LIFE-Freshman: Extracting brackish groundwater to enhance Dunea's existing MAR system in the coastal dunes of The Hague

Freshman project

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dunea DUIN & WATER

KWR

AMSTERDAM INTERNATIONAL WATER WEEK

Workshop: November 8, 2023

Regional strategies and advanced groundwater management to sustain

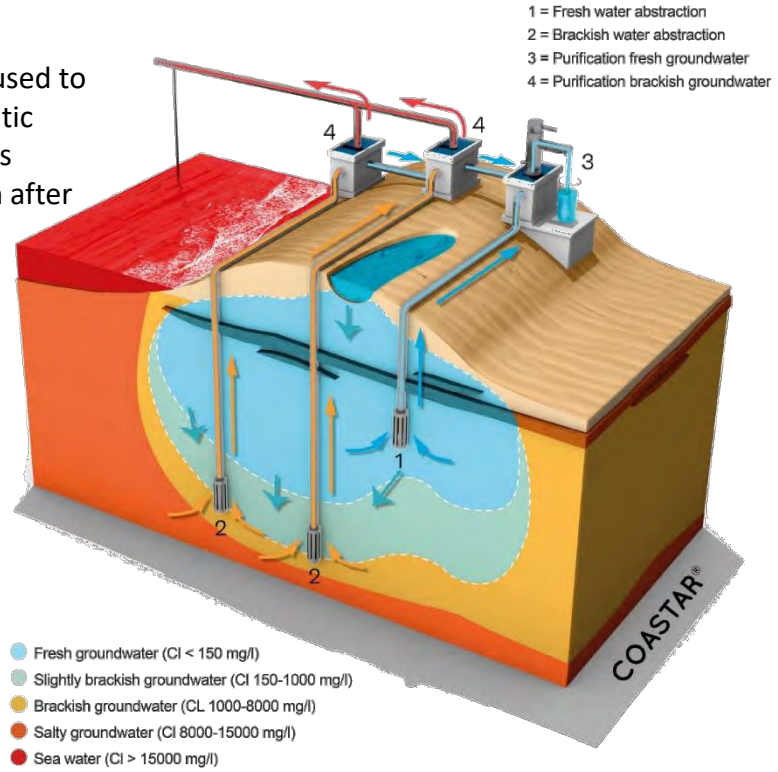
Life

MAR & Brackish groundwater extraction

MAR relies on continuous river water infiltration

No infiltration?:

- Deeper wells are used to prevent low phreatic groundwater levels
- Risk of salinization after approximately 5 weeks



Brackish groundwater extraction:

→ Interception of brackish groundwater to protect deep fresh wells

→ Additional source of fresh water (after RO)

→ Increase of fresh groundwater availability

Regular infiltration/production	≈ 80,000,000 m^3/j
Pilot: brackish groundwater extraction	≈ 400,000 m^3/j
	→ **0,5%**

