Zuckerberg Institute for Water Research

אוניברסיטת בן-גוריון בנגב
Ben-Gurion University of the Negev

The Jacob Blaustein Institutes
for Desert Research

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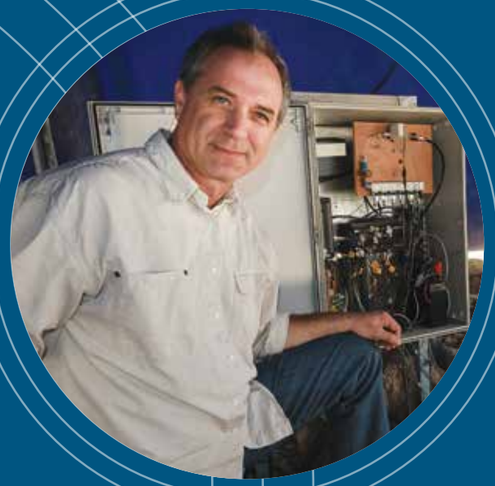
Our Mission

Water is vital to life. With it, we thrive; without it, we cannot prosper. Lack of water hinders human potential and brings the desert closer. Even abundant water is sometimes impure and dangerous. Dwindling water supplies and deteriorating water quality particularly impede the sustainable development of drylands and the well-being of their growing populations. Yet scarce water can be sustainably harnessed and impure water improved.

At the Zuckerberg Institute for Water Research, we carry out cutting-edge interdisciplinary research in hydrology and water engineering, and are leaders in graduate education in water sciences. Our guiding mission is the improvement of human well-being, based on advanced scientific technologies, innovation, and the sound and sustainable management of water resources in drylands and elsewhere.

Message from the Institute Director



The Zuckerberg Institute for Water Research is a vibrant young research institute with a true mission. Driven by a sense of urgency, our faculty members, technical staff and graduate students are engaged in fascinating and crucial avenues of research that will have implications for all humanity; striving to further understand fundamental water-related issues, meeting head-on the challenges of improving and better managing our deteriorating water resources, and solving practical problems through collaboration between science and industry.

Our faculty members are involved in projects around the globe, conducting cutting-edge multidisciplinary science and providing practical solutions that range from the local - to rural communities in Africa and farmers in California - to the global - to the transnational industrial companies. Just as fundamental to our ethos and mission is the education of the next generation of water scientists and engineers through our unique graduate program in Hydrology and Water Quality.

Noam Weisbrod

Prof. Noam Weisbrod, Director

About the Zuckerberg Institute for Water Research

The Zuckerberg Institute for Water Research was founded in January 2002 within the Jacob Blaustein Institutes for Desert Research at the Sede Boqer Campus of Ben-Gurion University of the Negev.

The Institute's scientists use experimental and theoretical approaches to conduct fundamental research related to water. This research encompasses nanoscience and pore-scale phenomena, and extends to pilot projects and field studies. The Institute places particular emphasis on the research and development of water resources in the drylands, in the interest of both the present and the future of the entire region. Our interdisciplinary team includes hydrologists, soil scientists, geologists, chemists, microbiologists, and engineers. The result is a unique scientific environment facilitating the investigation of environmental challenges and the development of engineering solutions for water-related problems.

As a young and dynamic institute, our research topics constantly evolve as the state of the field and the population's needs change. At present, our research areas include groundwater contamination, water engineering, environmental hydrology, hydrogeology, hydrobiology, hydrochemistry, vadose zone processes, wastewater treatment, desalination, the link between water and energy, and water resource economics and management, aimed at solving water-related problems at various scales and developing water-related technologies.

