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Hydrology and Earth System Sciences Discussions

Interactive comment on "Catchment features controlling nitrogen dynamics in running waters above the tree line (Central Italian Alps)" *by* R. Balestrini et al.

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Referee 1 (P 10454) and Referee 2 : Estimate of nitrate retention

We used an approach based on the comparison between nitrate and a geochemical descriptor (Ca) in order to infer the removal of nitrate by biological processes. The starting idea was to use Cl instead of Ca, analogously to the more known approach based on NO3:Cl ratio often applied in studies on sub-surface aquifers and groundwater (e.g. Sabater et al. 2003). The simultaneous decline in chloride and nitrate concentrations along a hydrological flow path can indicate the occurring of a dilution

process. Similarly, other Authors, e.g Lefreniere et al. (2005) used the difference in the NO3:Cl ratio between the snow and the streams as an indication of the effect of catchment processes on NO3 export to the streams. We did not used chloride for the following reasons. The Cl concentrations measured during the study period (June-October) were very low and steady in all sites, with small variations mostly due to the analytical variability. This suggested that the temporal variations of NO3 were not due to physical processes such as evaporation or dilution. On the other hand NO3 and some geochemical descriptors primary Ca, but also Mg and SO4, showed a similar trend with maximum concentration during October. Thus, assuming that the variations of Ca were principally due to the weathering and/or the soil leaching, we used the ratios NO3:Ca to distinguish the biological removal of nitrate from the other processes.

Why did we use the June ratio? i) To use this approach we need a starting point (i.e June ratio); ii) the first month of the year for which we had reliable stream concentrations was June; iii) the concentrations from spring months, only occasionally available (due the site inaccessibility), are not suitable because they are affected by the"ionic pulse" influence; iv) the Ca concentrations measured during the period after June are more influenced by processes deriving from the interaction water-soil (e.g. soil leaching). In other words, as summarize by reviewer 1, in June, NO3 and Ca could mostly originate from precipitation accumulated as snow in the catchment while in other period Ca could be most dependent on weathering processes.

The equation was incorrectly reported and it will be corrected as suggested in the revised version of the paper : expected NO3Jul = CaJul $\times$ (NO3Jun/CaJun)

We used this approach instead of most common mass balance method because both flow measures for each stream site and atmospheric inputs along the elevation gradient (2000-2500 m asl) were not available. Given the inaccessibility of most alpine sites above tree line, a simple approach such as the one proposed in the paper, even if relatively rough, can be effective for similar purposes in other areas.

Sabater et al. Nitrogen Removal by Riparian Buffers along a European Climatic Gradient: Patterns and Factors of Variation. Ecosystems (2003) 6: 20–30. Lafreniere M. J. and Sharp M. J. A comparison of solute fluxes and sources from glacial and non-glacial catchments over contrasting melt seasons, Hydrol. Process. 19, 2991–3012 (2005)

Referee 1 (P 10459, Ls 12–23) and Referee 2 (P 10453, L11-13): DON discussion

DON concentrations measured in all sites were very low, comparable to other stream sites at high elevation but lower than those reported by Kopacek et al. (2000) for mountain lakes. Conversely DOC concentrations were relatively higher and far from the analytical limit. We could not exclude that the analytical constrains were at the basis of the missed relationship between DON and the percentage of vegetated soil or N3. In any case we are more likely to think that the organic N represents a “leak” of N from the terrestrial ecosystem to aquatic ecosystem. Some Authors introduced the hypothesis called “leaky faucet” according to which there is a persistent “leak” of DON from terrestrial catchment due to the DON decoupling from biological demand for N. On the other hand the export of DON is more influenced by the soil standing stock of C and N. For these reasons the inorganic N and organic N export in streams could respond differently to increased amounts of inorganic N in atmospheric deposition [Aber et al., 1998].

We use the difference between TDN and TIN as an internal quality control. This means that every time we have a negative value we possibly repeat the analysis. If the “negative” is confirmed, we consider that the DON concentration in that sample is below our detection limit.

As regard all other minor comments from both referees we will be able to incorporate most of the suggestions during the revision of the manuscript.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 9, 10447, 2012.