Freshman project

Extraction wells
Fresh & brackish

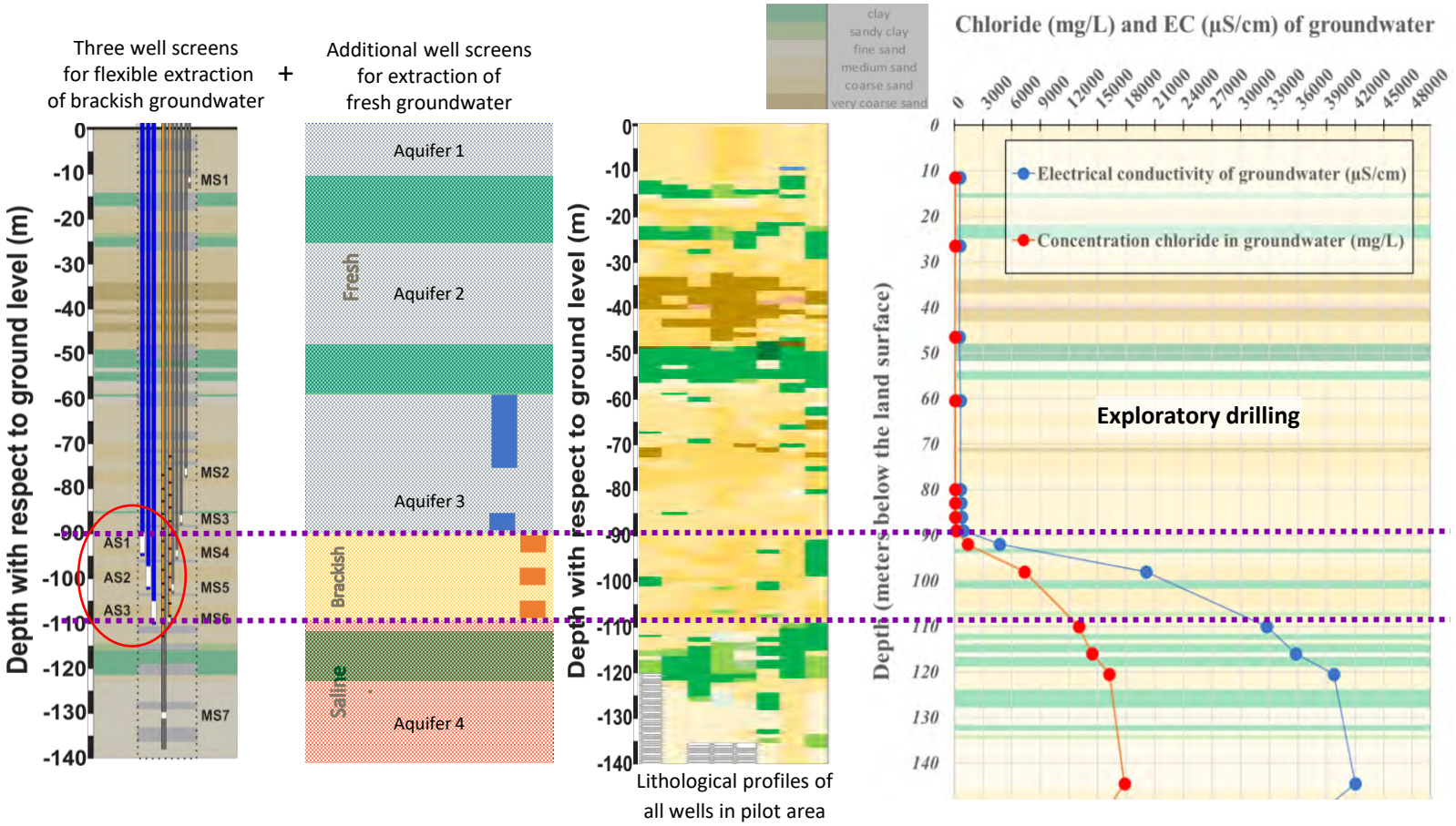
Treatment facility
Candle filter & RO

dunea.nl/algemeen/life-freshman

Monitoring well

The Freshman project is supported by the EU LIFE Climate Action Programme under Grant Agreement number LIFE19 CCA/NL/001222.

Geohydrological setting and design of the extraction well for brackish groundwater



Pilot phases

Freshman project

Start pilot: 31-1-2022

- 1.5 years extraction of brackish groundwater (pumping rate 50 m3/hr) — 31-1-2022
