The influence of the vegetation structure on the water flow through the Noordwaard (Brabant, The Netherlands)

Derk Jan Stobbelaar[a], Jack C.M. Schoenmakers[a]

[a] *University of applied sciences Van Hall Larenstein, P.O. box 9001, 6880 GB Velp, The Netherlands*

Keywords – Remote sensing, drones, vegetation classification, surface modelling (SOBEK), flood prevention

Multiple objectives in the Noordwaard

De Noordwaard is a recently established high-water flow area located near the Brabantse Biesbosch (Rijkswaterstaat, w.d., figure 1). In this area, dykes have been adapted and creeks have been dug, some of which are connected to the Hollands Diep and are subject to tidal influence. A large part of the agricultural land has been transformed into a flow area with nature as a secondary function and is partly grazed by water buffaloes, koniks, Scottish highlanders and sheep. In order to guarantee the flow of the area at high water on the Merwede, additional mowing management is carried out in addition to grazing in autumn. To this end, all vegetation is reset to the maximum height that has been set as a standard for safety reasons. This mowing is expensive and sometimes contrary to the nature objective in the area, where a great diversity in structures is sought.

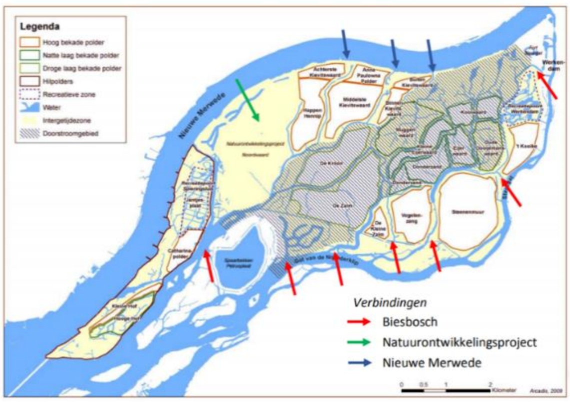

Figure 1: High water overflow area Noordwaard

The question now is to what extent that mowing management is necessary to ensure the flow. To answer this question, two studies were carried out: one to the flow of the area using the SOBEK model and one to the best remote sensing technique to be able to measure the vegetation structure by means of drone images.

Modelling water levels with SOBEK

Rijkswaterstaat has defined a zero situation for the Noorwaard in which the vegetation is divided into vegetation structure types. To this end, the WAQUA model was used (Project Office Noordwaard, Rijkswaterstaat Room for the River, 2010). Scenarios with a lower water level than the baseline situation, deliver more reduction than required and thus meet the safety requirement. From the zero situation, with the discharge-storm combination that is representative of the normative water level, a maximum water level of 5.16 meters + NAP follows at Gorinchem; that water level is leading. Without Noordwaard a water level of 5.59 meters + NAP is reached.

The expected water level at Gorinchem in the current situation was determined on the basis of the altitude and the vegetation present in 2016. The data were processed with the model SOBEK1D2D (Deltares, w.d.), that was first calibrated with the WAQAU model. However, the SOBEK model is a much easier to use model. The current situation, with the discharge-storm combination that is representative of the normative water level, gives 0.05 meter water level reduction compared to the zero situation. A maximum water level of 5.11 meters + NAP at Gorinchem has been achieved. The influence of different vegetation structure types in the Noordwaard was determined on the basis of the sensitivity analysis. This sensitivity analysis was performed by applying different

[1] Corresponding author
Email address DerkJan.Stobbelaar@hvhl.nl (Derk Jan Stobbelaar)

scenarios for the development of the roughness. From the calculations it follows that the situation from 2016 amply meets the flow requirement and that there is therefore less need to mow than is currently the case.

Tracking vegetation development via Remote sensing techniques

Before the start of this study, the vegetation structure in the Noordwaard was mapped using manual interpretation of RGB aerial photographs. This remote sensing technique does not deliver the desired result as classification of vegetation with these type of images has its limitations: it lacks the vegetation reflection in the near infrared part of the light spectrum. The aim of this research was therefore to find a better remote sensing technique to monitor the vegetation structure development in the Noordwaard. To this end, images were collected with a DJI Phantom 4 drone, equipped with a Sequoia multispectral camera. Based on literature (e.g. Dandois and Ellis, 2010) and interviews, 24 techniques were selected to analyze the resulting images. These 24 techniques have been tested in the Noordwaard and validated on the basis of a validation set. The results of the two best techniques have been compared with validation results of vegetation structure maps created by Bureau Waardenburg in 2016. Finally, an interview with Skeye BV has determined whether the best technique can be scaled up to application in the entire study area.

The results show that the remote sensing recording technique, consisting of the band combination Green, Red, Near InfraRed, Red Edge and a calculated digital terrain model with a resolution of 25cm, classified according to the Maximum Likelihood Classification, is the best technique. Vegetation structure classes that have a lot of resistance, such as reed and cattail, can still not be clearly distinguished. If aerial photographs are taken with good weather conditions and later in the growing season, a more reliable result could be achieved. But all in all, this technique gives such insight into the vegetation that it can be reliably monitored how the vegetation structure develops, what can be translated into new values for the vegetation rift. The drone technology still has limitations in terms of flight range, which can be accommodated by mounting the camera on another type of UAV.

Towards an integrated development of the Noordwaard

The SOBEK project has shown that in the current situation the vegetation in the Noordwaard is no obstacle to reaching the desired water level at Gorinchem. The remote sensing project has provided the technology to quickly and accurately measure the vegetation structure as it develops in the area. The results of this measurement are input for the SOBEK model. These two techniques together provide the opportunity to optimize the nature value within the conditions of flood risk management; more vegetation development is possible than Rijkswaterstaat initially thought possible. This is a building block for integral management where multiple goals can be served (Stobbelaar et al., in press).

A next step will be to find out how the vegetation development can be controlled with the help of the large grazers in the area so that the vegetation structure meets the requirements of water safety and nature quality.

References

Dandois, J. P., and Ellis, E. C., 2010. Remote Sensing of Vegetation Structure Using Computer Vision. Remote sensing, 2, 1157-1176.

Deltares, w.d.. https://www.deltares.nl/nl/software/d-hydro-suite/. Last accessed January 2018.

Kerkhoven, A.E. and Van Naamen, M. 2017. Laten groeien of mee bemoeien? Een onderzoek naar de invloed van diverse vegetatiestructuurtypen binnen het beheergebied van Gebr. van Kessel op de doorstroming in de Noordwaard. University of applied sciences Van Hall Larenstein. Velp, The Netherlands.

Mensink, A. and Boogaard, J., 2017. Remote sensing in de Noordwaard. Toegepast vegetatiestructuuronderzoek met geautomatiseerde classificatie. University of applied sciences Van Hall Larenstein. Velp, The Netherlands.

Rijkswaterstaat, w.d. https://www.ruimtevoorderivier.nl/depoldering-noordwaard/ last accessed January 2018.

Stobbelaar, D.J., Janssen, J.A.M., Van der Heide, M., in press. Geïntegreerd natuur- en landschapsbeheer. De opgave voor natuurbeschermers van vandaag. Westerlaan Publishers, Lichtenvoorde, The Netherlands.

Projectbureau Noordwaard Rijkswaterstaat Ruimte voor de rivier, 2010. Milieueffectrapport Planstudie Ontpoldering Noordwaard., http://api.commissiemer.nl/docs/mer/p17/p1754/1754-111mer.pdf last accessed 2-1-2018