Uncertainty in biofuel-induced indirect land use change in Brazil

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Introduction

An increased demand for biofuel feedstocks can lead to direct land use change (dLUC): land use is changed from some previous use to the biofuel feedstock. This, in turn, can lead to indirect land use change (iLUC): a change of land use elsewhere, induced by a change in use or production quantity of that biofuel feedstock (Figure 1). It is commonly recognized that there are large uncertainties in modelled biofuel induced dLUC and iLUC, but until now, quantification of such uncertainties has never been performed.

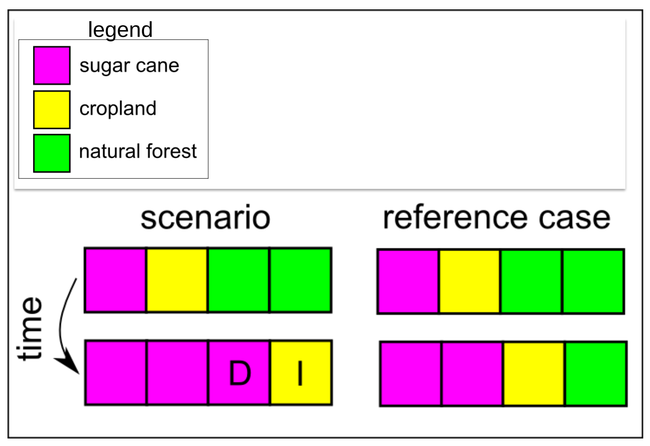

Figure 1: In a scenario, dLUC (D) occurs when a biofuel feedstock occurs at a location where it does not occur in the reference scenario at that time. This can result in iLUC through displacement (I).

Uncertainty quantification is critical to evaluate whether or not dLUC and iLUC indicators are reliable enough to be included in legislation, to identify which parts of the modelling chain have the highest priority for improvement, and to assess how this uncertainty propagates to the impacts of iLUC, like greenhouse gas (GHG) emissions. Therefore, we aim 1) to project dLUC and iLUC for Brazil, cause by sugar cane expansion as a result of an increased demand for biofuels, up to 2030 in a spatially explicit way, and 2) to quantify the uncertainty herein.

Methods

The projection of dLUC and iLUC in Brazil caused by an increasing demand for biofuels and the uncertainty herein is performed using MAGNET, a global Computable General Equilibrium (CGE) model, connected to the PCRaster Land Use Change model (PLUC) (Figure 2).

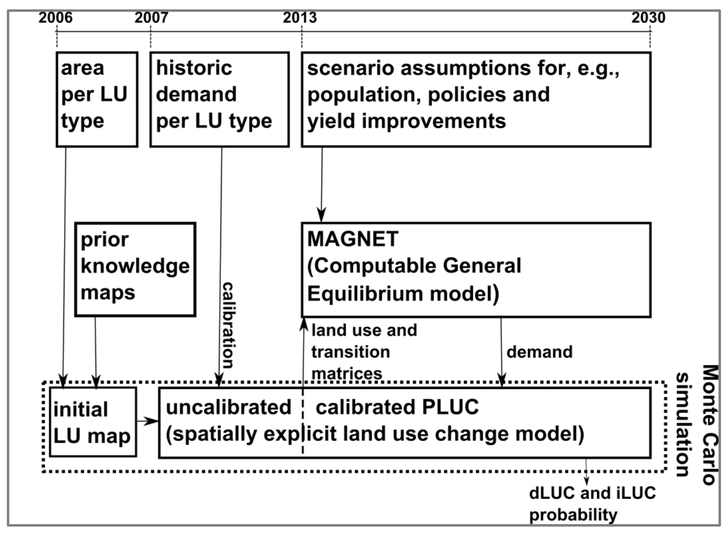

Figure 2: Overview of the modelling chain and model run time frame to simulate the probability of dLUC and iLUC in Brazil (after Verstegen et al, in review). Uncertainties in the inputs are quantified, part of which propagates to the outputs through the model coupling.