  → increase volume of freshwater lens (‘downconing’) and testing RO
- 3 months rest — 31-7-2023
  → partial recovery of original situation

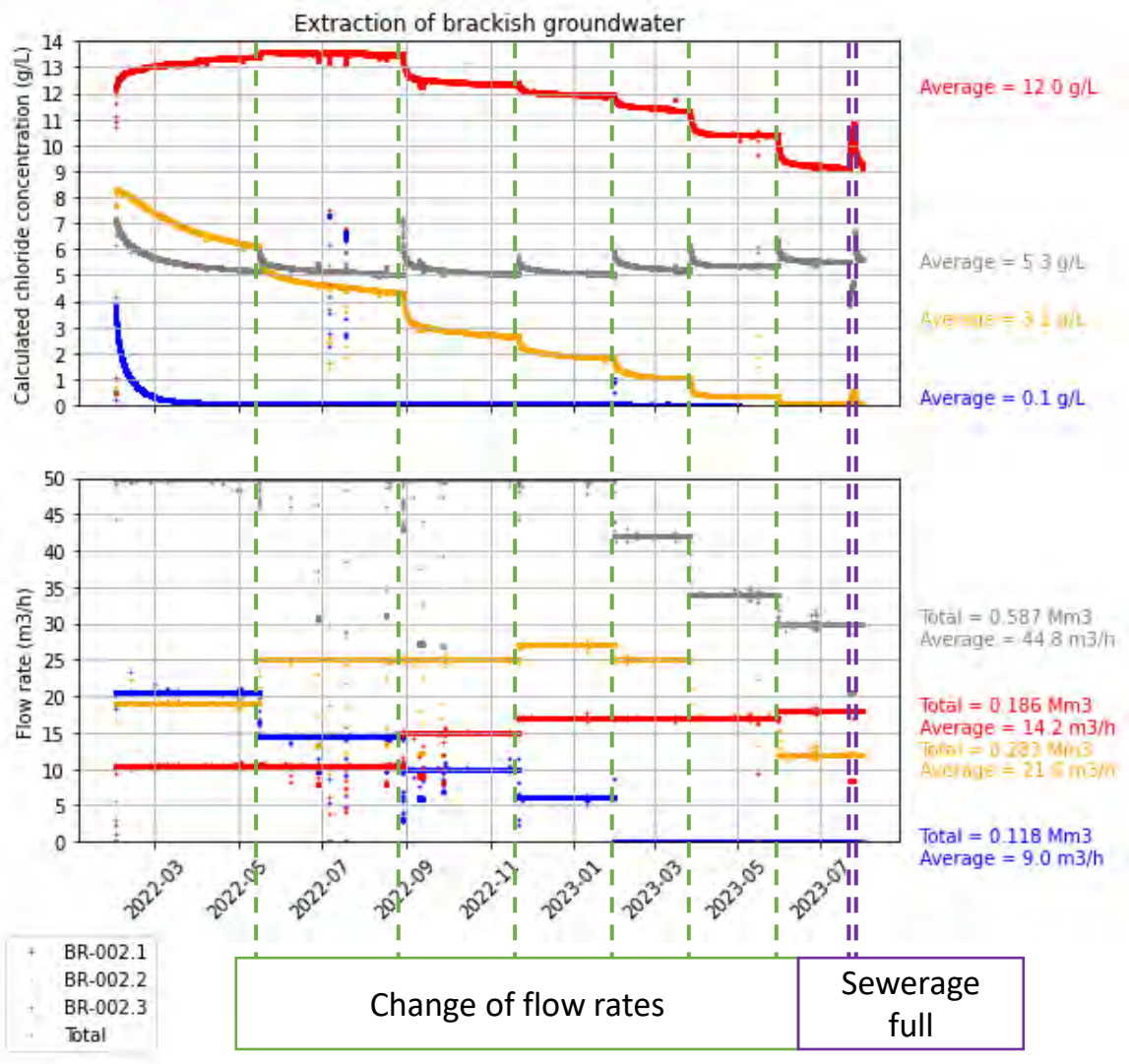
- 4 months extraction of deep fresh groundwater — 6-11-2023
  → decrease volume of freshwater lens (‘upconing’)
- 6 months extraction of brackish groundwater — March 2024
  → downconing
- 4 months simultaneous extraction of fresh ánd brackish groundwater — Sept. 2024
  → stabilize the fresh/brackish groundwater interface
  (increasing our robustness against calamities)

