Managed Aquifer Recharge with Highly Polished Treated Effluent in the Malta-South Regional Aquifer

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Introduction

The Malta South Pilot MAR Facility is one of the pilot case-studies under the MARSOL Project, financed under the EU's 7th Framework Programme.

MANAGED AQUIFER RECHARGE SOLUTIONS

www.marsol.eu

The main objective of MARSOL is to demonstrate that MAR is a sound, safe and sustainable strategy that can be applied with great confidence. With this, MARSOL aims to stimulate the use of reclaimed water and other alternative water sources in MAR and to optimize WRM through storage of excess water to be recovered in times of shortage.

The case study in Malta, aims to demonstrate the feasibility of the application of MAR for the development of a sea-water intrusion barrier in an island aquifer system.

Issue

The climate of the Maltese islands can typically be described as semi-arid Mediterranean. Mean annual rainfall amounts to 550mm, and natural losses due to evapotranspiration are estimated to exceed the 60% level.

This low natural availability of water resources is further compounded by the fact that the islands' have the highest population density in the EU – leading to a high demand for water resources.

This situation induces high pressures on the islands' natural water resources – namely groundwater bodies, which has historically led to overabstraction – resulting in the intrusion of sea-water.

Malta's 2nd RBMP addresses the achievement of good groundwater status through a suite of measures addressing increased efficiency in water use and the introduction of water re-use.

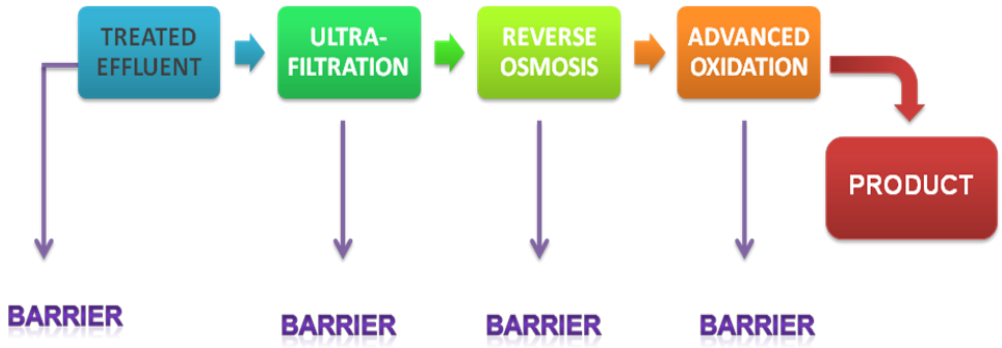
Water Re-Use

Development of three polishing plants at the UWWTPs with a production capacity of 7 million m^3/year for agricultural, industrial and landscaping applications.

Specific Distribution Strategy, where the effluent will progressively be distributed closer to the point of use.

Branding/Marketing Strategy:
New Water

Pilot Demonstration Sites and Information Campaign.

