MEWAC

Middle East Regional Water Research Cooperation Program

Kick-Off-Meeting, Module B
13 October 2021
Proceedings

SPONSORED BY THE

Federal Ministry of Education and Research

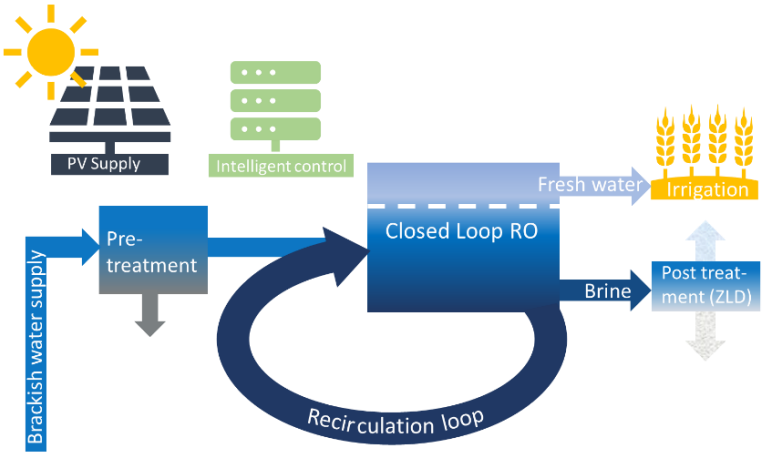
FONA
Research for Sustainability

HighRec - Enhancement of the recovery ratio in brackish water desalination systems for agricultural irrigation

PARTNER INFORMATION

- Fraunhofer Institute for Solar Energy Systems (ISE), Dr.-Ing. Joachim Koschikowski
- Technische Universität Berlin (TUB), Prof. Dr.-Ing. Sven-Uwe Geissen
- inter 3 GmbH - Institut für Ressourcenmanagement (inter3), Dr.-Ing. Shahrooz Mohajeri
- Qatar University (QU), Prof. Dr. Sami Sayadi
- University of Birjand (UBi), Dr. Mohsen Pourreza Bilondi

PROJECT SUMMARY



While in Qatar more than two third of the fresh water is supplied by desalination today, Iran has an increasing number of regions, which seriously suffer from freshwater shortages causing critical implications on the industrial and agricultural sector. General challenges of conventional brackish water desalination technologies are the low recovery ratios, the high energy demand associated with CO_2 emissions, the disposal of produced brines and the very limited resistance to changing raw water compositions. Therefore, the objective of the HighRec project is to develop highly flexible solar driven desalination systems including advanced pretreatment technologies, which enable very high recovery ratios and dynamic adaptation to changing raw water compositions. *Closed Loop Reverse Osmosis (CLRO)* was selected as highly flexible desalination technology. In CLRO the brine is continuously recirculated through the RO module while the salt concentration is increased up to a calculated salinity threshold. Then the brine is discharged. This way of operation already implies a continuous adaptation of the operation pressure and enables the adaptation to very different feed water compositions in combination with high water yields. Different chemical free pre-treatment technologies as e.g. *Electro Dialysis Metathesis (EDM)* and *Capacitive Deionization (CDI)* will be investigated and tested to prevent scaling in the CLRO system. The energy supply will be based on solar PV with minimum battery storage. Technical concepts for zero liquid discharge (ZLD) will be technically and economically evaluated. The project is focusing on two different applications: At Qatar University, brackish water desalination together with reuse of drainage water for hydroponic agriculture will be investigated. At University of Birjand, Iran, fresh water will be produced by brackish water desalination for saffron irrigation. A multi criteria analysis will be conducted to assess the different technical solutions with respect to the local boundary conditions and demands of different sectors versus their techno-economical soundness. A small-scale demonstration system will be built, operated and evaluated at Qatar University first and subsequently at the University of Birjand. Courses conveying the required operational and maintenance skills for technicians and engineering students will be developed in order to create a holistic technology transfer program involving all relevant stakeholders.

