Aquifer recharge in Malta

Year of issue

2025

Summary

Aquifer recharge with highly polished treated effluents. With a high population density and almost no surface waters, Malta faces chronic over-abstraction: total demand exceeds the sustainable yield of naturally renewable freshwater. Demand comes from domestic and agricultural uses (domestic peaks can exceed agriculture during the tourist season). Groundwater quality is threatened by nitrates and seawater intrusion.

A pilot at Bulebel (2010–2013, MEDIWAT) tested injection of ultra-polished reclaimed water via an injection well under strict quality monitoring. Since then, Malta has pursued MAR within a broader strategy: the EU MARSOL demonstrator (2013–2017) designed an injection-well barrier near the Malta South plant (Ta' Barkat) to counter seawater intrusion; the national New Water programme is expanding reclaimed-water production (~7 Mm^3/yr capacity) and distribution for agriculture, creating seasonal surpluses that can supply MAR. Under the LIFE-IP RBMP (2021–2027), Action C8 is developing a pilot MAR scheme in the Pwales coastal groundwater body using reclaimed water when irrigation demand is low; a 2024 hydrogeological study characterised Pwales to support MAR design.

Photo Gallery



Location

35.864492, 14.523394

Project

NWRM

National ID

Malta_01

Sector

Hydromorphology

Installation Date

2010

Implementation status

Completed

Contact

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Overview

Location of the project

Location on Bulebel Industrial Estate in Zejtun (southern region of Malta), overlying a degraded part of the sea level aquifer system, next to the old Sant'Antnin Waste Water Treatment Plant and surrounded by unutilized wells

Country

Malta

NUTS2 Code

Malta

Sponge measures implemented in the case study

Restoration of natural infiltration to groundwater

Objectives

Evaluate the technical & economic feasibility of using highly-polished treated effluent for artificial recharge of Malta's sea-level aquifers.
Determine the scale of impacts on aquifer status; enhance sustainability of freshwater systems; assess usability for irrigation.
Pilot configuration: UF+RO polishing, one injection well + 2–3 monitoring wells; test recharge at ~35 m^3/day.

Involved partners

Authority type	Authority name	Authority role	Comments
National water authority	Manuel Sapiano, Malta Resources Authority	Implementation	The MRA was responsible for leading the Maltese pilot project from the MEDIWAT research project's point of view. MRA is also responsible for issuing authorizations (after a quality control) for injecting water into the aquifer through boreholes.
Private property owners	Water Services Corporation	Monitoring	The WSC was responsible for assisting MRA from a technical and operational standing point. It owns the purification plant where the experiment took place, and provided the technical expertise and equipment.

Documents

cs-mt-01-final_version.pdf (791.86 Ko)

Site Information

Climate Zone

Warm temperate dry

Temperature (°C)

18.60 °C

Elevation range

45 m

Soil type

Calcisols

Groundwater level

‘poor’ qualitative status

Vegetation class

Dryland cropland/meadows—non-irrigated arable fields with scattered trees (carob, olive) and ruderal shrubs; immediately adjacent to/within an industrial estate (impervious surfaces at the injection works).

WFD Ecological status

Good

WFD Chemical status

Good

Water quality status

Threshold Values for Chloride and Electrical Conductivity are exceeded in seven and six monitoring stations respectively, a clear indication of saline intrusion. Threshold values for Lead and Ammonium were exceeded in one station.

Design and Implementation

Project scale

Micro

Project scale specifications

An artificial recharge plant and two monitoring wells

Project area

216.6 km2

Basis of design

Facilities included:
Ultrafiltration and Reverse Osmosis Unit
Test-site, injection well and three monitoring wells Tools included:
Water level and water quality monitoring probes
Data loggers for continuous in-situ monitoring
On the scale of the island: three treatment plants produce app. 17 million m3 of treated effluent annually. Out of these 17 million m3, current use is estimated at 1.2 million m3 overall (constrained by a lack of a dedicated distribution network).
On the scale of the application:
Quality: ±105 mg/l of Nitrate content was mitigated. All tested organic pollutants except Dibromochloromethane yielded a negative result. Also, Alkylbenzene content in unpolished effluent ranged between 1.5 and 2.8 ug/l.
Quantity: water level in the first well showed an increase of ±1.3m over the drawdown levels and 0.6m over the long-term background level; water level in the second well showed a variation of 0.8m compared to 0.5m pre-recharge.

