Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2019-389-AC3, 2020

Hydrology and Earth System Sciences
Discussions

Interactive comment on "A novel data-driven analytical framework on hierarchical water allocation integrated with blue and virtual water transfers" *by* Liming Yao et al.

Liming Yao et al.

chenxudong198401@163.com

Received and published: 24 February 2020

The authors proposed a bi-level methodology that combines two game theoretical models: Stakelberg competition and Nash-Harsanyi bargaining to optimize the water usage. The model is applied to a case study in the Chinese region of Hetao, a sensitivity analysis is carried and policy making insights are obtained. In my opinion the idea of combining Stakelberg competition and Nash-Harsanyi bargaining models to deal with the problem of water management is interesting and original, as far as this referee knows, for this reason the paper could be accepted for publication. Therefore minor revision of the current version of the paper is needed. Comments and suggestions are given

below.

[Comment 1.] 1. I do not understand why the authors need the disagreement point of the leader in the Stakelberg model because the leader does not take part in the bargaining procedure of the lower level. Please, add some more explanations.

[Response.] Thank you for your comment. We have provided additional information regarding the disagreement points for better clarity in the Solution Procedure section.

First, we introduced the importance of defining a disagreement point. Combined with the bi-level Stakelberg model, there was an interactive process between the leader and followers. The leader possesses a higher priority to move first, and the followers play among themselves according to the Nash-Harsanyi equilibrium after observing the leader's announced strategy; then, the followers provide feedback to the leader. The leader then maximizes its objective function based on the identified best-response strategies of the followers. During the bilevel strategic interaction, with the decrease in sectoral vulnerability at the lower level, the water utilization efficiency of the system at the upper level will decrease to some extent. Once the solution is worse than the disagreement point, irrespective of whether it is for the leader or the competing followers, the decision maker can no longer accept it.

Second, we introduced the derivation of the disagreement point and the application in this paper. Gao & Lv, (1989) introduced the interactive satisficing trade-off method based on the tactics of the ideal point method, which helped to resolve problems including multiple conflicting objective functions. The ideal point was the situation in which the objective function reached its optimal value; however, in general, not all objective functions would reach the ideal points simultaneously. A set of ideal points was not in the feasible set, but rather each objective value would exist between the negative ideal point and positive ideal point. Previously, Hans and Eric, (1991) described how the disagreement point approach can be applied to bargaining solutions. Furusawa and Wen, (2002) analyzed the tariff trade war and pointed out that the disagreement point was regarded as bargaining frontier in the bargaining process.

As for the biobjective models (Gao & Lv, 1989), a solution that was simultaneously optimal for each decision maker's objective function rarely occurred among the bilevel problems involving multiple decision makers, because of conflicts among the leader and the competing followers. Hence, by utilizing the concept of the bargaining game and negative ideal point in this paper, we extended the definition of the disagreement point, namely, the disagreement point that presented the worst result, which the decision maker was unwilling to accept. Hence, additional constraints for each level were added for which each objective function value was better than the respective disagreement point.

Finally, combined with the practical problem described in this paper, we have defined the vector of the disagreement points as the maximum vulnerability to the followers and the minimum efficiency to the leader. To be specific, the disagreement point of each objective was calculated at page 11.

References

Gao, J., & Lv, X. Interactive satisficing trade-off method for multiobjective optimization (in Chinese). Journal of Hefei University of Technology, 1989, (2), 32-41. Hans P, Eric V D. Characterizing the Nash and Raiffa Bargaining Solutions by Disagreement Point Axioms. Mathematics of Operations Research, 1991, 16(3):447-461. Furusawa T, Wen Q. Disagreement points in trade negotiations. Journal of International Economics, 2002, 57(1):133-150.

[Comment 2.] 2. Conclusion section is a little lengthy and therefore needs to be shrunk. Too much information would distract people's attention.

[Response.] Thank you for your suggestion. We have condensed the conclusion section in the revised manuscript following the layout including problem description, model, application results, comparative and sensitivity results, managerial insights and future

research directions.

[Comment 3.] The heading titles should be revised, such as Section 5.1 Which sector largely contributes to water stress.

[Response.] Thank you for your suggestion. We have revised the unsuitable section name. For example, heading title of section 5.1 was changed to "Main reasons for water stress".

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2019-389, 2019.