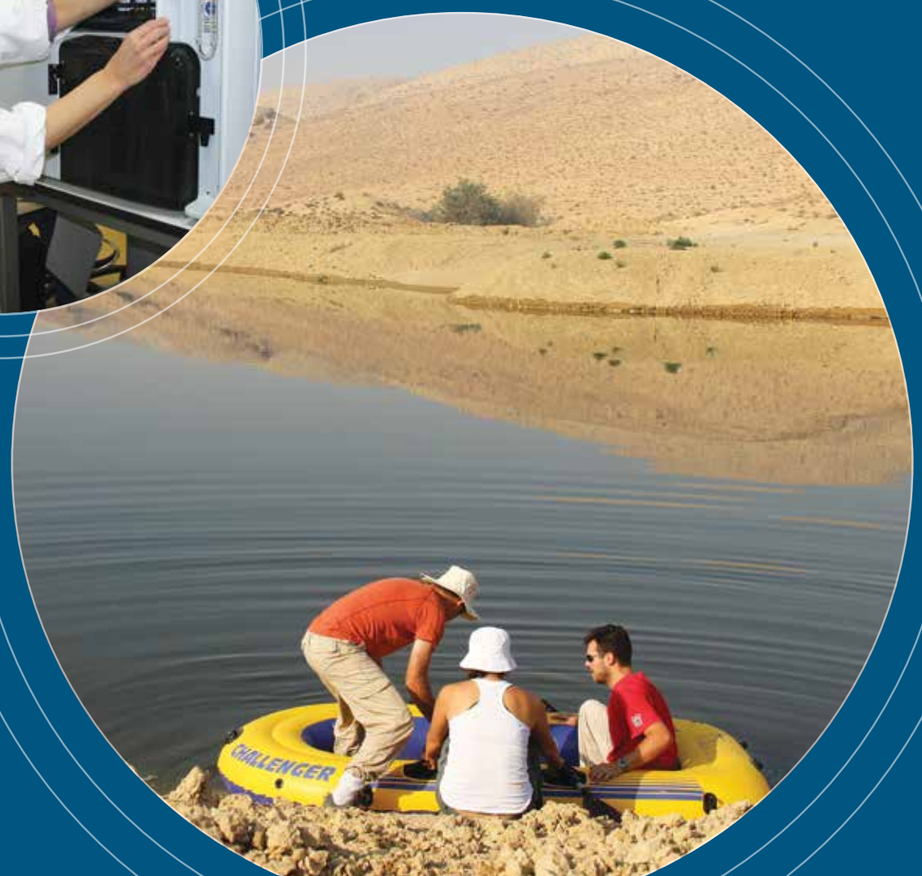
Members of the Zuckerberg Institute are involved in research projects, in Israel and abroad, in which basic and applied scientific theories and practices are explored and implemented. The Institute has many pilot- and field-scale facilities, including a membrane-based pilot plant for desalination and water treatment, which has been used to develop processes that are currently implemented in industrial settings around the world. These same facilities are used in training our students in the operation of advanced desalination technologies.

Two departments operate within the Zuckerberg Institute for Water Research:

- The Department of Environmental Hydrology and Microbiology
- The Department of Desalination and Water Treatment

The Institute's unique international graduate program in Hydrology and Water Quality helps meet the pressing need for hydrologists, water engineers and water planners in Israel, the Middle East and around the globe. Our graduates go on to take key positions in their countries' policy-making bodies and in the water desalination and treatment industry.

Department of Environmental Hydrology and Microbiology



The multidisciplinary faculty members of the Department of Environmental Hydrology and Microbiology include hydrologists, hydrogeologists, hydrobiologists, hydrochemists and microbiologists, all working to develop a better understanding of hydrological systems in general, and in arid environments in particular.

Our researchers investigate water resources in the field and laboratory, as well as at theoretical-modeling levels. They pursue research into the identification, quantification and quality improvement of water and focus particularly on water resources in desert basins with scarce hydrogeological information, with a specific emphasis on the development of methods for water treatment, reclamation and remediation.

Current research interests in the department include

- Identification and quantification of the sources of groundwater recharge
- Calculation and quantification of subsurface flow and transport mechanisms
- Remediation of water and soils using biotechnology
- Transport of contaminants to and within groundwater reservoirs
- Understanding of the ecology of flow systems in aquifers and underground water reservoirs
- Enhancement of groundwater collection (managed aquifer recharge and soil aquifer treatment)
- Management of regional and international transboundary groundwater reservoirs
- Development of biological treatments for industrial and domestic effluents
- Optimization of water production and transfer systems
- Upscaling of laboratory-scale treatment processes
- Exploration of the role of climate change in the hydrological cycle
- Exploration of the riparian zone and the biogeochemical processes in it
- Development of decentralized solutions for water and wastewater problems in remote communities

