SubSol Project
Cyprus

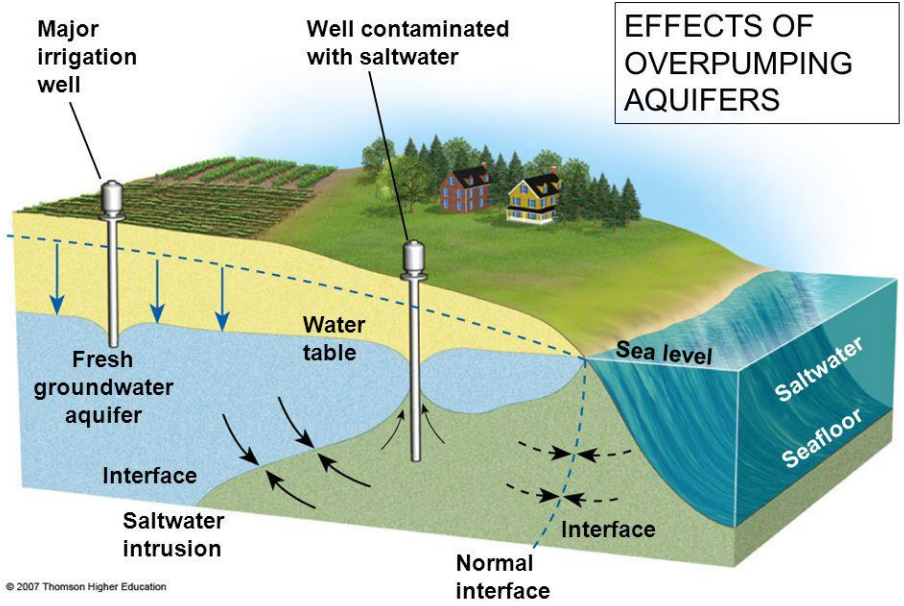
Mission January 2017

SUBSOL has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642228

SubSol Project

Groundwater solutions in coastal areas

- Financed by the E.U. Commission H2020.
- Consortium of 15 research institutes and private firms in the E.U.
- Emerging from the lack of solutions to address the issues of saltwater intrusion and fresh water scarcity



Objective of activities in 6 global destinations:

- Assessment of framework conditions in the Mediterranean region, Western Europe, Mexico, Brazil, China and Vietnam
- Identification of key partners
- Development of Subsurface Water Solutions (SWS)

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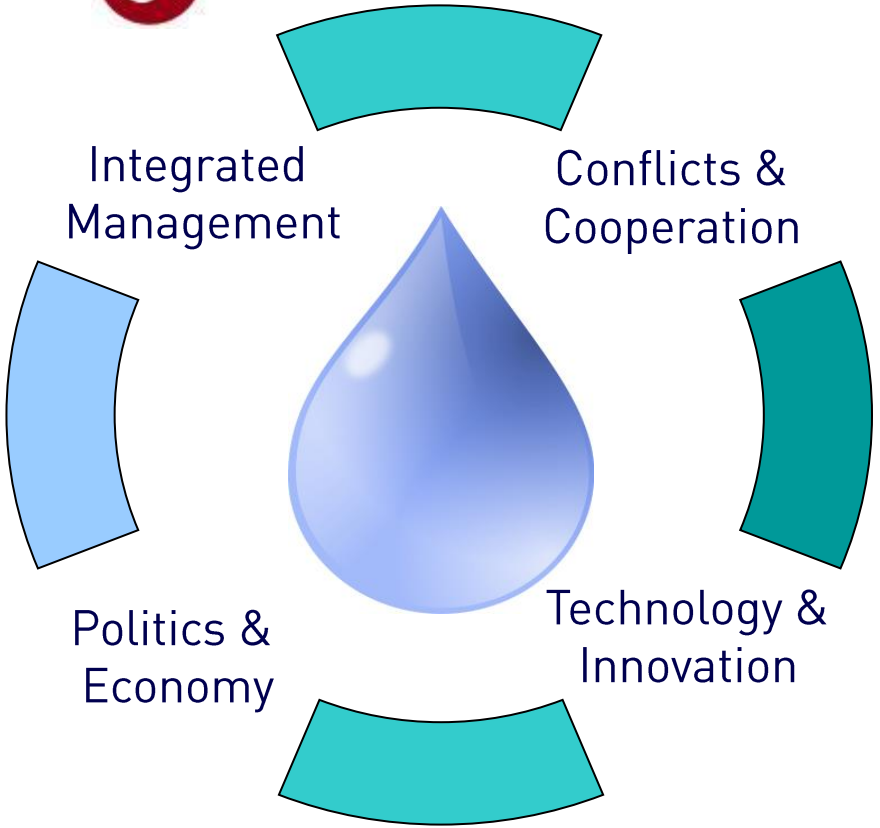
- Assess local situations in the identified sites that suffer from saline intrusion and freshwater shortage
- Local political and legislative analysis
- Presentation of good practices for subsurface wáter solutions (SWS)
- Identify strategies for SWS
- Development of capacities and market cases



