Assessing land impacts of biomass co-processing in Brazilian refineries

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1. Introduction

Modelled pathways that limit global warming to 1,5ºC or 2ºC indicate the reduction of oil industry operations, resulting in waves of decommissioning and retrofitting of infrastructure to adapt to the new energy demands[1,2]. In that context, refineries might assume other roles in the energy transition, such as biomass co-processing[3]. This strategy has the potential to expand the production of lower-carbon intensity fuels in a competitive way, since it takes advantage of the process units, utilities, logistics and skilled labour that already exist in refineries[3–8]. In this study, we propose the analysis of biomass co-processing in the Brazilian context.

2. Methods

As most IAMs do not fully capture the opportunity of co-processing, we included the existing refining assets in the sectoral model BLOEM, which is a spatially explicit model of bioenergy coupled with the national BLUES model[17]. In this study, we consider the use of soybean oil for the co-processing in hydrotreaters to produce hybrid diesel with 25% biomass content. Therefore, given a hybrid diesel production target, a set of constraints and the existing oil refineries, we use BLOEM to determine where to grow the bio-feedstocks that will be used for co-processing.

Constraints and assumptions

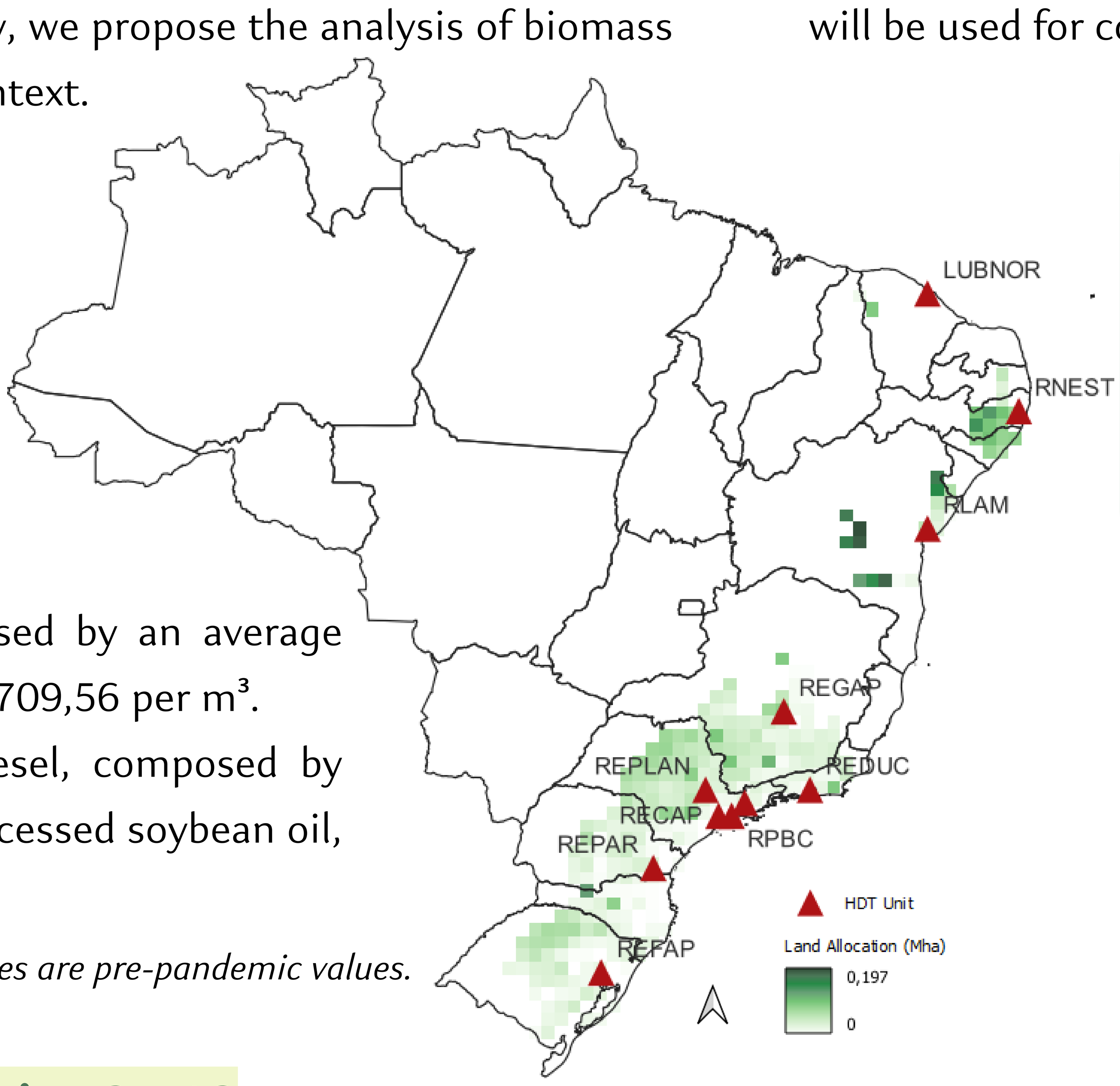
- Food first concept, i.e. no agricultural land available for bioenergy
- No forest area available for bioenergy
- Maximum distance for biomass logistics of 300km
- Refineries can adopt co-processing without major investment in infrastructure changes, i.e. no capital cost required

