MARSOL
Demonstrating Managed Aquifer Recharge as a Solution to Water Scarcity and Drought

MAR-SAT Expert Forum Workshop and Field Trip, Tel Aviv, Israel, December 3rd - 4th

WEDNESDAY December 3rd - MAR-SAT Field Trip with on-site presentations

Field Trip

MARSOL partners met with colleagues from the EU FP7 projects DEMEAU and DEMOWARE and other researchers and professionals working in the field of MAR-SAT to exchange information on MAR-SAT topics and to create a MAR-SAT expert forum. The 2 day meeting showed a lot of synergies. The workshop provided an excellent forum for networking and laying the ground for further new projects, e.g. in Horizon 2020.
It was very valuable to receive an overview of the different projects taking place in the EU and outside of the EU. It was emphasized to join forces to be able to efficiently contribute to EU policies, governance, guidelines, standards, policy recommendations etc.

9:00 - 15:00 Shafdan WWTP, presentations and tour of the WWTP and the pilots

Avi Aharoni (Mekorot)

Presentation of the Shafdan Project - Tel Aviv Region wastewater collection and treatment, and the conventional SAT technology.

Avi Aharoni, head of effluent reuse department at Mekorot, briefly introduced Israel's national water company Mekorot and Shafdan, Israel's largest waste-treatment facility.

Potable water is produced by using groundwater, surface water, and desalinated water. Mekorot supplies 80% of the drinking water (1.4 billion m^3/yr). Water is also collected by utilizing storm water. A central filtration plant for surface water is operating since 2007 with a filtration capability of 1.7 million m^3/day. Reclamation of effluent is up to 85% in Israel, for agriculture and irrigation. Wastewater is treated and recharged to the aquifer using Soil Aquifer Treatment (SAT) at the Shafdan. Around 240 million m^3/yr of treated wastewater is reused for agriculture.

In the Shafdan wastewater facilities, four treatment stages are applied: During pre-treatment, coarse or suspended material is removed mechanically. In the primary treatment about 30% of the organic substances and 40% to 60% of the suspended solids are removed through gravitational settling. In addition, during the secondary treatment bacteria remove further organic pollutants. Effluents of high quality are obtained which are permitted to be used in agriculture, pursuant to

the regulations of the Ministry of Health. During the tertiary treatment remaining contaminants, bacteria and other microorganisms are removed by filtering the effluents through a deep and sterilization granular (particulate) bed. The reclaimed effluents are permitted for the unrestricted irrigation of all agricultural crops.

The following issues occur during the SAT process: high hydraulic loading due to lack of new available land to cope with increasing effluent quantities and high biological activity in the upper part of the SAT system cause a lack of oxygen in the soil and therefore the development of anoxic conditions. The impacts are: i) slower infiltration rates and gradual clogging due to organic matter accumulation in the upper vadoze zone; ii) Manganese dissolution causing clogging problems in irrigation systems; and iii) some emerging micropollutants are difficult to remove since some of them are not biodegraded. Researches to cope with the problem currently are:

- Reclaim: UF + Short SAT (dug well)
- BMBF - MOST : Biofilter (H_2O_2) + Ozonation + Short SAT
- Comparison of three pre-treatments alternatives: UF, ISF, Filter Media, before SAT (column simulation)
- UF-RO: Effluent desalination
- Demoware: Advanced studies building on the BMBF - MOST research
- In the future: New hybrid combinations to check other uses

Anat Lakretz (Mekorot)

