D2.2.2 - Report on change in reed extent by changing numbers of muskrat and Coypu

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Summary

This report gives the change in reed extent for the project areas over the period 2019 to 2023 and compares it to changes in Muskrat and Coypu population sizes over the same period.

At this level of aggregation (the level of project areas) the reed vegetation extent was relatively stable over the duration of the LIFE MICA project. Still some trends are still visible: in three areas an increase was seen and in two areas a slight decrease. However, it turns out that these changes are not significantly related to changes in the muskrat and/or coypu population sizes (at the scale of project areas).

A more fine-grained analysis (a grid with a 5x5 km resolution) could only be done for two of the project areas (areas 8 and 9) because only in these there were sufficient sub-areas with both increases and decreases in muskrat abundancies. At this scale, a pattern did appear. The areas with an increase in reed area have no muskrats present (Area 8) or very small (Area 9) muskrat abundances. While in the areas with large decreases, larger muskrat populations are present.

These results indicate that to establish meaningful increases in reed vegetation extent, muskrat densities should be very low. However, the results should also be interpreted with care (and should be confirmed in other locations), because there may be co-varying factors at play in these areas that could also influence reed vegetation dynamics.

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1. Introduction

Reedbeds characterize some of the most biodiverse areas of North-West Europe and represent an important habitat for multiple vulnerable or endangered avian species (Morganti et al., 2019). That's why the reedbed extent is also taken as KPLI in the Life Mica project.

While some protected areas show large reedbed stands, reeds are often found as fragmented smaller patches or linear elements along water bodies in agricultural landscapes throughout the entirety of the N-W Europe. As a result, these areas are not only difficult to map, but also subject to change under influence of various factors like management of the bordering fields, mowing regimes, grazing by waterfowl in addition to the impact by the target-species in Life Mica: Muskrats and Coypu.

We have estimated the change of reedbed extent in the Life MICA project areas based on Sentinel-1 satellite images within the Google Earth Engine computational platform. Currently, the estimate has been made for the years 2018 to 2023, using the method developed by Koma et al (2021), Pettorelli et al. (2005), Xie et al. (2008) and Vreugdenhil et al. (2018), which is elaborated in Appendix 1. These estimated areas are reported in this report (section 2) and subsequently the changes are related to changes in estimated Muskrat and Coypu population sizes (section 3).

2. Methods

As input for this analysis, the Sentinel-1 images available for 2019 up to 2023 within Google Earth Engine have been clipped using the outlines of the project areas. Subsequently, the javascript-based processing algorithm by Koma et al (2021) has been applied to estimate reed area within the project areas. This algorithm classifies pixels for a given period as reed or non-reed. In this analysis calendar years have been used as periods, and the reed area estimates were made for the complete project areas.

For two large project areas (8 and 9), also 10% of the area with the largest reed increase and 10% with the largest decrease have been identified as well. As a basis for this, the Atlas Blocks (a 5 by 5 km grid, covering the Netherlands) are used (so, 10% of the ABs where the largest increase in reed surface occurs is selected as well as 10% where the largest decrease occurs, within the project areas). For these areas the muskrat population changes over the corresponding period have been identified as well.

3. Results

3.1 Habitat KPLI: the evolution of reedbed extent surface in the project areas (D.2.2.2) Number of coypu and muskrat caught

The outcomes of the sentinel-based reedbed estimates are shown in Table 3.1. Overall, there are some small variations in reed surface extent in most project areas. Given that the uncertainty of the estimation method is approximately 1% (Koma et al. 2021), the changes that are observed in one year are close to this detection limit. In spite of this aspect, as well as the limited length of the measurement period, some trends are still visible.
The direction of change has been provided in Table 3.1. This suggests that in most areas there is a stable situation (6 project areas). In three areas an increase is seen and in two areas a slight decrease is seen.

Table 3.1 Extent of the reed surfaces in km^2, separately for the Life MICA project areas over five years.

