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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Developing a nutrient pollution model to assist policy makers by using a meso-scale Minimum Information Requirement (MIR) approach" *by* R. Adams et al.

Anonymous Referee #1

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The authors describe a simple model to simulate loads and concentrations of nutrients with a focus on nitrate, total phosphorus, and soluble reactive phosphorus. They seek a simplified modeling approach that can be readily applied to meso-scale catchments with drainage areas of 10 to 1000 km2. They position this modeling approach as being more complex than a simple export coefficient model, but less complex than process-based nutrient models that can have 10s to 100s of parameters. This model is developed and applied to the much-studied Frome cachment in the south of England. Their goal is to develop a model that can be easily run by managers, and they test two management models as example applications.

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Interactive Discussion
Discussion Paper

I am certainly receptive to simpler modeling approaches, and agree with the authors that complex nutrient models have problems as they are not easy to calibrate and run for the non-expert, and can suffer from the well-known problem of equifinality. But here, I believe the authors may have gone too far in terms of simplification. The inability of the model to predict variation in nutrient concentrations as shown in Figure 5 is especially troubling. By focusing the model on simulating the catchment as a hillslope, they have likely failed to capture the key stores and processes that are needed to effectively simulate nitrate and phosphorus. The model does not formally consider any of the myriad biogeochemical processes such as denitrification and adsorption that are well known to greatly affect the transport of these nutrients. I am not necessarily advocating that a successful model must formally include several of these processes, but recognition and testing of the role of these processes can lead to formal inclusion of simple surrogate variables such as temperature, pH, or ionic strength that may capture the net effects of these biogeochemical processes. The authors claim to have applied a Minimum Information Requirement approach to develop their model, but I see no evidence in the manuscript that there was a formal testing of whether to include certain variables or processes in the model. They simply describe the model they have developed.

The model does seem to do a good job of simulating catchment hydrology, but the assumption of constant nutrient concentrations in each store is inadequate. As an example of what may be needed to effectively simulate nutrient concentrations and loads at the meso-scale, I suggest that a simple term to represent source/sink processes during stream transport could be applied to improve simulations. This term might consider velocity, temperature, and stream width or depth as factors. Testing of what might have been added (or not) in the way of predictive ability by considering how biogeochemical processes affect nutrient evolution could have convinced the reader that the approach applied was the simplest “that achieves the current modeling goals”.

The authors simulate the catchment landscape as a 3-box hillslope. This seems a reasonable simplification to simulate small headwater catchments, but seems inadequate

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at the meso-scale. These larger catchments, particularly those in agricultural regions, typically have a well developed riparian floodplain. These riparian areas are typically where key biogeochemical processes such as denitrification and phosphorus adsorption occur. Representation of the riparian area, even as a simple additional box in the model seems necessary, particularly to distinguish nutrient transport and fate in one catchment compared with another.

In the two management intervention examples provided in the paper, the model is applied to represent the effects of disconnecting nutrient hot spots from transport to the stream and reducing fertilizer application to the land. The 3-box approach does allow some exploration of these interventions in the context of the 3 stores/runoff processes included in the model. However, I am not convinced that these simulations provide much additional insight than could be gained through application of a simple export coefficient approach. In the end, it is difficult to support a modeling approach that attempts to simulate nutrient transport using only a hydrological process approach. The failure of the model to effectively simulate nutrient concentrations indicates that some consideration of biogeochemical processes as well as the catchment landscape is needed to provide managers with a useful model.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 10365, 2014.