FURTHER INFORMATION

- Project website: www.highrec.de (currently under construction)
- Contact: Dr.-Ing. Joachim Koschikowski; E-Mail: joachim.koschikowski@ise.fraunhofer.de

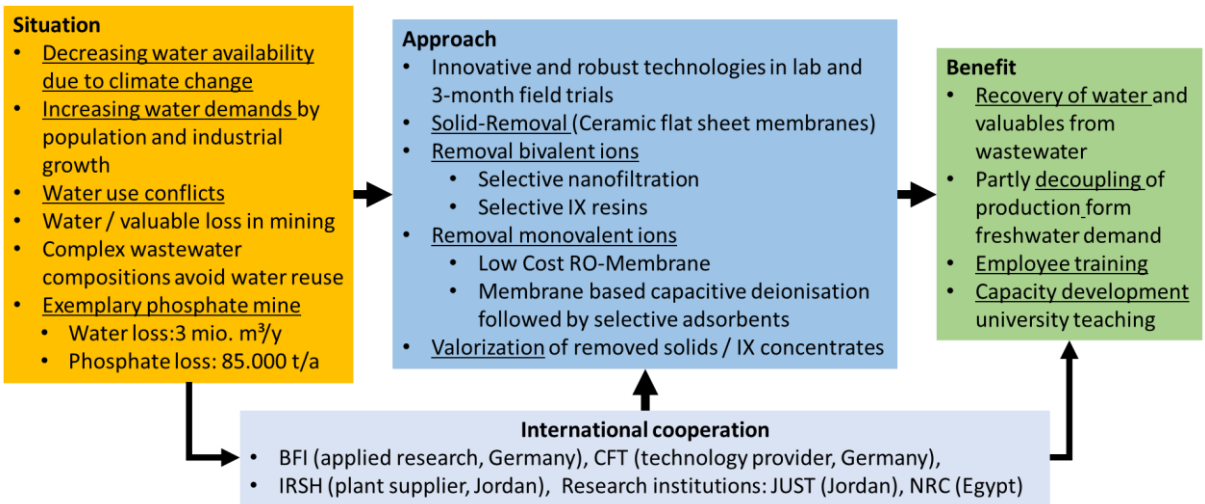
MiningWater - Mining water recovery using innovative technologies for saving fresh water

PARTNER INFORMATION

- VDEh-Betriebsforschungsinstitut GmbH (Coordinator), Germany, Dipl.-Ing. Martin Hubrich, Dr. Matthias Kozariszczuk
- CERAFILTEC Germany GmbH, Germany, Dr. Martin Kaschek, Dr. Miriam Sartor
- Jordan University of Science and Technology, Jordan, Prof. Mohammad Al-Harahsheh
- National Research Center, Egypt, Dr. Heba Abdallah
- Irshaidat Company for Trading & Contracting, Jordan, Mohammed Al-Zawahreh

PROJECT SUMMARY

Limitation of water availability due to global climate change increases in arid regions as Jordan conflicts between drinking water production, agriculture, and industry. Increasing water demands due to growth of population and industry in combination with inadequate cleaning treatment capacities tighten the situation. The complex composition of wastewaters from phosphate mines with corrosive salts, scaling enhancing compounds and fine particles in low µm size avoid a reuse of the waste waters by discharging into tailing ponds – about 3 million m³/a of water and 85.000 tons/a of phosphate for a single mine. The project focusses on wastewater recovery to reduce the freshwater demand and decouple partially the production form the freshwater demand. Approach is the investigation and use of novel robust process techniques in combination with a valorisation of occurring concentrates.



This includes the lab investigation and subsequent a 3-month field trial at a Jordan phosphate mine of energy saving separation of micrometre sized solids in a corrosive wastewater by ceramic flat membranes as mandatory step before the removal of dissolved components. The separation of polyvalent ions (e.g.: sulphate) will be tested by use of suitable resins and selective nanofiltration membranes, followed by the separation of chlorides using low-priced polymer membranes or the capacitive deionization and the removal of heavy metals by novel adsorbent. The utilization of the concentrates leads to valorisation (phosphate particles, sulphates from resin regeneration). The developed concepts are the basis for a subsequent operational implementation of the results of the joint project. Based on the exemplary application and considering the world resources of phosphate, here is transfer potential for phosphate mines in the Middle East and North Africa with a factor of 40.