Presentation on the secondary effluents pilot treatment by AOP-Short SAT. In the Shafdan, 130 million m^3/year is recharged by SAT through 5 infiltration basins (~1 million m^2, infiltration rate ~1 m/day) in flooding/drying cycles. Residence time is between 6-12 months. Reclamation takes place through wells (250-1600 m away from recharge area). Optimized pre-treatment is applied before soil infiltration using advanced oxidation processes (AOP). One problem during SAT is the high organic and ammonium load, which leads to oxygen deficiency in the soil and consequently to Mn oxides dissolution, precipitation of Mn oxides in pipelines, and clogging of drippers in agricultural irrigation systems. To decrease the content load inside the secondary effluent e.g. adding of H_2O_2, biofiltration, and ozonation are applied. Experiments are carried out here also in the frame of the DEMOWARE project. Results show that 92% of the particles were removed after biofiltration, DOC, turbidity, and UVA (absorbance of UV light) decreased significantly as well. In addition, after ozonation DOC decreased also, and more significantly UVA, while DO increased about 10 times. By biofiltration/ozonation TrOCs (trace level organic compounds) were removed up to 100% (pharma-ceuticals).

Anat Lakretz (Mekorot)

Presentation on the secondary effluents pilot treatment by UF-RO. Reverse-osmosis (RO) based desalination technologies are applied to treat the excess secondary effluents of the Shafdan WWTP. The main goal is the optimization of the UF (ultrafiltration)/RO operating parameters in order to reduce the wastewater desalination cost. This was done by high UF operating fluxes and high (up to 90%) RO recovery. This was achieved by UF operating mode innovation and desalination system optimization (Proprietary antiscalant aimed to prevent $Ca_3(PO_4)_2$ precipitation, pH adjustment, and biocides).

From the results it can be concluded that i) the UF/RO system solution has proven successful in the difficult conditions of high organics content, fluctuations of phosphates, high bacteria, coli and faecal load, ii) combination of UF operating

mode innovation, antiscalant for $Ca_3(PO_4)_2$ precipitation prevention, and successful biocide for fouling control is a cost effective solution for secondary effluents desalination at high fluxes and recovery rates, and iii) the long term experience will be used in the design of a commercial unit (up to 24,000 m^3/day) which will be implemented in the short term.

Omer Minis, Ido Negev (Mekorot)

Presentation on the secondary effluents pilot treatment by SAT, simulation by sand columns. The influence of filtration treatment on infiltration rates, hydraulic loads and water quality in SAT system was studied. The objectives were i) to examine the effect of Filtration Treatment (FT) before SAT on infiltration rates (IR) and on the hydraulic loads (HL), ii) to examine the influence of FT on soil and water quality, iii) to evaluate the additional cost and the benefits of FT (cost performance analyses), and iv) the optimization of the flooding regime and the infiltration process in the recharge basins. The experiment is conducted with large columns (3 m, 10" diameter) that are designed to simulate the top layer SAT conditions of the soil. Pre-SAT filtration treatments includes i) rapid Sand Filtration (SF), ii) Ultra Filtration (UF), ii) Intermittent Sand Filtration (ISF), and iv) unfiltered secondary effluent as control group (EFF). The results can be summarized as:

- Effluents filtration tends to increase (oxidize) the soil redox, particularly the ISF treatment
- Relatively prolong conditioning was required: Infiltration rates decreased continuously during the first ~17 months (1st, 2nd and the beginning of the 3rd phases)
- Seasonal affect plays significant rule on infiltration rates
- Relatively high variability was observed between replicates (soil columns), despite the controlled conditions
- During the last months there was some (not yet significant) effect of the ISF and UF treatments on infiltration rates

11:00 - 15:00 Visit of the Shafdan Wastewater Treatment Plant and the Shafdan conventional SAT infiltration basins

After the presentations a field trip was made to waste water treatment facilities and SAT fields of the Shafdan. The different treatment stages were visited like the biological reactors, experimental sites of DEMOWARE and other research facilities. During the field trip a lively discussion and information exchange between the MARSOL and other EU project partners took place. Ideas were discussed and suggestions for further research were made.

16:00 - 19:00 Work package meetings were held after returning from the field visit to the Shafdan WWTP south of Tel Aviv (WP 11, WP 12, WP 14).

19:00 - 22:00 Workshop dinner

THURSDAY December 4th - MAR-SAT Workshop

EU MAR-SAT Experts Forum Workshop, ISERD headquarters, Tel Aviv

Presentations were given from EU FP7 project partners and other researchers about all kind of aspects of MAR-SAT. During the Welcome Session a video message from the EU office in Brussels with Rossella Riggio and Robert Schroder was shown focussing on the future water policy and water funding strategy of the EU.

