

# ***Interactive comment on* “Phosphorus dynamics in lowland streams as a response to climatic, hydrological and agricultural land use gradients” by G. Goyenola et al.**

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Reviewer Comments Phosphorus dynamics in lowland streams as a response to climatic, hydrological and agricultural land use gradients

## GENERAL COMMENTS

This study encompasses an extensive sampling and analytical effort to evaluate phosphorus dynamics in streams under different climatic, hydrologic and land use gradients. It is ambitious and international, covering two countries in two climate regimes. Two watersheds in temperate Denmark and two in subtropical Uruguay were selected, and

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the two watersheds in each country differed in the level of arable land use: 90% or more compared to 30% or less in the other. The study also compared phosphorus sampling including high frequency composite and instantaneous grab sampling with analyses of a range of P forms. Point and diffuse sources of P were then modeled for each watershed as well.

Unfortunately, to encompass the variation of climate, hydrology and landuse in only four watersheds is extremely limited by insufficient replication due to all four watersheds having very different landuse and subsequent management (cropland drained by tiles vs forage crops and dairy farms without tiles and forest vs Pampa grasslands (used as pasture)). Furthermore, there was little to no description of topography and slope or even the spatial distribution of the different land uses across each of the watersheds. The mechanisms for runoff generation and nutrient transport could be drastically different between these watersheds. Therefore, large uncertainties due to these variations are likely in the results.

More complications from uncertainty arise considering only the outlet was monitored. Field-level (or even hillslope) management effects on water quality cannot be inferred adequately from outlet monitoring only. This can also be true for the particular processes driving runoff generation and other important hydrological processes affecting nutrient transport. While septic and wastewater effluents were estimated for the appropriation model, are there particular differences in animal units and/or manure management that could be described for each watershed. Other particular field management differences (manure and fertilizer use, grazing intensity, etc.) in the agricultural watersheds were described only very limitedly. Only livestock access to streams in Uruguay was discussed to any degree. In Denmark, was animal production focused on confined animal operations or others?

On the modeling front, upstream and field or hillslope monitoring would be very important to serve as corroboration of processes in any continued modeling efforts as suggested in the last paragraph of section 4.4. Calibration can easily allow the model to

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match measured flows, but the particular processes driving the processes could likely be overshadowed by excessive calibration. The particular hydrological processes determined from both outlet and upstream evaluation, however, can facilitate parameterization and allow better representation of the processes. Therefore, the suggestion to use models to select management (“Strategies that allow to generate scientific based management actions which maximize agronomic productivity while reducing environmental concerns include the development of catchment models (e.g. SWAT; Gassman et al., 2007),...”) for these watersheds would require broad familiarity with the watershed and its various processes together with direct management input from the farming communities in order to indicate management strategies with any degree of certainty. In my experience in modeling, watershed models are not given the “benefit of the doubt” by most, and it would require some strong convincing.

It is apparent there was a large effort involved in the study. However, there are some critical concerns in connecting the results of four very dissimilar watersheds to the expansive conclusions on agricultural intensification offered in the Discussion and the Conclusions. The Uruguayan dairy farming systems were condemned and the Danish farming systems were applauded for being “properly managed”. However, there are no results from other agricultural watersheds in each country to indicate a range of water quality expected from agricultural watersheds, or in other words, a comparison of other subtropical watersheds was not available to indicate the extent of impairment of this study’s particular intensive agriculture watershed. Indeed, eutrophication issues in Uruguay, as in other countries across the world, do need to be addressed in order to secure clean water for the populace; however, the regulations on farming will need to truly impact nutrient losses, fit within the capabilities of the farming community, and continue to allow them to meet market demands and their needs.

## PARTICULAR COMMENTS AND QUESTIONS

I supplied some suggestions and have a few questions that I have presented below:

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â€” I would suggest a more in-depth discussion on fertilizer and/or manure application rates and timings, especially in the intensive watersheds. â€” A map of the land use around each watershed would be helpful as well. Topography and other watershed characteristics could be presented. â€” In the high frequency composite sampling, how many samples were generated within a fortnight and what duration of time did they represent? Or was a single sample of all the composites collected together for the full two weeks? Besides refrigeration, was there any processing of composite samples soon after collection? â€” While the ratio of runoff to precipitation is an important aspect to consider in hydrologic assessments and has been used as a “proxy of catchment water balance”, it clearly is not the only means of characterizing hydrological processes between watersheds. It may also be quite variable within a year and over several years. Are there any discharge gages available near to any or all of the watersheds that may provide some indication of the variation of this ratio? â€” In the appropriation model, was there any work to corroborate some of the point source wastewater estimates that were used as input to the model?

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