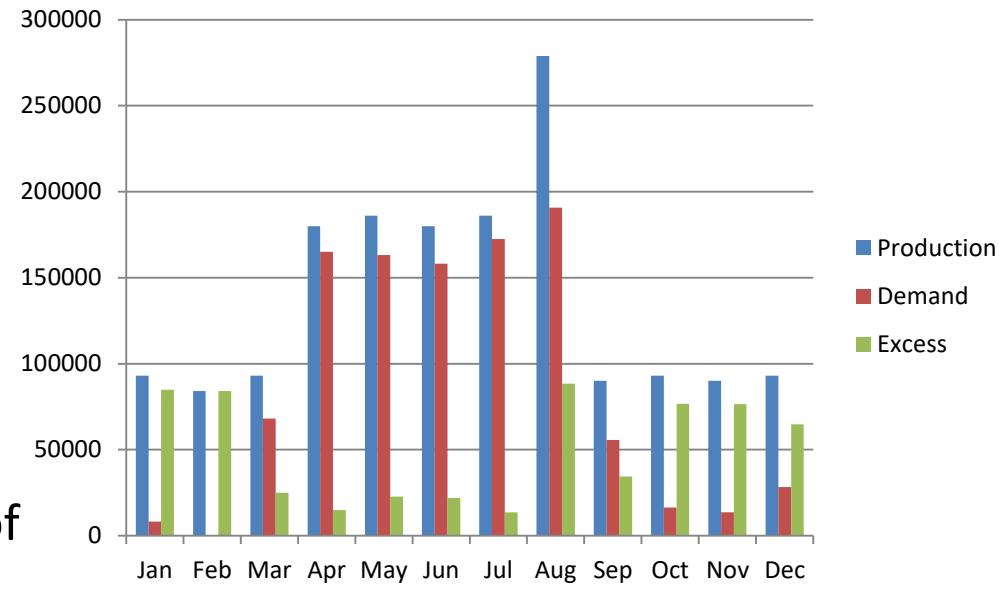


Water Demand Assessments

Water demand assessments show that the production capacity of the polishing plants is expected to exceed water demand by agricultural sector, in particular during the winter months, when rainwater is available.

A step-wise production process has been adopted to low over-production and reduce costs; but production will still exceed demand.

In the Malta South region, estimates show a potential mean annual excess production of New Water of 600 - 800,000m^3.



Managed Aquifer Recharge

The availability of high quality water opens up considerations of diverting this water for MAR purposes.

MAR is considered as a positive measure addressing the imbalance between water supply and demand in the mean sea level aquifer system, thereby reducing stress on the aquifer. From an economic perspective it enables the generation of environmental and resource benefits.

MAR considered as a 'basic measure' under Article 11(3)(f) of the WFD: "*controls, including a requirement for prior authorisation of artificial recharge or augmentation of groundwater bodies. ..... does not compromise the achievement of the environmental objectives established for the source or the recharged or augmented body of groundwater. .....*"

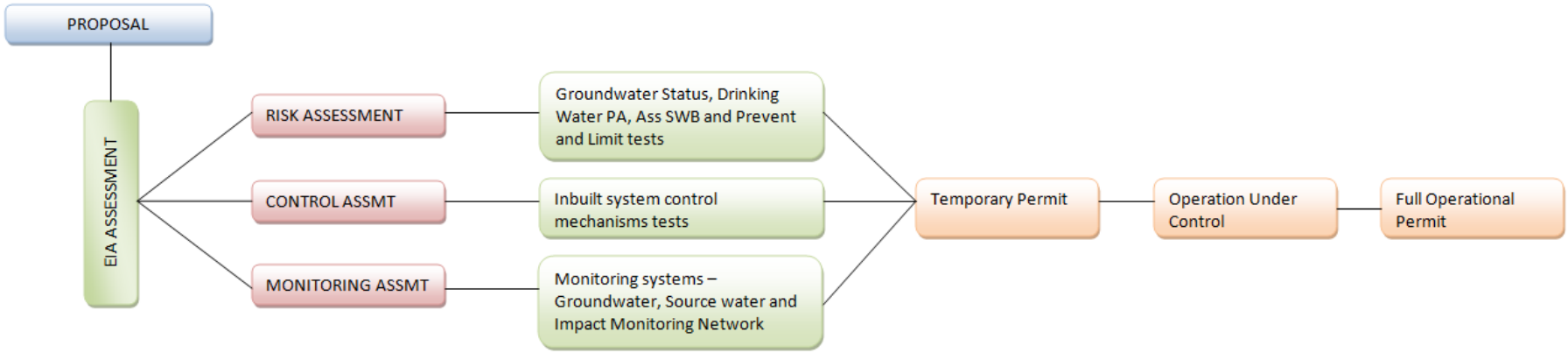
Regulatory Assessment

Regulatory assessment based on the following decision phases:

(i) The undertaking of a risk assessment to assess the potential adverse impacts on the status of the groundwater body.

