Stochastic projection of the effects of an increased biofuel demand on direct and indirect land use change in Brazil

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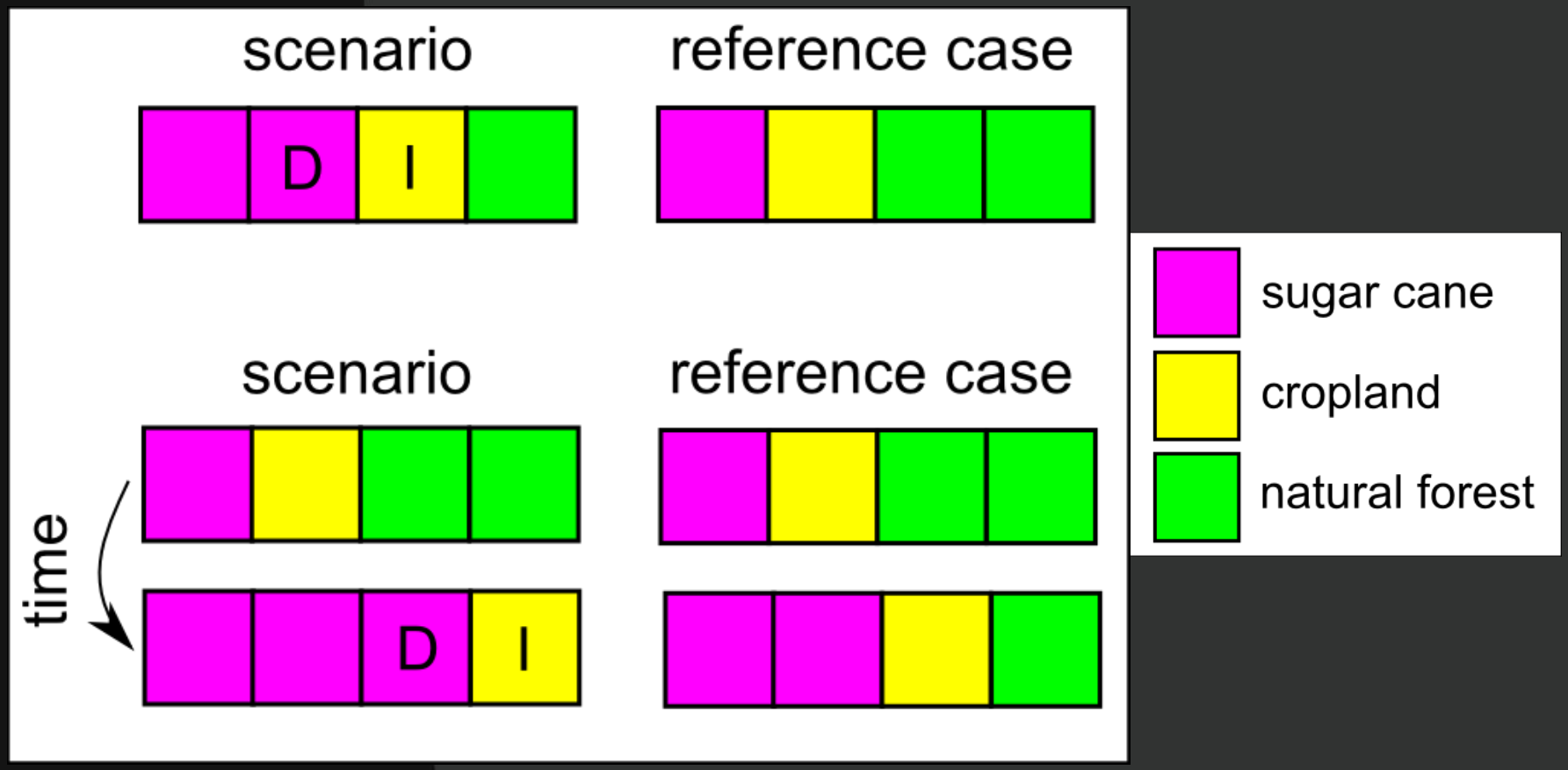
Modelling land use change

Impacts of a future increase in demand for bioenergy depend on the magnitude, location and pattern of energy cropland expansion. We apply an integrated model.

