Summary

The Drents-Friese Wold National Park, situated on the border of the Dutch provinces of Friesland and Drenthe, covers approx. 6,100 hectares of varied landscape, including shifting sands, heathlands, nutrient-poor grasslands and forests with dozens of fens. The area is part of the European Natura 2000 network. Located in the centre of the area is the former agricultural enclave of Oude Willem – almost 450 hectares - which is being transformed into nature. The drainage systems for cultivation and tillage cause unfavourable hydrological effects for the wet habitats in the Drents-Friese Wold. Excessive fertilization in the past is also an issue. This is reflected in the high concentrations of mobile phosphate in the topsoil at Oude Willem. Removing the topsoil was a possible solution to lower the phosphorus (P) levels in the soil, but this would cause more drought in the neighbouring nature areas on higher grounds. The high costs for these measures were also an issue. Thus, it was decided to choose for the measure of phosphorus-mining (phytoextraction of phosphorus-enriched grassland soils by targeted fertilization of K and/or N)) as the best option over an area of approximately 300 hectares.

Carrying out P-mining focusses on extracting phosphate from the soil by grassland or grass-clover, in combination with nitrogen and potassium fertilization, mowing and removing the biomass. The Steering Committee of the Oude Willem project gave Prolander the mandate to place an order with the Antea Group and NMI to implement a P-mining pilot between 2015 and 2019. A subsidy was available through the European Life+ programme “Life going up a level”.

Aim of the project was, on the one hand, to develop a method for the removal of phosphate on a practical level, with the involvement of farmers, and on the other hand to increase knowledge about P-mining and share this with nature management organizations, farmers and other stakeholders.

Field study in the area revealed that Oude Willem is lower than the surrounding landscape and there are clear height variations - between 8.5 and 11 meters above NAP (Amsterdam’s Sea Level Measurement). The most common soil types are mainly sandy soil , usually loamy and sometimes peaty. The annual groundwater level varies from shallower than 50 cm in wet parts to deeper than 140 cm in drier sections. These levels will provide more water for wet habitat types.

Additional analysis in 2015 showed a great differentiation in phosphate availability in the topsoil of the 70 land parcels in the area. On a number of fields that had not been cultivated for a while the P levels are lower than the target value of 10 for flowery meadowland (P-AL<10 mg P_2O_5/100 g). Furthermore, there are some fields that have a fairly high P status, even from an agricultural perspective (P-AL>40 mg P_2O_5/100 g).

For the purpose of P-mining on a practical level three types of grassland were distinguished, namely natural grassland (uncultivated for several years), former arable land (sown with a grassclover mixture) and grasslands in use. In the period 2016 – 2019 most of this area was leased to a group of about 10 (farm) tenants. Some of these tenants wanted to participate in this experiment because they were interested in P-mining and more natural farm management. Most participated because the removed biomass could be used as roughage for cattle.
The leased fields were mainly grass-clover (these were the most popular, particularly with organic farmers) and grasslands for production. Agreements were made with the farm tenants regarding the way in which P-mining should be carried out. Based on the results of soil analyses, a guiding advice was given per field in terms of the required fertilization with nitrogen (N) and potassium (K).

Moreover, the crop had to be mowed and removed at least three times a year. The farmers had to keep a log book registering the fertilizers used and yield from the leased fields. By combining with the analysis of the crop composition, the P- removal could be calculated. P-mining was evaluated with the farmers annually. As a result, the lease prices and the advised fertilization were adapted in 2016 and from 2017 there was an allowance of 50% towards the costs of potassium. The yield and quality of the hay was an important factor when finding and keeping tenant farmers. In most cases the cut grass was used as rough feed for calves, non-lactating cows and horses. Some farmers used the crop for their own animals, others traded it. Some others

also used it as stable litter. Natural grassland sometimes contained a lot of rush and these fields were not popular amongst tenants. Fertilizers were not used, and the grass was only mowed and then removed. The same applies for fields where there was an increase of ragwort (Senecio jacobaea) over time. The mowed grass is no longer suitable for use as course fodder.