Your contacts for Cyprus:
Ronjon Chakrabarti and Jeremy Lhoir

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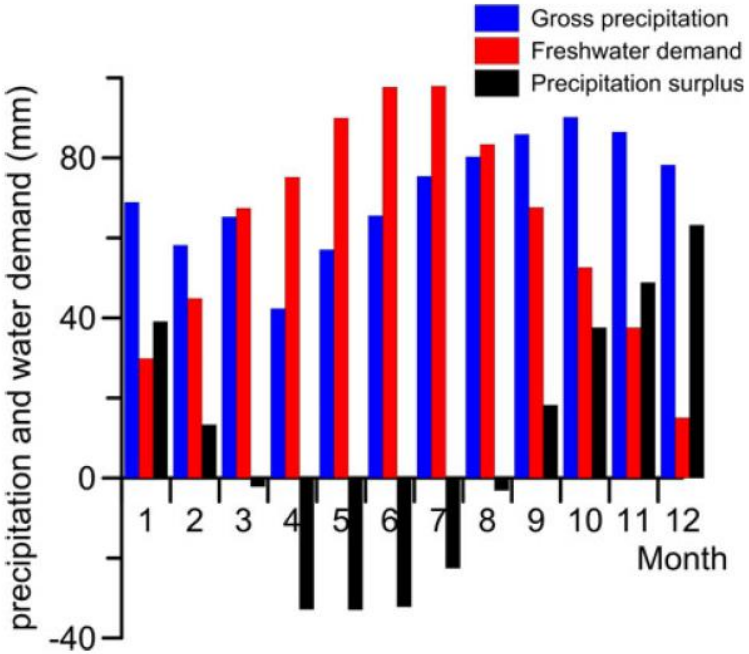
The problem

Fresh water scarcity: imbalance between the **availability** and **demand** of fresh water



Situation in coastal areas:

Fresh water scarcity + salinization

Traditionally:

- **Expensive** surface storage solutions or
- Unsustainable solutions (**desalinization + saline residue management**)

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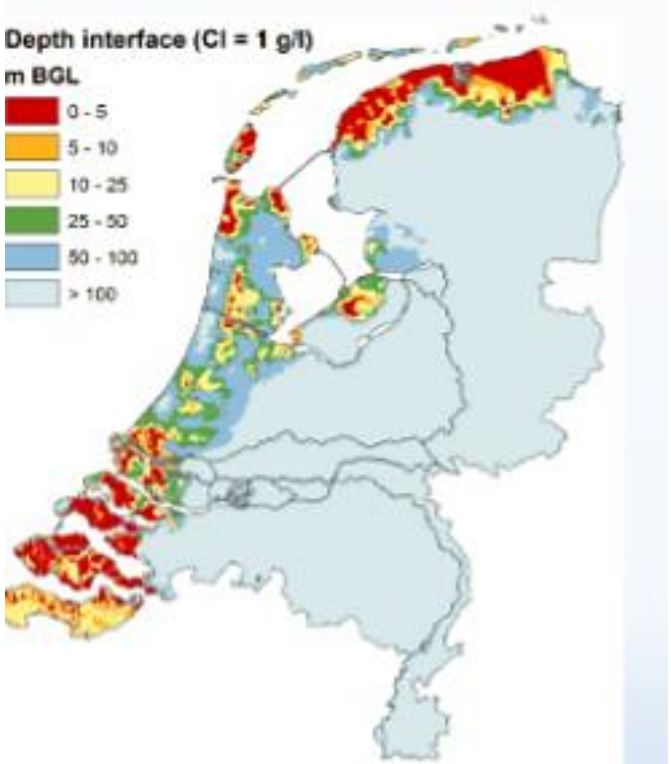
Situation in Holland