Scenarios

- 1 scenario to evaluate the dynamics of optimizing the set of selected refineries jointly
- 11 scenarios to evaluate each selected refinery individually

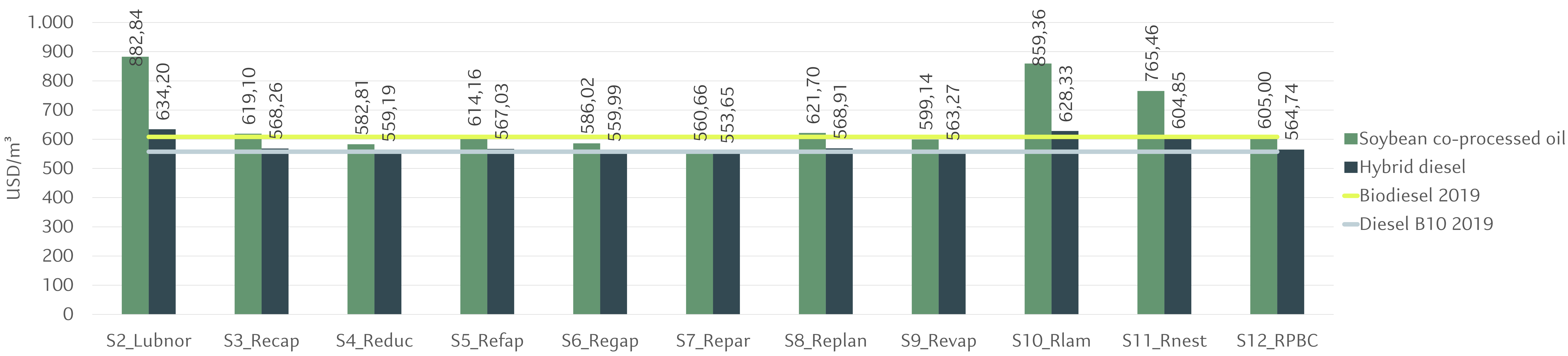
3. Results

Scenario 1



- An area of 2,9 Mha is destinated to the oil crop growth, but only 1 Mha represents land use change.
- The soybean oil gets co-processed by an average cost of USD 17,71 per GJ or USD 709,56 per m³.
- The levelized cost of hybrid diesel, composed by 75% fossil diesel and 25% co-processed soybean oil, is USD 593,64 per m³.
  - *Note: both soybean and diesel prices are pre-pandemic values.*

Scenarios 2 - 12



- The average cost of the hydrotreated soybean oil is USD 16,55 per GJ or USD 663,30 per m³. In energy basis, this cost is 11% lower than biodiesel cost in 2019.
- The biomass production in the Northeast requires more land, resulting in a higher cost for the 25% soybean oil that goes in the co-processing.
- For the other refineries, the hydrotreated soybean oil cost is lower than biodiesel. In these refineries, the hybrid diesel is cost-competitive with conventional diesel.
  - *Note: In 2019, the conventional diesel had a biodiesel mandate of 10-11%.*

4. Final remarks

- Results show that co-processing can lead to the production of a hybrid diesel with higher biomass content than the biodiesel mandate for roughly the same cost. Therefore, the same land that is used to grow oil crops to produce biodiesel, could be used to produce a higher quality fuel – higher cetane number and heating value, and lower sulfur content.
- In addition to preventing refineries to become stranded assets with the energy transition, co-processing can elevate the current mandate of renewable content in diesel.
- The land use change in the results indicates that lower-carbon intensity fuels can be produced in Brazil without further intensifying deforestation or land competition for food production.

References and acknowledgment

anp Agência Nacional do Petróleo, Gás Natural e Biocombustíveis

prh Programa de Recursos Humanos da ANP

GESTÃO: Finep