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Evaluating the impact of Room for the River flood management measures on vegetation health and diversity in the Netherlands via optical remote sensing

Amber Spriggs[a*], Erik Mosselman[ab], Ralph Schielen[ac], Laura Stancanelli[a]
[a] *Delft University of Technology, Department of River, Ports, and Dredging Engineering, Faculty of Hydraulic Engineering, Stevinweg 1, 2628 CN Delft, The Netherlands*
[b] *Deltares, P.O. Box 177 2600 MH Delft, The Netherlands*
[c] *Ministry of Infrastructure and Water Management (Rijkswaterstaat), P.O. Box 2232, 3500 GE Utrecht, The Netherlands*

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Introduction

Recent policy initiatives in Europe emphasize a movement towards nature-based solutions in flood management; however, a quantitative relationship between specific flood management measures and indicators of ecological health and biodiversity is difficult to establish (Penning et al., 2023). In the Netherlands, several studies have been conducted on floodplain vegetation monitoring; however, these studies are primarily focused on monitoring changes to hydraulic roughness for flood risk assessment (Harezlak et al., 2020; Penning & van de Vries, 2020). These works provide an opportunity to expand upon existing research to explicitly connect river management practices with indicators of floodplain biodiversity change in the Netherlands.

In this study, we utilize publicly available geospatial data to identify changes in land use, vegetation classification and spectral indicators of vegetation health at restoration sites associated with the Room for the River (RftR) program in the Netherlands. Completed in 2018, RftR involved over 30 river management projects constructed to reduce flood risk by lowering peak water levels (Mosselman, 2022).

Our objective is to quantify the impact of ecologically focused RftR projects on habitat heterogeneity and river connectivity in the surrounding floodplains.

Study Area

To first establish a methodology for quantifying the connection between Room for the River measures and changes to ecological health, we examined a case study site of the Noordwaard depoldering project near the Biesbosch National Park.

Completed in 2015, the depoldering of the Noordwaard is one of the largest Room for the River projects and resulted in a significant transition from agricultural to natural land-uses.

Figure 1. Depoldered area, Noordwaard near Werkendam, the Netherlands.

Methodology

To quantify the relationship between these land-use changes and floodplain ecological health, we:

1. Utilized the LGN (Landelijk Grondgebruiksbestand Nederland) datasets, a raster database with a resolution of 25 m (5 m resolution for LGN 2018 – 2022), to identify areas in the Noordwaard and its surroundings that have transitioned from agricultural to natural land-use classifications between 1995 and 2018.
2. Identified land-use changes within the areas labelled as “changed to natural” throughout the entire series of LGN datasets, to quantify incremental trends in vegetation heterogeneity.
3. Utilized satellite multispectral imagery from Landsat-8 with less

* Corresponding author
Email address: a.m.s.spriggs@tudelft.nl (Amber Spriggs)

than 20% cloud cover during the growing seasons of 2013 through 2022, cropped to the extent of the “changed to natural” areas. With this imagery, we calculated the Normalized Difference Vegetation Index (NDVI), which has correlation to photosynthetic activity and biomass (Suir and Sasser, 2019).

Preliminary Results

Between LGN3 (based on 1995 satellite and aerial imagery) and LGN 2018 (based on 2018 satellite and aerial imagery), we observed a transition from agricultural to natural land-use classifications within the study area, as shown in the dark green (“changed to natural”) areas of Figure 2. Areas newly classified as inundated with water in LGN 2018 (as compared with LGN3) are shown in the dark blue (“changed to water”) areas of Figure 2.

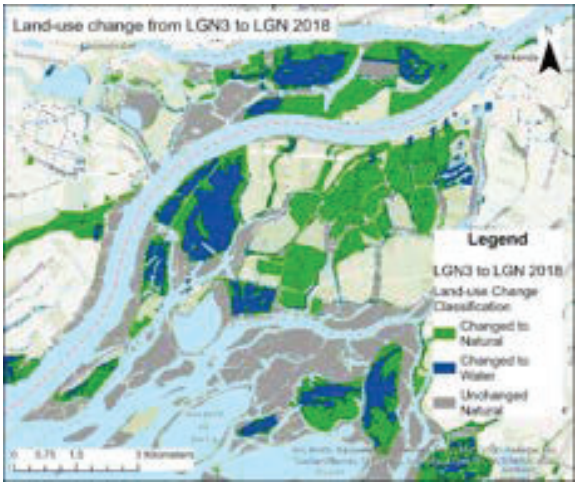

Figure 2. Land-use change at the Noordwaard depoldering project site and surrounding area, from LGN3 (1995) to LGN2018 (2018).

Within the areas designated here as “changed to natural”, we observed a general trend towards increased heterogeneity of the LGN classifications over time. For the averaged growing-season NDVI values from 2013 through 2022, we observed increased stability in NDVI fluctuations over time, with increased NDVI concentrated in the areas immediately surrounding the areas designated as “changed to water”. This underscores the importance of the vicinity of water for the natural terrestrial areas. Further analysis will incorporate more detailed information on management practices in the Noordwaard area, to validate the connection between these observations and construction of the depoldering project.

Future Work

Moving forward, we will expand this methodology to other RftR sites, connecting these changes with floodplain ecological health more broadly throughout the Netherlands.

We will utilize an application of graph theory, where different RftR project sites are considered as nodes, to compare impacts of different RftR projects on vegetation diversity changes, and to evaluate connectivity throughout the entire system.

Establishing remote-sensing based evaluation metrics to connect floodplain management practices and biodiversity changes can help inform more ecology-focused floodplain management practices and enhance site selection for future applications of RftR-type flood management programs in the Netherlands and abroad.

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