For the purpose of monitoring, ten representative test plots were selected. The plots differed in terms of soil, groundwater levels, the phosphate conditions and the type of grassland. This also resulted in a great variation in the combinations of vegetation, the production of bio-mass and the extraction of phosphate through the crop. Measurements taken in the spring of 2016 and autumn of 2018, at three depths (0-10, 10-30 en 30-50cm), showed that the P-levels fluctuated from low to very high. At locations where the P-conditions were high the P-levels were 30-50 cm deep. As a result of P-mining between 2016 – 2018, the P-availability was lowered in the 0-10 cm layer. In places where the P-conditions need to be lowered to 30 – 50 cm, more time is needed. The necessary time required to lower the phosphate levels to the aspired values of flowery grassland varies greatly between fields in the area. For locations with the highest P-conditions at the initial phase it is estimated to take 18 – 22 years, while other locations with a lower P-rating only need one or two years.

At some spots within and outside the pilot area, an interesting development of vegetation has been noted, while the phosphate levels in the soil are (still) relatively high. It must be said that the nitrogen and potassium levels are mostly low. Apparently low phosphate values are not always a requisite for the development of sparse, nutrient-poor vegetation. This can also be a result of low potassium and/or nitrogen levels.

Main conclusions

- Involving farmers in the removal of phosphate from former agricultural areas makes sense and offers opportunities if there are good possibilities for selling the crop (course fodder, stable litter, etc.). In some cases, farmers are keen to participate simply out of interest.
- Individual agreements between landlord and farm tenant are necessary, for example with organic farmers who are limited in their choice of fertilizers.
- The effectiveness of p-mining can vary strongly, depending on the conditions (soil composition, moisture levels, vegetation). P-mining actually does reduce the phosphate levels in the soil and is also a good way to speed up the improvement of ground quality when making it suitable for the development of a nature area. The process is not as effective on natural grassland where the vegetation and ground quality is often already in the desired condition. These are also usually the higher, dryer grounds (poor and less cultivated) or the lower laying wet grounds (less suitable for farming, harder to till and graze). Fertilization and active mowing have a more negative effect on ecological values. The natural grasslands are less popular with farmers because both the yield and quality of the produce is less. P-mining is also less effective on fields that have been farmed intensively for years; it takes decades to reach the desired phosphate situation.
- The necessary removal period to ultimately achieve the phosphate levels of flowery grassland varied within the area from 0 – 44 years.

Recommendations

- When taking measures to support the development of nature on former agricultural land, it is very important to have a good picture of the initial situation, by doing soil analysis. In this way the information regarding the phosphate conditions at various depths in the soil provide insights into the achievability of nature goals and the measures required (e.g. P-mining, excavation) to lower the phosphate status to the desired level. Soil analysis is also necessary in order to set up a suitable advice for fertilization in combination with P-mining.

- Fields have also been sown with clover, as an alternative for fertilizing with nitrogen. This would have worked even better (more clover) if the soil composition had been optimized (e.g. if the correct pH value had been set).

- There are more parts of Oude Willem which would profit from continuing phosphate removal, with the cooperation of the farmers, and thereby monitoring the phosphate status in the soil. This applies particularly to those fields where the added value for tenant farmers (good off-take possibilities for mowed crop) look promising for the long term and where lowering phosphate content in the topsoil is expected to show good results at the short term.

- Attention should be paid to the composition of vegetation during P-mining (e.g. maintaining the amount of clover content and handling plants that could influence the process, like common ragwort).

- Apparently other secondary conditions are also needed for the development of nutrient-poor vegetation (e.g. low nitrogen and potassium levels), even if the phosphate content in the soil is high. In areas transitioning from agricultural production to nature development it is therefore important to investigate alternatives for the realization of a nutrient-poor vegetation with a rich diversity.