electrodes. However, the effect of alternating (AC) EF on colloidal fouling is not very well understood and received far less attention. We hypothesize that diffusivity mismatch between ions of asymmetric electrolytes leads to the formation of long-range electric fields under AC EF, which prevents particles from reaching the membrane. This phenomenon can be used as a membrane fouling mitigation technique.

In the present study, we investigated the effect of AC EF on colloidal deposition near an electrically conductive ultrafiltration membrane, in-situ, using confocal microscopy. Carboxylated polystyrene microparticles and a diffusivity-asymmetric electrolyte (NaOH) were used as a model system, where hydroxide ions have higher diffusivity than sodium.

The results, presented in Fig. 1, show that the application of AC EF reduced colloidal deposition and, importantly, was affected by the AC frequency. We attribute this behavior to a negative long-range EF that formed due to negative charge excess of the highly diffusive hydroxide ions. These EFs repelled the negatively charged microparticles from the membrane surface. Interestingly, a frequency threshold for deposition mitigation was observed. Frequencies above the threshold may lead to higher hydroxide ion velocities and smaller displacements that eliminate the negative EF and increase colloidal deposition. This research provides insights into the ability and mechanism of AC EFs to mitigate colloidal fouling on ultrafiltration membranes.

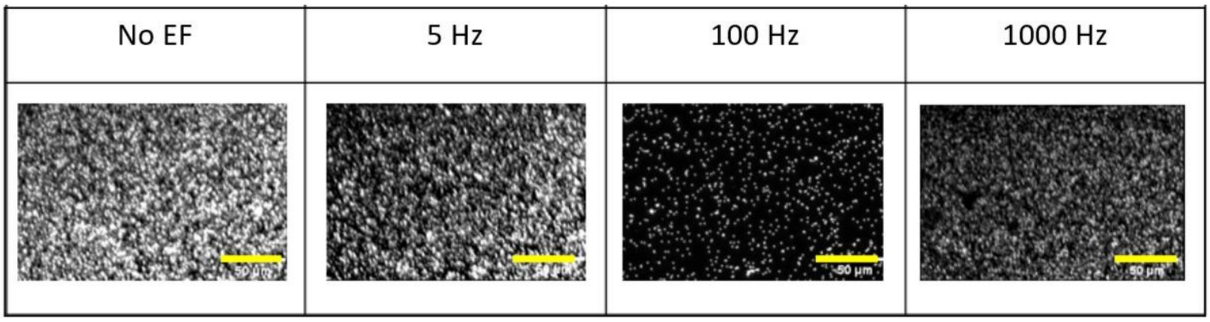


Figure 1: The effect of alternating electric field on colloidal deposition on a carbon nanotube–polyvinyl alcohol composite ultrafiltration membrane surface. Snapshots of the membrane surface after 60 mins of filtration using a suspension of 1mM NaOH and 1 micron fluorescent beads. The water flux of the membranes in all experiments was 50 liters per square meter per hour (LMH). Alternating potential with amplitude of 1V was applied. The frequency of the applied electric field was varied and compared with an identical experiment where no electric field was applied.

The Effect of the Organic Plasticizer TXIB on the Coral *Stylophora pistillata*

Mai Am-Shalom, Rotem Kanfy-Weinberger, Esti Winter, and Ariel Kushmaro

Many organic pollutants have been reported entering the Gulf of Aqaba (GoA), possibly affecting reef health. To assess possible effects of common micro pollutants we sampled pore water in a number of sites and carried out analyses using gas chromatography-mass spectrometry. (GC-MS) analysis revealed a number of contaminants including 2-ethylhexanol, 2,4-dimethylbenzaldehyde, and 2,2,4-Trimethyl-1,3-pentadiol-diisobutyrate (TXIB) a plasticizer, were frequently found in the GoA. This lead to the question does TXIB affect the local fauna. We exposed planulae of the common coral *Stylophora pistillata*, under controlled laboratory conditions, to assess possible effects of exposure to TXIB.. Ten planulae were maintained in glass petri-dishes each with different concentrations (0.01, 0.1, 1 ppm) of TXIB in AFSW (Artificial Filtered Sea Water), at 19°C. Due to poor solubility in seawater, TXIB was solubilized in DMSO. An additional ten planulae were maintained in AFSW with DMSO as control at the same temperature. Three days after exposure, effects were assessed using fluorescence and transmission electron microscopy (TEM). Effects included bleaching degradation of chloroplasts, notably the thylakoid membranes, indicates oxidative stress and metabolic dysfunction within coral cells. This research contributes to understanding the risks posed by SGD pollutants and provides valuable insights to guide future conservation efforts in marine environments experiencing similar stressors from human activities.

