Emission estimates for diffuse sources
Netherlands Emission Inventory

Nutrient losses from farmland and uncultivated land

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NETHERLANDS NATIONAL WATER BOARD WATER UNIT
in cooperation with ALTERRA

Nutrient Losses from farmland and uncultivated land

1 Description of emission source

This fact sheet describes how nutrient losses from farmland and uncultivated land into surface water are quantified.
This emission source is attributed to the governmental target sector "Agriculture"

2 Explanation of calculation method

The data is generated by the national modelling instrument STONE [3] that was created jointly by the Netherlands Environmental Assessment Agency (MNP), the Netherlands National Water Board Water Unit ('Waterdienst') and Wageningen University and Research Centre (WUR).

STONE divides the Netherlands into computational units and then calculates the nitrogen and phosphorus balance for each unit [1]. This method of determining emissions is therefore different from that applied to other diffuse sources, where emissions are generally determined as the product of an activity rate and an emission factor.

Actual nutrient loads by agricultural activity are based on the agriculture survey ("Meitelling") conducted in the spring of 2007, which incorporate data from 2006. This is the main reason why the calculation results described here are valid for the period up to and including the year 2006.

3 STONE model

The STONE model divides the Netherlands into 6,405 plots each with a geographically specific combination of 'soil-plant-water-pollution'. Final emissions per plot are calculated as part of the total nitrogen and phosphorus mass balance and can be presented in simplified form as:

accumulation in soil = total load - removal via crops - emission into atmosphere and water

STONE has sub-models which are used to calculate the mass balance (see [1]) for aspects such as:

- production and application of manure
- application of fertilisers
- application of manure, deposition and emission of NH_3
- uptake of Nitrogen and Phosphorus by crops
- transformation processes in the soil (nitrification, denitrification, sorption, desorption, mineralisation, immobilisation)
- transport of Nitrogen and Phosphorus in the soil
- leaching and run-off of nitrogen and phosphorus into surface water
- seepage into deep groundwater

The extent to which relevant processes take place within these sub-models, and the rate at which they occur, depends in the final analysis on weather conditions, soil type, crops type, total nutrient loading, hydrology and groundwater level.
Hydrology and associated groundwater conditions are calculated separately [2].

Emission calculations are performed for two different sets of weather conditions:

- Actual weather conditions in the year of interest. This is done using weather data for the year in which the emission occurred. The emission calculated in this way is an estimate of the actual emission.
- Baseline year weather conditions.. This is done using weather data for 1985 (year of baseline) in order to calculate emissions in the years between 1985 and 2005. The weather conditions are kept constant while other variables change over time. The emission calculated in this way

does not produce an estimate of the actual emission, but allows individual years to be compared with each other. This data makes trends visible on a comparable basis.

The final result of the calculation is a quantification of the emission of nitrogen and phosphate into soil and groundwater. More information about STONE is also available via the website (see [4]).

4 Effects of policy measures

The STONE model takes account of the effects of emission-reducing measures on le of nitrogen and phosphorus (see [1]).

5 Emissions calculated

The emissions calculated by STONE are summarised in tables 1 and 2.

Table 1: Leaching and run-off in ktonnes/year for the actual weather year [7]

	1985	1990	1995	2000	2002	2003	2004	2005	2006
N run-off	1.671	0.711	1.161	0.779	0.708	0.208	0.823	0.699	0.637
N leaching	61.549	53.847	81.922	82.139	66.238	32.064	54.906	42.561	41.542
P run-off	0.136	0.065	0.077	0.096	0.085	0.021	0.083	0.106	0.057
P leaching	3.134	2.712	3.734	4.202	4.553	2.317	3.421	2.914	2.776

Table 2: Leaching and run-off in ktonnes/year based on weather records for 1985 [7]

	1985	1990	1995	2000	2002	2003	2004	2005	2006
N run-off	1.671	0.988	0.979	0.707	0.624	0.631	0.616	0.574	0.586
N leaching	61.549	54.941	66.954	59.189	51.377	48.700	48.550	48.823	46.120
P run-off	0.136	0.089	0.090	0.086	0.078	0.079	0.074	0.076	0.073
P leaching	3.134	3.138	3.543	3.423	3.594	3.611	3.218	3.371	3.255

The leaching and run-off values for the actual weather year (table 1) produce an estimate of actual emissions in the years 1985 to 2006.
Leaching and run-off for weather year 1985 (table 2) does not produce an estimate of the actual emissions, but does allow trends in the values to be recognised. In table 2 we see a downward trend in run-off (both nitrogen and phosphorus), but the situation is different when it comes to leaching: the nitrogen load falls, while the phosphorus load increases until 2003 and then stabilises at around 1.2 ktonnes/year.