Principles

Evaluation of the feasibility (technical and economic) of using highly polished treated effluent for the artificial recharge of the island’s sea level aquifer systems.
Determination of the scale of the impact of artificial recharge on the status of the aquifer; enhance the sustainability of (aquifer) freshwater systems; usability for irrigation.

Factor constraints

The main constraints limiting the application of this technique are not so much island-size specific, but more related to the availability, the quality of the polished effluent and the cost of implementing the technique.
The factors that influenced the selection and design of the application are linked to the context of over-abstraction of the aquifers due to the high water-demands on the island and to legal requirements (especially under the Urban Wastewater Treatment Directive (91/271/EEC), as well as the Water Framework and Groundwater Directives) – including the achievement of the good status objectives of the Water Framework Directive (Dir 2000/60/EC).

Constraints

Availability of sufficient treated effluent; quality of the polished effluent; production costs for delivering and polishing the effluent; short- and long-term cyclic behaviour in the water levels.

Favourable preconditions

Location (next to a wastewater treatment plant); available equipment.

Financing

Financing authorities

Authority name	Type of funding	Comments
European Union	EU-funds: Cohesion and regional development funds	As part of the MEDIWAT project

Compensations

Non

Policy and Governance

Policy description

With a high population density and almost inexistent surface waters, Malta is in a situation of over abstraction of its groundwater resources and where its total water demand exceeds the sustainable yield of the naturally renewable freshwater resources. Demand comes from the domestic and agricultural sectors alike (the domestic use can even exceed the agricultural use with the arrival of tourists during touristic seasons). From a qualitative point of view, freshwater resources are also under threat resulting from nitrates and salt water intrusions.

Land ownership

The site lies within Bulebel Industrial Estate, a government-owned estate administered by INDIS Malta.

Policy targets

Groundwater Recharge

Pollutants Removal

Target remarks

Natural assimilation (purification) of effluents through dilution, dispersion, and physic-chemical processes
Regulation of the chemical status of freshwater
Self-regulation of water by filtration / storage / accumulation by ecosystems
While the primary target of this application is the assimilation (purification) of effluents to recharge the aquifer, it is only partly done in a natural way (passage through porous rock), as they are artificially treated first.

Policy pressure

Directive	Relevant pressure
WFD identified pressure	1.1 Point – Urban waste water
WFD identified pressure	3.2 Abstraction – Public Water Supply
WFD identified pressure	3.1 Abstraction – Agriculture
Other EU	Groundwater Directive Direct and indirect inputs of hazardous substances in groundwater

Policy impact

Directive	Relevant impact
WFD identified pressure	Abstraction exceeds available GW resource (lowering water table)
WFD identified pressure	Saline pollution

Directive	Relevant impact
WFD identified pressure	Nutrient pollution

Requirement directive

Requirement directive	Specification
WFD-restoring a HMWB	—
Water Framework Directive (WFD) 2000/60/EC	WFD-achievement of good GWB quantitative status
Other EU	Groundwater Directive-protection of the qualitative status of the receiving GWB
Other EU	Urban Waste Water Treatment Directive

Requirement directive remarks

The adoption by Malta and other Mediterranean countries of the Urban Waste Water Treatment Directive has seen the commissioning of an increasing number of wastewater treatment plants treating water prior to its discharge into the sea or other inland freshwater bodies. Re-use of treated effluents is progressively seen as a new source of water in local contexts of high stress-levels on freshwater resources and semi-arid climate. The Directive was transposed in Malta under the Environment Protection Act (2001) and its Urban Waste Water Treatment Regulations (2005). However, an issue concerns the controls on the qualitative status of water that need to be carried out, including a prior authorization by competent authorities of artificial recharge or augmentation of GWB.