Validation and Improvement of Microplastic Image-Based Quantification Method Based on Nile Red Staining

Ofir Shorshy, Iris Zohar, Shai Arnon, and Emily Tran

The rapid and efficient identification and quantification of microplastic particles in the environment is essential for assessing the extent of environmental exposure to plastics. However, there is no single standard method that is universally accepted for microplastic quantification. Previous studies have used photographic methods and fluorescent dyes to mark microplastics which involve filtration, photography, and analysis using image processing software. However, this method has limitations and lacks validation against stereomicroscopic techniques in literature. During the image analysis stage, significant errors may occur due to the aggregation of particles interpreted as a single particle in the analysis, while in reality, multiple adjacent or overlapping particles are present. This error can lead to underestimation of the quantity of plastic particles and a reduced understanding of the scale of the problem and its mitigation. This work aims to validate existing methods for microplastic quantification and characterization of particle size distribution using stereomicroscopy with ImageJ software. In particular, the issue of particle coincidence will be demonstrated. Additionally, the use of image-stitching software will be presented as a solution to overcome the limitations of a small frame size in stereomicroscopic imaging of filters and to enable comparison to whole-filter imaging with a camera. We use synthetic polyethylene particles with non-uniform shape, texture, and size to simulate microplastics found in the environment. First, the particles are marked with Nile Red dye, serially diluted, and dispersed on a glass fiber filter. The filter is photographed using both a DSLR camera and a stereomicroscope under UV light. The resulting images are analyzed using ImageJ software, employing either the MP-VAT code or manual thresholding and the MP-ACT code. Additionally, the images obtained from the stereomicroscope are manually counted and used for validating the processed images. Preliminary results have already shown a decline in the ability of image processing codes to accurately quantify particles as their concentration increases, due to aggregation. The aim of this study is to validate existing image processing codes for microplastic analysis, illustrate their limitations and demonstrate the method's effectiveness in a controlled laboratory column experiment.

Visualizing pH Spreading in Miscible Displacement through Porous Media

Tongzhou Gan, Ludmila Abezgauz, Yaniv Edery

pH-induced reactive transport among miscible phases in porous environments is pivotal in carbon capture and storage (CCS) applications, especially in the carbon sequestration process, where the mixing process among the miscible phases affects the pH transport. However, separating the pH migration from the mixing is challenging due to the pore-scale heterogeneities and limited understanding of the role of pH in the mixing and displacement processes within porous media. In this study, we designed two parallel experiments. In both experiments, we displaced weak acidic water-glycerol solution with basic water solution in porous media. The mixing experiment used Rhodamine 6G as a conservative tracer to visualize the mixing and displacement process, which allowed us to derive a theoretical pH pattern based solely on mixing degree. The second experiment employed pH-sensitive fluorescent dye Pyranine to directly visualize the actual pH migration pattern (Figure 1). Both processes were captured using confocal microscopy for detailed visualization and analysis. By comparing these two patterns, we could identify the special behavior of pH transport during the miscible displacement.

Our experimental results reveal that pH propagation consistently precedes the mixing and displacement processes. Specifically, by comparing the pore volumes (PV) required to reach the 95% displaced breakthrough points, we observed that the actual pH pattern arrives earlier than the predicted pH pattern derived from the mixing process. These insights enhance our understanding of reactive transport in porous media and provide crucial implications for modeling complex subsurface processes in both natural and industrial applications, particularly in scenarios where pH-dependent reactions play a dominant role in mass transfer and fluid displacement.