Holland in 80's: **ASR (Aquifer Storage and Recharge)** was introduced to counteract the imbalance between demand and availability

… But many of the small-scale ASR systems failed in coastal areas due to buoyancy effects

=> Stimulation of research and development of new innovative methods for fresh water storage: SWS



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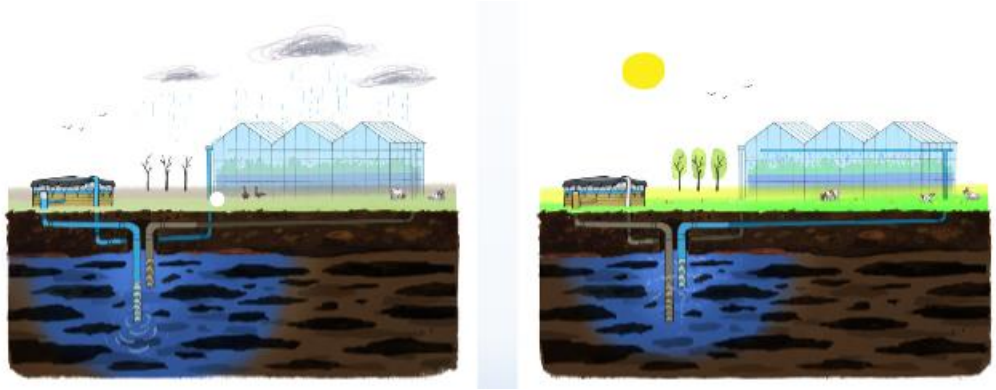
SWS solutions

SWS are new tools that combine technology with advanced groundwater management to **protect, enlarge, and utilize fresh groundwater resources**.

Sophisticated new well designs, configurations, and management strategies were designed to obtain maximum control over the water resources.

SWS can provide robust, effective, and cost-efficient solutions to manage freshwater resources.



ASR principal

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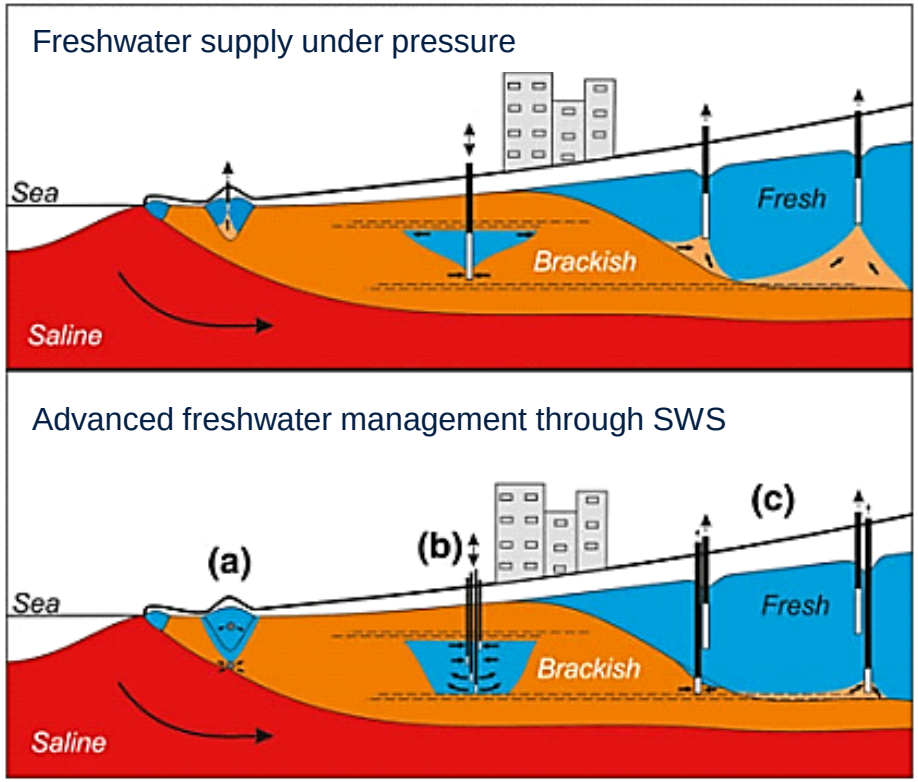
Types of SWS functionalities