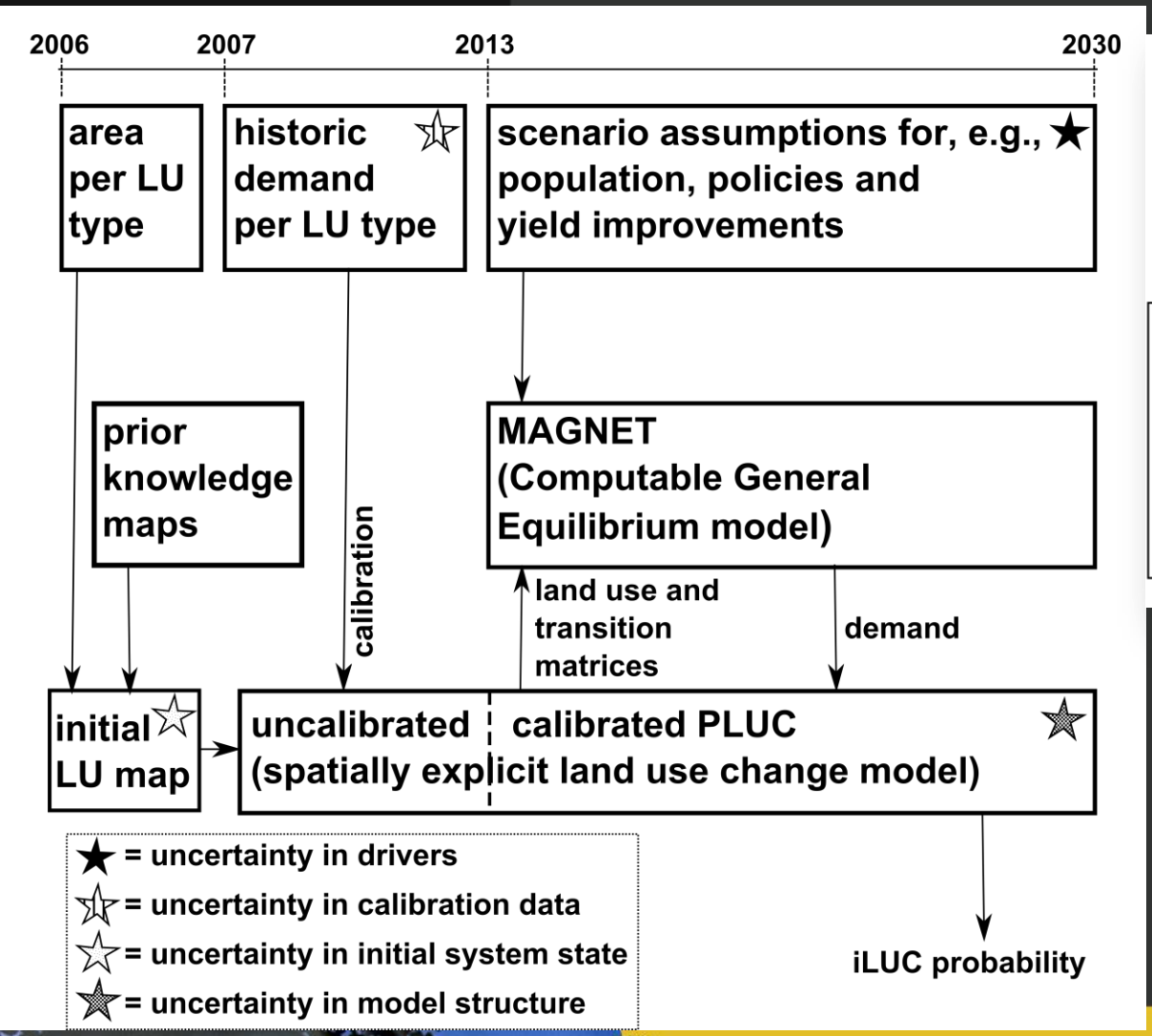
We aim at:

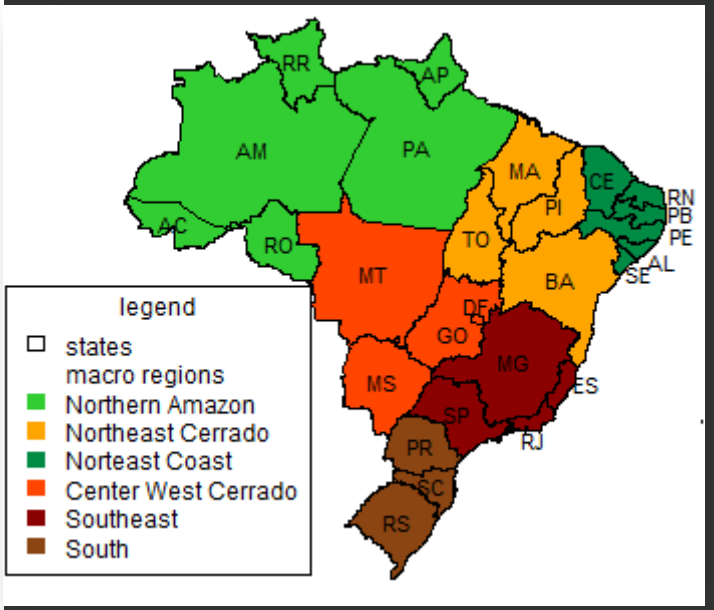
1. projecting the magnitude and spatiotemporal pattern of sugar cane expansion and the effect on other land uses (iLUC) in Brazil towards 2030, and
2. assessing the uncertainty herein.

