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Hydrology and Earth System Sciences Discussions

Interactive comment on "A multi-objective optimization tool for the selection and placement of BMPs for pesticide control" *by* C. Maringanti et al.

Anonymous Referee #1

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General Comments:

This paper describes a multiobjective modeling approach to select and place the best management practices (BMPs) in a large watershed. The BMPs are chosen to reduce the water pollution due to Atrazin with minimal management costs. The authors argue that their modeling approach is innovative – it considers the ecological and environmental objectives simultaneously, and removes the need for dynamic linkage to the simulation by utilizing the BMP tools, therefore significantly reducing computing time.

In general, I doubt that the proposed method can properly address the spatial heterogeneity in consideration of allocating BMPs. I am not convinced that using BMP tool (as developed by this paper) exceeds the benefits of removing the dynamic linkage between the simulation model and optimization, as the proposed model is very much limited to address the spatial heterogeneity and dynamics in developing BMPs at a watershed scale. This is because the performance of BMP was based on onsite evaluation at the field level and the authors do not show (or prove) that their results can be scaled up to the watershed level. This performance information could be found from the literature. At best, the paper is useful to develop BMPs that would stop the delivery of Atrazine from the field to else where.

I suggest shortening discussion on the generic algorithm and more elaborating on the results from your optimization model. It will be very interesting to see scientific reasoning and explanation on why your BMP placement and selection make sense. The subject covered by this paper is a very relevant research topic in water resource management. Moreover, the state-of-the-art in this respect is still far from satisfactory, thus, publications of relevant research in this subject should be encouraged. In the present paper, however, there are many points that have to be clarified before publication.

Specific Comment

1. I am not convinced that the SWAT has been properly calibrated to produce any reliable result. As you can see clearly from figure 5, there seems a linear trend between actual and simulated result, but the simulated results are not much close to the actual one. What was the r-sq for the pesticide result? Did you use any optimization method to find the model parameters? Report the parameter values and describe fully how the calibration was done. The SWAT model should be properly calibrated before any kind of analysis.

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Interactive Comment

2. Is the goal of the optimization to meet the maximum pollutant reduction at the watershed level or at the farm level? If the goal is to have the maximum deduction at the watershed level, I strongly disagree with your 1st assumption that was used for developing the BMP tool. How can you assume that the pollution reduction with BMP at the watershed scale approximates that at the field level? Can you explain your assumption using the physics of the transport and fate of pollutants in the watershed system? Can you show the simulation results provide reasonable outputs to make this assumption? How do you account for the spatial heterogeneity in finding the location and selection of BMP using your method?

3. I also disagree with the 2nd assumption that were used for BMP tool. The BMP performance varies temporarily under different hydrological conditions and land use practices. It cannot remove certain percentages of the pesticide (for example 45 % as you shown in table 3) for all cases. I am guessing if you made the 2nd assumption based on the average BMP performance estimated from the SWAT results. Was the BMP tool based on the results of the continuous simulation from a specific time period? How these values varied temporarily? Clarify how the SWAT simulation was done to develop the BMP tool. Please provide descriptions of the hydrological conditions and the land use scenarios in detail.

4. I cannot fully follow how BMP tool was developed. In section 3.3., you mentioned that allele set was prepared only changing land use practices and BMPs on corn fields. The 2nd sentence in section 3.4, you mentioned that you have chosen all the HRUs that have a common land use. What is a common land use? Is it a corn field? The 4th paragraph described that how you chose different BMPs one by one (“one BMP at a time is allotted"). How did you evaluate the effects of mixture of different BMPs? Again, how does the BMP performance vary by place to place? How does your model consider that?

5. How does SWAT simulate the atrazine leaching to the groundwater? Does SWAT

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fully simulate the groundwater flow? How atrazine reduction is related to the application rate? What was the application rate? Are you considering any changes in that? 6. Does your model only concern atrazine? Are you only optimizing the BMPs for the corn fields? Pease clarify the scope and purpose of your optimization upfront.

6. How your BMP tool reflect the BMP performance if locations and amounts of corn fields changes or if there are any land use changes in the watershed? Can you perform any kinds of sensitivity analysis to address this issue?

7. How did you choose the width of buffer strip ? The 20, 27, and 30m are a very similar type and would give a similar performance (as you showed in Table 3). Why not try to test a wide range of buffer strips?

8. Pg 1830. the last paragraph. I do not understand what it means by “the near optimal solution reached as close as possible to the global optima"? As you stated earlier, the MOP provides a set of efficient solutions (pareto-optimal), but cannot provide a single solution (called global optimal one).

9. Pg 1831, Section 2,1,6. the 2nd paragraph. I do not understand “crowding distance is half the perimeter of the maximum hypercube allowed around a solution" and think an average reader could not understand this either. Without clarification, it is difficult to follow how the elite set and the next generations set are used to find the optimal solution sets.

10. P. 1833. Section 3: the 2nd sentence: Specify what “the variables" mean

11. P. 1834 How can you guarantee that the solution would converge before the maximum number of iterations? What is the maximum number of iteration? How many iterations are needed before convergence on average? Have you done any numerical assessment?

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12. P 1835 last sentences. Clarify what the baseline scenario is? How does it affect your optimization (in other words, how the optimal results are dependent upon the base scenarios)?

13. Section 3.6 & 4.1 How does the population size is related to the number of decision variables? Isn't it fixed by the number of corn fields? How is it related to the SWAT input? Why do you perform sensitivity analysis on the population size?

14. Perhaps, you should explicitly explain why the pareto-front moves toward the origin is preferred

15. Figure 11 – show the current agricultural (and other land use) practices in the study watershed

Editorial comments

1. In Eq(4) what is η? It was not defined.

2. Be consistent with the symbols – you have used the subscript m for mutation. Why use c_k, and p_k (eq 5) and r_k (eq 6) for mutation? I suggest changing k to m. Define all symbols such as rk and η_m.

3. Use the subscript (instead rm, td, etc) to clarify eq(11). Define the symbol τ.

4. Figure 8. I suggest adding the label for x-axes for the top figures

5. What is CN2, and OV_N in Table 2

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 5, 1821, 2008.