Impact of agricultural practices on surface water quality: A case study in the problem area of the Horstgaterbeek in North Limburg, Flanders

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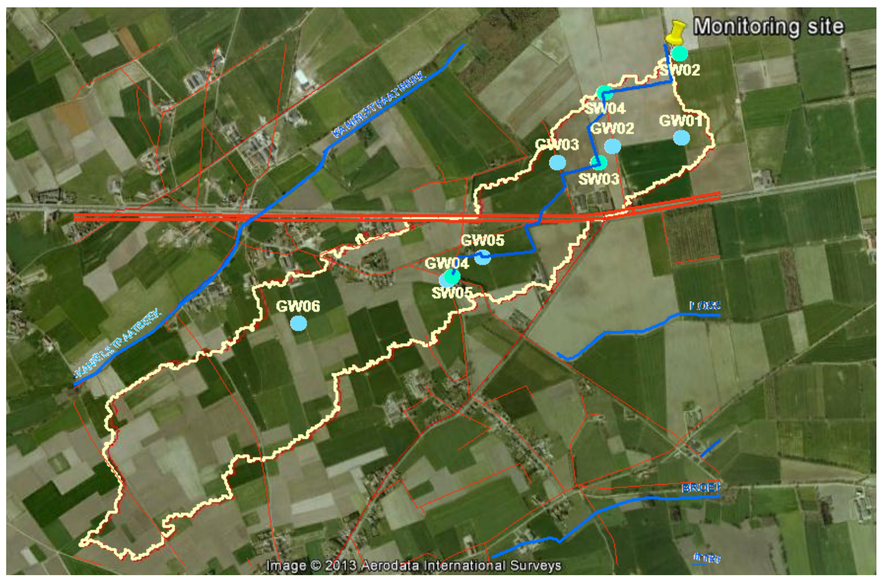
In the context of the EU Nitrate directive, a project on surface water quality was started in 2012 in the area of the Horstgaterbeek, a stream in North Limburg, Flanders. The area has an important agricultural activity, with many livestock farms and grassland, but also arable crops. It is a flat area with sandy to sandy-loam soils and shallow groundwater tables. In the area, some monitoring sites for surface water quality, belonging to the monitoring network of the Flemish Environmental Agency, are situated in small ditches. In one of them, the nitrate content regularly exceeds the allowed maximal level (50 mg $NO_3^-.l^{-1}$).

The aim of the project is to get a better insight in the nitrate flows in the area of this monitoring site and to improve surface water quality, through an intensive follow-up of the agricultural activities, in collaboration with the local farmers.



The catchment of the monitoring site was determined, covering a total area of about 140 ha (fig. 1). In this area, information was collected on:

- Water flows: drainage, streams and ditches were mapped. Because of the shallow groundwater levels, the parcels in the northern part of the area are drained. In some, mainly arable parcels, irrigation is applied.
- Farms: the agricultural parcels in the study area belong to cattle farms (6), pig farms (4) and 1 arable farm.
- Agricultural parcels: soil types vary from sand to sandy loam. In most of the parcels, the C-content as well as the pH are below optimum. The P-content is mostly high.
- Fertilisation history: in all the parcels considerable amounts of cattle or pig slurry are applied frequently.
- Crops: in 2012, the project area consisted mainly of maize and grassland parcels, belonging to livestock farms. Also sugar beet, peas, beans, fodder beet, potatoes and spring barley were grown.

During 2012, water quality as well as soil nitrogen content and agricultural activities were monitored intensively.

Fig. 1 – Location of the study area and the water quality monitoring sites (SW = surface water; GW = groundwater).

Monitoring of surface and groundwater quality

Beside the existing monitoring site, the surface water quality (SW) was monitored upstream in 3 supplementary sites, also situated in small ditches (fig. 1). Furthermore 6 monitoring sites for groundwater (monitoring wells) were installed (GW). The location of these wells was chosen in such a way that their infiltration areas correspond with agricultural parcels within the project area.
Nitrate was determined monthly in water samples of all monitoring sites.