After the presentations a round table and discussion for the foundation of a MAR-SAT Experts Forum took place.

Workshop program Session 1 - Welcome Session:

Presenter	Affiliation	Country
Avraham Ben Yosef VP for Engineering and Technology	Mekorot Israel National Water Company	Israel
Ayala Karniol Director Health, KBBE, Environment, Energy	ISERD The Israel-Europe R&D Directorate	Israel
Yossi Yaacobi WaTech Innovation Center in Mekorot	Mekorot Israel National Water Company	Israel
Main Speaker (Video presentation): Rossella Riggio, Robert Schroeder	European Commission, DG RTD, Unit I2 Eco-Innovation	Belgium

Workshop program Session 2 - Presentations of projects and activities related to MAR-SAT:

Project	Presenter	Institute	Country
MARSOL: Project presentation	Christoph Schueth	Darmstadt University	Germany
SAPH-PANI and DEMEAU: Highlights from the projects	Christoph Sprenger	KW Berlin	Germany
DEMOWARE: Project presentation	Ulf Miehe	KW Berlin	Germany
IAH Commission on Managing Aquifer Recharge and its activities	Peter Dillon	CSIRO	Australia
MAR to Market AG: Relationship with the European Commission action group (AG 128)	Enrique Fernandez Escalante	TRAGSA	Spain
MAR activities in Mekorot: Design of new injection wells for injecting surplus desalinated water into the aquifer	Yossi Guttman	Mekorot	Israel

Workshop program Session 3 - EU and worldwide MAR-SAT related projects' results:

Presentation	Presenter	Institute	Country
BMBF-MOST: Ozonation of treated wastewater followed by groundwater recharge	Martin Jekel, Uwe Huebner	TU Berlin	Germany
Urban Storm Water Biofiltration and Recharge to groundwater	Yaron Zinger	Monash Univesity	Australia
MAR-SAT: The Australian experience	Peter Dillon	CSIRO	Australia
MAR to MARket AG 128: Examples of MAR based on alternative sources of water	Lobo Ferreira	LNEC	Portugal
Dunes of St. André: Recent experiences with infiltration of reclaimed secondary effluent	Emmanuel Van Houtte	IWVA	Belgium
SAT-MAR pilot facility in Arenales aquifer (Spain): Clogging and water quality evaluation	Enrique Fernandez Escalante	TRAGSA	Spain
EU project RECLAIM: Results related to MAR-SAT	Thomas Wintgens	FHNW	Switzerland
El Porto Del Selva Northern Spain: A demonstration study on MAR for wastewater reuse	Ulf Miehe	KW Berlin	Germany
Reduction of manganese dissolution and micro-pollutants by Enhanced Short SAT	Avi Aharoni, Haim Cikurel	Mekorot and TAU	Israel

Workshop program Session 4 - Round table discussion:

First, the MAR-SAT workshop presentations were briefly summarized and reviewed: It was pointed out that the different MAR-SAT work groups show a lot of synergies. The workshop provided an excellent forum for laying the ground for further new projects, e.g. in Horizon 2020. It was very valuable to receive an overview of the different projects taking place in the EU and outside of the EU. It was suggested to send a message to the EU that it was a very useful event. It was emphasized that we should aggregate forces to be able to efficiently contribute to EU policies, governance, guidelines, standards, policy recommendations etc. In addition, knowledge gaps have to be addressed in the future. Stakeholders should be taken into account.

In the following, further activities were discussed, as well as how MAR-SAT can be better represented in the future. It was suggested that EIP on water will be used to further promote MAR-SAT and as a platform to connect stakeholders. It would be welcomed if Mekorot would play an active role in this activity.

Group picture of the MAR-SAT workshop in Tel Aviv, December 4th

Rapporteur: A. Wefer-Roehl