European Evaluation Helpdesk for Rural Development

EVALUATING HUNGARIAN GROSS NUTRIENT BALANCE DATA THROUGH A COUNTERFACTUAL APPROACH BASED ON HISTOGRAMS

FACTSHEET OF THE EUROPEAN EVALUATION HELPDESK FOR RURAL DEVELOPMENT - MARCH 2021

A DELICATE BALANCING ACT

Water and soil quality make up the foundation for all agricultural activity as these vital resources are two of the most important inputs to ensuring not only sustainable agriculture, but also biodiversity and food security. Farm and land management can play a vital role in ensuring that the delicate balancing act of protecting both soil and water are achieved to ensure long term sustainable agriculture and a prosperous society. Evaluating these conditions and practices are essential to make sure management practices are fostering the necessary balance of nutrients, while protecting water quality. In the EU's Common Monitoring and Evaluation System (CMES) of the rural development policy this is monitored through both impact and context indicators including I.11 Water quality and C.40 Water quality.

USING HISTOGRAMS TO GAIN DEEPER UNDERSTANDING OF EXTREMES

The purpose of this thematic evaluation was to achieve a better assessment of C.40 and I.11 or gross nutrient balance (GNB) on agricultural land. In the case of Hungary, national balance levels often mask the share of extreme positive and negative dissolved nitrogen (DN) and dissolved phosphorus (DP) data, both of which may cause environmental risks. Therefore, the evaluator has used a counterfactual approach with the calculation of histograms[1]. The assessment period for the comparison was 2010-2014 and 2016-2019. Histograms have been calculated at parcel-level for DN and DP data, for both RDP supported and non-supported (control) areas during these two time periods.

Working steps of the evaluation

1. Collection of agricultural cultivation data from supported areas, for temporal comparison from 2010 to 2019.
2. Collection of agricultural data on non-supported areas from the Hungarian Central Statistical Office (KSH) database.
3. Calculation of GNB for all available agricultural parcels.
4. Calculation of histograms of the DN and DP data separately for the supported and non-supported areas aggregated for 2010-14 and 2016-19 respectively.
5. Comparison and evaluation of the histograms.

Data collection (Steps 1 and 2)

Collection of agricultural cultivation data (such as area of each plot, type of plant, crop, and applied organic and chemical fertilizer) of the supported areas was gathered from the National Food Chain Safety Office (NÉBIH). The collection and provision of agricultural data of the non-supported (control) areas was provided by the Hungarian Central Statistical Office (KSH). However, both databases lack data on the ratio of the removed crop residues, so the evaluator used the data in the national GNB calculation from Eurostat. In order to harmonise the data, the evaluator calculated the part of the nutrients added to the autumn sown crops for the previous year since the data collection has recently been switched to the calendar year instead of the agricultural year for the GNB calculations.

Calculation of histograms (Steps 3 and 4)

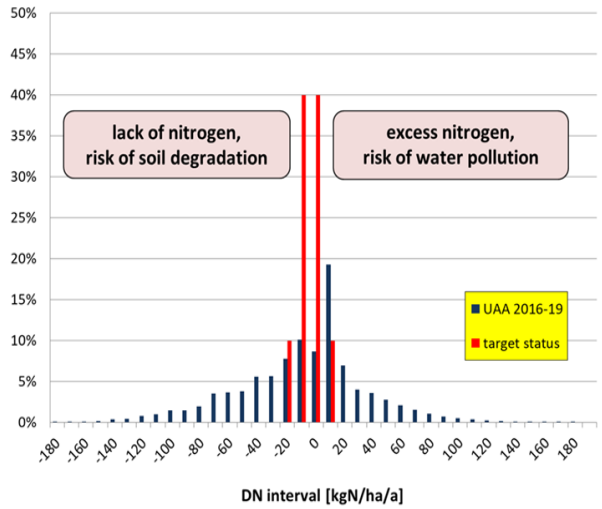
Based on this data, calculation of the GNB from available cultivation data for each agricultural parcel and calculating histograms separately for supported and non-supported areas

FURTHER INFORMATION

Thematic Evaluation Report 2020: Effectiveness and efficiency of water management interventions

Available from June 2021 on https://www.palyazat.gov.hu/vidkfejlesztsi-program-

Figure 1. Supported UAA areas compared to a optimal histogram presenting the target status (DN)



Source: GWIS Ltd, 2021

[1] A histogram is an approximate representation of the distribution of numerical data allowing one too see the extremes in the set. A histogram is used for continuous data, where the bins represent ranges of data, while a bar chart is a plot of categorical variables.

was achieved. The evaluator then compared these histograms, instead of the national averages, primarily examining the share of extreme DN and DP data, which indicates the impact of agricultural activities on soil and water quality.

