Nutrient retention and transformation in shallow groundwater

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Background & Objectives

- The efficiency of vegetated buffer strips in reducing sediment and nutrient emissions into surface waters via surface runoff is well documented.
- In contrast to that, little is known about retention performance of buffer strips on groundwater, especially if narrow strips (<10 m) are considered. The latter might be easier to establish in regions with high pressure on agriculture.
- This study was initiated to gain insight into governing processes of nitrogen transport and transformation in the shallow groundwater of small sized vegetated buffer strips.

Material & Methods

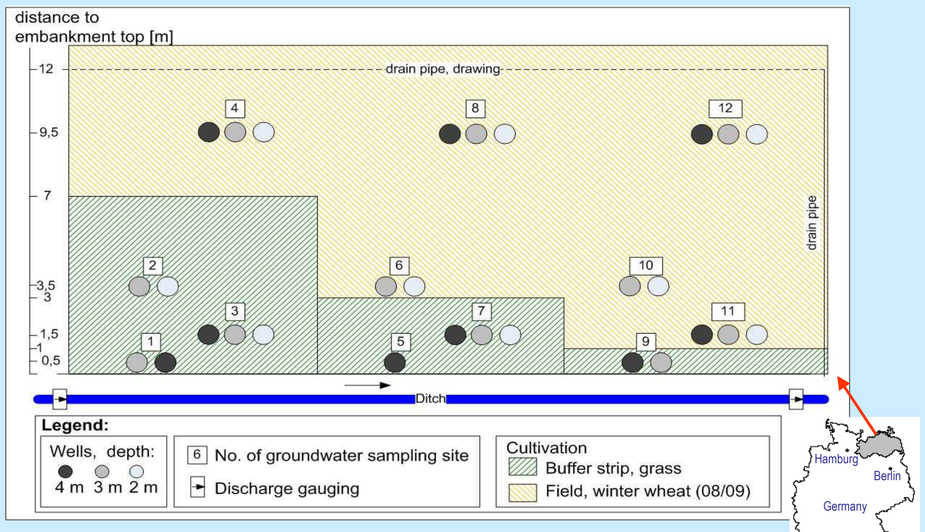

Fig. 1 : Study site, schematic drawing

Location:

- near to Dummerstorf south of Rostock in North-East Germany

Instrumentation:

- Three buffer strip segments (30 m each) of 1, 3 and 7 m width along a ditch draining a small agricultural catchment, installed in Nov. 2008
- Dip wells in field and buffer strips with screened 1m-intervals at depths of 1-2, 2-3 or 3-4 m (Fig.1)

Monitoring and Analysis:

- Monitoring of groundwater and ditch water level – weekly
- Groundwater (GW) sampling with bailer sampler, manual ditch water sampling– weekly to biweekly
- GW and ditch samples are analysed for NO_3^-, Cl^-, SO_4^{2-} with an Ion Chromatograph
- Monitoring of precipitation and temperature at a nearby station (about 200 m)