End pilot: February 2025

Extraction:

Chloride concentration:

Flow rate:

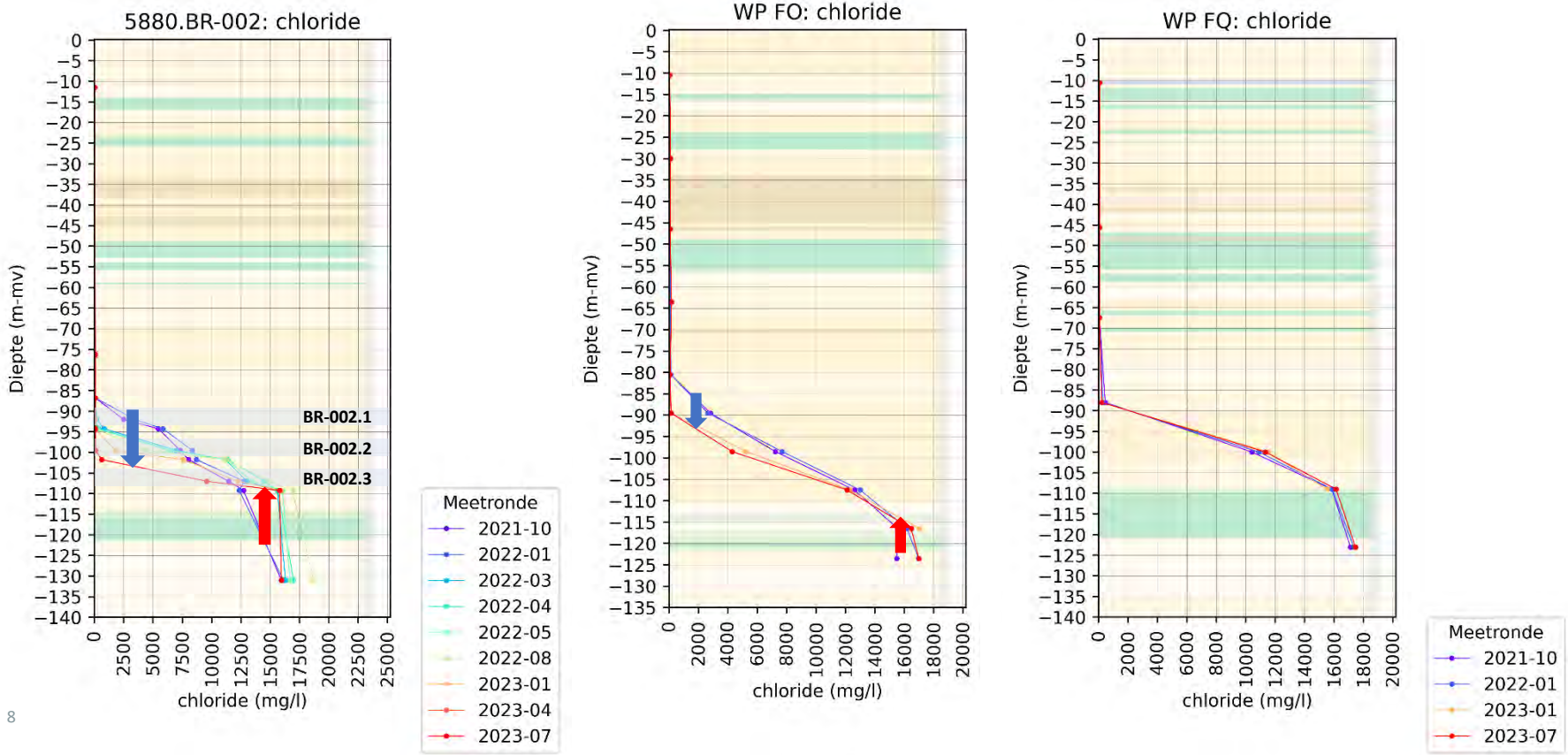


Next phase started on 6-11-2023

Extraction of fresh groundwater with BR-001.1

Cl measurements in groundwater during BGW extraction

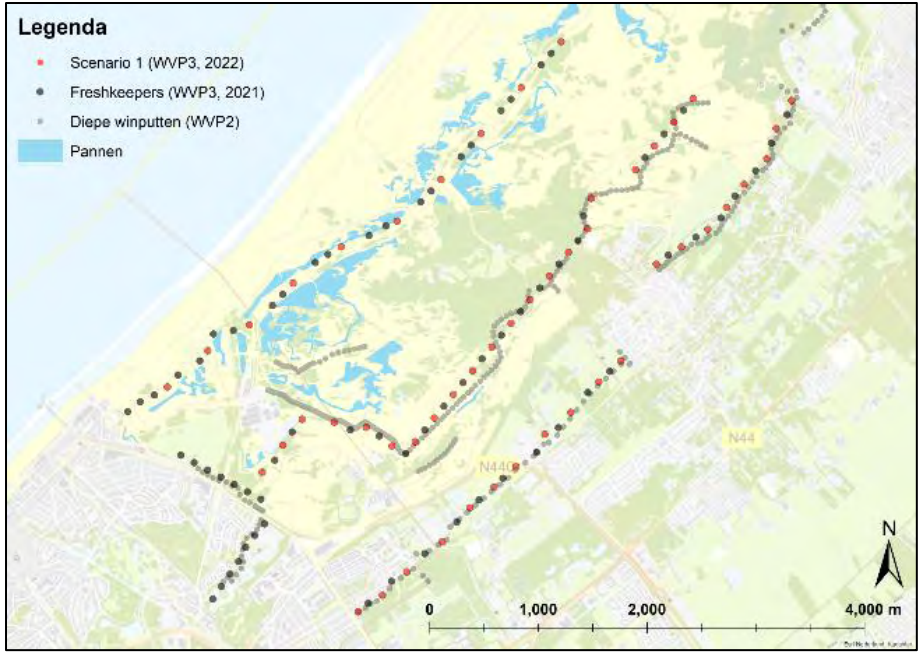
Extraction → 30 m → 130 m



Van pilot naar (model voor) full scale winning

- <u>Brakwaterwinputten</u>
  - 10 winputten westelijke raai
  - 21 winputten centrale raai
  - 19 winputten oostelijke raai
  - Debiet: 20 m^3/u per winput
  - Filterdiepte: NAP -90 t/m -100 m