(ii) The establishment of control mechanisms to ensure the reliable performance of the MAR scheme

(iii) Monitoring of the performance of the MAR scheme and its impact on the augmented body of groundwater



Water Quality

Membrane treatment ensures that the highly polished effluent achieves high quality levels.

In fact, significantly better compared to the status of groundwater in the region.

The recharge effluent attains all the quality standard and threshold values established under the EU's Groundwater Directive.

Similar positive results are encountered in assessments for organic pollutants of concern.

Parameter	UF Product WW11-2228	RO Product WW11-2227
Turbidity (NTU)	0.75	-
Conductivity (□S/cm)	9900	380
pH	6.68	5.75
Temperature (°C)	23.0	23.1
Chlorides (mg/L Cl^-)	3000	81
Nitrates (mg/L NO_3^-)	50	13.9
Nitrites (mg/L N)	<0.05	-
BOD (mg/L)	24	-
Total Solids (mg/L)	6244	-
Total Dissolved Solids (mg/L)	5860	180
Total Suspended Solids (mg/L)	5.0	-
Alkalinity (mg/L $CaCO_3$)	134	4.3
Ammonia (mg/L N)	3.16	0.29
COD (mg/L)	210	-
Silica (mg/L SiO_2)	4.705	0.09
Total Phosphorus (mg/L P)	1.18	-
Sulphates (mg/L SO_4^{2-})	415	Negligible
Fluorides (mg/L F^-)	0.708	002
Iron (mg/L Fe)	0.069	-
Calcium (mg/L Ca)	136	2.3
Magnesium (mg/L Mg)	198.05	3

MARSOL Pilot Facility

The MAR pilot facility is located in the immediate coastal area, and includes 7 recharge wells and 4 monitoring wells.

Due to the high quality of the recharge effluent, direct recharge through boreholes is undertaken.

Water Level and Electrical Conductivity are the selected monitoring indicators. Monitoring undertaken through OTT Eco-Log probes installed in boreholes.

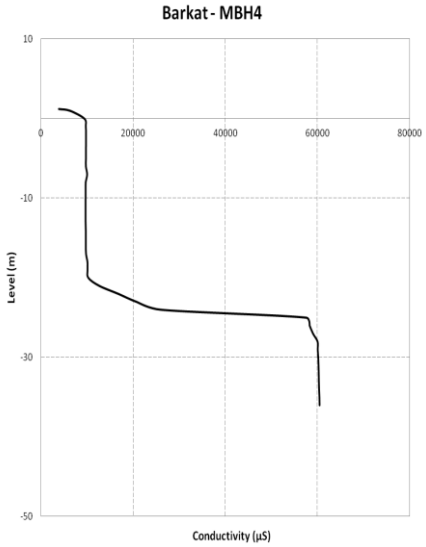
Borehole diameters are also monitored to assess any potential carbonate solution.

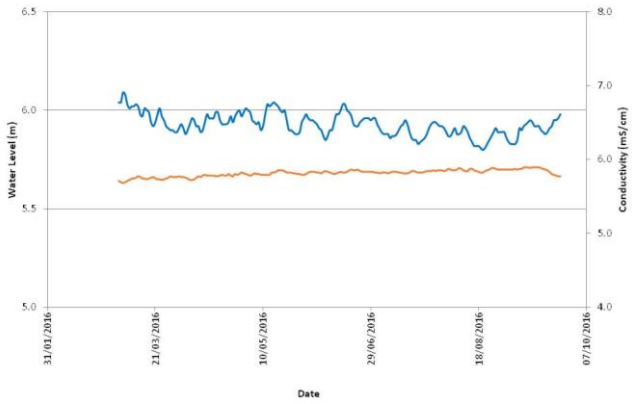
Monitoring Results

Electrical conductivity profiles show a sharp interface, separating brackish water and sea-water.

Water levels in the monitoring boreholes show (as expected) significant variations, whilst electrical conductivity levels (at an established depth) are fairly stable.

