

Potential map for large-scale implementation of subsurface water solutions: COASTAR

Gualbert Oude Essink^{1,2}, Esther van Baaren¹, Sandra Galvis Rodriguez¹, Koen Zuurbier³, Klaasjan Raat³, Jan Willem Kooiman³, Toon Boonekamp⁴

¹Deltares, Utrecht, The Netherlands

²Utrecht University, Utrecht, The Netherlands

³KWR Watercycle Research Institute, The Netherlands

⁴Arcadis, The Netherlands

ABSTRACT

Currently, already a large part of the global population experiences water scarcity at least once a month. On top, fresh groundwater resources are deteriorating in an ever more populated urbanized world. In coastal areas, increased groundwater extraction rates and climate change stresses (including sea-level rise) are expected to increase the shortage of enough high quality water at the right place and on the right moment (Custodio, 2002; Döll, 2009; Vorosmarty et al., 2000; Wada et al., 2010, 2014). Fresh groundwater resources in the coastal zone are also facing serious salinization issues (van Weert et al., 2009). Increasing water scarcity may limit food production, putting pressure on food prices (UNESCO, 2009), and could eventually possibly act as a catalyst for conflicts causing large scale immigration. Up till now, Aquifer Storage and Recovery in (saline) deltaic areas has been focused on fresh water resources, but in this Water-Food-Energy Nexus era, brackish groundwater should be considered as additional valuable water source (Fig. 1). The COASTAR approach (COastal Aquifer Storage And Recovery) is to prevent salinization by strategically capturing and using brackish groundwater in the production of fresh water. For now, we focus on the technical and financial-economic feasibility. For the lower areas of The Netherlands, we started to investigate the potential of the subsurface to attain a robust and sustainable fresh water supply and to combat droughts.

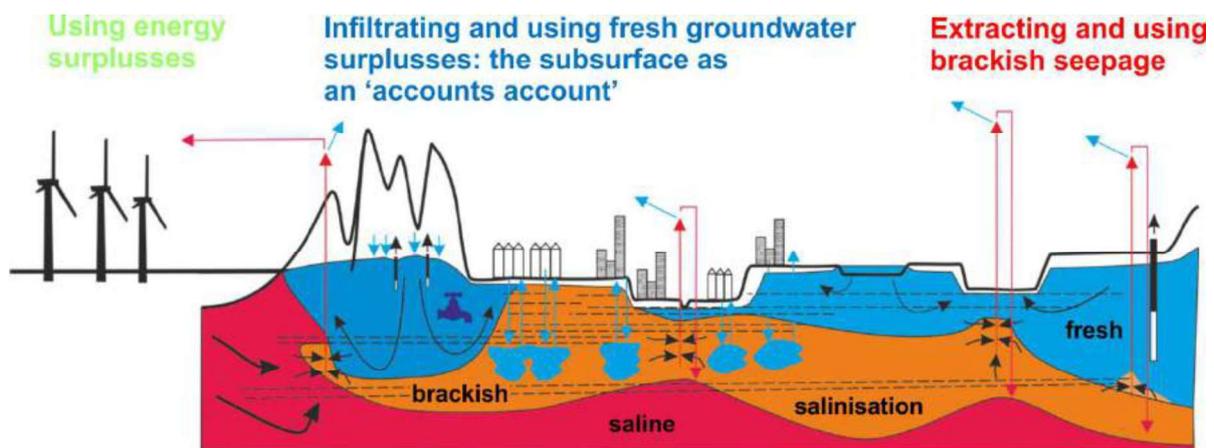


Figure 1. A conceptual schematization of COASTAR: Subsurface water solutions using brackish groundwater when possible.

The ultimate aim is to implement proven subsurface water solutions worldwide, as we believe this approach could serve as a bridge between water demand and supply as regards to space and time. In Fig. 2, we present a global potential map for large-scale implementation

of COASTAR subsurface water solutions: the map shows quite some areas with brackish groundwater resources potential.

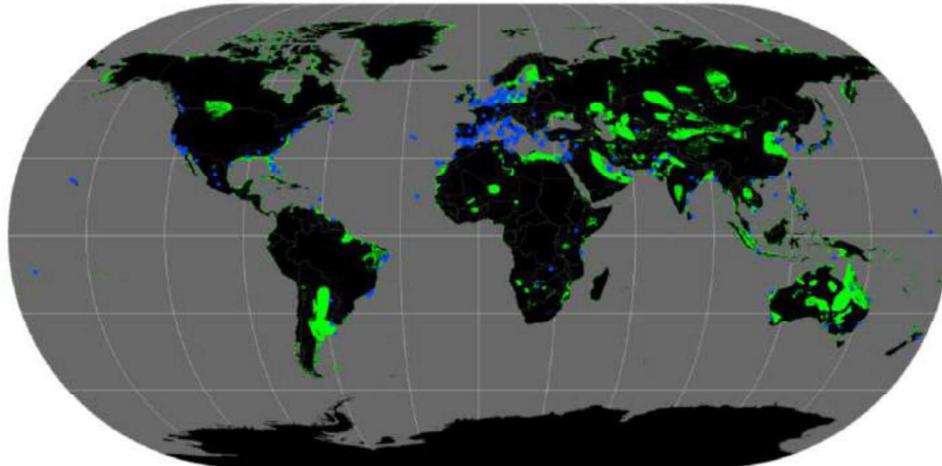


Figure 2. The World COASTAR map (version 1.0): the green parts are potential areas for subsurface water solutions. The map contains information about DEM, transmissivity of the aquifer system, the presence of a sedimentary medium and the IGRAC saline groundwater map (van Weert et al., 2009); the blue dots are locations of case studies where groundwater salinization issues are occurring now.

REFERENCES

- Custodio, E. (2002). Aquifer overexploitation: what does it mean? *Hydrogeology Journal*, 10(2), 254–277. <https://doi.org/10.1007/s10040-002-0188-6>
- Döll, P. (2009). Vulnerability to the impact of climate change on renewable groundwater resources: a global-scale assessment. *Environmental Research Letters*, 4(3), 35006. <https://doi.org/10.1088/1748-9326/4/3/035006>
- UNESCO. (2009). *Water in a Changing World. World Water* (Vol. 11). <https://doi.org/10.3390/w3020618>
- Vorosmarty, C. J., Green, P., Salisbury, J., & Lammers, R. B. (2000). Global Water Resources: Vulnerability from Climate Change and Population Growth. *Science Magazine*, 289(JULY), 284–288. <https://doi.org/10.1126/science.289.5477.284>
- Wada, Y., Wisser, D., & Bierkens, M. F. P. (2014). Global modeling of withdrawal, allocation and consumptive use of surface water and groundwater resources. *Earth System Dynamics*, 5(1), 15–40. <https://doi.org/10.5194/esd-5-15-2014>
- Wada, Y., Van Beek, L. P. H., Van Kempen, C. M., Reckman, J. W. T. M., Vasak, S., & Bierkens, M. F. P. (2010). Global depletion of groundwater resources. *Geophysical Research Letters*, 37(20), L20402. <https://doi.org/10.1029/2010GL044571>
- van Weert, F., van der Gun, J., & Reckman, J. (2009). *Global Overview of Saline Groundwater Occurrence and Genesis. IGRAC, GP 2009-1*.

Contact Information: Gualbert Oude Essink, Deltares and Utrecht University, Daltonlaan 600, 3584 BK Utrecht, PO Box 13040, 3507 LA Utrecht, The Netherlands, +31 6 3055 0408
Email: gualbert.oudeessink@deltares.nl