Area	Name	2019	2020	2021	2022	2023	direction of change
1	Lake Dümmer	1.27	1.24	1.23	1.21	1.24	0
2	Aschau Teiche	0.14	0.13	0.12	0.12	0.13	0
3	Vechtegebiet	0.59	0.61	0.63	0.65	0.66	+
4	Sint-Laureins	0.36	0.33	0.34	0.32	0.31	-
5	Sint-Maartensheide - De Luysen	0.08	0.09	0.08	0.09	0.09	0
6	Mark Valley Herne Galmaarden	0.10	0.08	0.07	0.07	0.08	0
7	Hoogstraten	0.18	0.16	0.15	0.16	0.18	0
8	Wetterskyp Fryslan	38.5	38.9	39.4	39.9	40.1	+
9	Noord-Holland North from Alkmaar	18.8	18.3	18.2	18.4	18.1	0
10	Border Gelderse Poort / Kreis Kleve	3.1	3.3	3.4	3.5	3.5	+
11	Border Hunze en Aa's	4.3	4.2	4.1	4.1	4.0	-

For project areas 8 and 9, the 0.1 percentile of the area with the largest reed increase as well as with the largest decrease has been identified as well over the period 2019-2023. The results of this are shown in Table 3.2. By definition the trends in Table 3.2 should be more pronounced than those seen in Table 3.1 (because we selected for the most upward and downward trends for smaller areas within the region). But even when considering this aspect, it seems that the area changes are quite dramatic (a reduction of sever square kilometers of reed vegetation in area 9 seems a lot).

Table 3.2 Change in reed surfaces in km^2, upward and downward in the upper and lower 0.1 percentiles of the area, for project areas 8 and 9.

Area	Name	2019	2020	2021	2022	2023
10% area with largest increase						
8	Wetterskyp Fryslan	2.3	2.6	2.8	2.9	3.1
9	Noord-Holland North from Alkmaar	1.3	1.6	1.5	1.9	1.9
10% area with largest decrease						
8	Wetterskyp Fryslan	1.1	1.3	0.9	0.3	0
9	Noord-Holland North from Alkmaar	2.1	2.3	1.2	0.5	0.1

3.2 Change in reedbed area in relation to Coypu and Muskrat changes

Estimated population sizes of Muskrat and Coypu for the areas matching with Table 3.1 and Table 3.2 are given in Appendix 2.

It turns out that there are no significant correlations between any of the trends in muskrat or coypu abundance and reed extent at the scale of project areas and these are therefore not reported here.

However, for the analysis at the finer scale (viz Table 3.2 and Table A.2.3) it is striking that the areas with an increase in reed area have no muskrats present (Area 8) or very small (Area 9) muskrat abundances. While in the areas with large decreases large and stable muskrat populations are present.

4. Conclusions

The reed vegetation extent, when analysed at the level of project areas, was relatively stable over the duration of the LIFE MICA project. Still some trends are still visible: in three areas, an increase is seen and in two areas a slight decrease is seen.

However, it turns out that these changes are not significantly related to changes in the muskrat and/or coypu population sizes at the scale of project areas.

When conducting the analysis at the finer scale (which could only be done for two of the project areas), a pattern does however appear (viz Table 3.2). Here it turns out that the areas with an increase in reed area have no muskrats present (Area 8) or very small (Area 9) muskrat abundances. While in the areas with large decreases larger muskrat populations are present.

These results still have to be interpreted with care, because there may be various other factors at play in these areas, but it is a first indication that to establish a meaningful increase in reed vegetation extent, muskrat densities must be very low.

5. References

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Appendix 1 - Explanation of satellite products and feature extraction

Sentinel-1 is an imaging radar mission providing (cross-)polarization products continuously from a variety of collection modes. The European Space Agency (ESA) defines Interferometric Wide Swath (IW) as Sentinel-1's primary operational mode over land and only mode for typical applications regarding vegetation (e.g. forestry/agriculture monitoring). Sentinel-1 provides VH (vertical transmit, horizontal receive) and VV (vertical transmit, vertical receive) in subpolar regions at a resolution of 10 m. Pre-processed Sentinel-1 data is freely available in the Google Earth Engine (GEE) database; these pre-processing steps include thermal noise removal, radiometric calibration and terrain correction.

