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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Natural stochasticity vs. management effort: use of year-to-year variance for disentangling significance of two mutually confounding factors affecting water quality of a Norwegian cold dimictic lake" *by* A. T. Romarheim et al.

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In the responses below, please refer to the track-change manuscript produced by the difflatex utility. The page numbers reflect the page numbers on this track change PDF file.

RC:

In the abstract and at the beginning of the introduction it is stated explicitly that natural stochasticity may obscure the effectiveness of management efforts, and that this is considered a problem. Although this study does a good job in showing the relative importance of year-to-year variation of different forcings for lake water quality, it does not show the importance of these forcings in relation to management efforts. In order not to set false expectations, the authors should be more straightforward in describing in de introduction how the aim of this paper contributes to disentangling between variation and management effort. Currently most attention in the paper goes to linking specific forcings to certain lake responses, and although this reveals some interesting insights, most of these relations are quite obvious.

AR:

We have now set the theme to be disentangling two contributing factors (above lake weather and runoff), changed from the original theme of disentangling natural factors and management efforts. This should rectify the situation that might bear false expectation from the readers, as suggested by the reviewer.

Relevant parts that says "management" or "management efforts" are corrected to "runoff", except the cases where we really meant management effort (section 4.2 specifically).

In addition, as the reviewer also suggested in the first point of the "Minor" comments below, new title is proposed to the editorial office.

Furthermore, we now correctly refer to runoff as the combination results between hydrological element (partially determined by meteorological forcing on land) and the management effort (agriculture and urban related nutrient loading).

Changes:

P1 A new title "The importance of year-to-year variantion of meteorological and runoff forcings for water quality of a temperate, dimictic lake" is suggested.

P2L11. '(management) and weather (the confounding natural stochasticity)' is now changed to 'in runoff and meteorology on the lake'.

P2L10. 'difference in the management goad' is now changed to 'differences in lake water quality'.

P3L4. A new sentence is inserted: 'In particular, nutrient loading is determined both by hydrology (partially determined by meteorological forcing on land) and by the management effort (agriculture and urban related nutrient loading). Furthermore, weather may also be directly consequential in the alek processes such as algal growth.

RC:

Although the results of the calibration procedure look very convincing, and validation is given for different depths, it is a pity that the authors show no validation in time. As the paper deals with year-to-year variation, one would like to see proof that the model does a good job in predicting the year-to-year variations. It would be good if the authors could show some validation using an independent dataset.

AR:

Unfortunately other independent data that is able to challenge the lake model is not available. Moreover, it was not appropriate to divide the available data into parts and use one part (for example one year of observation) as the validation dataset, because we unfortunately have only three years of observation, and these years vary vastly in terms of both runoff, meteorological inputs, and the in-lake observations. This implies that different processes may be dominant in different seasons or different years, and we improve our confidence by calibrating these different years together into a calibrated parameter set.

RC:

P12496 L6 Six scenarios are presented, and also in table 3 (A, B, C, D, Dt and Dp). However, nowhere in de manuscript I can trace back the results of scenarios Dt and Dp.

This is a pity because such scenarios could provide information about the importance of individual forcings, rather than studying the effect a whole group of forcings. Please include the results of scenarios Dt and Dp, or change the text and the table at least.

AR:

The scenario Dt and Dp were included in the Table by mistake from the earlier iteration of manuscript preparation. Because they were not discussed in the main manuscript, we removed them. In addition, the sentence at page 12496 line 6 now correctly reads "four scenarios" rather than "six scenarios".

We do however now include a supplementary material which does have additional scenarios.

Changes:

Please see the new Table 3.

P9L2 'six' is now replaced with 'four'

Please see the new Supplementary Material.

RC:

Table 3: The 'runoff inputs' include more than only nutrient loading e.g. also suspended matter and inflow water temperature, while it is explicitly stated in the introduction that the aim of the paper is to differentiate between meteorological forcing and nutrient loading. I miss an explicit motivation for taking a group of runoff inputs (thereby obscuring the effect of nutrient loading alone), and an explanation why specifically these runoff inputs were chosen.

AC:

Please see our first comment above regarding how we addressed this problem.

RC:

For example, why was nitrogen not considered,

AR:

There is large amount of N in Årungen, as N is applied in surplus at the agricultural fields. Even though there is some reduction in N during summer, N is excluded as the limiting nutrient (ref. Romarheim PhD theses, 2012).