LUC model – dLUC + iLUC



Model chain





Sugar cane
Crops
Pasture
Rangeland
Planted forest

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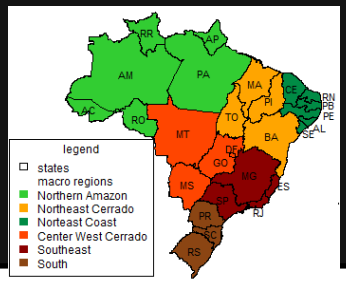
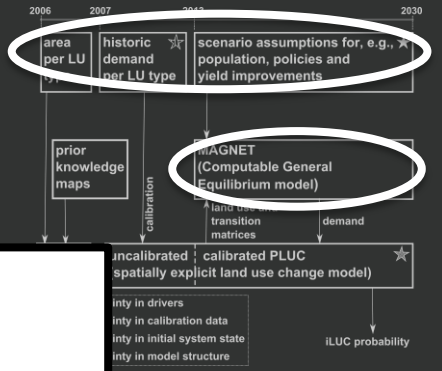
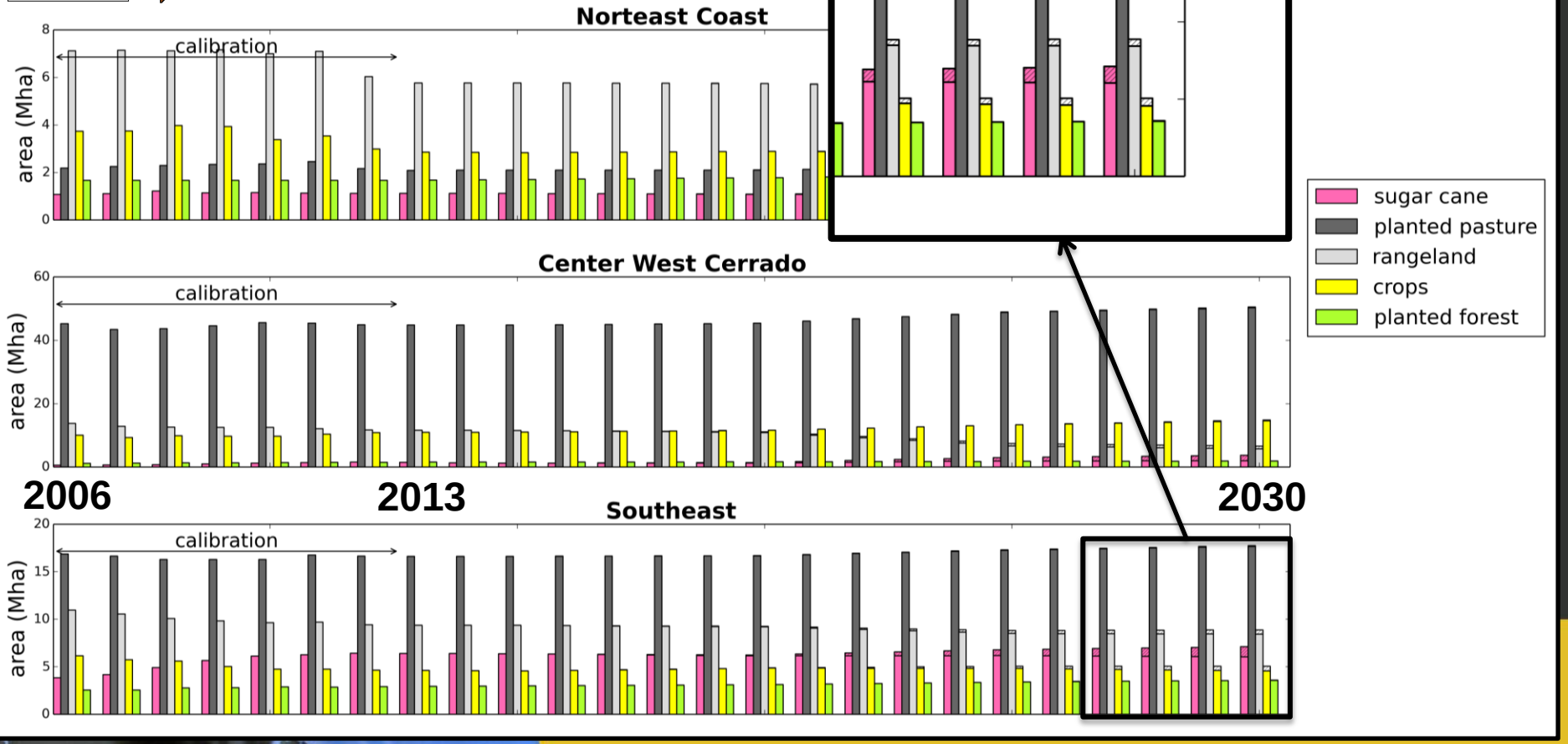
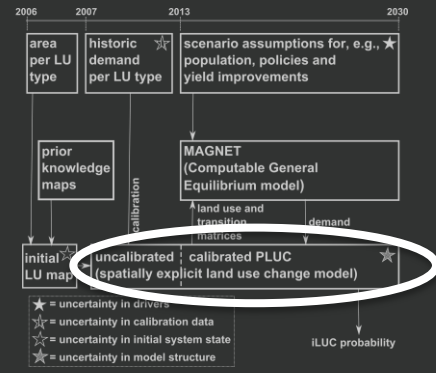
Demand - results historic and from MAGNET







LUC model - method



attributes		suitabilities	weights	weighted suitabilities
neighborhood (nr neighboring cells sugar cane)	standardize	values 0-1	x 0.2 =	
distance to processing mills (km)	standardize	values 0-1	x 0.3 =	
potential yield (tonnes/ha)	standardize	values 0-1	x 0.1 =	
slope (%)	standardize	values 0-1	x 0.4 =	+