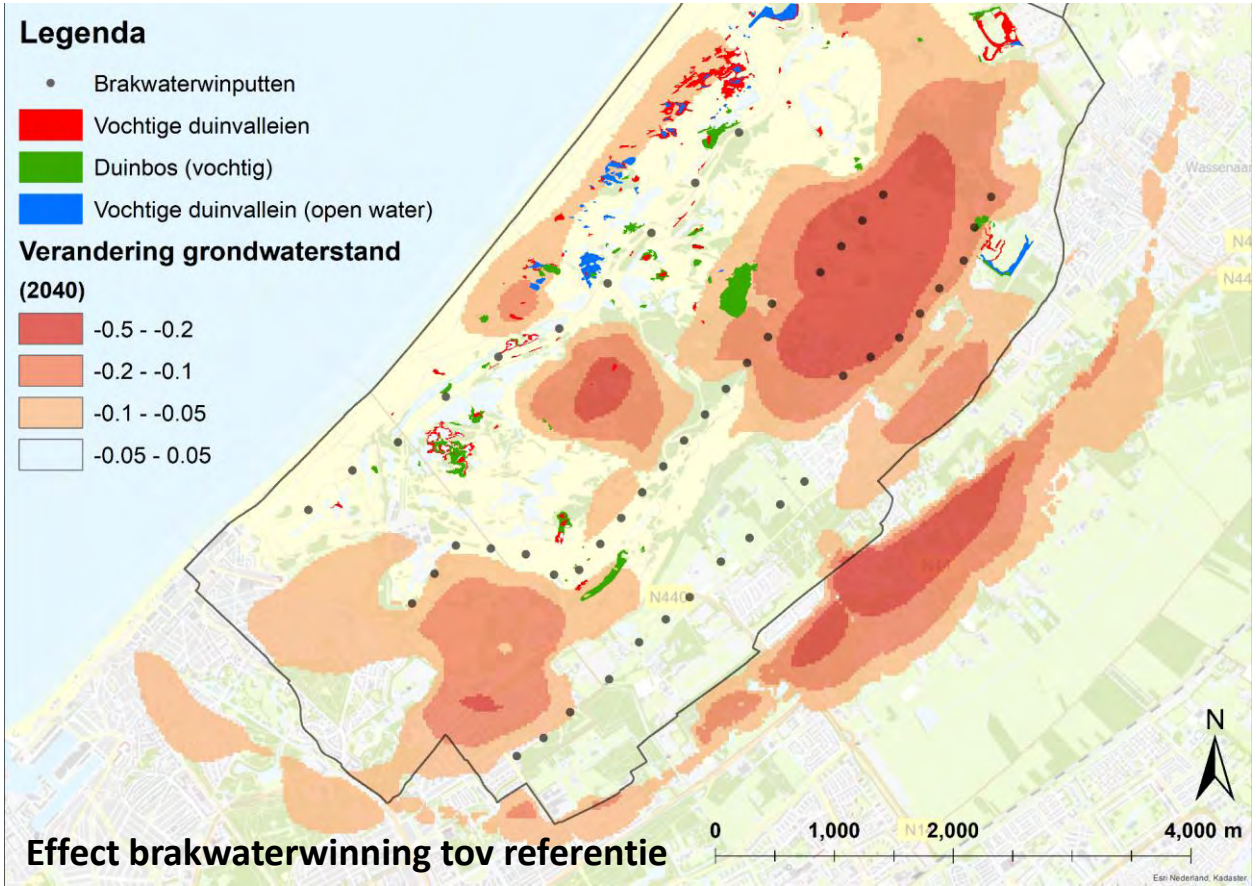
- Voor scenario BW1 en referentie geldt:
  - Periode 2030 t/m 2080
  - Klimaatscenario G_H (KNMI ’14)
  - Zeespiegelstijging
    - NAP 0,16 m in 2030
    - NAP 0,56 m in 2080



Scenario BW1

- Effect brakwaterwinning in 2040
- Brakwaterwinputten
  - 10 winputten westelijke raai
  - 21 winputten centrale raai
  - 19 winputten oostelijke raai
  - Debiet: 20 m^3/u per winput
  - Filterdiepte: NAP -90 t/m -100 m

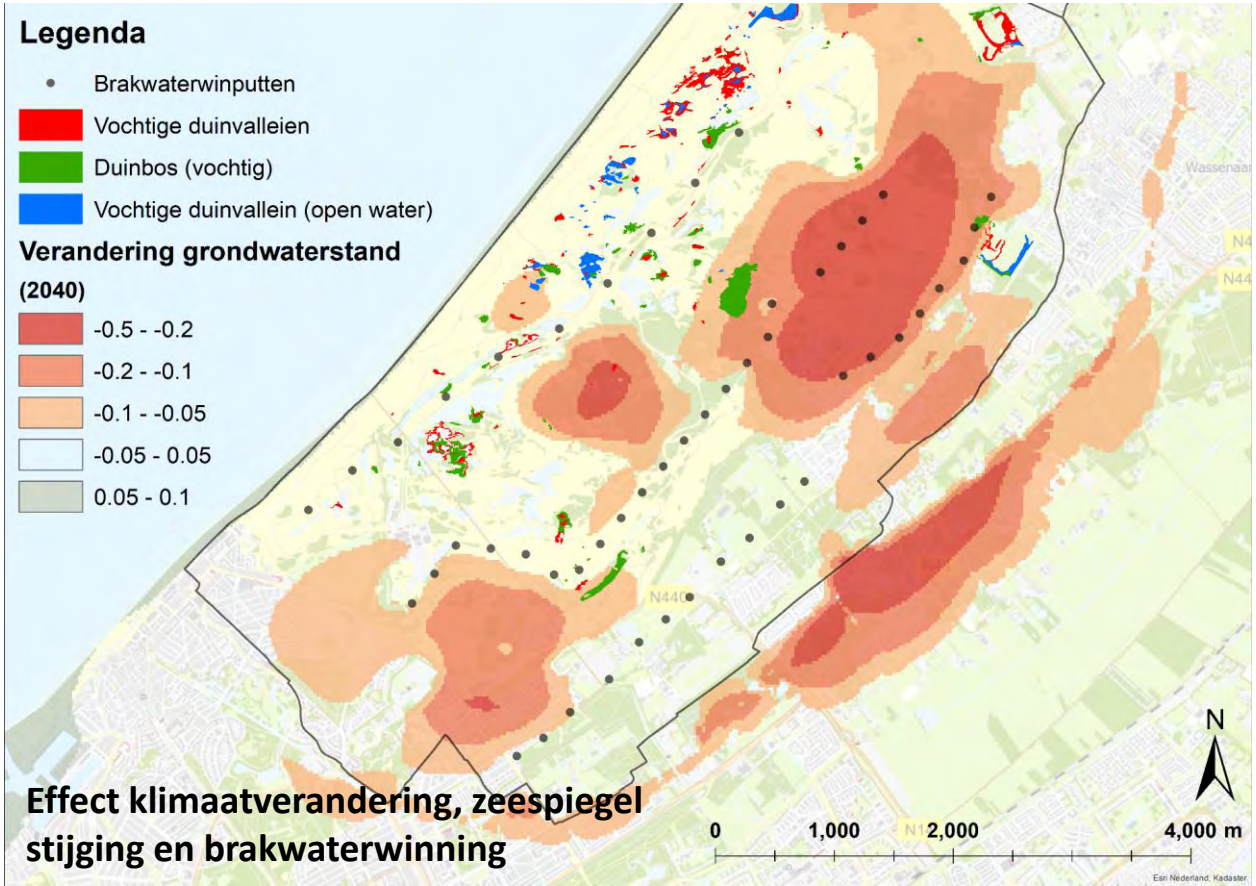
Verandering freatische grondwaterstand (2040)



