

## Workshop 3 – Hydrology and management of dunes and estuaries

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### Introductory statements *(for full-text articles see Proceedings)*

1. The role of hydrogeological research in the realization of a combined pumping and deep infiltration system at the excavation ‘Duinenabdij’ (*Louwyck et al.*)
2. Sustainable groundwater management of a dune aquifer by re-use of wastewater effluent in Flanders, Belgium (*Van Houtte et al.*)
3. The importance of groundwater and other ecohydrological impacts in the management of salt marsh plant communities (*Boorman & Hazelden*)
4. Supporting dune management by quantitative estimation of evapotranspiration (*Samson et al.*)

### Major questions/statements

1. The *role of hydrogeological research and groundwater modelling* in dune management is very important.
2. Is *recharge of extracted dune aquifers* (water catchment, drainage, etc.) by means of infiltration realizable?
3. Can *artificial recharge of treated waste water* be beneficial to the dune ecosystem? And does EC-legislation hinder this?
4. For (re)creation of salt marshes, *knowledge of the fresh-water situation* is crucial.
5. Will a good quantitative estimation of *evapotranspiration* of various vegetation types lead to changes in dune management?

## Discussion/answers to questions

### 1. The role of hydrological research and groundwater modelling

*(based upon introductory statement 1)*

#### Discussion

**Roeland Samson:** (Q) Has the used model already been calibrated? (A) Not yet, because we were not involved in the following up of the drainage system. However, the model has been calibrated with a double pumping test and under the assumption of homogeneity of the concerned permeable and semi-permeable layers. This should be sufficient to guarantee an efficient functioning of the system.

**Ralf Gyselings:** (Q) Is the underground very homogeneous or heterogeneous, and how is this presented in the hydrological model? (A) The situation in ‘Duinenabdij’ is quite homogeneous, which is confirmed by the various borehole descriptions and the geophysical borehole measurements. Based on these data, the studied groundwater reservoir was schematised in three permeable layers, separated by two semi-permeable layers. Below, the aquifer is bounded by a Tertiary clay layer which was considered impervious in this study.

**Luc Geelen:** (Q) Is there also a rise of the freatic groundwater level measured/calculated? (A) The influence area is only dune area, and a moistening of the soil is favourable in this area. Furthermore, this rise is kept small by letting the infiltration happen in a deep aquifer, under the uppermost semi-permeable layer.

**Arjen Kok:** (Q) The aim to use a hydrological model is of course to calculate the drawdown of the hydraulic head in the different aquifers. Has there been also research on the effects of changing the water quality? (A) The studied aquifer only contains fresh water. The extracted water is immediately deep infiltrated by means of a ‘closed’ system, which prevents the water to oxidize.

**Piet Veel:** (Q) Without modelling, what would have happened? (A) Modelling the system enabled us to find the optimal well configuration and to estimate the required discharges. Without modelling one risks an overestimation or underestimation of these discharges and ‘too dry’ or ‘too wet’ circumstances as a consequence.

**Laurence Boorman:** (Q) Has there been any interaction between surface and groundwater? What was the size/scale of the model? (A) There is no relation between surface and groundwater. The scale of the model is 1 by 1 km.

#### Conclusion

*The role of hydrological research and groundwater modelling in dune management is very important, since one is dealing with a vulnerable dune situation. Investing in detailed hydrological research and groundwater modelling is essential.*

**2. Is recharge of extracted dune aquifers (water catchment, drainage, etc.) by means of infiltration realizable?** *(based upon introductory statement 2)*

**Discussion**

**Roeland Samson:** (Q) Is the infiltration system cost effective, what are the costs? (A) Costs: 250,000 EUR drilling and infrastructure, 2,500 EUR energy, 50,000 EUR preliminary studies (which include the construction of observation wells, the performance and interpretation of geophysical borehole measurements, the performance and interpretation of the double pumping test, and the modelling of the combined system of pumping and deep infiltration). Note that the wells constructed for the pumping test were used in this drainage system afterwards.

**Luc Geelen:** (Q) Is there a difference in the fluctuation of the groundwater table during summer and wintertime? (A) The water table level is at a minimum by the end of the summer and at a maximum by the end of the winter. As a consequence, draining the site is particularly needed during winter. The difference between the mean level in September 2000 and May 2001 was about 1.5 m. The drainage system is constructed as flexible as necessary to meet these fluctuations.