First Results & Discussion

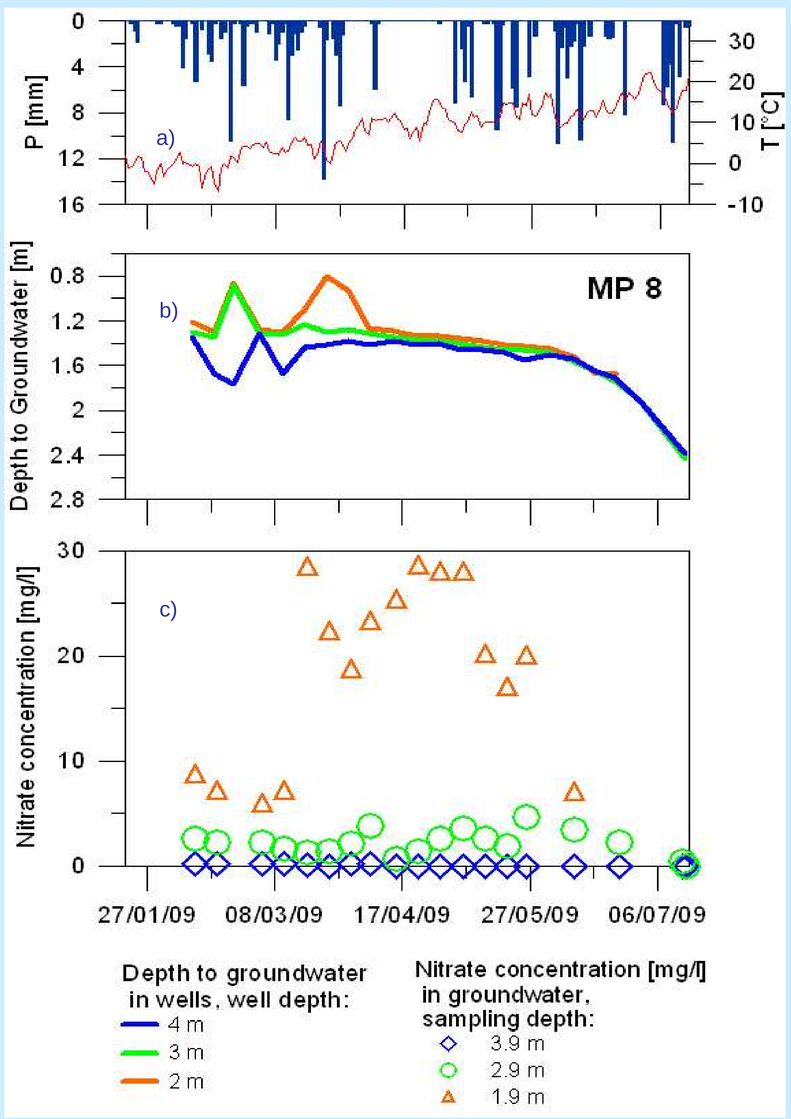

Fig 2. : (a) P and T, (b) Depth to GW and (c) NO_3^--concentration at GW monitoring point 8 from February to July 2009

Groundwater Levels

- Fig. 2 a and b indicate a dynamic behaviour of the groundwater in response to precipitation until start of growing season.
- Response in very shallow dip wells (2 m) faster.
- Water table contours and gradient vectors (generated by means of kriging) induce a flux from field to the ditch.

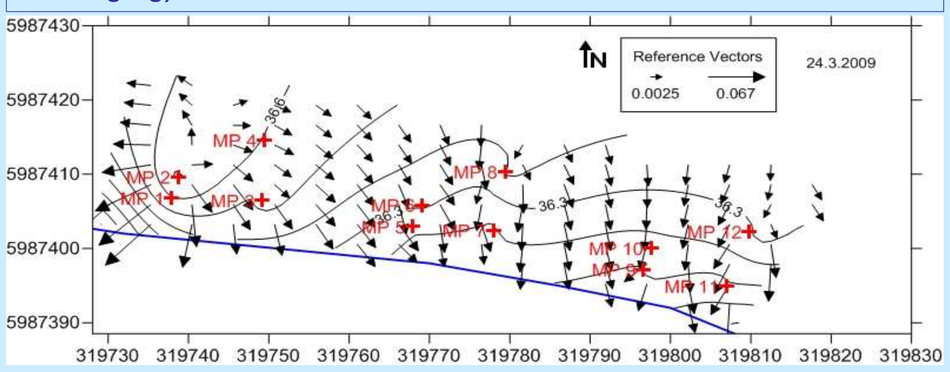

Fig 3. : Water table contours (m a. s.l.) and vectors indicating gradients for the 24. 3. 2009.

Nitrate in groundwater

- Nitrate concentrations at sampling sites vary both spatially and temporally in several magnitudes (0-30 mg/l).
- Nitrate concentrations decrease with increasing groundwater depth (Fig. 2c), and along groundwater flow direction being almost zero in vicinity of the ditch (Fig. 4).
- As response to snowmelt/ thawing (23.2.), fertilisation (8.3.) and the first rain precipitation event (11.3.) of the season, Nitrate concentrations sampled from 1.9 m at MP 8 jump up from ca. 7 to 28 mg/l (Fig. 2). At the respective well at MP 7 concentrations stay below 5 mg/l (Fig. 4).
- These concentration reductions with increasing distance to the field (Fig. 4) were observed at all three buffer strips - no specific effect of buffer strips occurred until now. It is assumed that low saturated hydraulic conductivity of the soil at groundwater depth may have caused denitrification and low nitrate concentrations.

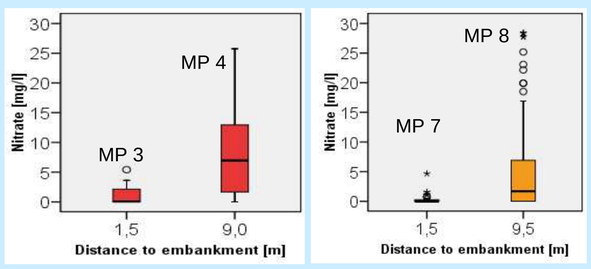

Fig 4. : Nitrate concentrations at GW monitoring points 3 & 4 (left) amd 7 & 8 (right), samples from February to July 2009

Outlook

- Sampling of pH, concentration of O_2 in solution, redox potential and water temperature prior to taking water samples with the help of a multiparameter probe to help assess denitrification potential in groundwater.
- Continued monitoring of water level and nutrient concentration.
- Quantification of groundwater influx to the ditch via temperature difference in ditch bed and groundwater.

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