Promotie Sebastian Huizer

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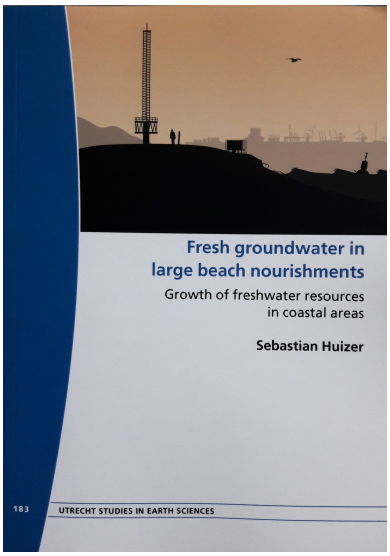
The groundwater system at the Sand Engine was modelled and intensively monitored in order to predict the effects of tides, waves and storms surges on fresh groundwater resources. A substantial increase in fresh groundwater resources is expected, making this pilot a blueprint for coastal areas around the world under water shortage stresses.



Fresh groundwater in large beach nourishments

One of the potential responses is to protect coastal communities and their vulnerable fresh groundwater resources, is to actively protect the coast against erosion and flooding with large beach nourishments. One prime example of this strategy is The Sand Engine (also called 'De Zandmotor' in Dutch), which is a mega-nourishment that was constructed at the Dutch coast in 2011. Since the Sand Engine is the first of its kind, little is known about the influence of mega-scale beach nourishments on existing fresh groundwater resources in the coastal zone which are often used for drinking water production. This raised the question: What is the impact of a large beach nourishment on coastal fresh groundwater resources? This question was answered with four sub-questions:

1. What is the potential increase in fresh groundwater resources over a long period, as widening the dune area should lead to bigger fresh groundwater lenses?
2. What is the impact of tides, waves and storms on the fresh groundwater lens?
3. What were the changes in the volume of fresh groundwater in the study area of The Sand Engine since its construction in 2011, and which processes drove these changes?
4. Which coastal sites are potentially suitable for large-scale beach nourishments, with regard to the growth of existing fresh groundwater resources?

Variable-density groundwater flow and coupled salt transport model simulations – calibrated and validated with (geophysical) measurements – which include morphological changes of the Sand Engine confirmed that the construction of a large beach nourishments led to an increase of the volume of fresh groundwater. Until 2016 the growth in fresh groundwater resources was determined primarily by the groundwater recharge, land-surface inundations due to storm surges, groundwater in- and outflow, and to a lesser extent by geomorphological changes. This suggests that large beach nourishments may become an interesting solution for some coastal areas around the world to serve two objectives: to protect the hinterland and its inhabitants from flooding and to increase fresh groundwater resources which could be used as a resource of fresh water for domestic use. Simulations showed that large beach nourishments will likely lead to a (temporary) increase of fresh groundwater resources in most settings, and therefore potentially for most erosive sandy shores.

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Articles

- Huizer, S., Radermacher, M., de Vries, S., Oude Essink, G. H. P., and Bierkens, M. F. P. 2018. Impact of coastal forcing and groundwater recharge on the growth of a fresh groundwater lens in a mega-scale beach nourishment, Hydrol. Earth Syst. Sci., 22, 1065-1080, https://doi.org/10.5194/hess-22-1065-2018.
- Huizer, S., Karaoulis, M.C., Oude Essink, G.H.P., Bierkens, M.F.P., 2017, Monitoring and simulation of salinity changes in response to tide and storm surges in a sandy coastal aquifer system, Water Resources Research, doi: 10.1002/2016WR020339. *download*
- Huizer, S., Oude Essink, G.H.P., Bierkens, M.F.P., 2016, Fresh groundwater resources in a large sand replenishment, Hydrol. Earth Syst. Sci., 20, 3149-3166, doi:10.5194/hess-20-3149-2016. *download*