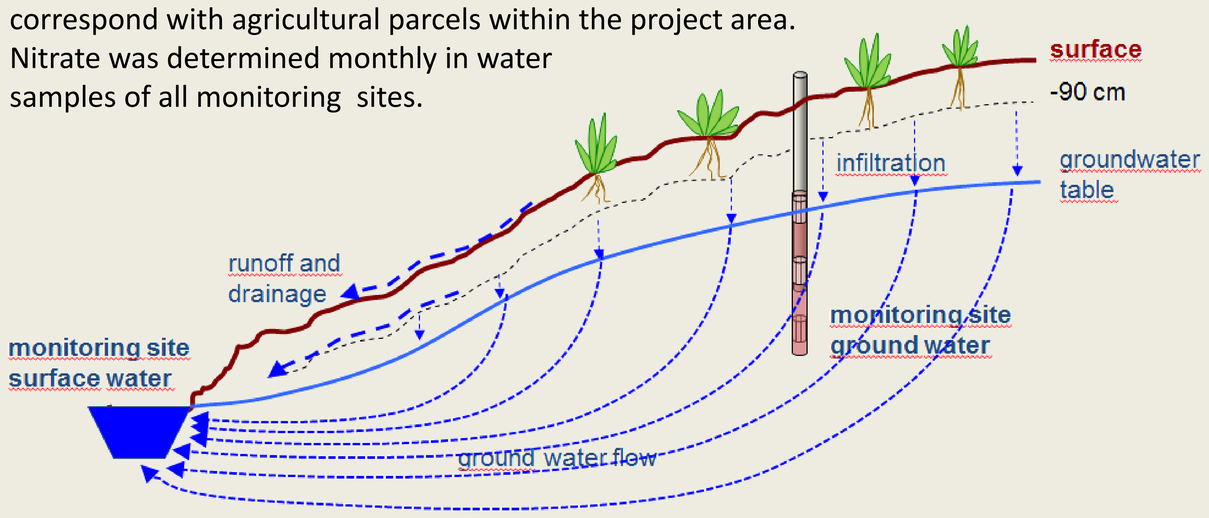


Fig. 2 – Schematic view of the different water flows in a surface water catchment and a corresponding groundwater monitoring site (well).

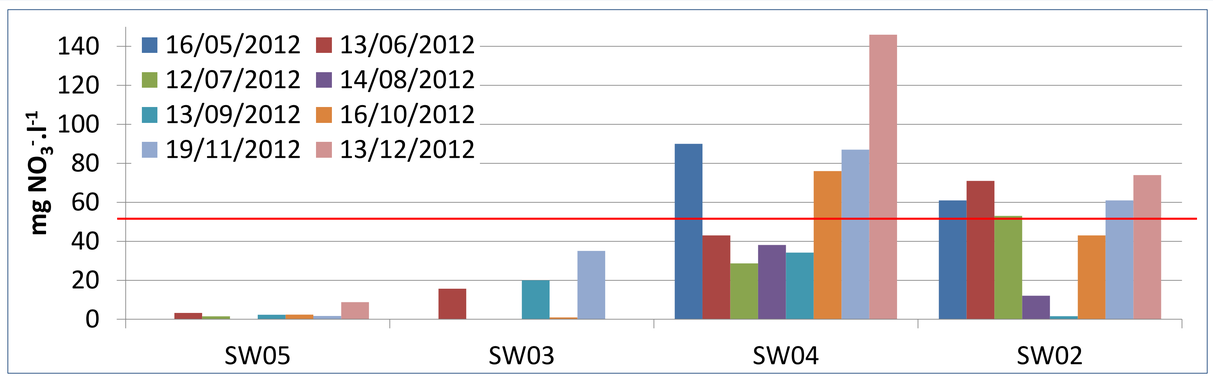


Fig. 3 – Evolution of the nitrate content in the surface water in 2012.

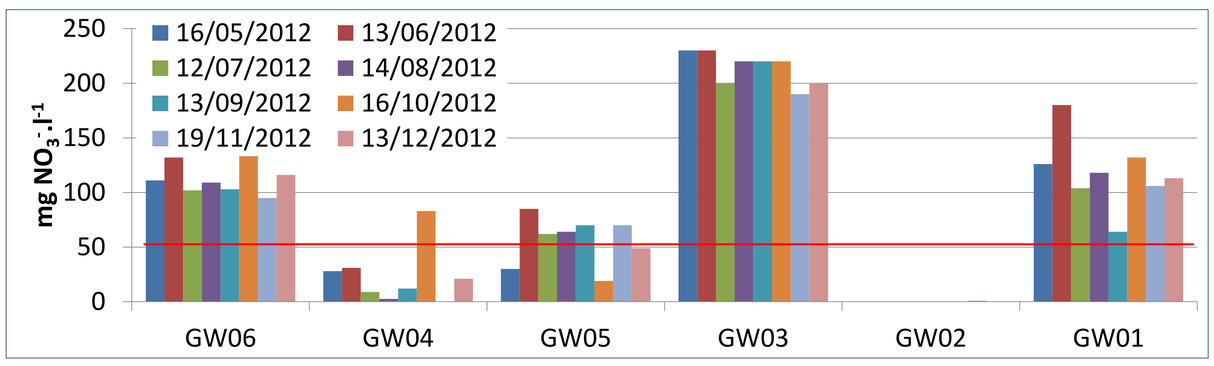


Fig. 4 – Evolution of the nitrate content in the groundwater in 2012.