suitability for sugar cane expansion

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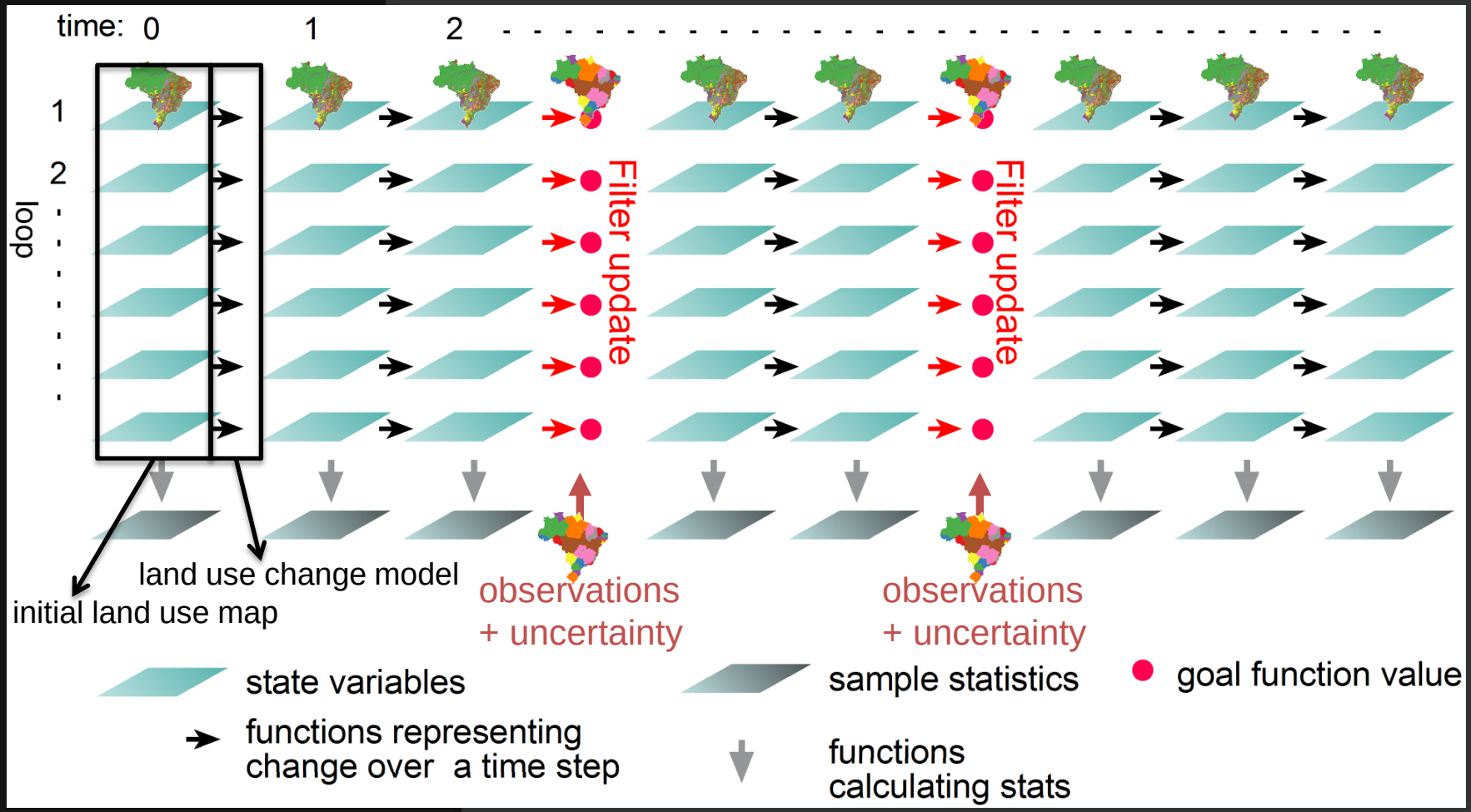
LUC model - calibration framework



See also: Verstegen, J.A., Karssenberg, D., van der Hilst, F., Faaij, A.P.C., 2014. Identifying a land use change cellular automaton by Bayesian data assimilation. Environmental Modelling & Software.