Future directions in research

Studies in which hydrologists, microbiologists and engineers work together to solve complex multidisciplinary problems are an important emerging avenue of research in the department. Additional future topics of research by our faculty include:

- Development of new solutions for remediating soils and groundwater, especially in saline and arid environments
- Enhancement of the understanding of the impact of climate change on evaporation and gas emission processes
- Development of decentralized systems for water treatment combined with energy production
- Development of new tools for vadose zone monitoring
- Continuation of work in improving water quality and addressing water scarcity in rural areas in developing countries
- Improvement of the understanding of biogeochemical processes in surface and subsurface water

Research in the Department of Environmental Hydrology and Microbiology

The Department of Environmental Hydrology and Microbiology has state-of-the-art water and soil chemistry analytical laboratories as well as an isotope laboratory that facilitates the analyses of water and contaminants using various cutting-edge methodologies. The microbiology lab space includes a full microbial culture and the full complement of molecular biology equipment, .

A great deal of the department's research is carried out in the field. The technical staff and students operate a unique workshop, in which they develop and manufacture the tailor-made equipment required for this fieldwork.

In addition, two flumes were recently built in the department laboratories, which simulate river flow with the most current measuring equipment, enabling the exploration of biogeochemical processes occurring at the interface of flowing rivers and the sediments below.

Finally, a first-generation climate-controlled laboratory is being established, enabling studies of the links between climatic conditions, temperature variation, wind speed and other variables, and the hydrological cycle.

Department of Desalination and Water Treatment

The growing population of drylands makes it essential to expand local water supplies. Scientists, technicians, and students in the Department of Desalination and Water Treatment explore high-tech desalination technologies for providing drinking water, as well as water for agricultural and industrial use.

The department's faculty members investigate many aspects of desalination and the treatment of wastewater for reuse.

Current research topics include

- Improvement and development of new membranes for reverse osmosis and nanofiltration in seawater desalination
- Improvement of membranes for various types of wastewater and urban effluents after tertiary treatment
- Development of novel ion-conducting membranes
- Pre-treatment of water for reverse osmosis
- Development of methods to eliminate organic substances from industrial effluents and polluted groundwater
- Study of mechanisms in low/high-pressure desalination systems associated with reverse osmosis and nanofiltration
- Improvement of materials used in reverse osmosis
- Development of management practices and methods to reduce concentrate volume
- Development of new techniques for the reuse of urban effluents
- Improvement of electrodialysis processes for desalination of brackish water and for use in industry

Future directions in research

In addition to the existing traditional membrane processes, the Department of Desalination and Water Treatment is expanding its studies to new processes for water treatment and the remediation of groundwater and industrial streams, including forward osmosis, pervaporation, anaerobic bioreactors, novel air injection methods for organic removal and oxygenation in bioreactors, ion exchange membrane bioreactors, novel methods for removal of scaling and colloidal components from water that is to be desalinated and manipulation of water chemistry to promote boron removal.

Many of these methods will be combined into hybrid processes to improve their efficiency, and will involve collaboration with our colleagues in the Department of Environmental Hydrology and Microbiology at the Institute and across BGU. Since a significant portion of water use is for agriculture, the Department is also working on methods to upgrade groundwater and wastewater for this purpose. A greater effort to do bottom-up design of membrane surfaces, including patterned surfaces, biomimetic membranes and novel surface topologies, will lead to novel membrane properties and new water treatment surfaces that will generate innovative processes for water desalination and water treatment. Understanding of biofouling, colloidal fouling and organic fouling mechanisms will inform the development of both new processes and novel membrane materials. In addition, new in-situ methods are being developed to monitor fouling that could allow earlier, less severe, yet more effective interventions to keep the membrane systems operating smoothly.