Monitoring of soil nitrogen and agricultural activities

In all the agricultural parcels, the soil N content was determined in spring, manure samples were taken and field activities were registered. All farmers received parcel-specific N fertilisation recommendations based on N-index soil analyses. At the end of the growing season, residual nitrate in the soil (0-90 cm), subject to leaching during winter, was measured and soil balances for N were calculated.

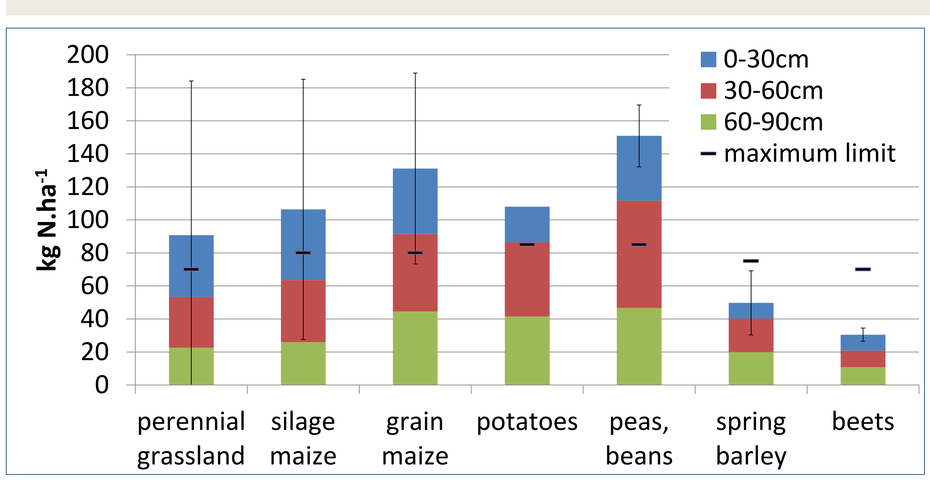


Fig. 5 – Nitrate residues after different crops in 2012.

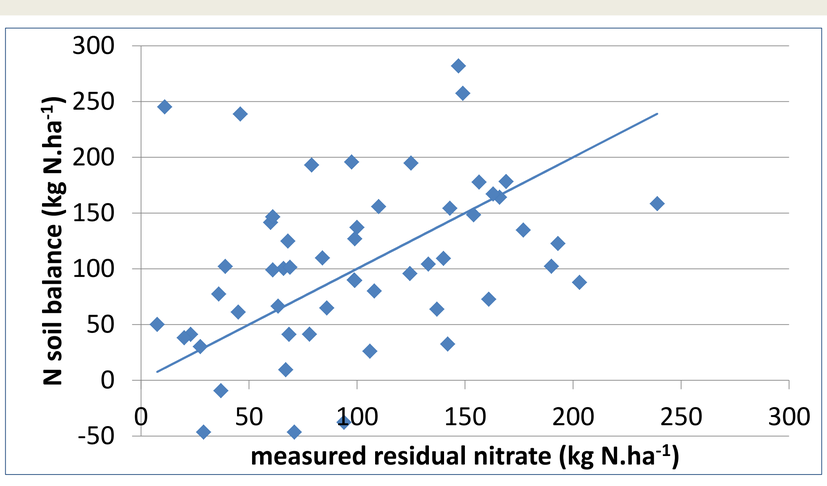


Fig. 6 – Calculated N-balances vs. measured nitrate residues.

After the first research season, highly variable nitrate residues were measured in the parcels, in some cases with extremely high values (fig 5). In most of the parcels, the calculated N balances correspond reasonably well to the measured nitrate residues (fig. 6). In some parcels manure and slurry was applied or registered incorrectly (overlaps,…), causing aberrant N balances. In the other parcels, the N balances show the importance of parcel specific fertilisation based on N analyses and fertilisation recommendations.

Conclusion

Throughout the study area, the water quality standard of 50 mg $NO_3^-.l^{-1}$ was exceeded regularly, both in surface water and in groundwater. Taking into account the travelling delay of groundwater, these results indicate that the poor water quality in the surface water of the catchment probably is not only due to recent (excessive) fertilisation in surrounding parcels, but can also be attributed to historical pollution in parcels located at a greater distance.