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Hydrology and Earth System Sciences Discussions

Interactive comment on "Model-based analysis of nutrient retention and management for a lowland river" *by* D. Kneis et al.

D. Kneis et al.

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In reply to the comments of Referee #4:

We like to thank you for your comments on our manuscript. The notes below describe how we dealt with your comments in the preparation of a revised paper:

Notes on "online comments":

1) It was criticized that Results and Discussion were pooled in one section. In the revised manuscript both sections were separated. A separate "Study site" section was also added.

2) We revised the model approach with respect to phosphorus (see reply on comments of referee #3 for details). Data on sediment cores as well as sampling and analysis methods that were missed in the prior version of the manuscript are now presented.

Notes on “additional comments” (received on a printout via the editor):

The corrections to grammar and rephrasing suggestions were considered.

The question, whether ammonia volatilization significantly contributes to N retention in the Havel River is interesting. There are numerous investigations on NH3 volatilization from soils after application of fertilizer (manure) but studies on the relevance of this process in natural waters are rare:

In a study on Lake Mueggelsee (located at a tributary of the Havel River) [1], denitrification and (to a lesser extent) N sedimentation were identified as the dominant processes of N retention. Also in a fertilizer experiment on a fish pond, N losses to the atmosphere were found to be relatively low and uptake of phytoplankton explained most of the diurnal fluctuation in ammonium [2]. In a study on N retention in a constructed wetland receiving very high N loads [3], the contribution of denitrification was found to be clearly dominant over NH3 losses.

Nevertheless, some N retention due to ammonia volatilization should be possible in highly eutrophic waters since the increase in pH due to primary production shifts the equilibrium of NH4+/NH3 towards the base (NH3). The median pH in summer is about 8.5 in the Havel River. Using a dissociation constant of pKa = 9.3 the equilibrium ratio of NH3/NH4+ at this pH is about 0.16. Thus, the majority of ammoniacal N is still NH4+. Secondly, one must consider that, in summer when pH is highest, inorganic nitrogen concentration are lowest as DIN is consumed by the phytoplankton. Also, at the time of maximum primary production, most of the DIN in the Havel River is in the oxidized form (nitrate). Presumably, the ammonium preference of phytoplankton (ammonium uptake is energetically more efficient than nitrate uptake) is responsible for this. The average observed ammonium concentration in the Havel River is about 0.2-0.4 mg/l in summer. According to the above pH-dependent equilibrium calculation the NH3 concentration should be as low as 0.03-0.06 mg/l. It should also be taken into account that in the sediment, where ammonimum concentrations are much higher, the pH is much lower

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(about 7-7.5) and only a very small fraction of NH4+ is unionized.

In conclusion we believe that N sedimentation and denitrification are - in agreement with the literature - the primary causes of N retention in the Havel River. Ammonia volatilization could possibly contribute to N retention in periods of highly increased NH4+ concentrations (e.g. during the breakdown of algal blooms).

[1] Dudel, G. & Kohl, J.G.: The nitrogen budget of a shallow lake (Grosser Müggelsee, Berlin), Int. Revue. ges. Hydrobiol., 1992 , 77 , 43-72

[2] Abdalla A.A.F., McNabb C.D., Batterson T.R.: Ammonia dynamics in fertilized fish ponds stocked with Nile tilapia, PROGRESSIVE FISH-CULTURIST 58 (2): 117-123, 1996

[3] Poach, M.E., Hunt, P.G., Sadler, E.J., Matheny, T.A., Johnson, M.H., Stone, K.C., Humenik, F.J., Rice, J.M. Ammonia Volatilization from Constructed Wetlands That Treat Swine Wastewater. Transactions of the American Society of Agricultural Engineers. 2002. V. 45. P. 619-627

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