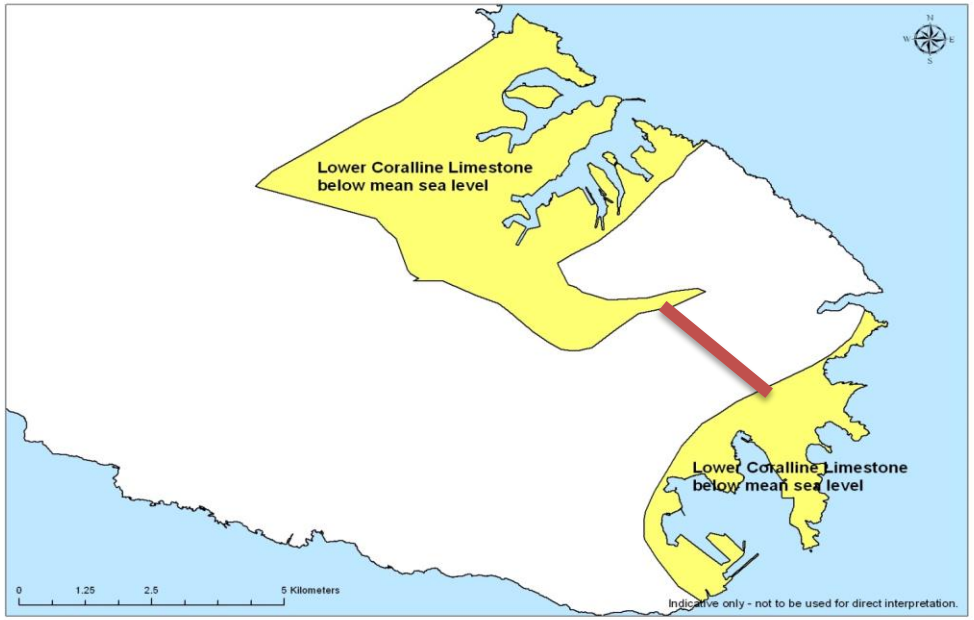
Under these conditions, long term data are required to isolate any head increases due to MAR, whilst a time lag is expected for changes in Electrical Conductivity to be registered.





Upscaled Model

Planned MAR upscaled model.



In the Malta South the mean sea level aquifer system takes the shape of a corridor, flanked by two less permeable formations.

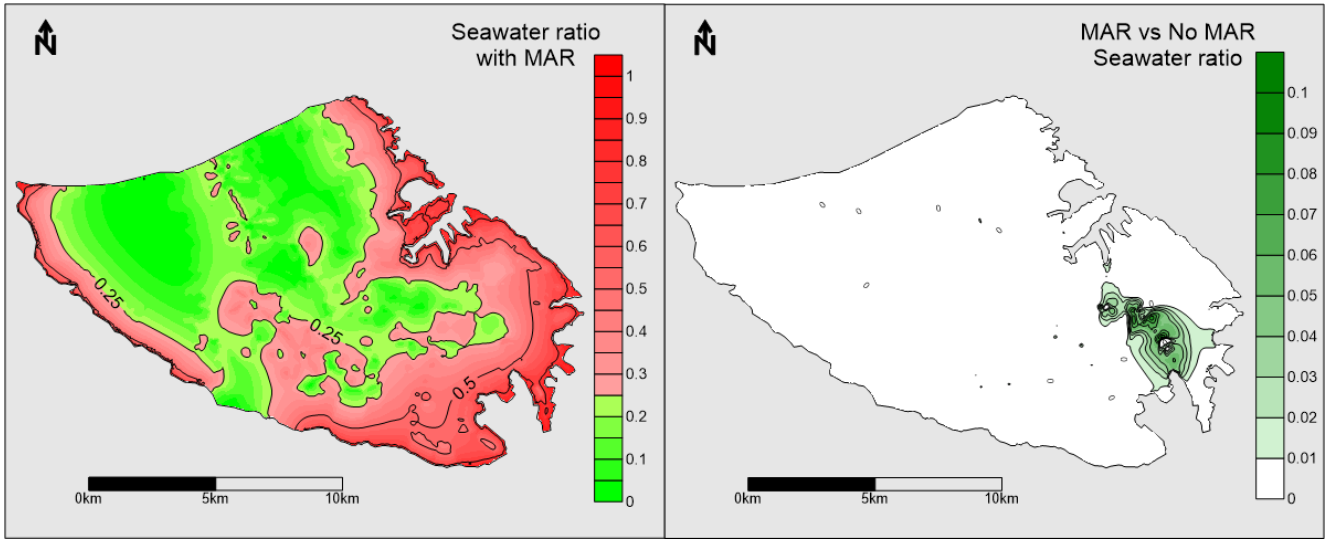
MAR planned to be undertaken in this corridor structure to limit flow of groundwater from central region of aquifer.