Sentinel-2 is a multi-spectral imaging mission, specifically focused on land-monitoring. Of the two products available to users of GEE, Level-2A was chosen based on its orthorectified Bottom-Of-Atmosphere reflectance, in comparison to Level-1C in which the reflectance is Top-Of-Atmosphere; this is relevant especially for the typical weather conditions of the region of interest, as cloud cover leaves Sentinel-2 optical imagery practically useless. Sentinel-2 samples its red and near infra-red (NIR) at 10m resolutions and contains a cloud mask band, freely available in the GEE database.

Sentinel-1 and Sentinel-2 features for the years 2021 and 2022 (up to November) were processed in and extracted from GEE. Sentinel-1 data was filtered for the images collected using the Interferometric Wide swath mode and a cloud mask filtering based on the QA60 band of Sentinel-2 was applied to the spectral imagery. All pixels identified by the QA60 band as clouds were removed.

NDVI was calculated using the red and NIR band from the Sentinel-2 product, as for the following formula:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

VV and VH from Sentinel-1 and NDVI from Sentinel-2 rasters were projected to the projection of the other databases in GEE using the nearest neighbor method. The NDVI, VV and VH features were chosen based on their ability to distinguish reedbed habitat from other land cover types and vegetation. Normalized Difference Vegetation Index (NDVI) metrics can be used to distinguish land from water, as water pixels have a much lower NDVI value (Pettorelli et al., 2005); NDVI is also a good indicator of periodically dynamic changes of vegetation groups if multiple time images are analyzed (Xie et al., 2008). Sentinel-1 backscatter coefficients, on the other hand, are applicable and often used in discerning vegetation dynamics, as outlined in Vreugdenhil et al. (2018). Reeds are an annual grass that go dormant in the winter, while the dead stalks remain upright, so we calculated these metrics over the period of a year to encapsulate this unique lifecycle which distinguishes this species from other vegetation. These metrics included the mean, median, max, min, standard deviation, 10th and 90th percentile of all features over the year. Visual inspection, however, revealed artifacts in the raster products of VVmin, VVstdDev, VHmin and VHstdDev which can be related to their dependency on errors in acquisition. These features were further excluded from the analysis.

Appendix 2 – Muskrat and Coypu abundances

Table A.2.1. Estimated muskrat population size per project area. The numbers refer to the expected number of reproductive individuals at the start of the breeding season.

nr	2018	2019	2020	2021	2022	2023
1	63	67	85	73	75	77
2	0	0	0	0	0	0
3	512	602	569	482	424	441
4	1078	1156	1346	1248	1124	1072
5	0	0	0	0	0	0
6	115	108	138	154	144	156
7	0	0	0	0	0	0
8	653	529	592	586	476	494
9	1752	2162	2947	3520	3021	3217
10	174	171	142	119	88	90
11	2706	2460	2778	2828	2859	3280

Table A.2.2 Estimated coypu population size per project area. The numbers refer to the expected number reproductive individuals at the start of the breeding season.

Nr	2018	2019	2020	2021	2022	2023
1	67	82	84	100	115	138
2	44	46	50	56	64	74
3	590	589	464	417	467	542
4	0	0	0	0	0	0
5	10	10	7	7	6	5
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0
10	48	54	52	61	52	65
11	154	165	152	121	97	75

Table A.2.3 Estimated muskrat population size for parts of project areas 8 and 9 with largest increase as well as decrease in reed extent.

Area	Name	2019	2020	2021	2022	2023
10% area with largest increase in reed extent						
8	Wetterskyp Fryslan	2	0	0	0	0
9	Noord-Holland North from Alkmaar	3	4	3	3	5
10% area with largest decrease						
8	Wetterskyp Fryslan	20	21	35	24	38
9	Noord-Holland North from Alkmaar	47	23	35	53	76