Supply chain optimization of the ethanol industry in Brazil.

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Introduction

Brazil is the second largest producer and consumer of ethanol and has a long term history of ethanol production. Brazilian ethanol is predominantly produced by sugarcane processing and is mainly concentrated in the Centre South region. Due to the availability of suitable land, industrial processing technology, experience and know-how, Brazil has a large potential to further expand its ethanol production. Previous work has assessed the current and future ethanol production cost of different combinations of biomass feedstock and industrial processing options (Jonker et al 2015) In São Paulo state the ethanol production expanded progressively, in recent decades the neighbouring states are also expanding rapidly. Sugarcane ethanol from Brazil has low production cost and could achieve high direct greenhouse gas emission reduction compared to other biofuels in the world. **To support the *optimal* expansion of the ethanol production in the Centre-South region of Brazil, a detailed strategic supply chain optimization for ethanol production cost is performed.**

Case study

The sugarcane production in Goiás increased from 13 million tonne cane in harvest season 2003-2004 to 62 million tonne in season 2013-2014. The sugarcane cultivation in 2013-2014 has been converted to 1.9 million tonne sugar and 3.9 million cubic metre ethanol. In Goiás, 41 sugarcane processing units are installed, however not all facilities are operational due to the economic situation. In Goiás both dedicated ethanol plants as well as flexible plants (producing both sugar and ethanol) have been constructed.

Methods

The expansion of the ethanol industry in Goiás is assessed through use of the BioScope linear programming model to determine the optimal supply chain configuration. The objective function for the model is to minimize overall ethanol production costs. Figure 1 represents a schematic overview of the BioScope model. The model formulation is based on the superstructure where biomass supply regions send the biomass directly to the potential location of industrial processing plants. The distribution of biomass supply regions in Goiás is determined by the land use change model (PLUC model), see BE-Basic subprogram 9.1.1 (Verstegen et al 2015).

