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Analysis of drought impact on sugarcane bagasse based electricity generation under Climate Change scenarios

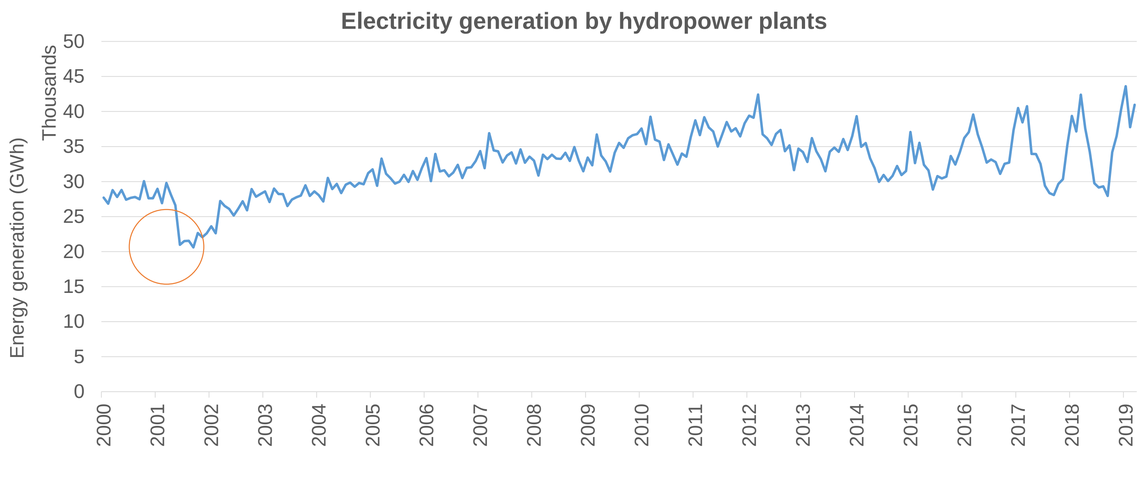
Jazmin Campos Zeballos[a], Vinicius Bof Bufon[b] and Zita Sebesvari[c]

[a, c] *United Nations University, Institute for Environment and Human Security (UNU - EHS)*

[b] *Brazilian Agricultural Research Corporation (Embrapa Cerrados)*

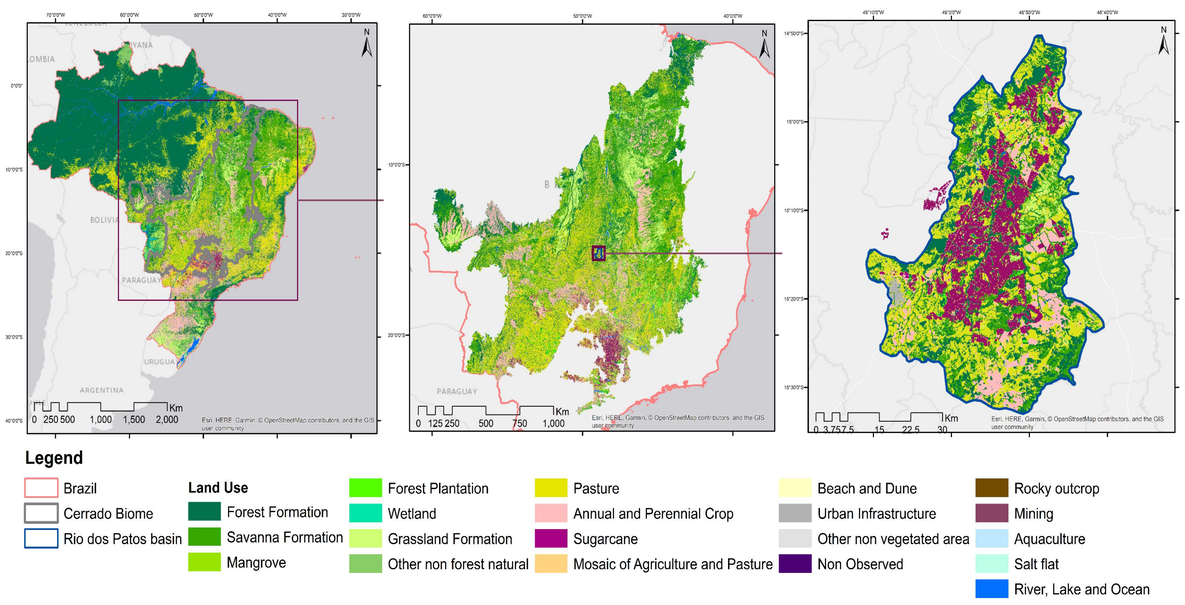
Background

Hydropower contributes around 65% to Brazil´s electricity matrix [1]. Climate change scenarios forecast increasing drought intensity and frequency, which would challenge hydropower generation as experienced in 2001. The extended drought event affected reservoir water levels. The reduced electricity generation triggered blackouts throughout the country. After this event, the government recognised the need to diversify the electricity matrix. It capitalizes also on the electricity surplus generated in sugarcane mills, by connecting the mills to the grid [2].