(a) **Freshmaker** (infiltration through horizontal wells, to enlarge and utilize freshwater lenses in coastal areas)

(b) **ASR-Coastal** (inject water deep, recover in upper area in brackish groundwater environments)

(c) **Freshkeeper** (protect water supply in abstraction wells prone to salinization: intercept upconing)

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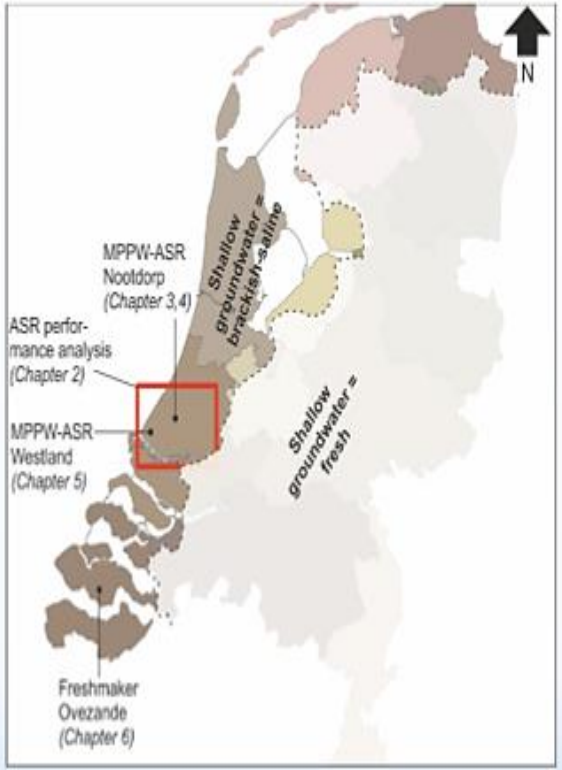
Reference sites in Europe

2010-2014:

1. Mapping of spatial ASR - performance

2. Three field pilots testing optimizations
   - Nootdorp (MPPW)
   - Westland (MPPW + RO)
   - Ovezande (HDDW)

3. Transport modelling (SEAWAT)
   - Compare well configurations
   - Predict future performance



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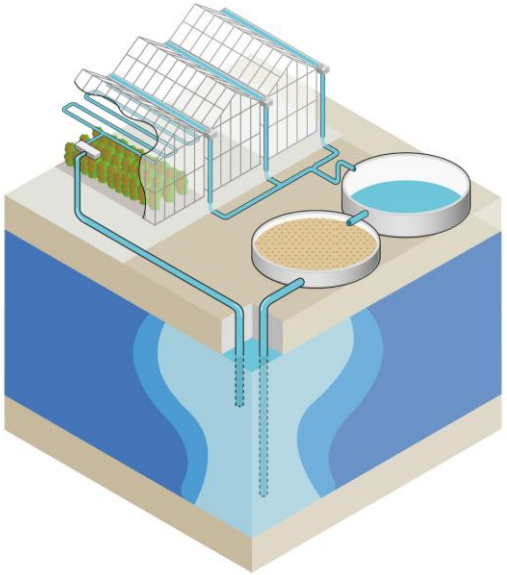
Reference site in Nootdorp