FURTHER INFORMATION

- Project website: https://www.bfi.de/en/projects/miningwater-mining-water-recovery-using-innovative-technologies-for-saving-fresh-water/
- Contact: Dipl.-Ing. Martin Hubrich, VDEh-Betriebsforschungsinstitut GmbH, Sohnstraße 69, 40237 Düsseldorf, Tel.: +49 211 98492 -343, Fax: +49 211 98492 - 202, E-Mail: martin.hubrich@bfi.de

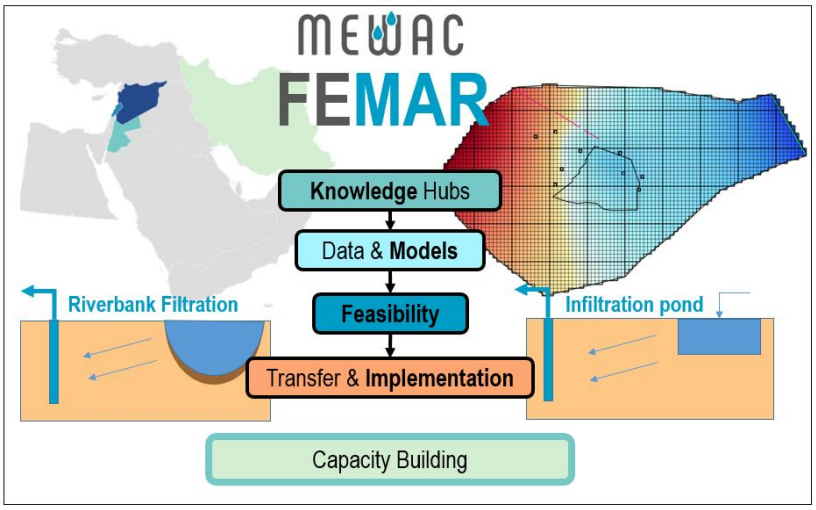
FEMAR: Feasibility of MAR for safe and sustainable water supply

PARTNER INFORMATION

- University of Applied Sciences Dresden (HTWD), Prof. Dr.-Ing. Thomas Grischek
- Technische Universität Dresden (TUD), Dr.-Ing. Thomas Reimann
- Umweltbüro GmbH Vogtland (UBV), Dr. Carsten Leibenath
- Royal Scientific Society, Amman, Prof. Dr. Othman Al-Mashaqbeh
- Shiraz University, Prof. Dr. Mehdi Zarei
- Yasouj University, Prof. Dr. Mohammad Sedghi-Asl
- University Aleppo, Prof. Dr. Abdulnaser Aldarir
- American University of Beirut, Prof. Dr. Joanna Doummar

PROJECT SUMMARY

Many countries in the Middle East region are characterized by steep increase in population combined with an arid to semi-arid climate. The increased water demand combined with the relatively low water availability results in recurring problems in the region such as falling groundwater levels, saline water intrusion and land subsidence. The application of Managed Aquifer Recharge (MAR) has potential to bridge the gap in the water deficit in middle eastern countries, thus avoiding further depletion of groundwater resources. Therefore, the main goal of the MEWAC-FEMAR project is to contribute to the establishment of MAR methods in the target regions in order to achieve a safe water supply. The project focuses in four different countries: Iran, Jordan, Lebanon and Syria. Integrated Hydrologic Models (IHM) are first set up, which describe the water cycle of the target regions. Based on a literature and data collection, suitable methods and locations for MAR application are identified supported by modeling. Methods are adapted for selected locations, for which laboratory and field tests are planned in order to assure the transferability of the methods within the IHM. The use of MAR methods is then coordinated and optimized with the actors involved, so that these can be implemented in pilot projects in the target regions during the course of the project. Another focus point is capacity building, which comprises education and training to gain expertise required for MAR. For this purpose, students from the target regions are trained as doctoral/master's at the participating German universities. At the same time, local professionals are trained in courses and workshops in order to support the project developments and continue it after the funding period has expired.



FURTHER INFORMATION

- Project website:
  https://www.htw-dresden.de/hochschule/fakultaeten/bauingenieurwesen/studium/lehrgebiete/wasserwesen/forschung
- Contact: M.Eng. Gustavo Covatti, Prof. Dr.-Ing. Thomas Grischek (Project Coordinator); University of Applied Sciences Dresden, Division of Water Sciences, Friedrich-List-Platz 1, 10169 Dresden; Email: gustavo.covatti@htw-dresden.de; thomas.grischek@htw-dresden.de

HydroDeSal: Forward Osmosis Desalination by Thermo-Responsive Hydrogels for Small Villages Close to the Persian Gulf