Scenario BW1

- Effect klimaatscenario, SLR en brakwaterwinning in 2040
- Brakwaterwinputten
  - 10 winputten westelijke raai
  - 21 winputten centrale raai
  - 19 winputten oostelijke raai
  - Debiet: 20 m^3/u per winput
  - Filterdiepte: NAP -90 t/m -100 m
- Voor zowel scenario BW1 als referentie geldt:
  - Periode 2030 t/m 2080
  - Klimaatscenario G_H (KNMI '14)
  - Zeespiegelstijging
    - NAP 0,16 m in 2030
    - NAP 0,56 m in 2080

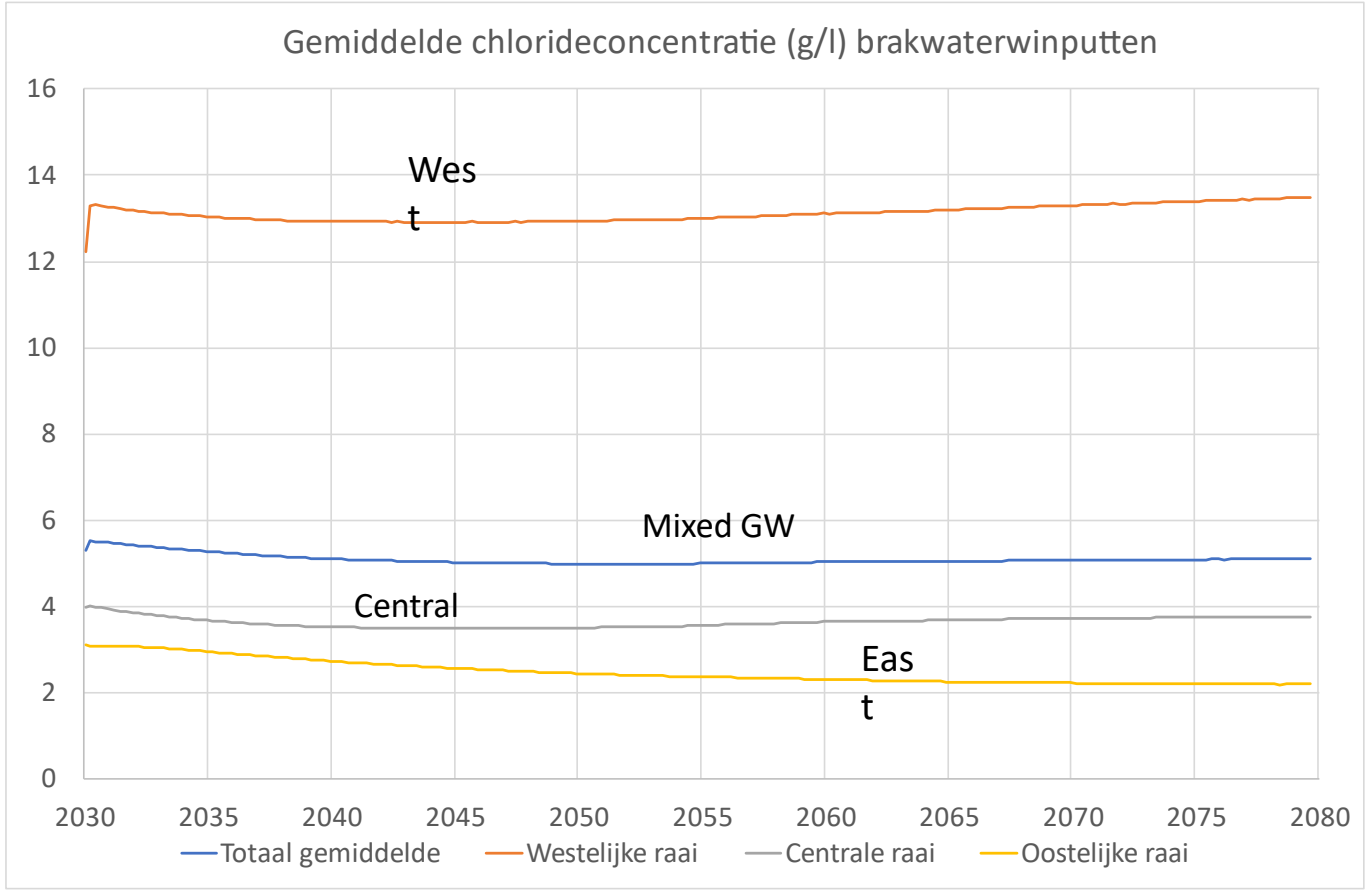
Verandering freatische grondwaterstand (2040)