ASR-Coastal (inject water deep, recover in upper area in brackish groundwater environments)



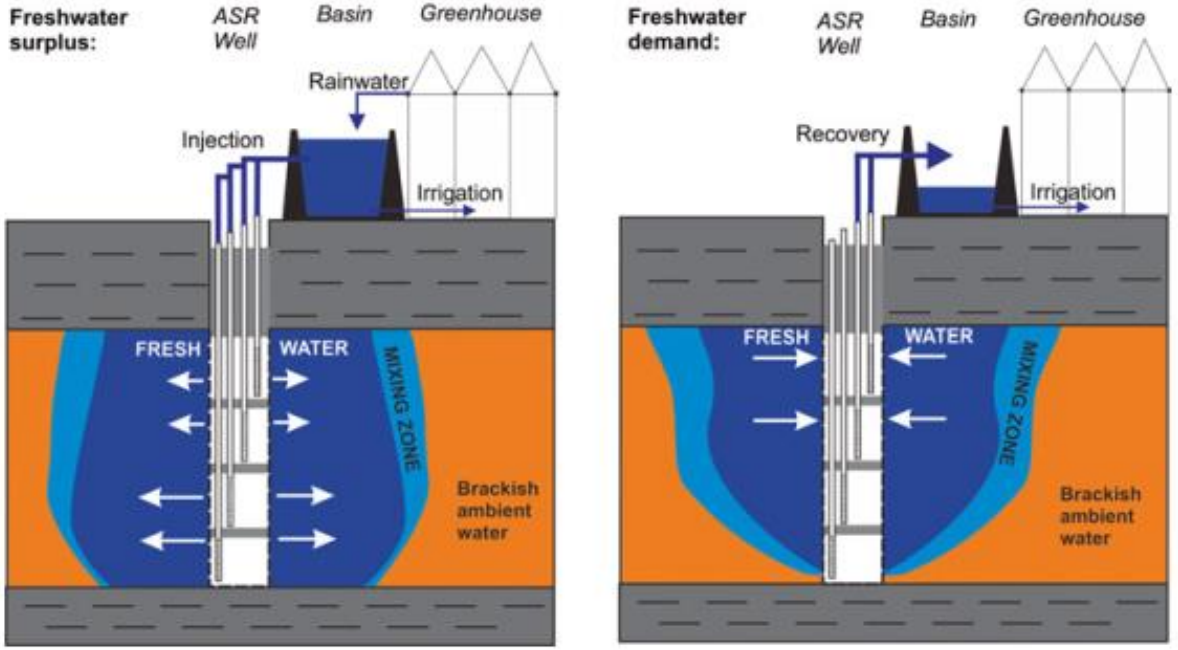


Fig. 3 Use of multiple partially penetrating wells (MPPW) for improvement of freshwater recovery of coastal ASR systems storing rainwater harvested from greenhouse roofs

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Multiple Partially Penetrating Wells (MPPW)

Objective of SWS:	**Temporal storage**
Target conditions:	Brackish aquifers
Artificial recharge:	Yes
Saltwater interception:	No
Well type:	MPPW
Water treatment:	Pre-treatment