GNB calculations were performed using the Eurostat AEI_NITRNAT_A_HU and AEI_PHOSNAT_A_HU software and coefficients, with the distinction that livestock data is not included in the evaluator's data, but the amount of manure and fertilizer applied for each parcel is included. While there are different values for each coefficient in the literature the evaluator used values from the Eurostat country report of Hungary.

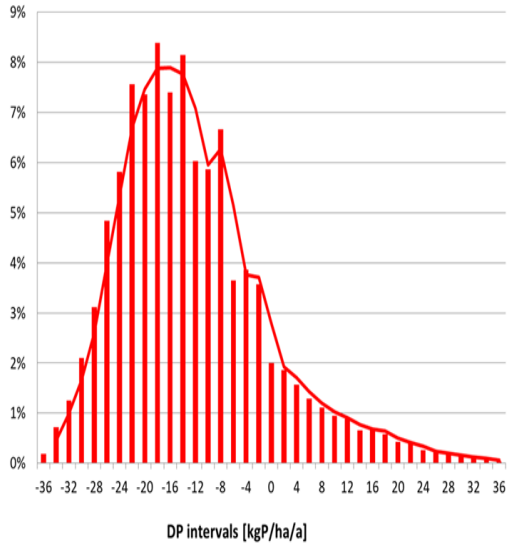
Histograms were made by aggregating the calculated GNB data into intervals of width DN=10 kgN/ha and DP=2 kgP/ha respectively, which were then summarised per area. Each interval contains the ratio of the sum of the areas related to the total area. In the figures below the number belonging to the interval indicates the lower limit of the interval, for example, if the number for DN=0 or DP=0 this would indicate that values are shown between 0 and 10 and 0 and 2 respectively.

To show the temporal change, the evaluator compared the histograms of the supported areas in 2010-2014 vs. 2016-2019 (Example for DN can be seen in Figure 3). To calculate the indicators C.40 and I.11 the evaluator used histograms instead of the proposed national balance levels in order to achieve a more robust assessment while being able to better pinpoint extremes.

Added value of using histograms

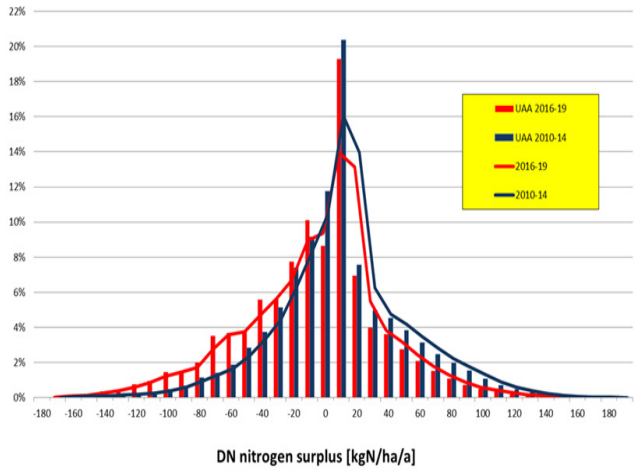
Histograms are generated using parcel level GNB calculations. The inadequacies of the required crop and nutrient data influence the extremes, the treatment of which is the main advantage of the histogram method compared to the national level balance.

Figure 2. DP Intervals for RDP supported arable land 2016-2019



Source: GWIS Ltd, 2021

Figure 3. Comparison of DN histograms of supported UAA areas for 2010-2014 and 2016-2019



Source: GWIS Ltd, 2021

The added value of this approach is that it facilitates the comparison between the histograms of the supported and non-supported fields, primarily concerning the share of parcels with strongly negative and strongly positive DN and DP balances. Assessing these extremes is important because the former may cause degradation in soil fertility and erosion, while the latter may cause surface and groundwater (including drinking water) pollution and eutrophication.

If one only analyses the national GNB average, even a possible improvement does not mean that favourable changes have taken place in environmentally relevant extremes, however, through the calculation and use of histograms, these extremes can be shown. The real environmental impacts of agriculture can be shown by the decrease in the width of the above two types of GNB through the 'slimming' of the histograms or the approximation to the edge marked 'optimal' as seen in Figure 1. As one can see in Figure 1 the goal is to avoid values in the tails of the distribution which represent extremes (either a lack of, or excess nitrogen) while trying to achieve a better balanced status in the center. The common goal of farmers and environmental protection is zero DN on a multiannual average. Therefore, in this case the more concentrated the columns of the histogram are in the center indicates the closer one gets to reaching the goal of more sustainable DN levels. Histograms give a more detailed picture of the relationship between agriculture and the environment than the national level balances.