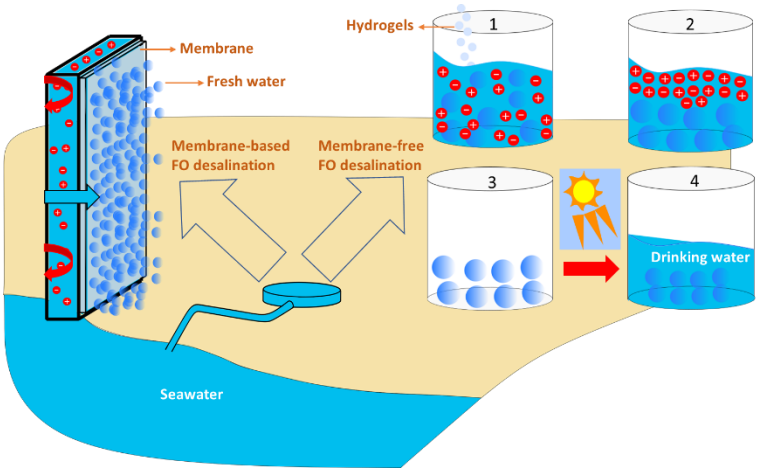
PARTNER INFORMATION

- Joahnnes Gutenberg University Mainz, Prof. Dr. Sebastian Seiffert
- Johannes Gutenberg University Mainz, Prof. Dr. Michael Maskos
- Tehran University, Prof. Dr. Alireza Shakeri
- Persian Gulf University, Dr. S. Abdollatif Hashemifard
- University of Technology, Iraq, Dr. Qusay Alsalhy

PROJECT SUMMARY

This project targets to develop membrane-based- and membrane-free FO desalination processes (MbFO and MFFO, respectively, illustrated in the Scheme 1) by developing charged, thermo-responsive hydrogels and new membranes. The targeted desalination approach should be suitable to serve as a basis for designing desalination setups on a lab-scale, aiming at a prototype-scale capacity as well as at capital and operation plus maintenance costs smaller than those of existing desalination plants. With these characteristics, the target method should be suitable for providing fresh water for small villages close to salty water sources like seawater and can thereby be considered as a local solution for water scarcity, which is a global challenge specifically emergent in the Middle-East region.

The proposed project is aimed to be done in two main stages. In the first stage, which is done mainly by the German partners, the focus is on the synthesis, characterization, and desalination performance of charged, thermo-responsive hydrogels with different morphologies and macromolecular architectures to be either employed as simultaneous draw and separation agents in MFFO or as draw agent in a membrane-based FO process. In parallel, FO membranes with optimum performance will be developed by the international partners to be utilized in MbFO desalination. In the second stage, a lab-scale desalination setup with a capacity of ~10 L/day will be designed by a collaboration of German and international partners. This setup will be tested and evaluated on the Persian Gulf University campus in the south of Iran, which is located very close to the coastal strip of the Persian Gulf.



Scheme 1. Seawater desalination by (left) membrane-based FO and (right) membrane.free FO.

FURTHER INFORMATION

- Project website: https://www.hydrodesal.uni-mainz.de/
- Contact details: Prof. Dr. Sebastian Seiffert (Project Coordinator)
  Johannes Gutenberg-Universität Mainz; Department of Chemistry
  Duesbergweg 10–14; D-55128 Mainz
  +49 (0) 6131 39 23887; sebastian.seiffert@uni-mainz.de

The responsibility for the content of this publication lies with the authors of the individual contributions.

Contacts at the sponsoring ministry

Federal Ministry of Education and Research (BMBF), Germany

Dr. Helmut Löwe
E-Mail: helmut.loewe@bmbf.bund.de

Acting on behalf of the BMBF: Project Management Agency Karlsruhe (PTKA), Germany

Dr. Anna Ender
E-Mail: anna.ender@kit.edu

Dr. Leif Wolf
E-Mail: leif.wolf@kit.edu

Further information on the MEWAC funding measure is available at
https://www.fona.de/en/measures/funding-measures/mewac-multilateral-water-research.php

Imprint

Edited by
Project Management Agency Karlsruhe (PTKA), Karlsruhe

Layout
Project Management Agency Karlsruhe (PTKA), Karlsruhe

Photo Credits
p.1 © Michael Xiao/iStock.com

SPONSORED BY THE
Federal Ministry of Education and Research