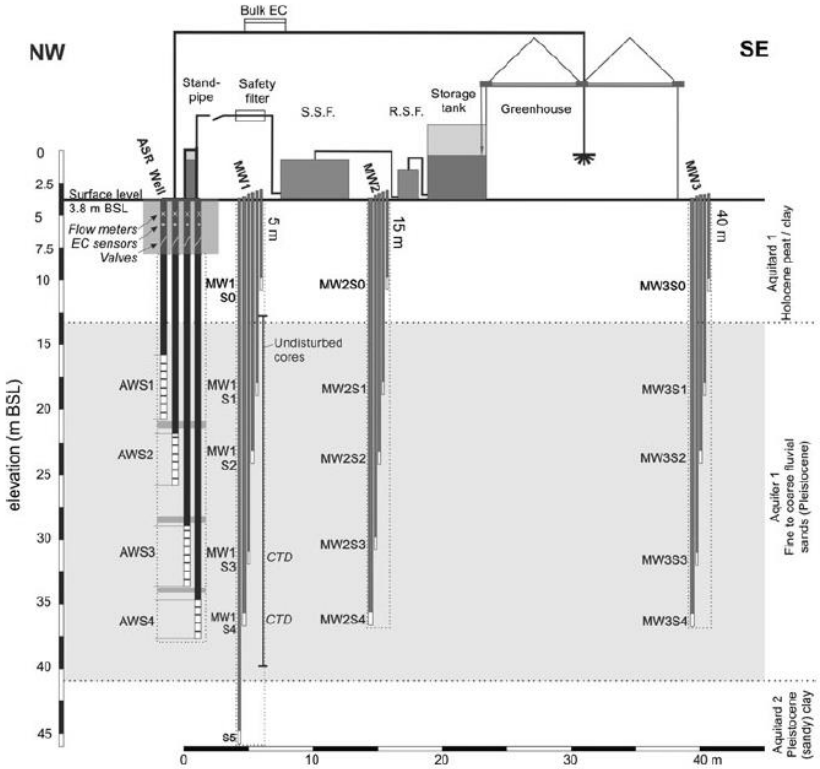

Fig. 4 Cross-section of the Nootdorp ASR system as presented in Zuurbier et al. (2014). Water from the greenhouse is first pre-treated by rapid sand filtration (R.S.F.) and slow sand filtration (S.S.F) and then injected mainly by deeper wells in the aquifer, whereas recovery occurs from the shallow wells

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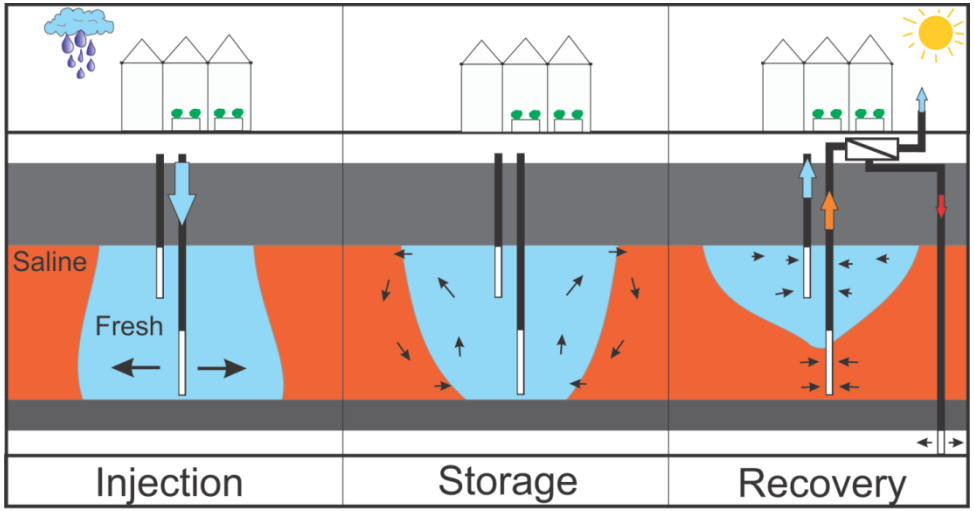
Reference site in Westland

Freshkeeper (protect water supply in abstraction wells prone to salinization: intercept upconing)



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Multiple Partially Penetrating Wells (MPPW) + Reverse Osmosis (RO)

Freshkeeper (protect water supply in abstraction wells prone to salinization: intercept upconing)

Objective of SWS:	**Protect well fields**
Target conditions:	Stratified groundwater quality
Artificial recharge:	No
Saltwater interception:	Yes
Well type:	MPPW + RO
Water treatment:	Pre-treatment

