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Geoscientific Model Development Discussions

# *Interactive comment on* "Modeling Land Use and Land Cover Change: Using a Hindcast to Estimate Economic Parameters in gcamland v2.0" *by* Katherine V. Calvin et al.

**Anonymous Referee #2**

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Summary of the paper This paper uses gcamland/GCAM to calibrate/estimate/tune the land distribution parameters of a nested logit land allocation function used in this model. In the lack of econometrically estimated values for these parameters, it is an important effort to accomplish this task. However, the paper suffers from some important deficiencies and lack of clarity, in particular for those who do not know this mode.

Some important comments:

1. I am not a GCAM modeler but is seems gcamland operates under GCAM. For non GCAM community the links and interactions between these two models are not clear. How they linked and interact. A simple chart can help.



2. The model clearly uses a nesting logit format, perhaps three nests. Equation 1 of the paper shows only on nest. The formula should be replaced with a formula for the full nest.

3. How the land constraint/constraints is/are defined? Does a simple land constraint directly add all types of land: Total land =forest + pasture + corm + soy+ etc.? or each nest has its own land constraint?

4. It is not clear how the estimation process is defined to estimate these parameters. Does the process estimate all the distribution parameters (s) simultaneously or individually?

5. How distribution parameters () were perturbed? Are they coming from given distribution? If yes, what type of distribution? Is this a random selection of three values limited between 0.01 and 3?

6. Over time total area of agricultural land in the US has declined sharply, due to conversion to non-agricultural uses of land (urbanization, infrastructure, ....). How gacamland handles conversion of land to non-forestry-ag land. How land availability land has been taken care off over time? Is it an exogenous variable in each year?

7. A big issue in land use modeling is marginal cropland (idled land under CRP, cropland pasture, other types of idled). Area of idled cropland in the US have changed a lot. The definition of "cropland pasture" has also changed over time. How idled land is treated?

8. It is noted that harvested area from FAO is used. FAO is missing many feed crops since 2011, including million hectares of those crops. without proper steps to cover missing crops in FAO, the estimated parameters will be subject to major issues and biases. Figure three suggest that those feed crops is missed. That is a major issue.

9. GCAM is using commodity price to model land allocation. It seems wholesale farm prices is used. That is a bad proxy for exporting crops such as cone and soybeans.

For example, half of soybean is exported at much higher price farm price.

10. In this paper, in one case, subsidy has been examined in a sensitivity test. Subsidy is the key item in deriving land use, land rent, and the price received by farmers. The distribution parameters of the logit should be evaluated with subsidies. Sensitivity test is meaningless. The key here is to capture all types of subsidies paid to famers in the estimation processes.

11. How biofuels were included in the simulations? Biofuels and biofuel policies were major drives of land use. How that included in your simulations

12. Th dapper highlights that gcamland uses commodity prices in land allocation. But the model allocates land across land cover items. What prices are used for forest products, livestock products, etc.? The paper is silent on these prices. What prices were used for land cover items

13. Regarding forestry, how gcamland treats forest land. Is it operates based on managed forest? Managed + unmanaged? How it treats unmanaged forest with no economic output.

14. GCAM and gcamland are not forestry models. Forestry is not an annual crop. How these models take care of forestry in a dynamic setting. Do these models treat forestry as an annual crop?

15. In each case, the model is solved for a range of parameters. Then a set of parameters that minimizes NRMSE is selected. But NRMSE is defined for a single crop. How this variable is aggregated over crops? How NRMSE is calculated for non-cropland (e.g. forest, pasture, grass land, and etc.)? How cropland and non-cropland aggregated?

16. How productivity of non-cropland is measured?

17. GCAM aggregates crops into some specific categories? How prices were generated for those categories. In many cases there is no data on crop prices?



18. The paper provides mixed messages on endogenous and exogenous variable. In determining targeted distribution parameters, what variables were targeted and what variables were determined in the model. It seems prices, areas, and yields were exogenous. Be more specific.

19. The whole practice implicitly assumes that other model parameters are accurate and valid. This is a strong assumption. The land supply parameters were determined while demand parameters held constant. The estimated supply parameters will be entirely wrong if the demand parameters (e.g. income and price elasticities for crops, livestock products, and forestry) are not valid. Any change in the demand parameters could alter your estimated parameters for the land supply. Can you test sensitivity of your results with respect to changes in other elasticities of the model?

20. The results are counterintuitive. Let me explain using figure 2. In the adaptive case, for the first two nests the values are about 0.4 and for the last nest (cropland) the value of is about 0.6. Given that limited land movements among land cover items occurred at national level in the US and lots of change occurred in the crop nest, one could justify this outcome. However, for the other three cases (hybrid, linear, and perfect) the ranking is of values shows revers. Meaning that land conversion is easier at the land cover nests than the cropland land nest. These outcomes do not make sense. Am I missing something?

21. In showing the results, level variables were used to show errors. For example, figure 2 compares estimated harvested areas with their observations for four types of expectations. This hides the errors involved. It is better to calculate errors as percent difference between the estimated and observed areas.

22. The main manuscript only presents comparison of the projected and observed harvested areas and provided no comparison for other land types.

23. Results are highly aggregated into four groups of crops. how about the 12 categories of crops in GCAM?

24. The figure S5 of SI shows major errors for the change in forest area. This show that the model fails to represent changes in forest area correctly.

25. The figure S5 show increases in all land cover types and harvested areas. How that could be possible?

26. Figure S7 shows no results for land cover items including grassland and shrubland for three types of expectations. Why?

27. Figure S7 shows major errors for grassland and shrubland in the adaptive approach project huge errors. Why?

28. It seems the whole practice has failed to take care of land cover changes.

29. The examined practice estimated a few parameters of the model for land use. A good way to test the outcomes of this practice is to run the GCAM model with the estimated parameters and compare the model results for land use changes, land cover changes, changes in crop prices, and changes in yield with actual observations over the examined period.

30. Finally, the whole work could be a valuable practice for the CGAM community. It uses “hindcast” to estimate the logit distribution parameters for this model. Hindcast Is not a new approach. The outcome of this practice may help the GCAM community to improve their work on land use modeling. However, the results of this practice may be not useable for other models. As they may follow very different modeling structure and assumptions. The author of this paper should make this point very carefully.

31. The abstract provides trivial information. It is not an abstract of this paper.

32. Following a summary of land use change at the global scale, the second paragraph of the introduction begins with: “Similar trends occurred in the United States”. This is not an accurate statement. The US land use change did not follow the global land use changes in terms of land conversion to crop production. No expansion in cropland has been observed for the cases of US.



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