Germasogeia riverbed artificial groundwater recharge in Cyprus

Year of issue

2025

Summary

Germasogeia (Amathos) River crosses Yermasoyia municipality near Limassol. The measure, launched in 1982, restores natural purification and recharge of the Germasogeia alluvial aquifer, processes disrupted by the upstream dam. It works by gradual reservoir releases while maintaining the riverbed's high transmissivity. Monitoring includes flows at four weirs, groundwater levels in observation wells and coastal salinity; pumped water supplies Limassol and nearby communities.

More recently, the Water Development Department (WDD) and academic partners developed and validated optimisation models (2016–2019) on WDD data to keep target water tables with lower release volumes, formalising the conjunctive-use operation. In 2015, a 1–1.5 m concrete weir on the Germasogeia was removed within a hydromorphological restoration project; it had reportedly been built to enhance recharge. In parallel, desalination capacity serving Limassol (e.g., Episkopi, Vasilikos, and new/expanded units) now provides a major share of potable supply, easing pressure on the aquifer in dry years. In the wider district, WDD also operates a separate MAR scheme at Akrotiri (17 recharge ponds, since 2016) using tertiary-treated effluent against seawater intrusion.

Overall, Germasogeia remains a long-running SAT/MAR scheme, now embedded in a diversified water-supply system and supported by modelling and river restoration actions.

Photo Gallery



Location

34.742003, 33.084036

Project

NWRM

National ID

Cyprus_02

Sector

Hydromorphology

Installation Date

1982-03

Implementation status

Completed

Contact

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Overview

Location of the project

In Yermasoyia (Germasogeia) municipality, just east of Limassol, between Germasogeia Dam and the coast.

Country

Cyprus

NUTS2 Code

Κύπρος (Kýpros)

Sponge measures implemented in the case study

Restoration of natural infiltration to groundwater

Removal of dams and other longitudinal barriers

Objectives

Restore recharge & SAT via controlled releases (~15,000–25,000 m³/d typical).
Operate conjunctively (dam + riverbed aquifer) to supply Limassol and nearby communities; average ~5.9 Mm³/yr pumped (1982–88) after implementation; flows measured at 4 weirs and levels in 43 wells to maintain heads and curb seawater intrusion.

Involved partners

Authority type	Authority name	Authority role
National water authority	Water development Department	Implementation

Site Information

Climate Zone

Warm temperate dry

Precipitation

615.00 mm

Temperature (°C)

16.50 °C

Evapotranspiration

1230.00 mm

Runoff

143.50 mm

Runoff coefficient

0.23

Imperviousness

23.00 %

Elevation range

58 m

Slope range

1.0

Groundwater level

1.9, 6.4 and 17.6 m a.s.l. at 3 monitoring points

Vegetation class

Bare river bed with disperds reedbeds

WFD Ecological status

Good

WFD Chemical status

Good

Water quality status

Historic/ongoing risk of seawater intrusion due to reduced natural recharge and over-pumping; chloride used as indicator.

Design and Implementation

Project scale

Meso

Project scale specifications

River-reach scale within a metropolitan area

Project area

192

Size

5000.00

Size unit

m2

Constraints

A streambed aquifer of high transmissivity and large storage coefficient is required. High infiltration capacity is also needed of the riverbed to enable recharge to occur. Low or free from sediment surface water will maintain infiltration rates.

Favourable preconditions

Availability of surface water (reservoir), need for increased recharge due to use of aquifer, suitable hydrogeologic conditions of streambed aquifer such as high infiltration capacity and permaeability coupled with high storage coefficient.

Financing

Total cost information

No costs for the upstream reservoir or for the pumping wells are considered. Estimated costs are of the order of 60000€ for observation wells, weirs, earthworks, and initial studies by hydrologists and engineers.

Costs capital

38000.00 €

Costs capital information

Estimated costs for drilling of 5 observation boreholes (2500€each) equipped with water level recorders (1000€ each) and construction of 4 weirs at every 700 m along the riverbed (3000€each) with recorders (1500€each). Earthworks within riverbed (2500€).

Costs operational

6000.00 €

Costs operational information

Estimated expenses 6000€/year Dam Attendant for releases and Technician for operating weirs and carrying out monitoring. Assumed 20% of their time per year. No cost of fresh water is assumed.