The Pilot Plant for Desalination and Water Treatment

The Department of Desalination and Water Treatment operates a pilot plant for desalination and water treatment, which is used to test, simulate and demonstrate, on a semi-industrial scale, various aspects of the processes used in water and wastewater treatment. These include:

- Desalination (seawater, brackish water, wastewater, etc.)
- Upgrading of industrial and municipal wastewater for reuse and recycling
- Minimization of effluents
- Pre-treatment and preparation of difficult-to-treat effluents for downstream treatment processes
- Separation and recovery of valuable components from waste and process streams

The pilot plant is instrumental in investigating and demonstrating solutions and improvements to existing industrial plants, and in assisting in the development of new methods of water treatment. It is also used as a teaching and training facility for our graduate students, as well as for personnel from companies and other institutes involved in water treatment, desalination and effluent treatment. The plant is equipped with test units for carrying out the following operations:

- Reverse osmosis/nanofiltration at high pressure
- Reverse osmosis/nanofiltration at low pressure
- A ZENON ultra-filtration (hollow fiber) unit for simulating membrane biological reactor processes
- Microfiltration
- Ozonation
- Electrodialysis
- Adsorption and ion-exchange
- Wind-assisted intensified evaporation, an innovative evaporation technology
- Sand filtration

Graduate Studies at the Zuckerberg Institute

All faculty at the Zuckerberg Institute for Water Research are members of Ben-Gurion University's academic staff, and teach and supervise graduate students at the Albert Katz International School for Desert Studies, the teaching arm of the Jacob Blaustein Institutes for Desert Research. The Albert Katz International School offers two graduate study programs awarding both M.Sc. and Ph.D. degrees: Desert Studies, and Hydrology and Water Quality.

The unique program in Hydrology and Water Quality was developed at the Zuckerberg Institute in order to meet the increasing global need for hydrologists, water engineers and water planners. The program emphasizes an interdisciplinary approach through the integration of science with engineering. It offers three courses of specializations: Water Resources; Desalination and Water Treatment; and Microbiology and Water Quality.

Course subjects include hydrology, hydrogeology, hydrochemistry, flow dynamics and mechanics, transport of fluids, dissolved minerals and pollutants, environmental microbiology, treatment and recovery of sewage, water resources management, desalination of seawater and brackish water by reverse osmosis and electrodialysis, nanofiltration techniques, treatment of wastewater and effluents, and membrane technology and maintenance. Our courses offer theoretical, technical and practical training; for example, a course addressing rural water development problems includes practical hands-on work in rural villages in Africa.

Faculty members at the Zuckerberg Institute also actively contribute to the graduate program in Desert Studies at the Albert Katz International School for Desert Studies.

Our international program draws students from Israel, North and South America, Asia, Europe and Africa. Many of our graduates have gone on to assume key positions in academia, research institutes, the water treatment and desalination commercial sector, consulting firms, and in policy-making and governmental bodies.

For further information on the graduate program, visit the Albert Katz International School website: http://in.bgu.ac.il/en/akis

Ben-Gurion University of the Negev, founded in 1969, aspires to fulfill the vision of Israel's first Prime Minister, David Ben-Gurion, who believed that Israel's bright scientific future lay in the development of the Negev, Israel's vast southern desert. Today, as it approaches its 50th anniversary, BGU is realizing its mandate to teach, conduct research and drive development in the Negev: some 20,000 students are enrolled in six faculties at its campuses in Beer-Sheva, Sede Boqer and Eilat.

BGU is not only a well-established university in Israel; it has also acquired an international reputation. BGU conducts major world-class research in biotechnology, conversion and inter-religious encounters, cyber security, energy, European politics and society, Hebrew literature, Jewish thought, nanotechnology, neuroscience, robotics, water and agriculture, and much more. Our special commitment to the community means that thousands of students take part in community-oriented activities and special tutoring projects while pursuing academic excellence.

The Jacob Blaustein Institutes for Desert Research are acknowledged leaders in desert studies. Its multidisciplinary approach to research has emerged in response to the lack of science-based responses to the urgent needs of humanity. Desert Studies, as a discipline, is likely to grow into a distinct scientific field in its own right.

In light of the worldwide need for expertise in the study of drylands, BGU and the Blaustein Institutes have established the Albert Katz International School for Desert Studies, which offers a two-year program leading to a master's degree in Desert Studies or in Hydrology, as well as a Ph.D. program. The innovative, multidisciplinary curriculum is structured to provide an integrated approach, offering students exceptional opportunities to pursue a combination of basic and applied research. Students are exposed to a wide range of disciplines that complement their main areas of specialization.

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