

## ***Interactive comment on “Sustaining the Ogallala Aquifer: From the Wells to People, A Holistic CNH Model” by Joseph A. Aistrup et al.***

**Anonymous Referee #1**

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Sustaining the Ogallala Aquifer: From the wells to people, a holistic CNH model, Aistrup et al.

The paper presents a coupled model which is used to analyze different scenarios in the Groundwater Management District 3, of the Ogallala aquifer. The model integrates 4 modules: a socio-economic, crop choice, crop production and a groundwater module. The coupled model is run for 100 years.

It is an interesting model with an interesting application, which relates agricultural policies and its impacts on economy, population and groundwater quantity.

General comments

1 In the introduction (L13-14, P2), it is mentioned that one of the paper objectives is to

C1

"accurately model the current hyper-extractive CNH system". However there is not a single result that proves that. There is no evaluation of the model performance. Was the coupled model calibrated?

2 In general the coupled model setup, integration, calibration and limitations are not well explained.

3 Objective 3 (L16-17, P2) is to "communicate the model's outcomes". There is nothing about this in the paper. Were the model results communicated to the stakeholders? How did the model helped to communicate the policy scenarios?

4 The title suggests that paper seeks to achieve a sustainable use of the aquifer. A definition of sustainability is shown on page 10, and it is also adapted for the specific situation of the Ogallala aquifer. In L13 P10, it is mentioned "our sustainability policy scenarios focus on maintaining current saturated thicknesses and stemming the current pattern of continuous depletion, while maintaining to the extent possible the employment levels, wealth generation, and population impacts in the region". However, not a single scenario maintains the current saturated thickness. If I understood the model correctly, the objective function seeks to maximize farmers' profits, and it does not have a single constrain on the groundwater level or saturated thickness. The coupled model, as it is, is actually seeking to maintain the profits and employment.

5 Regarding the coupled model, a diagram showing which data is exchanged between the different models would be very helpful. Did you consider feedbacks between the models?

6 The data exchange between models is one year, is that enough? What are the dynamics of the groundwater model?

7 Groundwater model is very simple, how does it impact the results? In Bulatewicz et al., 2010 the authors mentioned that one of the problems in coupled models is that some of their components are very simplified. What are the implication of using a

C2

bass balance equation for modeling the groundwater? What are the implications of the coarse spatial discretization used?

8 In section 2.6 it is stated that the recharge to the groundwater model is taken from Hansen (1987). I understand that the recharge was not calculated, is that correct? Was it kept constant for the whole 100 years of simulation?

9 More information about the weather data use should be provided. By how much was the precipitation changed? Was the temperature also changed? By how much? What are the impacts on the recharge?

10 It is missing a discussion about the uncertainty of the results given by the coupled model. How reliable are they? How accurate can be a 100 years projection? What are the limitations of the model?

Specific comments

1 Title: Do not use acronyms, if space permits, write: "Coupled Natural Human model"

2 Title should mentioned that the paper is not analyzing the whole Ogallala aquifer, but the Groundwater Management District 3.

3 Is it valid to say "Sustaining the Ogallala Aquifer...", when at the end there is no scenario that will do it? (Also see general comment 4).

4 L7-9, P1: It should be also mentioned the environmental impacts of the expanded presence of irrigated acreage.

5 L4-7, P2: Nothing is mentioned about the CMD3.

6 L 16-17, P2: How communicating the model's outcomes will minimize the economic pain for the region's communities? Can you better explain or rephrase?

7 Improve quality of Figure 1.

8 Figure 2 is not showing the crop production model.

C3

9 Figure 2 shows a "Socio-Economic impact model" L1-L8, P5: only mentions a "Economic impact model" are they the same?

10 L9, P5: The socio-economic impact model described here refers to the "Economic impact model" mentioned in L1-L8, P5?

11 L23-25, P6: Inside the section "crop choice model", it is mentioned that crop yields were simulated within the model from water response functions. How is this related to the crop yields calculated with the crop production model?

12 L27-28, P6: It is mentioned that the crop choice model assumes that yields will continue to improve into the future. How is this considered in the crop production model?

13 L3, P7: Armoa (2015) is not in listed in the references.

14 L7-8, P9. It is not clear what you mean with "uncertainty by simulating a policy scenario 100 times". Which parameters were modified for making the uncertainty analysis? Where 100 simulations performed for a period of 100 years? Which "policy scenario" was modeled?

15 Table 2. Show an indicator of the groundwater system.

16 L11, L13, P13. What do you mean by "policy issues"?

17 L14, P13. Please specify which are the the "meaningful policies".

Bulatewicz, T., X. Yang, J. M. Peterson, S. Staggenborg, S. M. Welch, and D. R. Steward. "Accessible Integration of Agriculture, Groundwater, and Economic Models Using the Open Modeling Interface (OpenMI): Methodology and Initial Results." *Hydrol. Earth Syst. Sci.* 14, no. 3 (March 16, 2010): 521–34. doi:10.5194/hess-14-521-2010.

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C4