Costs maintenance

3500.00 €

Costs maintenance information

2500€/year for earthworks within riverbed. 1000€/year to maintain recorders, wells and water meters.

Economic costs additional

7500.00 €

Information on Economic costs additional

Estimated cost for staff for evaluating results of the measure and planning of its further implementation being about 7500 €.

Administrative annual cost information

Estimated Costs for the operation of the measure (Scientific staff and field assistants (at 10% of their annual time) not including drilling and construction but including travelling and analytical costs are about 18000€/year.

Financing authorities

Type of funding	Financing share
National funds	100 %

Compensations

No

Policy and Governance

Policy description

Construction of the upstream dam disrupted natural recharge; increasing urban/tourism demand around Limassol; need to secure potable supplies while preventing seawater intrusion and minimizing freshwater losses to the sea. WFD-related pressures: Abstraction (quantitative pressure) and saline intrusion risk (chemical pressure signal).

Land ownership

unknown

Policy targets

Groundwater Recharge

Increase Water Storage

Pollutants Removal

Oher Societal Benefits

Part of a wider plan

Yes

Wider plan

Name
Drinking water supply

Public consultation

No

Has contractual arrangements

No

Impacts and Monitoring

Monitoring System

Monitoring requirements

Continuous tracking of releases, river flows at four weirs, groundwater levels in 43 piezometers, pumped volumes and chloride for seawater-intrusion control, supported by modelling.

Maintenance

Maintenance requirements

Routine earthworks in the active riverbed and servicing of instruments (recorders, wells, meters) are carried out by WDD, budgeted at ~€3,500/yr. NWRM

Impact Assessment Methodology

Performance impact assessment method

Catchment outlet

Performance impact estimation information

Monitoring included: surface water released, flow in stream monitored by four weirs 700 m apart, groundwater pumping, water-table fluctuation through 43 observation wells, samples for chemical analysis to monitor sea intrusion and a groundwater model.

Socio-economic Impacts

Direct benefits information

The aquifer is used as a natural water treatment plant. By the regulation of the aquifer a) the water demand with groundwater of acceptable quality is met, b) sea intrusion is controlled and groundwater losses to the sea are minimized.
Water supply reliability & capacity: By 1988, total groundwater extraction (65% for Limassol; plus four nearby communities) increased by ~90% compared to pre-measure (1982), meeting potable demand with acceptable quality.

Ancillary benefits information

Defertment of additional works to meet growing water supply demand (desalination, treatment works, drilling for wells etc.) Reduced cost of water supply to consumer.

Biophysical impacts: Hydrology

Retained water

7.10

Retained water unit

mio m3/month

Information on retained water

The number given refers to monthly average infiltrated water (1982-87) between weirs 700m apart (or 1400 m length) and a riverbed of 50 m width.
Modelling with recent WDD data (2013–2016) shows optimised recharge can maintain target water tables with lower release volumes (“considerable water savings” vs. current practice).

Increased water storage

5.90

Increased water storage unit

mio m3/year

Information on increased water storage

The number refers to average annual quantity pumped (1982-88) from the aquifer as a result of the artificial recharge plus losses from the upstream reservoir.

Runoff reduction

188.00

Runoff reduction unit

% Percent

Information on runoff reduction

The number refers to the ratio of extraction of 1988 to that of 1982

Biophysical impacts: Biodiversity

Improved biodiversity

Yes

Information on improved biodiversity

Riparian vegetation as habitat has improved. Related river action (same river, 2015): a 1–1.5 m concrete weir was removed on the Germasogeia (Amathos) to restore hydromorphology and aid eel migration (complementary to, not the same as, the MAR works).

Biophysical impacts: Water & Soil Quality

Water quality overall improvements

Positive impact-WQ improvement

Information on water quality overall

Chloride in time for selected wells in the delta area is used as index to the extent of sea intrusion. This fluctuates in response to the recharge releases and to prolonged periods of extraction without recharge. No deterioration trend is observed.

Soil quality overall improvements

Neutral impact-no change in SQ status

Information on soil quality overall improvements

Water is released in the active normally dry riverbed. The fresh water is free of sediments being water stored in reservoir, thus no detrimental effect is noticed on infiltration rate.