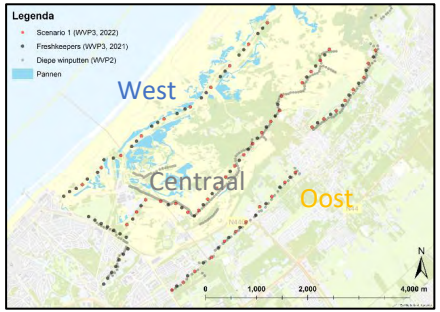
Effect klimaatverandering, zeespiegel stijging en brakwaterwinning

Modelling full scale brackish water abstraction (1000 m3/hr)

Chloride concentration (g/l) extraction wells

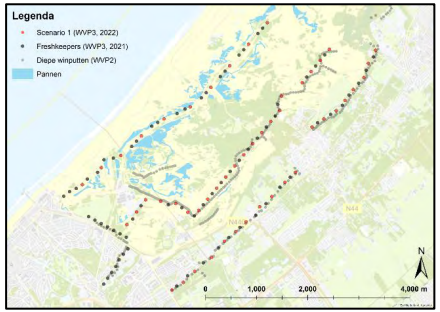


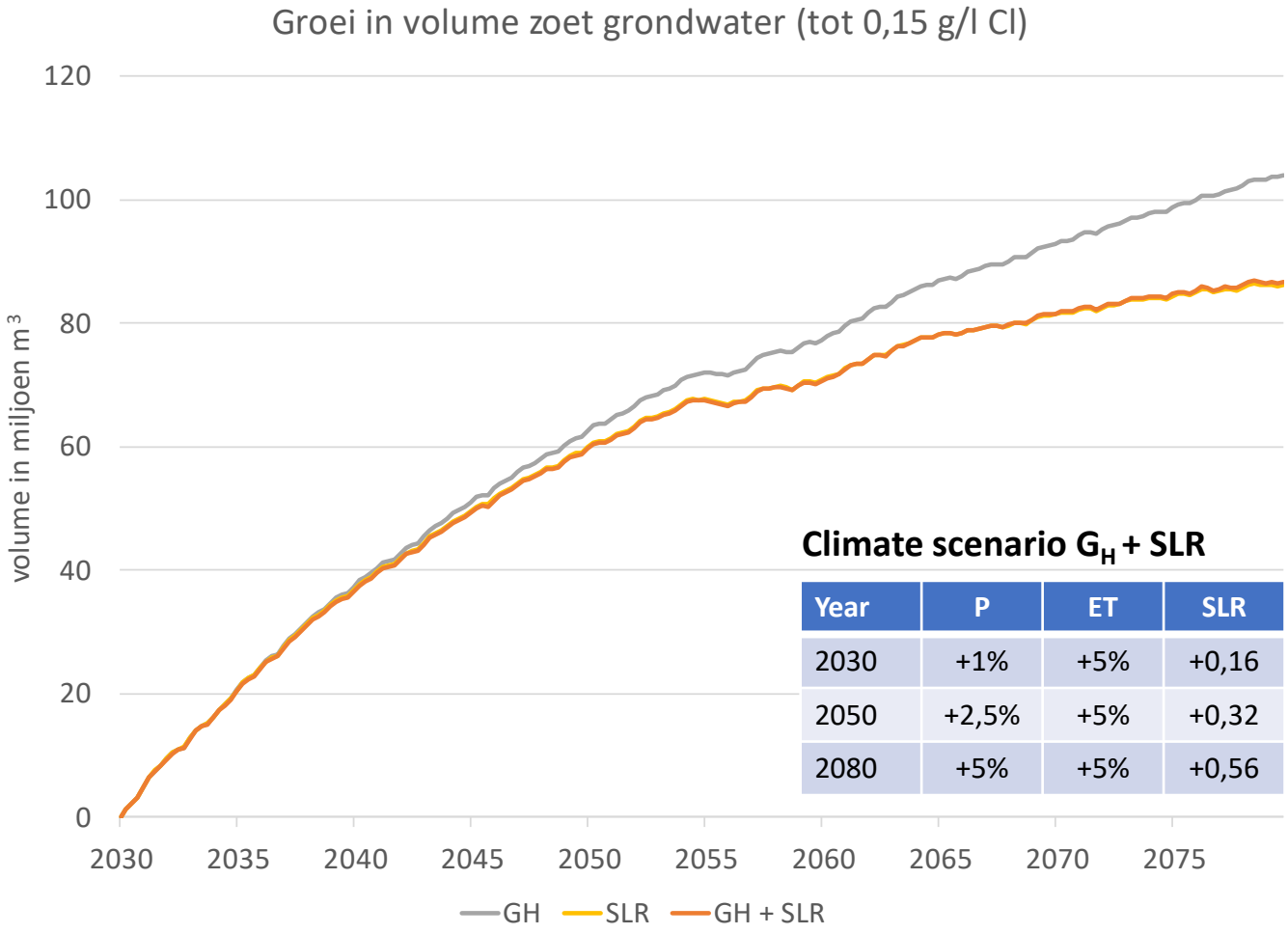
Three well series



Growth of the freshwater lens during 50 years of abstraction

Three well series



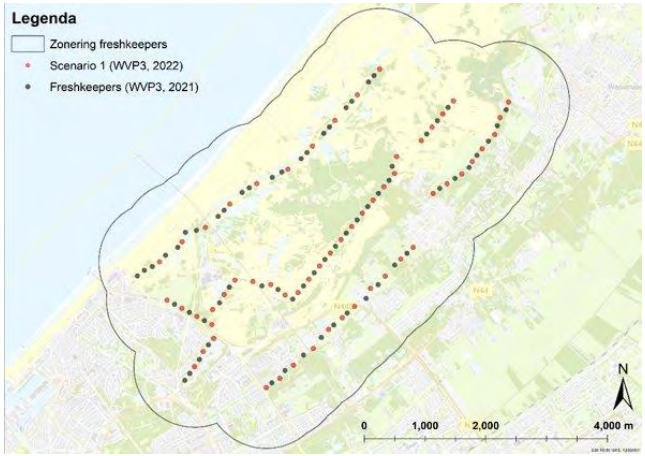