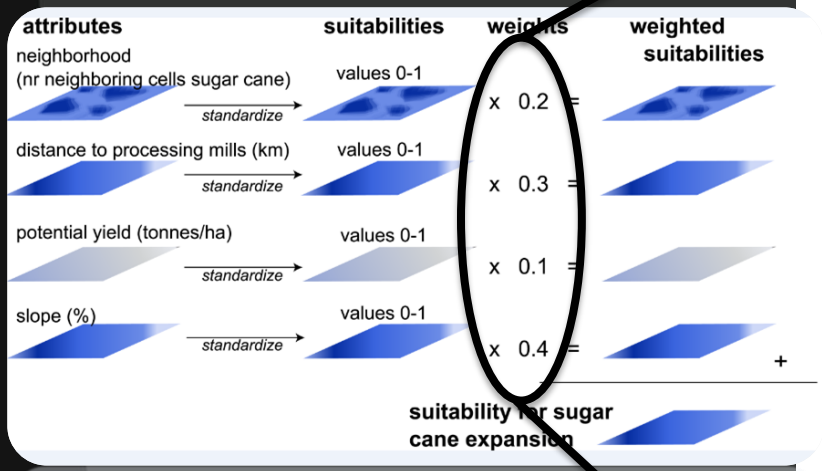
LUC model - calibration results

Calibration:

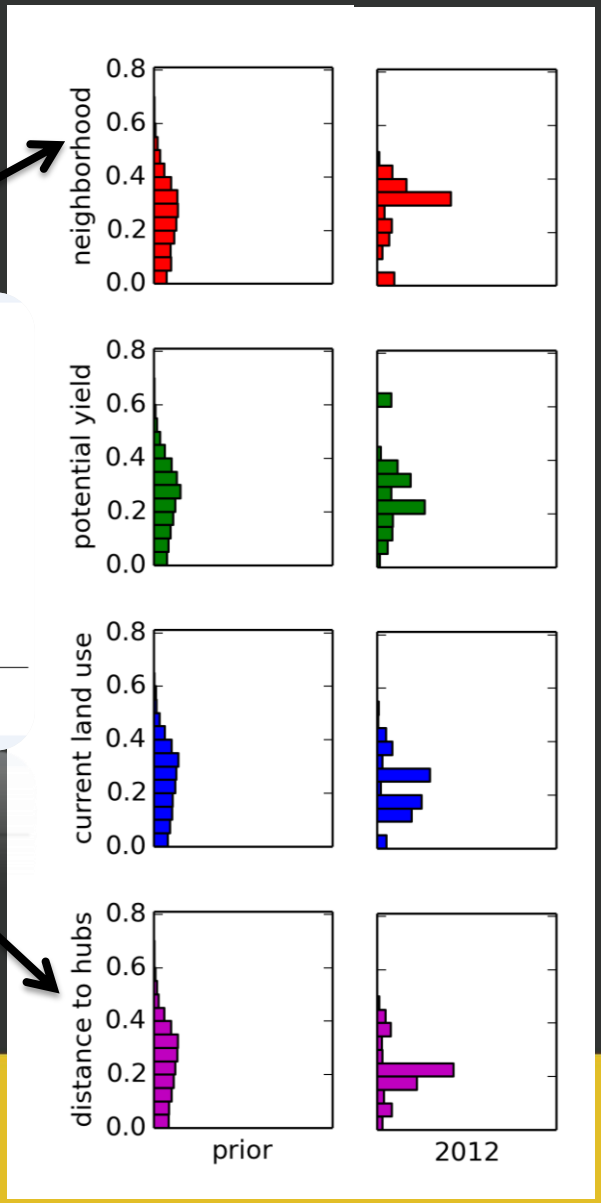
- initial land use map
- model structure
- observations

Results:

- better understanding system
- lower confidence intervals output



weights of the suitability factors of sugar cane



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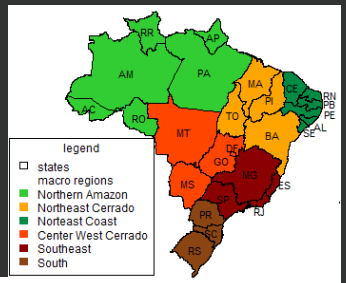
LUC model - calibration results



observed

modelled median

95% confidence interval

total cropland area (10e6 ha)