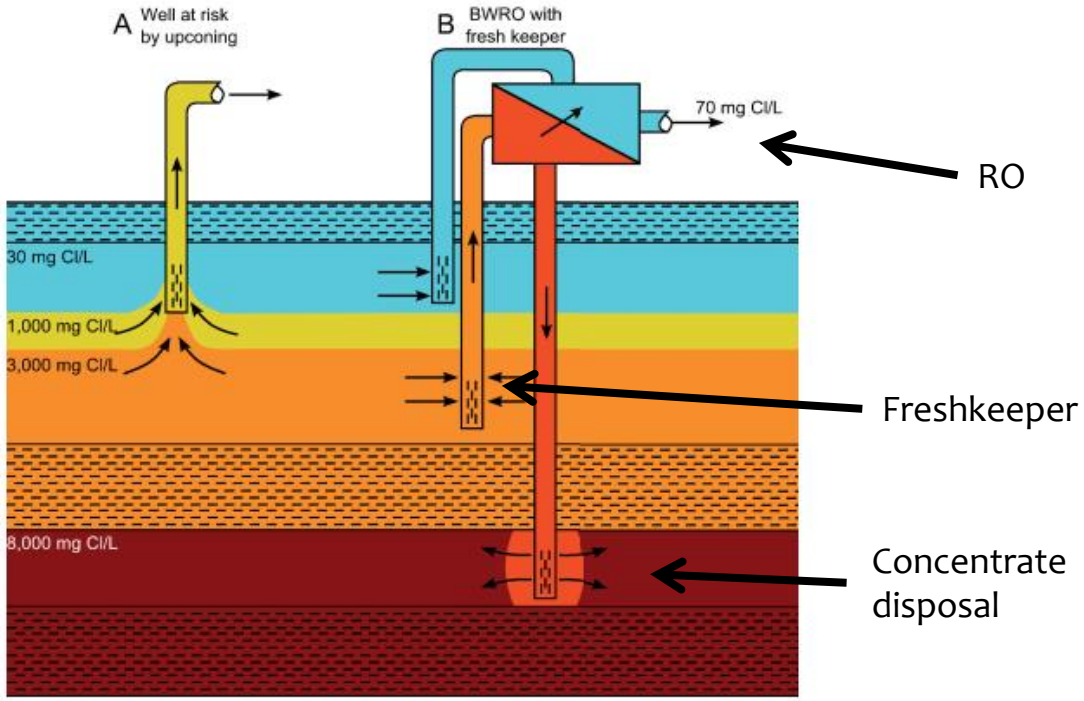

Figure 2. The fresh keeper concept, in combination with BWRO and membrane disposal through deep well injection.

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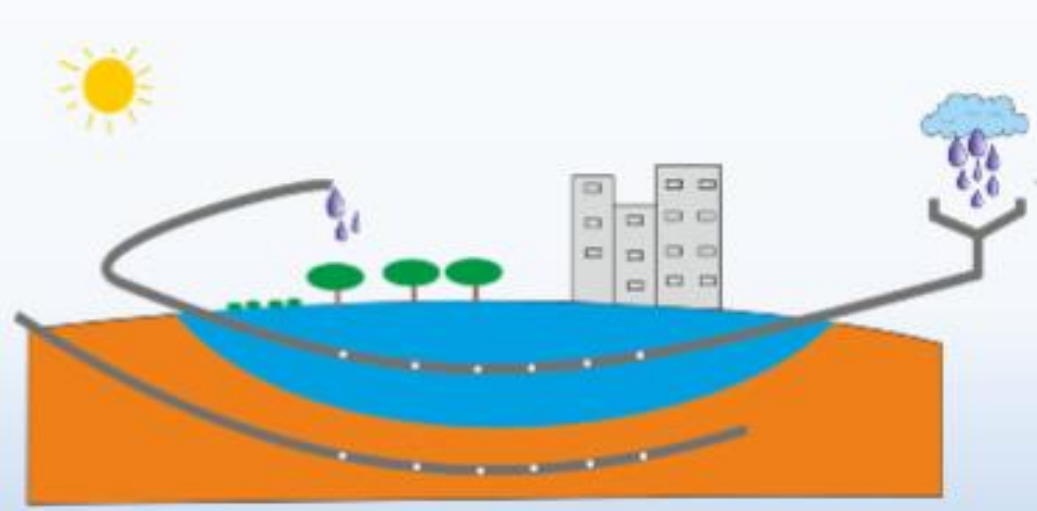
Reference site in Ovezande