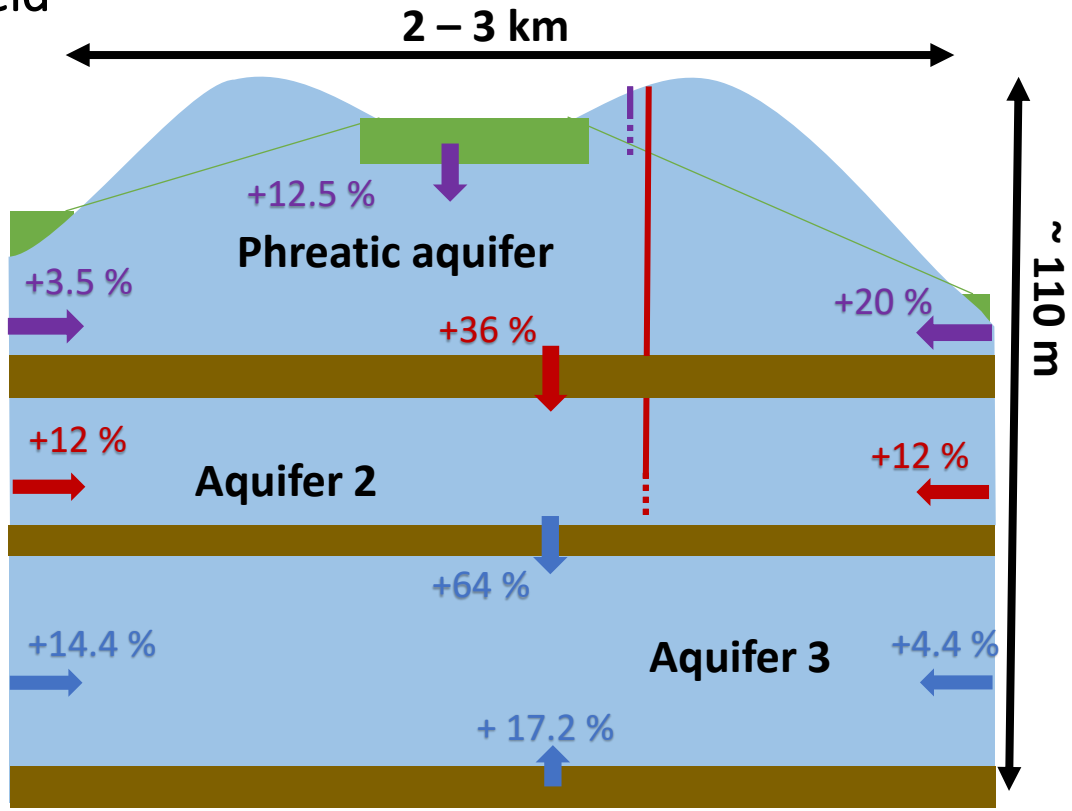
Climate scenario G_H + SLR

Year	P	ET	SLR
2030	+1%	+5%	+0,16
2050	+2,5%	+5%	+0,32
2080	+5%	+5%	+0,56

Water balance full scale well field

- Only 12.5% additional net freshwater infiltration
- Increased freshwater availability is mainly attributed to the decrease of lateral outflow of fresh groundwater





Omkering stromingsrichting WVP2 – hoe lang gaat dat goed?