Results

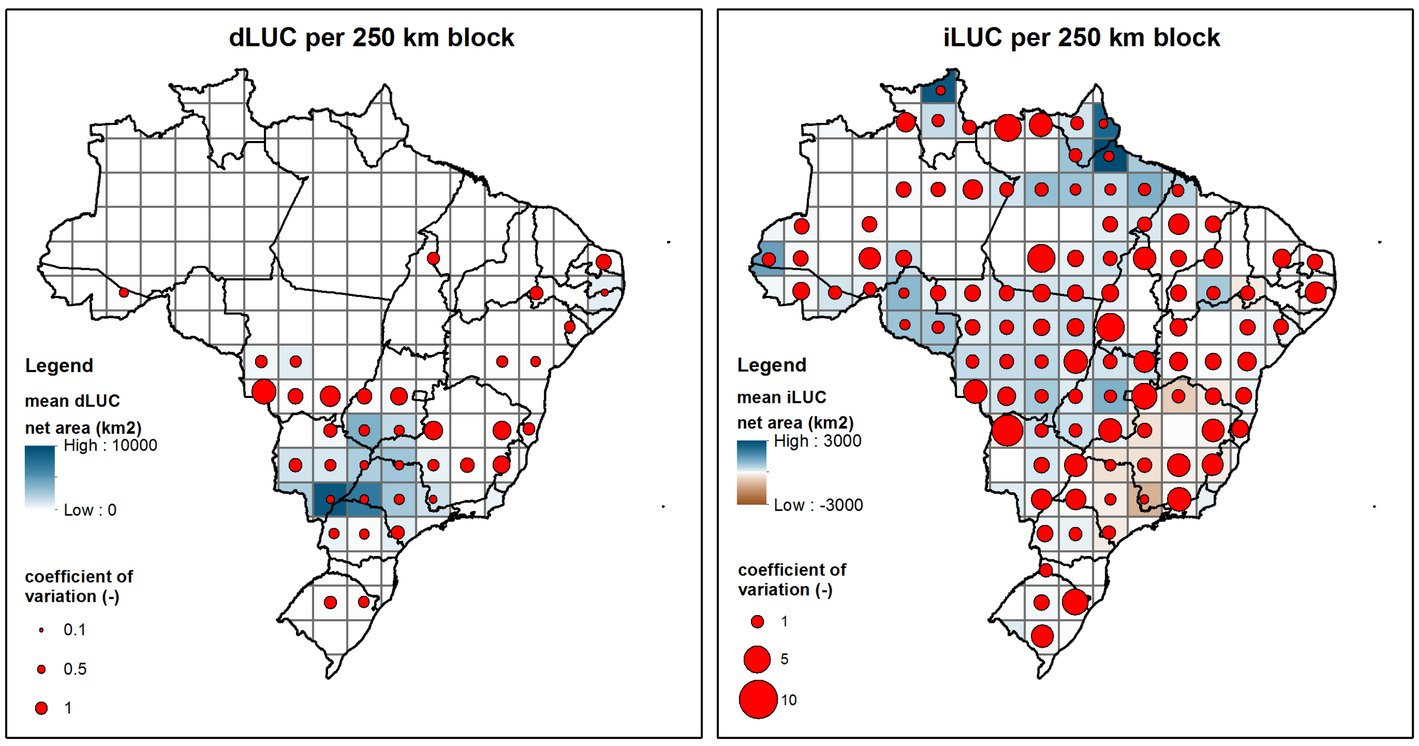

Figure 3: Mean net area (km^2) (colour of the block) and the coefficient of variation (cv) (-) (size of the red circle) of dLUC (left) and iLUC (right), per 250 x 250 km^2 block in Brazil. For the display of the cv, blocks smaller than 31250 km^2 (half of a 250 x 250 km^2 block, occurring at the map edges) are filtered out, as the cv is heavily influenced by the support size of the block. Also blocks with mean dLUC or iLUC area smaller than 25 km^2 (one cell) are filtered out, because when the mean goes to zero, the cv becomes infinite (after Verstegen et al, in review).

Discussion and conclusions

The uncertainty in iLUC area and location is generally higher than in dLUC (Figure 3), because iLUC is caused by the interplay of various land use types that each have their uncertain model parameters, while dLUC is mainly affected by the parameters for sugar cane. Estimated iLUC areas, even at country level, might as well be 2.4 times as high or as low, given the 95% confidence interval.

Based on our case study, our opinion is that iLUC indicators are not reliable enough to be included in legislation. Strict thresholds in legislation have no use when the model, used to check whether an indicator for a specific case is above or below this threshold, gives an output confidence interval that straddles this threshold. This is likely to happen considering the high uncertainties found in our study.

Reference

Verstegen, JA, van der Hilst, F, Woltjer, G., Karssenberg, D, Faaij, APC (in review) What can and can't we say about indirect land use change in Brazil using an integrated economic - land use change model?

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