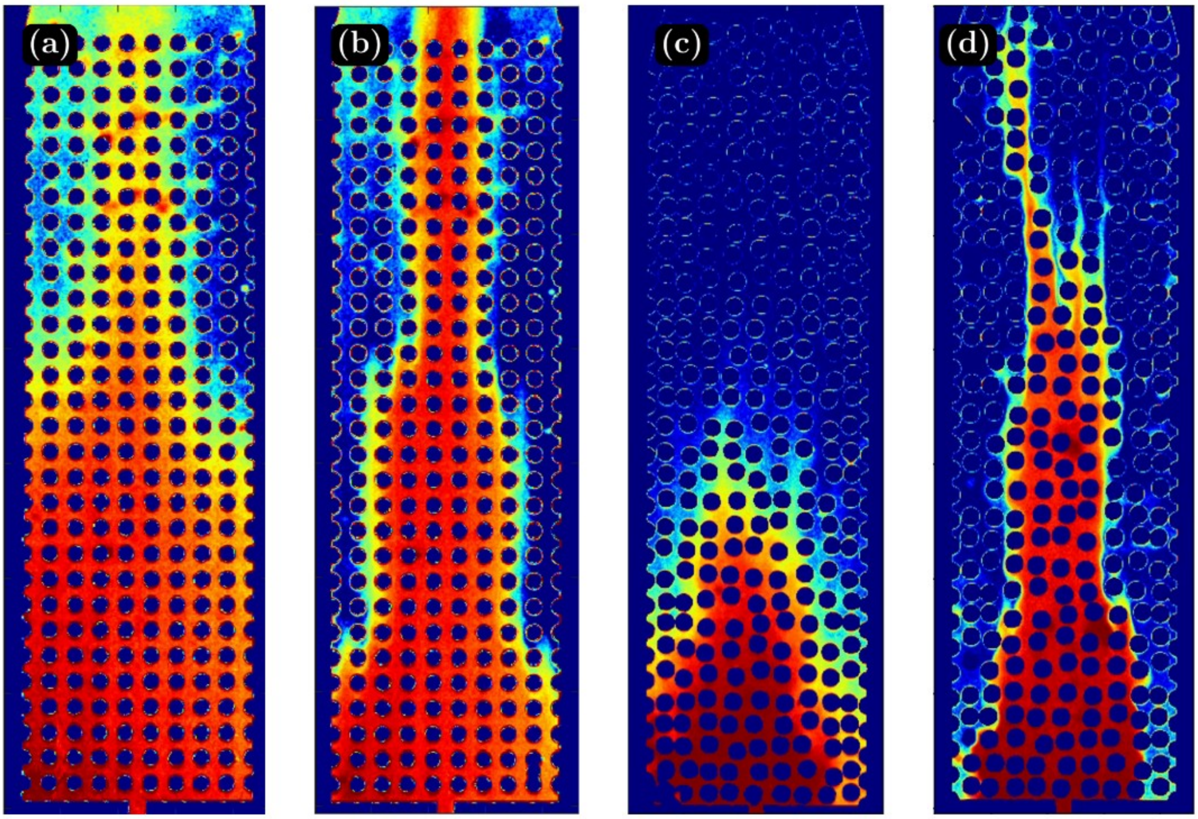


Figure 1: Actual pH propagation patterns: (a) low flow rate in homogeneous cell, (b) high flow rate in homogeneous cell, (c) low flow rate in heterogeneous cell, and (d) high flow rate in heterogeneous cell. Red indicates high pH and blue indicates low pH.

VOCs Profile in Marine Surface Microlayer and Its Spatiotemporal Variations

Aviya Ziner, Irena Kuzmenkov, and Yael Dubowski

The marine surface microlayer (SML) is distinct from subsurface water by physical, chemical and biological properties. Due to its location at the air-water interface, SML regulates mass transfer between ocean and overlying atmosphere. Any alteration in such fluxes can have significant impact considering that most of the globe's surface is covered by oceans. Marine emissions of volatile and semi-volatile organic compounds (VOCs/SVOCs) are of special interests due to their potential role in aerosol formation and resulting impact on the Earth's radiation balance. Yet, our current knowledge regarding these complex fluxes is highly lacking. SML sampling is technically challenging, especially in high seas and when using large research vessels. These limitations may introduce biases in the available database and resulting scientific conclusions.

Here we present a new approach to study SML chemical composition, using water sub-sampling combined with application of membrane filter followed by SPME-GC-MS analysis. The new method allows quantitative analysis of VOCs/SVOCs profile of the SML, with higher efficiency and accuracy than traditional methods, as well as the ability to sample in variety of sea conditions. Applying this new methodology in field campaigns conducted near Herzliya and in Haifa-Bay revealed clear spatial and temporal variations in the chemical composition of the SML, both on diurnal and seasonal scales. The obtained data indicates that SML composition is affected by both biological and anthropogenic sources. Furthermore, complimentary atmospheric VOCs measurements in the marine boundary layer suggests that its is affected by the chemical composition of the SML.

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