

# Creating wetlands with cohesive sediment

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## The case Lake Marken

Lake Marken is a fresh water lake in the centre of the Netherlands, separated by a dike from Lake IJssel. The latter was created by closing off an estuary in the 1930's. From then onwards, the water changed from salt and brackish to fresh. In the 1970's a dike was constructed in Lake IJssel and Lake Marken was born. Since that time, the ecosystem in Lake Marken has strongly declined. Nowadays, the lake has a high turbidity. Water plants and bivalves have difficulties to survive or have disappeared and what should be a birds paradise has a low biodiversity.

In 2010 Royal HaskoningDHV was granted a 6 year research programme by the Department of Waterways and Public works of the Dutch Ministry of Infrastructure and the Environment. The goal of this programme was to find out which measures would be most suitable and fruitful to improve the biodiversity and resilience of the ecosystem. One of the measures to be examined was a large scale wetland. However, the wetland needed to be constructed with local materials, in this case cohesive sediments from the bed of the lake. A pilot project was set up to examine the possibilities of building with cohesive sediment. The pilot project consists of the creation of a lagoon with different depth regions and wetlands of different altitudes. The construction phase started in 2013 and an extensive monitoring programme started at the same time. At the end of 2015, the research programme and the monitoring will end. By that time the project is expected to have given much insight in the behaviour of cohesive sediment when used as building material and the possibilities for flora and fauna when developing such an island.

## Design of the island

The pilot island was constructed for the sole reason of gathering scientific knowledge on constructing such an island. The results can be used at a later stage for designing and constructing a large scale wetland. The island as constructed at the moment can therefore be seen as a laboratory in the field. Fig. 1 shows a photograph of the island just after finalising the construction. The island consists of two compartments and 8 small test fields. One of the compartments is in open contact with the water of lake Marken while the other compartment is closed off from the lake. At the start of the experiment, bed levels in the open compartment lie between just above the water level to 80cm below water level. In the closed compartment bed levels vary from 1m above water level to 20cm below water level. Furthermore the sediment in the closed compartment is constructed with a slope (from the top left corner to the right low corner in the photograph). All material in the compartments and test fields consists of cohesive sediment. The boundaries of the island consist of geo containers and geo tubes that are filled with cohesive sediment.



Fig. 1. Aerial photograph of the pilot island.

### **Monitoring programme**

There are several research questions to be answered by the pilot project. Most important are the questions relating to the behaviour of the cohesive sediment, such as consolidation velocity and soil formation. Other important questions relate to morphology and ecology, e.g. sustainability of the island and morphological and ecological development. In order to answer these questions we set up an extensive monitoring programme. We use settlement rods, water pressure meters and sediment samples for consolidation monitoring. Morphological monitoring is performed by using flow meters, wave rods, settlement rods, visual observations, echo sounder measurements and OBS measurements for turbidity. Finally, the ecological development is monitored, thereby focussing on specific species of fish, birds and fauna.

### **Preliminary results**

The first results already give some insight in the suitability of using the soft, cohesive material as building material. From the construction phase it became clear that the material is not suitable for creating slopes of more than 1:100 and that landscaping, i.e. creating differences in height, is difficult. Differences in height however do develop due to different consolidation velocities at different parts of the island. Furthermore, it was striking that after a few months the top layer at some locations already developed a crust which was strong enough to carry a person. More results, especially on consolidation velocity and morphological development will be available in 2015.

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