Source: Own preparation based on data available by the National Electric System Operator (ONS in Portuguese) [4]

Sugarcane bagasse based electricity delivers already available surplus renewable energy to Brazil´s electricity matrix. However sugarcane production itself might also be impacted by drought events. For that reason, we evaluated drought impacts on sugarcane bagasse based electricity under climate change scenarios. This study was carried out in the Rio dos Patos watershed, located in the Cerrado Biome. The Cerrado Biome is home to half of Brazil´s sugarcane area with the highest sugarcane expansion rate across the country [3] due to land availability, flat topography and climatological characteristics.



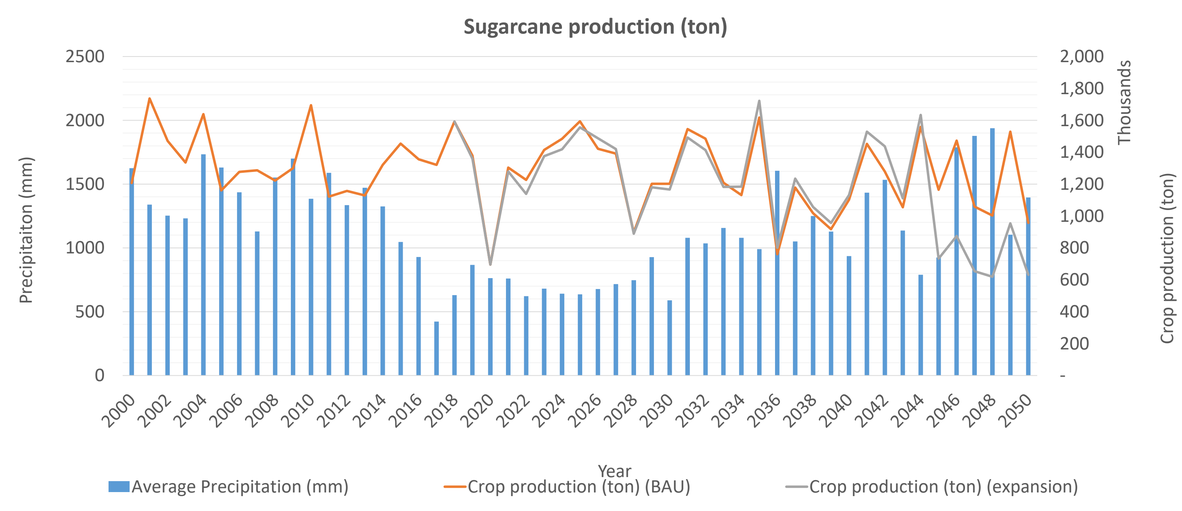
Source: Own map using ArcGIS. Database source: [5–7]

Material and Methods

The sugarcane bagasse hydrology of the basin, sugarcane yield and production and, therefore electricity production potential, were modelled using the SWAT model for ArcGIS under the Representative Concertation Pathway 4.5 (RCP4.5) projections based on HadGEM2 General Circulation model (GCM) downscaled by National Institute for Space Research (INPE in Portuguese) [8]. The main inputs were: i) precipitation and temperature [9–11], ii) soil [12] and land use [5–7]. The database for both, soil and land use, were modified based on literature review and Embrapa Cerrados expertise. Future scenarios analysis, considering potential to crop sugarcane were identified using the Sugarcane Zoning [13], proximity to the sugarcane mill, sugarcane crop areas, water dams and streams. Different expansion scenarios were modelled, for this poster were selected a no expansion scenario and a scenario to 45% of the available land suitable for sugarcane.

Results

The model output showed that at no sugarcane expansion and under the RCP4.5 scenario, sugarcane and electricity production suffers a small reduction by 2050. The sugarcane and electricity production decreases in years of lower amount or more concentrated precipitation. On the other hand, under the sugarcane expansion scenario, sugarcane yield and electricity generation are also affected by drought events, and are more impacted by lack of water retention of the soil of the expansion areas. Expansion of sugarcane over pasture, crop or grassland using irrigated production system, maintains sugarcane yield and increases sugarcane and electricity production. Whilst without irrigation, sugarcane expansion over grassland, reduces sugarcane yield, and therefore, electricity generation.



Source: Own preparation based on modelled results using SWAT and precipitation projection data [8]

Conclusion

The results showed that sugarcane in areas where it is currently growing, is able to cope with projected variability in precipitation driven by climate change. The total sugarcane produced, is however affected in consecutive years with significant low precipitation (around 800 mm). For the electricity matrix, it means that sugarcane based electricity generation may provide a valuable contribution during drought years, when water levels in reservoirs are low. Under the RCP4.5 downscaled projections used, sugarcane expansion should occurred ideally in areas where can be irrigated or in areas currently under agricultural practices, where the soil characteristics can help to maintain the sugarcane yield. The study should be complemented by the downscaled projections by the GMC MIROC, which shows higher precipitation for the area.

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