Part of a wider plan

Oui

Wider plan

Wider plan focus	Name	Comments
Environment & Biodiversity	MEDIWAT project	Sustainable management of environmental issues related to water stress in Mediterranean Islands Second call of the MED programme (2007-2013). It involved 10 partners covering 6 NUTS II regions (islands in France, Italy, Greece, Spain, Malta and Cyprus). It was co-financed by the European Union and the European Regional Development Fund (ERDF)

Public consultation

Non

Has contractual arrangements

Non

Impacts and Monitoring

Monitoring System

Monitoring parameters

Water level (height of water column above probe), salinity, electrical conductivity and groundwater temperature.
Organic pollutants (Pharmaceuticals - Carbamezepine, Acetominophen, Diazemam, Diclofenac, Dilantin, Fluoxetine, Gemfibrozil, Hydrocodone, Ibuprofen, Iopromide, Meprobamate, Naproxen, Pentoxifylene, Mefanamic Acid
Solvents/Plasticizers/Surfactants - Dibutylphtalate, Glycol Ether, Alkyl Benzene, Dibromochloromethane, Perfluorooctanic Acid, Perfluorooctanesulfonic Acid, BisphenolA
Personal Care Products - Caffeine, Galoxolide, Oxybenzone, TCEP and DEET
Steroids - Androstenedione, Estradiol, Estriol, Estrone, Ethinylestradiol, Progesterone, Testosterone
AntiMicrobial Agents - Trimethoprim, Triclosan, Sulfamedthoxazole, Erythromycin) and conventional pollutants (electrical conductivity, chloride, nitrate and bacterial content).

Impact Assessment Methodology

Performance impact assessment method

Catchment outlet

Performance impact estimation information

Background conditions at the recharge site monitored through two wells located in the immediate vicinity of the recharge well (pre-recharge): use of two multi-parametric groundwater probes; Water level monitoring (post-recharge): use of a water level contact gauge.

Socio-economic Impacts

Direct benefits

Water storage and natural barrier against salt intrusion functions for water security and water provision services. New Water is documented to target ~35% of agricultural demand at full capacity, indicating a system-level benefit relevant for MAR supply/seasonality.

Biophysical impacts: Hydrology

Information on increased groundwater level

+1.3 m and +0.8 m post-recharge

Biophysical impacts: Water & Soil Quality

Information on water quality overall

very low residual organics after polishing; nitrate ~105 mg/L mitigated in the feed—these remain the main published quantitative results.

Lessons Learned

Key lessons

A hydro-geological assessment of the aquifer system must be carried out before any artificial recharge scheme using treated effluents is implemented, in order to assess the prevalence of local and regional groundwater flow should anything go wrong. Effluents should undergo further treatment in order to comply with the EU Directives' requirements concerning recharge of groundwater bodies.
Any proposed artificial recharge scheme using treated effluents should seriously consider the impact on the aquifer system, through a hydro-geological assessment of the aquifer system in order to assess the prevalence of local and regional groundwater flow. If not so, groundwater users located in the immediate vicinity of the scheme could be strongly impacted should an unplanned incident occur, whereas the impact on a regional scale could only be minor.

Barriers

Barrier type	Barrier role	Comments
Other	Main barrier	Lack of sufficient treated wastewater resource (quantity of effluents available for recharge)
Lacking financing sources	Main barrier	Cost of polishing effluent too high to be sustainable at the moment
Other	Secondary barrier	Lack of a dedicated distribution network for the re-use of treated effluent

Drivers

Driver type	Driver role	Comments

Legal obligations	Main driver	WFD requirements (annual abstraction from the groundwater body does not exceed the long-term annual average rate of overall recharge of the body of groundwater; necessary controls are in place to eliminate the possibility of any degradation in the qualitative status of the receiving body of groundwater)
Other	Main driver	Availability of European funding for research projects in this area

Success factors

Success factor type	Success factor role	Comments
Financing possibilities	Main factor	Financing for the treatment of effluents that will be injected into the aquifer
Other	Main factor	Location of the recharge facility (close to a wastewater treatment plant)
Existing regulations	Secondary factor	Enforcement of control for illegal abstractions

Basin characteristics influence

Fairly stable background conditions of the aquifer at the recharge site allowed for the monitoring to take place. However, short- and longterm cyclic behaviour in the water levels was observed

Sources

Sources

Assessing the environmental impact of artificial recharge by highly polished treated effluent on an unconfined aquifer system

Annual Report 2024

3rd River Basin Management Plan: MALTA

Hydraulic characterization of Pwales aquifer in Malta Island preparatory for planning managed aquifer recharge (MAR) pilot plant

C8 Development of a Managed Aquifer Recharge Scheme in the Pwales Groundwater Body Author: RBMP Life (Energy & Water Agency)

New Water

DEMO Site 8 – South Malta Coastal Aquifer