Major findings of the evaluation (Step 5)

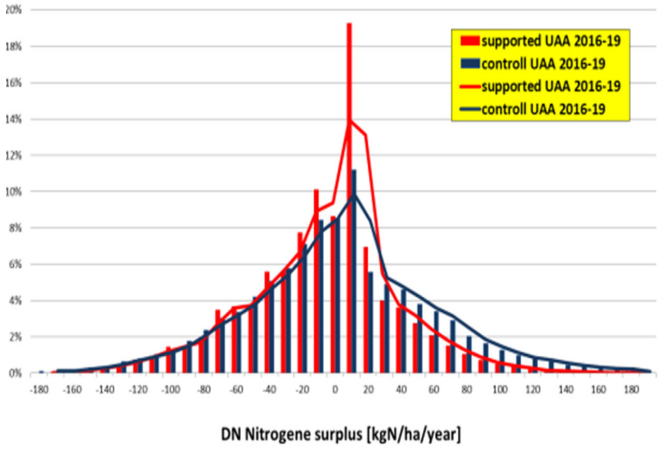
Histogram analysis shows that in nearly half of the supported areas more nitrogen and phosphorus are removed from arable land than replenished. This is especially important for P, as according to the histogram, the DP balance is negative in 87% of the supported arable land (Figure 2).

In other cases, there is a relatively high proportion of significant DNs that are likely to cause groundwater contamination. Histograms defined by grouping the parcels according to different aspects (e.g. soil type and organic matter content,

infiltration) allow for an even more thorough and multi-aspect assessment. A comparison of the DN histograms of supported UAA areas for 2010-2014 and 2016-2019 (Figure 3) shows that the proportion of large DN areas decreased, which is a favourable change for water protection. At the same time, however, the proportion of negative DN areas has increased, which is an unfavourable change in terms of soil quality. This suggests there is a trade off in some cases between better water protection and unfavourable soil quality, which can be resolved with optimal nutrient management (GNB balances around zero). A comparison of the histograms of 2016-19 (Figure 4) shows that the proportion of DN areas exceeding 30 kgN/ha/year is significantly lower in the supported areas than in the non-supported (control) areas. The largest difference is in the DN interval between -20 and 30 kgN/ha/year, meaning the supported areas are closer to the optimal condition shown in Figure 1.

Although this is the first evaluation of this kind in Hungary, the evaluators have already obtained useful results with the help of histograms. While the national GNB average (DN= -3.7 kgN/ha/a) is satisfactory, the histograms indicate that there are parcels where agricultural cultivation is likely to contaminate groundwater and parcels where it causes soil degradation. Reducing the share of both areas by achieving optimal nutrient management is in the common interest of both the environment and farmers. Based on the histograms, the achievement of this ideal state can be examined at both the national and regional levels. Lastly, the histograms show that the standard deviation of the distribution of DN and DP data is extremely large, so the averages calculated from them are very inaccurate. Therefore, their comparison does not give significant results and histograms are better suited to show the reality.

Figure 4. Comparison of 2016-19 DN histograms in supported and non-supported UAA areas



Source: GWIS Ltd, 2021

METHODOLOGICAL CHALLENGES AND SOLUTIONS

For the two databases used, data collection is not uniform. The data also includes erroneous data that had to be filtered out as a first step by the evaluator. Therefore, data collection should be standardised between these databases and supplemented with data of the removed crop residues. For the future instead of a more simplified GNB calculation method, a GNB calculation method taking into account N and P losses could then be applied in the calculation of histograms to make them even more robust. Furthermore, for the future it will be necessary to further specify the coefficients used for the GNB calculations. Field groundwater and soil explorations and assessments are required in order to further calibrate the GNB calculation method. The histograms made after such an exercise will show a state even closer to reality. In this regard, field exploration and calibration on 200 representative parcels have already begun and will be completed in 2022. Histograms for smaller area units can also be produced in the future to allow for regional comparisons of the environmental impacts of agriculture.

RECOMMENDATIONS FOR THE RDP

1. Support optimal nutrient management where not only the maximum N and P but also the minimum N and P are targeted through farm management practices and RDP support.

2. Involve farmers throughout the process to make them more invested in the process and to reduce uncertainties in the incoming data. This will also make it more likely that farmers will adopt evaluation recommendations.

3. Make sure that databases are compatible with each other through uniformed data.

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The Evaluation Helpdesk works under the supervision of Unit C.4 (Monitoring and Evaluation) of the European Commission's Directorate-General for Agriculture and Rural Development.

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