RO 0.5 0.3
AC 0.2 0.0
AM 0.3 0.1
RR 0.1 0.0
PA 1.1 0.8
AP 0.1 -0.1
TO 0.6 0.3
MA 1.7 1.3
PI 1.8 1.0
BA 4.0 3.2
RN 0.4 0.1
PB 0.9 0.4
PE 0.9 0.3
AL 0.6 0.1
SE 0.4 0.0
CE 2.0 0.8
MG 3.8 2.6
ES 0.6 0.3
RJ 0.1 0.0
SP 2.5 0.0
PR 5.8 5.2
SC 1.9 1.6
RS 6.8 6.3
MS 2.2 0.8
MT 6.4 4.8
GO 3.6 2.0
DF 0.2 0.0

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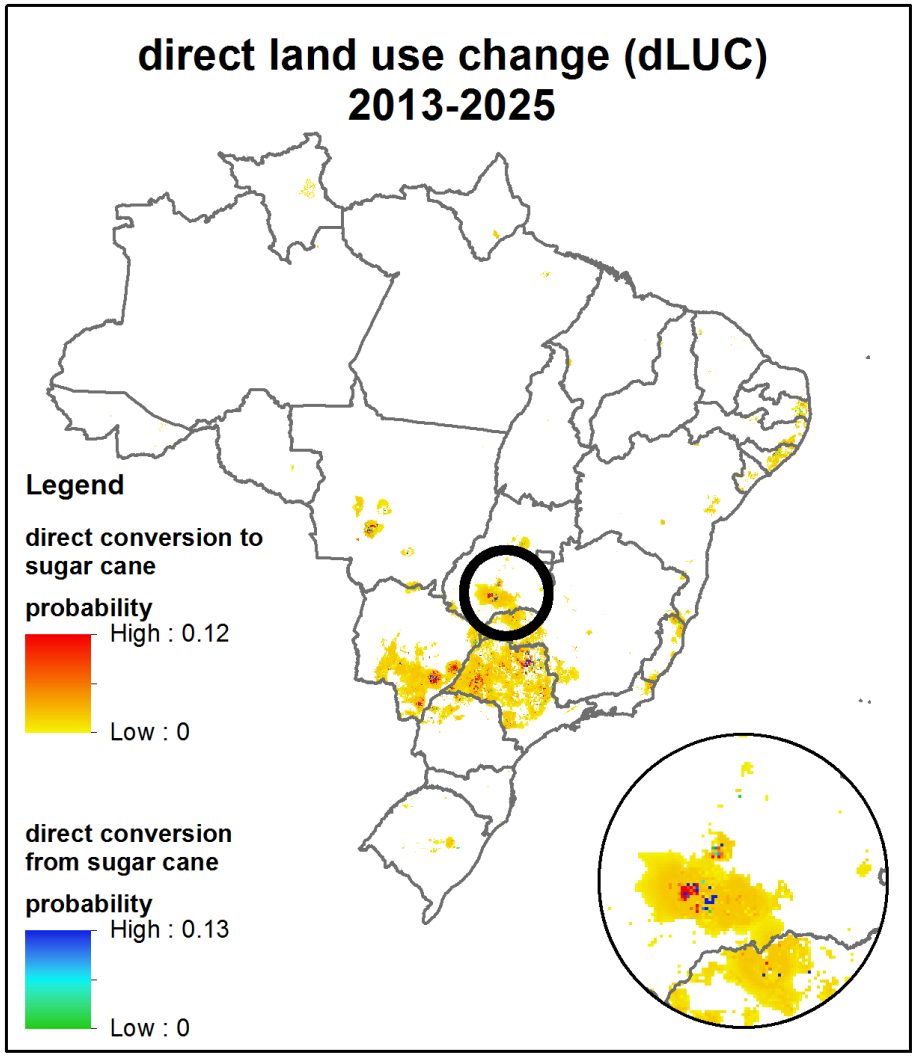
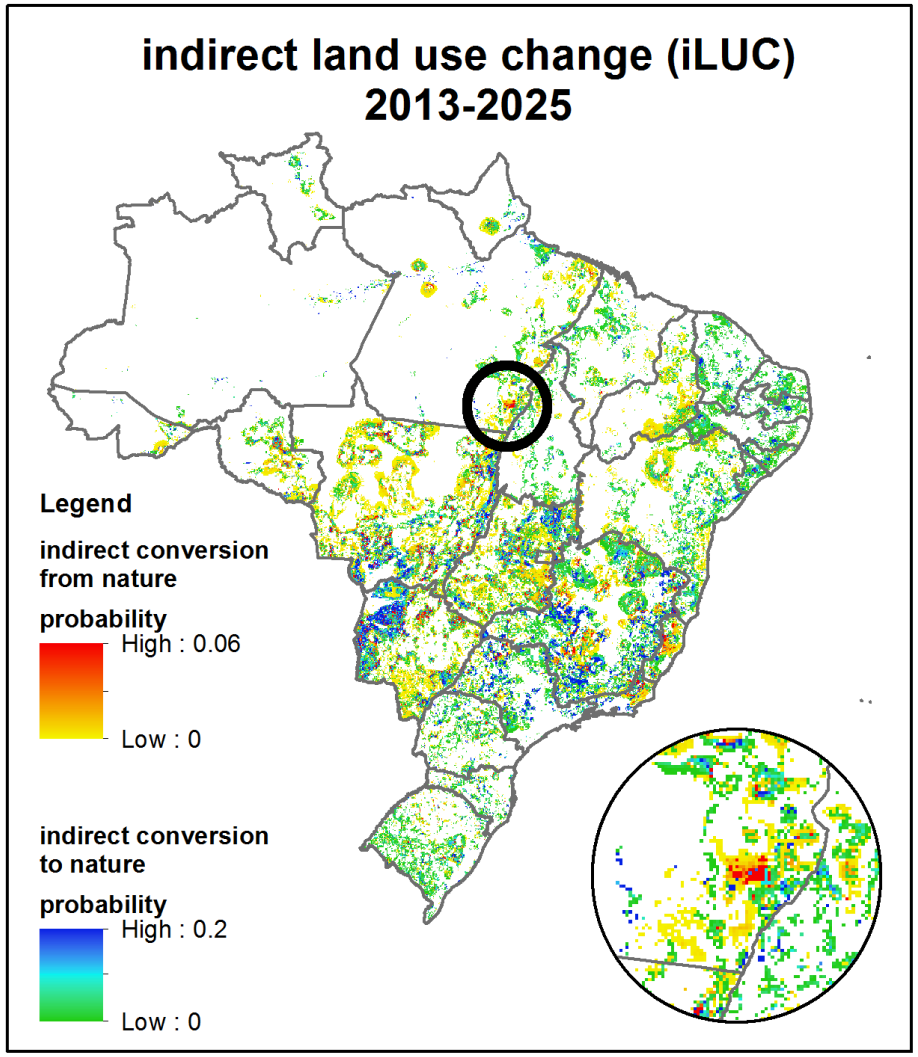
year