Recharge (infiltration) capacity estimated at 1 million m^3/year.

Numerical Modelling

Preliminary numerical models developed under MARSOL Project with the support of the University of Algarve, indicate promising results:

- positive regional impact on water level and water quality, and
- infiltrated water will be preferentially lost to the sea instead of central groundwater (no landward movement of infiltrated waters).

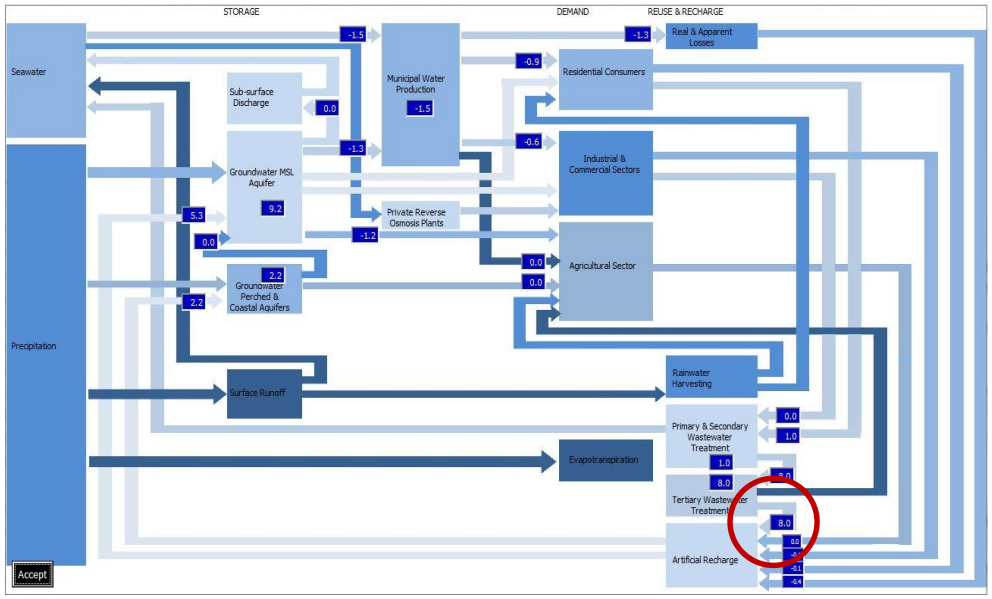


Economic Assessment

From an economic perspective, the inclusion of the MAR scheme into the RBMP implementation framework requires a consideration of the following principles:

Resource and Environmental Costs and Benefits

Polluter, User and Beneficiary Pays Principle



FNPV	-11,450,133
ENPV	6,419,780
ERR	26%
B-C Ratio	1.572

Assumptions:

Investment Cost: Eur2,500,000

Operating Cost: Eur0.66c/m^3

Project Lifetime: 35 years

Scheme operates at peak level every year

Conclusion

Preliminary results from the MARSOL Pilot Project show that MAR can have a positive impact on the mean sea-level aquifer system in Malta form an

-Environmental,

-Regulatory, and

-Economic perspective.

In as much, it should be considered as one of the available tools which can be used by water managers for the progressive achievement of the environmental objectives of the Water Framework Directive in the Maltese islands.

Thank-you for your attention

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