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Impact of climate change on the groundwater flow system of the water board of Rijnland, The Netherlands

Gualbert Oude Essink[1] & Frans Schaars[2]

ABSTRACT

The water board of Rijnland, in the western coastal part of The Netherlands, is situated below mean sea. The groundwater system of the water board already contains brackish and saline groundwater, as the area is situated close to the sea. The system is not yet in a steady-state situation. In addition, future developments as climate change, sea level rise, land subsidence and human activities (possibly land reclamation in front of the coast and changes in groundwater extraction rates) will lead to quantitative and qualitative changes in the groundwater system. The water board of Rijnland initiated a study to assess the effects of different climate scenarios stresses on density dependent groundwater flow in this system. A numerical model was created to quantify changes in density dependent groundwater flow, head and salinity distribution, as well as seepage and salt load fluxes to the surface water system. The computer code MOCDENS3D (Oude Essink, 1998, 2001) create the model in three dimensions with a surface of 3150 km^2 by 190 m thick, whereas over 1,2 million elements were used to simulate the coastal groundwater system. Numerical computations show that a serious salt water intrusion can be expected during the coming tens of years. For the coming 50 years, the order of importance to the contribution of salt water intrusion will be: 1. the autonomous development, 2. the land subsidence of the polder area, and 3. the rise in sea level. For instance, the combined effect for the year 2050 AD for the maximum scenario of climate change is: an 8% increase of the seepage and a 41% increase of the salt load. The more rapid increase in salt load is caused by the salinisation of the upper aquifers. The increase in especially salt load will definitely affect surface water management aspects at the water board, even for the autonomous case (nearly 30% increase of salt load for the year 2050 AD).

References

- Oude Essink, G.H.P., MOC3D adapted to simulate 3D density-dependent groundwater flow, In: *Proc. of the MODFLOW'98 Conference, October 4-8, 1998, Golden, Colorado, USA, Volume I, pp. 291-303, 1998.*
- Oude Essink, G.H.P., Salt Water Intrusion in a three-dimensional groundwater system in The Netherlands: a numerical study, *Transport in Porous Media*, **43** (1): *137-158, April 2001*.

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Corresponding author:
Gualbert H.P.Oude Essink
1. Netherlands Institute of Applied Geosciences (NITG), Princeton 6, 3584 CB Utrecht, The Netherlands, g.oudeessink@nitg.tno.nl
2. Free University (VU), Faculty of Earth and Life Sciences, De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands, oudg@geo.vu.nl