Freshmaker

infiltration through horizontal wells, to enlarge and utilize freshwater lenses in coastal areas



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Horizontal Directional Drilled Well (HDDW)

Freshmaker

infiltration through horizontal wells, to enlarge and utilize freshwater lenses in coastal areas

Objective of SWS:	**Temporal storage**
Target conditions:	Freshwater lenses
Artificial recharge:	Yes
Saltwater interception:	Yes
Well type:	HDDW
Water treatment:	Pre-treatment

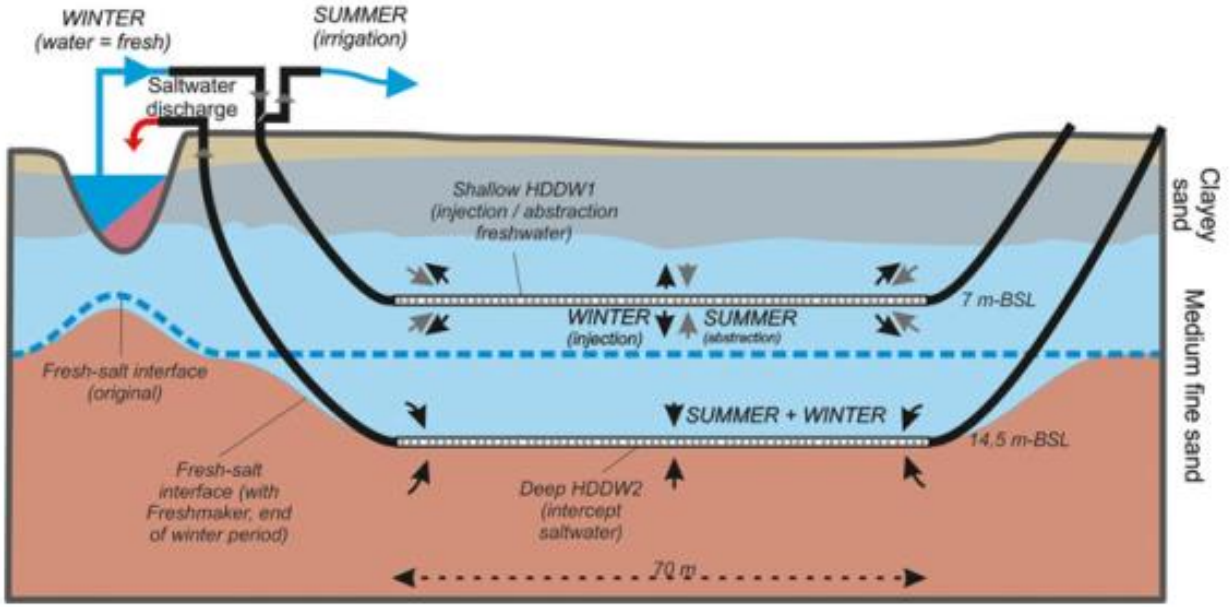

Fig. 6 Use of the Freshmaker principle to enlarge freshwater lenses. Side-view at the HDDWs. Set-up as installed at the Ovezande field-trial. m-BSL = meters below sea-level

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Subsequent steps of cooperation

Objectives at the target site Cyprus:

- Assess scope of problem related to the shortage of fresh water and saltwater intrusion in the coast Identify local stakeholders who are interested in future cooperation
- Share concepts of project technologies and experiences with SWS solutions
- Develop a suitable solution for local problems by adapting to specific framework conditions, demand and barriers to SWS solutions
- Organize promotion events together with local stakeholders, share decision-making tools and business cases
- Invite partners to our reference sites in Europe when concrete project plans are made at a target site

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Thank you for your attention

SubSol consortium

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