Ecosystem erosion control

No

Biophysical impacts: Others

Ecosystem impact climate regulation

No specific impact

Information on ecosystem impact climate regulation

It can be said that some impact of the measure may have to do with reduction of energy use and GHGs (desalination, treatment etc.)

Lessons Learned

Key lessons

Germasogeia shows how a river-bed alluvial aquifer can act as a natural treatment step while supplying potable water: controlled releases and regulated pumping keep groundwater quality acceptable, limit seawater intrusion, and minimise losses to the sea.

Success hinges on rigorous, data-rich conjunctive management. The scheme is operated with flows at four weirs (~700 m spacing), 43 observation wells and chloride as a seawater-intrusion indicator; recent modelling on WDD data demonstrates that target heads can be maintained with lower release volumes than empirical practice.

Maintaining riverbed transmissivity is critical: periodic earthworks and low-sediment water from the reservoir sustain infiltration capacity—otherwise clogging would degrade performance.

Embedding MAR within a diversified supply portfolio matters. Limassol now draws part of its drinking water from the Episkopi (Limassol) and Vasilikos desalination plants, reducing pressure on the aquifer in dry years.

Coordination with river restoration and continuity goals is needed: a 1-1.5 m weir on the Germasogeia (Amathos) was removed in 2015 to restore hydromorphology and aid eel migration.

Barriers

Barrier type	Barrier role	Comments
Limited staff and consultant knowledge	Secondary barrier	Demanding practice requiring good hydrogeologic knowledge of system to fine tune releases.
Attitude of decision makers	Secondary barrier	—
Expected maintenance needs	Secondary barrier	Risk of riverbed clogging if sediments are high; needs ongoing maintenance.
Other	Secondary barrier	Dependence on available reservoir inflows during drought.

Drivers

Driver type	Driver role	Comments
Legal obligations	Main driver	Downstream user rights affected by construction of Germasogeia dam together with increasing water demand
Organisation committed to it	Secondary driver	—

Success factors

Success factor type	Success factor role	Comments

Existing staff and consultant knowledge	Main factor	Studies and good knowledge of aquifer response. Models and trial releases are needed
Attitude of relevant stakeholders	Secondary factor	Strong operator: Water Development Department (national authority) with long operational memory.
Other	Main factor	Dense monitoring network + modelling capability to guide adaptive releases.
Financing possibilities	Secondary factor	National funding and stakeholder buy-in.

Transferability

Highly transferable to semi-arid coastal rivers with permeable alluvium and upstream storage. Requires low-sediment releases, strong governance, and dense monitoring/modelling to balance heads, pumping and seawater intrusion. Watch drought risk, clogging, and river continuity; optimisation can cut releases for the same service level.

Sources

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Artificial groundwater recharge practice in Cyprus: The Yermasoyia aquifer.

Conjunctive use of surface and groundwater resources of the Yermasoyia River Basin in Cyprus

Conjunctive use of the Germasogeia Riverbed Aquifer and Germasogeia Dam for water supply

Evaluation of the operation of Yermasoyia surface and groundwater reservoirs using environmental isotopes

One-dimensional Groundwatyer simulation model of the Yermasoyia river aquifer

Assessment of Groundwater Resources of Cyprus (TCP/CYP/8921 – Objective 1, Output 1.4.2)

Modelling and optimisation of water management in sloping coastal aquifers with seepage, extraction and recharge

First Documented Barrier Removals in Cyprus

Mathematical modelling of the Germasogeia aquifer (ESGI125 report)

Modelling and optimisation of water management in sloping coastal aquifers with seepage, extraction and recharge (preprint)

Desalination Plants

Securing Potable Water Supply under Extreme Scarcity — Lessons and Perspectives from the Republic of Cyprus

Έκθεση Αξιολόγησης, Επανεξέτασης, Αναθεώρησης και Επαναχαρακτηρισμού των Συστημάτων Υπόγειου Ύδατος... για την Εφαρμογή του Άρθρου 5 της Οδηγίας-Πλαίσιο περί Υδάτων, 2000/60/ΕΚ (Η/131) [Assessment/Review/Revision/Re-characterisation of Cyprus Groundwater Sy

Implementation of Articles 5 & 6 of the Water Framework Directive 2000/60/EC — Volume 6: Further Characterisation of Groundwater Bodies