Aquifer Storage & Recovery (ASR) to enable water reuse by greenhouse horticulture

Dr. Klaasjan J. Raat
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If you want to travel far, work together

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Water shortages in the Netherlands?
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Netherlands, “Holland” → Low lands (west)
- Clay and peat overlying sandy aquifers
- Brackish and saline groundwater
→ Freshwater shortages for drinking water and agriculture

Drinking water supply to Amsterdam
- Managed Aquifer Recharge
- Infiltration (river water) in coastal dunes
- Keep freshwater lenses intact
- >65 years of experience, 185 Mm³/yr

Managed Aquifer Recharge (MAR)
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Greenhouse (horticulture) industry
High freshwater demand, with very low sodium (Na\(^+\)) content

“Cities of glas”, western Netherlands
- Tomatoes, peppers, cucumbers, flowers
- High irrigation water demand
- Na\(^+\) < 11 mg/L, for recirculation

Potential water sources
- Surface water: 50 – 500 mg-Na/L
- Groundwater: 50 - 3000 mg-Na/L
- Drinking water: 50 mg-Na/L
- Rain water: 1 – 10 mg-Na/L
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Aquifer Storage and Recovery (ASR) to balance water supply and demand

Rain:
Na: 1-10 mg/l

Slow sand filtration

Autumn, Winter

Groundwater:
Na 50 - 3000 mg/l

Spring, Summer

Required:
Na <11 mg/l
Greenhouse (horticulture) industry
Aquifer Storage and Recovery (ASR) to balance water supply and demand

Required: Na <11 mg/l

Groundwater: Na 50 - 3000 mg/l
ASR Coastal
ASR tailor-made for application in saline groundwater environments

Multiple partially penetrating well
ASR Coastal

- Stand pipe
- Sand filter
- Buffer tank

Multiple partially penetrating well

ASR Coastal

Monitoring wells
ASR Coastal
ASR tailor-made for application in saline groundwater environments
ASR Coastal
The new standard for irrigation water supply to greenhouses
ASR Coastal
The new standard for irrigation water supply to greenhouses

PROMINENT TOMATOES
- 30 hectares of greenhouses
- Collective ASR system
- Operational since 2013
- Automated Operation & Control
- CAPEX + OPEX = ~0.30 €/m³

GLASPAREL+
- 250 hectares of greenhouses
- Collective ASR system
- Planned 2018

PROMINENT TOMATOES, WESTLAND
ASR to enable water reuse
Nieuw-Prinsenland, Dinteloord (NL). Greenhouses in development

- 200 ha greenhouses (mainly tomatoes)
- 50 ha industry
- 120 ha sugar factory

- Rainwater in small basins = primary source
- **Estimated 15% deficit (200,000 m³/yr)**
ASR to enable water reuse
Reuse water from food industry → irrigation water for farmers

Sugar factory
- 2.5 mln ton of sugar beets
- 1.8 mln m³ of waste water produced (Sep – Jan)
- 280.000 m³ is treated (reverse osmosis)
- 200.000 m³ freshwater water produced
  (Na < 1mg/L)
- 60 m³/h from September to January

- Where to water store until Spring and Summer?
Sugar Factory:
- Water supply 200,000 m$^3$/j
- Reverse osmosis treatment
- Max. supply rate 60 m$^3$/h
- September - January

ASR system
- Storage: 200,000 m$^3$
- 8 wells, each 25,000 m$^3$
- Max. supply rate: 200 m$^3$/h
- Efficiency: >80%

Greenhouses
- 200 hectares
- Reservoirs: 3,000 m$^3$/ha
- Additional demand: 1,000 m$^3$/ha/j
- April - August
ASR to enable water reuse
Reuse water from food industry → irrigation water for farmers
ASR to enable water reuse
Dinteloord. Performance modelling of eight (4x2) ASR wells
ASR to enable water reuse
Dinteloord. ASR “fill grade” based on historical rainfall / water demand
ASR to enable water reuse

Reuse water from food industry → irrigation water for farmers
ASR to enable rain water harvesting and water reuse

Take home message

The underground provides time and space to balance water supply and demand...

…and thereby enables water reuse.