LUC model – dLUC + iLUC results





Discussion and conclusions (1)

We have shown a framework to determine the spatially explicit impacts of a future increase in demand for bioenergy, including uncertainty.

Key questions session:

1. Which socio-ecological land-use effects occur in different countries due to international policies and markets

- Land-use effects in Brazil of the global ethanol demand are shown. Other impacts (biodiversity, water, etc.) can be derived from these
- High uncertainty in the location of change. Important to take into account uncertainty in all components

Discussion and conclusions (2)

Key questions session (continued):

2. Which methodological perspective (empirical, model-based, political science) is able to answer which questions?

- ILUC can only be modelled!
- Up to what point in time (if any) do different scenarios generate different results, given the uncertainty?

3. How could the results be coupled?

- We have combined the best empirical data with a model → best forecast
- Some policy options can be included in model scenarios

Questions?

Related publications:

Verstegen, J.A., Karssenberg, D., van der Hilst, F., Faaij, A.P.C., 2014. Identifying a land use change cellular automaton by Bayesian data assimilation. Environmental Modelling & Software 53, 121-136.

Verstegen, J.A., van der Hilst, F., Woltjer, G., Karssenberg, D., Faaij, A.P.C., in preparation. Uncertainty assessment of indirect land use change in Brazil using an integrated economic - land use change model.

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