

## SANDY FORESHORES AS DIKE REINFORCEMENT IN LAKE SYSTEMS: A NATURE-BASED SOLUTION AT THE HOUTRIBDIJK

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### Introduction

The present Houtribdijk reinforcement project (Figure 1) provides an innovative measure to guarantee safety against flooding. For the first time ever, a sandy nourishment is applied to ensure large-scale stability of a dike in a non-tidal, inland lake environment. To gain detailed insight into the key morphological and ecological processes, a dedicated monitoring and research programme will be carried out. It will enable the assessment of the feasibility of nature-based solutions for future dike safety programs.

### Previous research

The Houtribdijk sandy foreshore consists of a large quantity of sand that is capable of dissipating the incoming waves, thereby reducing or even eliminating the actual wave load on the existing dike. As a consequence of this alternative reinforcement, no reinforcement on the dike itself is needed. Moreover, this nature-based solution may be more cost-effective in terms of construction as well as maintenance in the long run (Steetzel *et al.* 2017). Aside from ensuring the security of the dike, which is the primary objective, a foreshore solution has various secondary benefits. The natural and societal values of the area are enhanced, especially when considering the effect of vegetation (Steetzel *et al.* 2017).

Since this reinforcement technique is a world-wide first, a pilot study was created in 2014 at the Houtribdijk, in which hydrodynamics, morphology and vegetation development were extensively studied. Although a lot of knowledge has already been developed, it is still uncertain which hydrodynamic and morphological processes are dominant in shaping the foreshore cross-shore profile and additional analysis is needed. Besides, the effectiveness of the vegetation in supplying extra safety to the flood defence has not been proven yet (Penning *et al.*, 2016).



Figure 1. Overview Houtribdijk reinforcement (Rijkswaterstaat,

### Plan of approach

As the sandy foreshore at the Houtribdijk will be constructed between 2018 and 2020, a monitoring programme is started in this same period. It will continue up to at least 2022. In this programme, uncertainties about the degree of robustness and the needed maintenance of the sandy reinforcement will be mapped and quantified. While doing so, we will separately address cross-shore and alongshore processes, and investigate the interaction of morphological processes with vegetation. Furthermore, a safety assessment of such sandy foreshore systems is to be developed and the possibilities for upscaling this type of nature-based solution to be explored. We foresee the work carried out in this project will contribute significantly to the future prospect of implementing nature-based solutions for high-water safety and other purposes.

Penning, E., Steetzel, H., van Santen, R., de Lange, M., Ouwkerk, S.J., Vuik, V., van Thiel de Vries, J.S.M. (2016). Establishing vegetated foreshores to increase dike safety along lake shores. In *Flood Risk 2017 Conference Proceedings*, E3S Web of Conferences (Vol. 7, p. 12008). EDP Sciences.

Rijkswaterstaat (2018). Factsheet: *For a safe IJsselmeer region; Reinforcement of the Houtribdijk*.

Steetzel, H., van der Goot, F., Fiselier, J., de Lange, M., Penning, E., van Santen, R., Vuik, V. (2017). Building With Nature Pilot Sandy Foreshore Houtribdijk: Design and behaviour of a sandy dike defence in a lake system. *Coastal Dynamics 2017 Conference Proceedings*.