**Conclusion**

*Recharge of extracted dune aquifers (water catchment, drainage, etc.) by means of infiltration is realizable.*

**3. Can artificial recharge of treated waste water be beneficial to the dune ecosystem and does EC-legislation hinder this?** *(based upon introductory statement 2)*

**Discussion**

**Luc Geelen:** (Q) This is a unique situation, has it ever been considered to combine this with a deep infiltration system. (A) Not really.

(Q) Catchment is now at the outside of the infiltration system. Is it possible to have a zero effect outside by combining the technique shown in the previous lecture and this project?

(A) At this time, prevention of spreading of the infiltration water had priority. By infiltration, we can now reduce the catchment of natural groundwater.

**Arjen Kok:**(Q) Is the infiltration capacity of this open infiltration system still good?

(A) Because the treated wastewater is very clean, there is no fouling effect in the dune sand.

**Piet Veel:** (Q) Why is chosen to have an open infiltration as well? Is the result of the Reversed Osmose (RO) treatment not clean enough to produce drinking water straight away. (A) (Soil)infiltration has been chosen for double safety reasons. Another benefit is that the hydrological system provides an additional buffering.

(Q) Does the EC-Habitat Directive hinder this kind of infiltration-system? (A) No, not for this area. However, since the dune habitat is not a fixed habitat and since it is changing all the time (also through human impact), the rigid Habitat Directive might be contra-productive for a changing nature. When you do not intervene in a dune habitat system, it will change in a monotone forest-dune.

**Marleen Vandewalle:** (Q) Was it difficult to get a permit to infiltrate the treated effluent into a dune area? (A) First, the water supply company got a permit for infiltration in which quality standards for the infiltration water had been stipulated. Using effluent as source water did not complicate that, compared with those standards. Moreover, there is no contact between the infiltrated water and the surface water outside the dune area.

### **Conclusion**

*When the natural hydrological system has already been affected, artificial recharge of treated waste water in dune ecosystems can be given a chance. For hydrological 'natural' dune ecosystems it is not advisable. Where it comes to EC legislation, it is felt that a more dynamic approach of the Habitat Directive could be beneficial in sufficiently large dune areas to get more recharge programmes of treated waste water accomplished. It is argued that the dune system is not a fixed habitat either.*

### **4. Is knowledge of the fresh-water situation crucial for (re)creation of salt marshes? (based on introductory statement 3)**

#### **Discussion**

**Piet Veel:** (Q) Is fresh water knowledge needed to understand the hydrological system of salt marshes? (A) The ecohydrological value of most of the salt marshes is based upon a gradient from fresh via brackish to salt (ground)water. So also the knowledge of the role of fresh groundwater is essential.

#### **Conclusion**

*Knowledge of the fresh-water situation is crucial for (re)creation of salt marshes.*

**5. Will a good quantitative estimation of evapotranspiration of various vegetation types lead to changes in dune management?**

*(based upon introductory statement 4)*

**Discussion**

**Luc Geelen:** (Q) Shrub development in dunes is one of the causes of lowering the groundwater table. Does that mean that shrub removal can be used as a management tool to restore groundwater table in dune slacks? (A) Indeed, measurements show that shrub has a much higher evapotranspiration than low open dune vegetation (grey dunes).

**Piet Veel:** (Q) Is also looked at seasonable effects? What happens after the growing season? (A) The values of evapotranspiration given in the presentation are values for the growing season only. During wintertime, some shrub species will keep their leaves. Shrub evaporation outside the growing season will thus also be higher than evaporation from the herbaceous vegetation.

**Laurence Boorman:** (Q) How much of the lowered groundwater table is restored by removing the shrub/reducing the evapotranspiration? (A) This effect has not been measured/ calculated. But the bigger the area where you remove the shrub, the more effective the decrease of evapotranspiration will be. Changing small patches of shrub won't work.

**Luc Geelen:** (Q) Has a distinction been made between wet and dry vegetations, because plants are reacting differently when they experience 'water stress'? (A) Vegetations growing at different water table depths were used for calculating the evapotranspiration. However, none of the selected plots experienced drought stress during the experimental period. Plants would indeed react to drought by lowering their transpirational losses.

**Conclusions**

*The removal of shrub out of the dunes is not only important for ecological reasons, but also for hydrological ones. By decreasing the evapotranspiration, more water can infiltrate into the dune soil. The result will be a higher groundwater level in the dunes.*