

Regional nitrogen soil surface budgets Germany

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Abstract

Results of the nitrogen (N) soil surface balances for the districts in Germany for the period 1995 to 2017 are presented. Biogas production and transfer of manure between districts are considered in the budget scheme. The surpluses of the national N soil surface budgets is 77 kg N/ha utilised agricultural land (UAA), while the surplus of the districts varies between 26 to 162 kg N/ha UAA (mean 2015 to 2017). Over the last 20 years the N surplus in Germany on the national level varied only slightly, but in districts with intensive livestock farming a significant amount of N in manure is transferred to arable farming regions with low N surplus.

Keywords: Agriculture; biogas; Germany; nitrogen soil surface budget; nitrogen use efficiency; NUTS 3

1. Introduction

Methodology and results of nutrient budgets for agriculture have been established in science and politics many years ago. The surplus of the nitrogen soil surface budget is used as a central indicator to characterize the potential water pollution with nitrate from agriculture and their trend over time. We calculated nitrogen soil surface budgets for the districts (Kreise, NUTS 3) in Germany for the time series 1995 to 2017. The agricultural nitrogen budget (synonym: farm gate budget, sectoral budget) comprises the three components soil surface budget, livestock budget and biogas budget. For administrative units below the level of the national territory only soil surface budgets can usually be calculated due to the limited availability of input data.

2. Results

The most important N supply quantity in the soil surface budget for German agriculture as a whole is mineral fertilisation with 104 kg N/ha UAA (mean 2015 to 2017). A total supply of about 226 kg N/ha UAA is opposed by a

withdrawal of nitrogen of about 149 kg N/ha UAA, which results in a surplus of the N soil surface budget of about 77 kg N/ha UAA (Table 1). The efficiency of nitrogen use in plant production (Nitrogen Use Efficiency, NUE) is thus 65.8 %. For the time series 1995 to 2017, the surplus of the N soil surface budget shows a trend of an annual decrease of about -0.4 kg N/(ha UAA · a). If only the last ten years (2008 to 2017) are taken into account, an increasing trend of +1.4 kg N/(ha UAA · a) per year results. The range of the N soil surface budget surpluses of the districts (mean 2015 to 2017) spans from 26 to 162 kg N/ha UAA (Figure 1). The N surplus summed over the districts corresponds to the N surplus calculated for Germany as a whole in most years to approx. +/-1 kg N/ha UAA.

The N soil surface budget surplus in the districts is closely related to the livestock number ($R^2 = 0.82$ for 2015 to 2017). The increase of the stocking density in the regions with high livestock density in the average 2015 to 2017 compared to the average 1995 to 1997 did not lead to an increase of the N soil surface budget surpluses to the same extent as it would have been expected due to the increase of the livestock density. Because of the increase in transfer of manure across districts, the N supply to the UAA has increasingly been

decoupled from the N excretion in animal husbandry. This development leads to a clear increase in the N soil surface budget surpluses in those regions which take up transferred manure.

Table 1: Nitrogen soil surface budget in Germany (averaged over all districts, mean 2015 – 2017)

Budget term	kg N ha ⁻¹ a ⁻¹
Input total, thereof	226.5
Mineral fertiliser (inorganic fertiliser)	103.7
Manure (on-farm production) used as fertiliser	57.8
Manure import from abroad	0.9
Digestate from biogas plants	33.3
Compost, sewage sludge, meat-and-bone meal	3.2
Biological N fixation	12.8
Seeds and planting material	1.3
Atmospheric NO _x deposition on UAA	4.0
Atmospheric gross NH ₃ deposition on UAA	9.5
Output total, thereof	-149.0
Harvest withdrawal of marketed crops	-66.7
Harvest withdrawal of fodder crops	-60.5
Harvest withdrawal of energy plants for biogas	-18.6
NH ₃ emissions from fertiliser application returned to UAA	-5.4
Budget surplus	77.4

The most significant change in agriculture in Germany in the period from 1995 to 2017 is the strong expansion of biogas production with a turnover of around 574,000 tonnes of N in 2017. The inclusion of biogas production in the budget sheet leads to a higher N soil surface budget surplus compared to earlier calculations without regarding biogas production. This is mostly due to the fact that the additional nitrogen supply with the digestate of the energy crops is now taken into account (netted) in the budget approach.

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References

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Figure 1: Nitrogen soil surface budget surplus of districts in Germany, mean 2015-2017