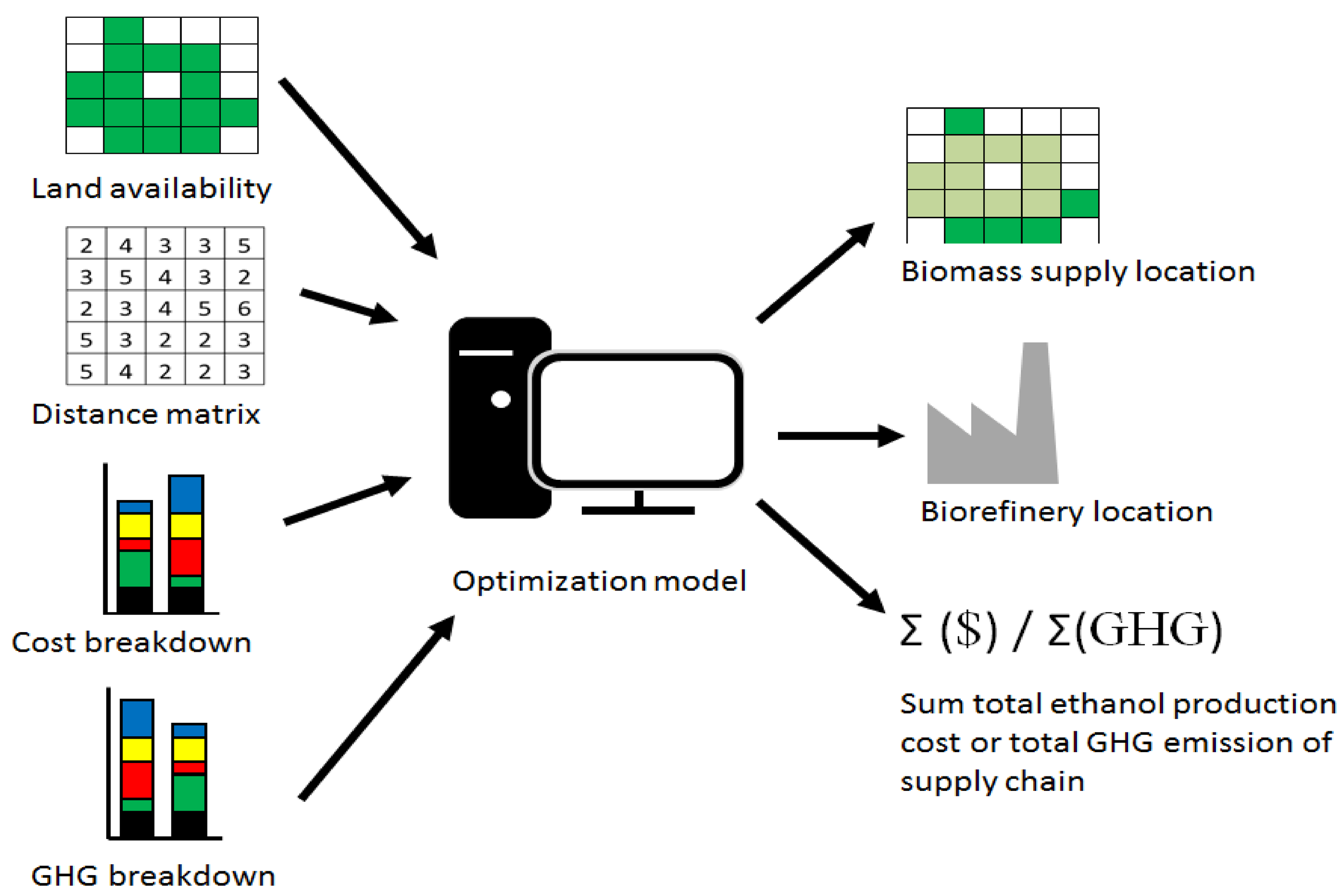

Figure 1 Structure of the strategic supply chain optimisation model utilized for the ethanol industry in Goiás.

Results and conclusion

The economic optimization is performed utilizing the biomass supply regions in 2030 using three approaches. First, no existing industrial processing facilities were pre-set, see Figure 2 left. Second, the locations of industrial locations in 2012 were provided to the model, Figure 2 middle figure. Lastly, a gradual expansion of the ethanol industry is modelled, using the potential locations of the previous run (2012, 2020 or 2025) as input for the next. Although the biomass utilization is equal in all approaches the "greenfield" approaches resulted in 29 industrial plants, mainly large scale plants. The one step expansion constructs 51 plants compared to 55 industrial facilities for the gradual expansion. This research has shown that large scale industrial processing is preferred economically if the biomass supply can support large scale industrial plants. The use of detailed supply chain cost optimization can be extended to detailed multi-objective optimization, including land use planning.

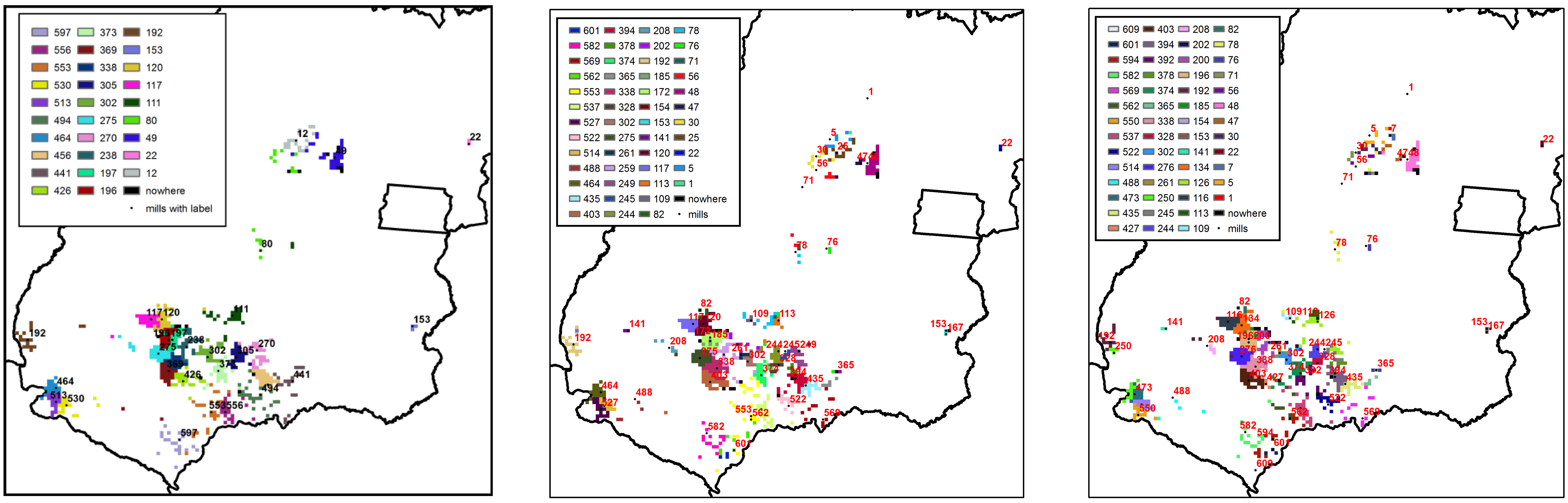

Figure 2. Economic supply chain optimization of sugarcane supply regions and locations of ethanol production plants in Goiás using "greenfield" expansion (no preset of industrial locations, left image), one step expansion (preset existing industrial plants in 2012, middle image) and gradual expansion (preset industrial plants of 2025, right image).

References

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