Changes:

P12L(bottom). These above two sentences were introduced.

RC:

and what is the consequence of including air temperature in the meteorological group, and including inflow water temperature in the loading group. In other words, what is the influence of the choices that were made regarding the grouping on the outcome of this study?

AR:

With the new theme of disentangling two factors: meteorological factor and runoff factor (see the first comment), we now correctly group the two categories (Table 3).

Runoff volume (in the runoff group) is predominantly influenced by precipitation (in the meteorology group), but runoff volume was kept together with runoff concentrations because the most important influence the runoff has is the total amount of nutrients, which we obtain by multiplying concentration by volume.

This grouping can potentially create inconsistency in the combination of inputs, and this point was also raised by the Reviewer #3. For example, because runoff is controlled by precipitation, the scenario C for instance (original weather + averaged runoff) on a daily basis may suffer from a potentially undesirable situation such as high precipitation with no cloud. This is unrealistic, but from the lake ecosystem perspective, we treat the runoff mostly as the source of nutrient, and weather as the source of energy, and the

fact that the lake water is accumulation of old water from runoff introduced many days ago, the influence of this inconsistency in combination is minimal.

We have further discussion in response to the Reviewer #3 for this matter.

Changes:

New Table 3.

P9L4. The following new sentences are introduced: Runoff volume (in the runoff group) is predominantly influenced by precipitation (in the meteorology group), but runoff volume was kept together with runoff concentrations because the most important influence the runoff has is the total amount of nutrients, which we obtain by multiplying concentration by volume.

Please also consult changes in response to Reviewer #3 on grouping variables.

RC:

I think the title does not cover the aim of the manuscript: Management is now prominently mentioned in the title, whereas the manuscript itself only addresses management effort indirectly. I also think a shorter title would be better. I suggest something like: “The importance of year-to-year variation of meteorological and runoff forcings for water quality of a cold dimictic lake”

AR:

We have adopted this suggestion and are forwarding this change to the editorial office. Please also see the first comment which is relevant to this response.

Changes:

P1 A new title "The importance of year-to-year variantion of meteorological and runoff forcings for water quality of a temperate, dimictic lake" is suggested.

RC:

The abstract is generally well written. The statement in lines 12-13, that the study revealed many scientifically and managerially relevant understandings, can be debated however as some of the examples that are mentioned subsequently are not very surprising, such as that thermal related properties in the lake are determined by weather conditions, and that nutrient loading is important for phytoplankton biomass.

AR:

We now suggest a new title and the new theme of disentangling two factors of meteorology and runoff (as described in earlier responses, please see especially the implemented changes in the Abstract).

We believe that (natural and limnological) understanding that repeats well established knowledge is still useful to provide as this is the interpretation of the focus of the present study – to disentangle two main factors that affects the water quality in a lake.

In addition, our finding suggests relevance of climate change impacts on areas applying countermeasures to improve water quality, and understandings and knowledge presented are existing knowledge but we keep them in the future context.

We augment this message by adding a sentence in Discussion.

Changes:

P18L13. Added the following sentences. The limnological and biogeochemical knowledge of this lake identified by decomposing year-to-year variation of the two factors, carries potential in connecting future management. Runoff is partially controlled by precipitation which in turn is predicted to change, and so are air temperature and global radiation.

RC:

1: P12491 L10: Here it is postulated that two factors affect nutrient loading to lakes (1) soil and land use in the catchment and (2) the hydrology of the watershed. I would

argue that sewage treatment is also very important, as sewage treatments have traditionally been an important cause of eutrophication, which is also stated by the authors at P12492 L13

AR:

Impact from sewage is generally considered to be small in the catchment, as the majority of the population in the area is connected to a municipal sewage plant, whose overflow is directed downstream our catchment.

RC:

2.4: Please present the default/apriori parameter values/ranges of the MyLake model in Table 2

AR/Changes:

The prior distributions are now included in Table 2

RC:

2.6: Please describe which software was used to do the statistics. It would be good to present the F-value of the Anova.

AR/Changes:

P11L1. A new sentence is introduced: All the data analysis and statistical analyses were done using R (version 3.1.2).

Please consult the new Table 4, which incorporates the F values. Furthermore, we have additionally done variance decomposition analysis, as suggested by Reviewer #3, and this result is also included in Table 4.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 12489, 2014.