6 Release into environmental compartments

The emission calculations are for emissions to surface water from rural areas (farmland (open-field cultivation) and uncultivated land). All the emissions directly enter the surface water.

7 Description of emission pathways to water

The model quantifies leaching and run-off as the pathways into surface water.

8 Spatial allocation

STONE does produce a spatial distribution of emissions. However, many of the drainage areas (a sub-unit of a water catchment area) in the National Emission Inventory are smaller than the minimum area for which STONE is able to give reliable outcomes. For that reason, individual drainage areas are clustered into larger geographical units [5] and then distributed among the drainage areas with an equal value based on the larger units. It should be borne in mind that the visualisation cannot therefore be completely accurate.

It is also important to realise that STONE does not calculate leaching and run-off for urban areas or transport/transformation in surface water. The outcomes from STONE do not therefore cover the entire country. This means that no leaching or run-off values are calculated for drainage areas that consist entirely of surface water.

The following assumptions have been used when clustering the drainage areas discerned in the National Emission Inventory Database [5]:

1. Exclusion. No leaching or run-off calculation needs to be executed for drainage areas than consist entirely of water (polder) and/or urban areas;
2. Size. All drainage areas less than 50 km^2 in area are clustered to form units covering at least 50 km^2;
3. Hydrological coherence. The clustered drainage areas must, taken together, form a coherent new hydrological unit;
4. Spatial diversity. The drainage areas clusters must be composed so as to retain the greatest possible spatial diversity.

Leaching and run-off calculations are then performed for each drainage area within a cluster of this type, with the result expressed as kilogramme per hectare.

9 Comments and changes in regard to previous version

STONE has gradually been improved over the past few years (2004 to 2008). The improvements relate to improvements and refinements of the sub-models or the incorporation of more up-to-date atmospheric deposition data [1]. Examples of adjustments include:

- Refinement of the schematisation of the nutrient balance of arable and horticultural plants;
- Improvements in hydrology (including distribution of wet and dry sandy soils, as dry sandy soils have become less dry);
- A better alignment between calculated stocks of Phosphorus in the soil with measurements of Phosphorus stocks in the national survey;
- The action coefficient of nitrogen in manure in the model chain;
- The background pollution caused by mineralisation of organic matter in deeper layers is now regarded as less significant.

These changes can have considerable consequences, as can be seen in the case of run-off and leaching calculations in NEI[1]2006 and NWI[2]2007. The method used to derive parameters from the action coefficients for manure was further improved in the transition from NEI2007 to NEI2008. The calculated results of NEI2008 are quite similar to those of NEI2007. The main difference is with regard to removal of N in 2002, which is shown as being 1.7% lower in NEI2008 than it was in NEI2007 (see [7] for a more detailed explanation).

10 Accuracy and indicated subjects for improvement

The method used in Emission Inventory publications [6] has been followed as far as possible in classifying the quality of information. It is based on the CORINAIR (CORe emission INventories AIR) methodology, which applies the following quality classifications:

A: a value based on a large number of measurements from representative sources;
B: a value based on a number of measurements from some of the sources that are representative of the sector;
C: a value based on a limited number of measurements, together with estimates based on technical knowledge of the process;

[1] NEI = National Emission Inventory
[2] NWI= National Water Inventory

D: a value based on a small number of measurements, together with estimates based on assumptions;

E: a value based on a technical calculation on the basis of a number of assumptions.

The STONE model was used to calculate the emissions. These calculations have undergone limited validation by measurements. At a national scale, the outcomes for sandy soils appear to be plausible. Emission calculation is classified as C.
The outcomes are less reliable at a regional scale, and an additional step has been performed to distribute the emissions to clustered drainage areas in the national emission inventory database [5]. The reliability of this distribution is unclear. There may be considerable differences between measured run-off and leaching and calculated run-off and leaching (see [8]). Spatial allocation is classified as D.
All the emissions enter water directly. The distribution among compartments and pathways is influenced by the schematisation approach used by STONE. For that reason distribution over compartments and emission pathways to water are classified as B.

Element of emission calculation	Reliability classification
Emissions	C
Distribution among compartments	B
Emission pathways to water	B
Spatial allocation	D

11 Request for reactions

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