WANDEL

Water Resources as important factor in the Energy Transition at local and global scale

Energy from Biomass: Electricity generation based on Sugarcane in Rio dos Patos, Brazil

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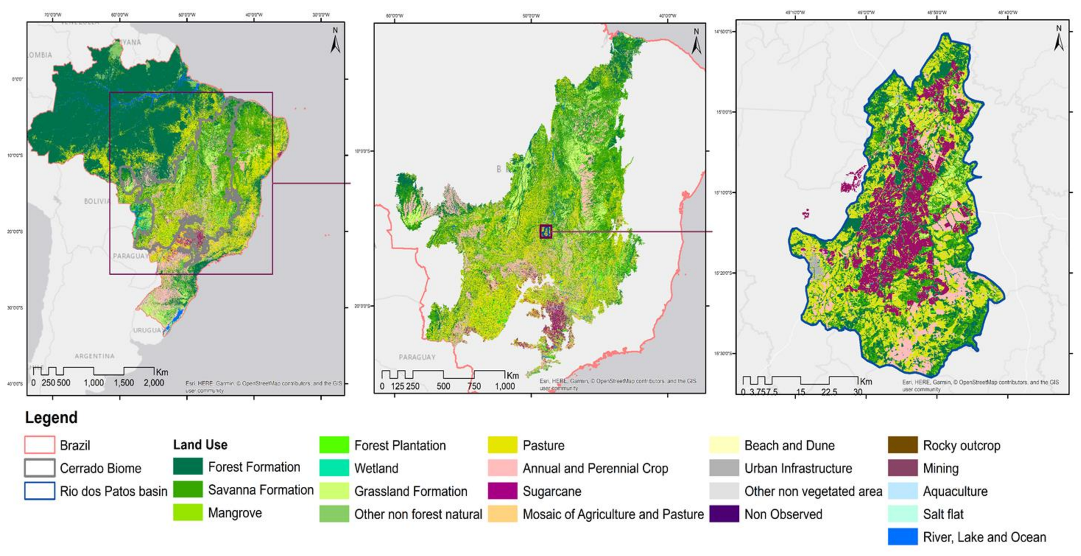
BACKGROUND

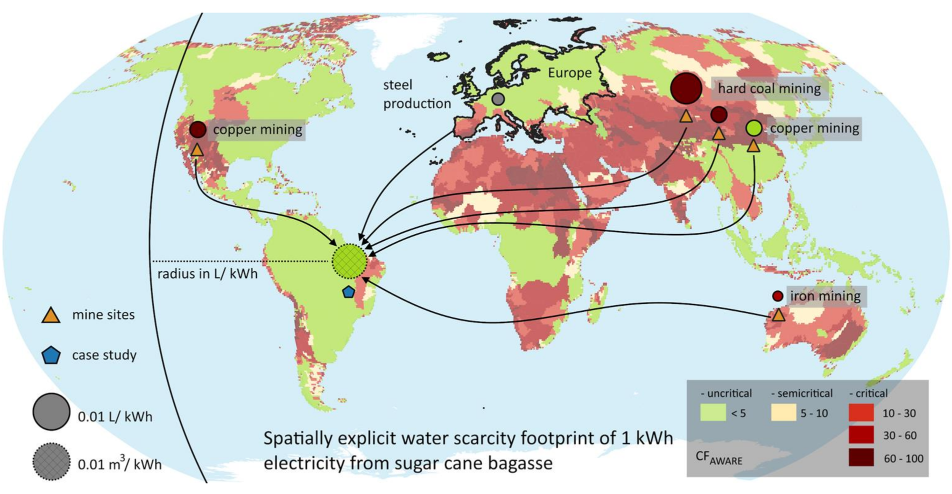
Brazil is the biggest sugarcane producer in the world [1]. Sugarcane is considered a key crop for the energy matrix due to ethanol production and the electricity generation as a by-product [2]. 8 % of the electricity installed capacity in Brazil originates from biomass [3]. Most of it comes from sugarcane mills which operate during the dry season; at a time when hydropower plants cannot cover electricity demand. The Cerrado Biome is home to half of Brazil's sugarcane area with the highest sugarcane expansion rate across the country [4] due to land availability, flat topography and climatological characteristics. It is where our case study, Rio dos Patos basin, is located.



WATER SCARCITY FOOTPRINT

The quantitative Water Scarcity Footprint (WSF) is the sum of losses from evapo(transpi)ration and product-incorporated water used along the supply chain (contributions > 1 %) and accounts for 0.023 L/kWh (construction) and 8.75 L/kWh (operation). Water uses are regionally weighted with respect to water availability on basin level. For the construction of the sugar mill, the largest quantities are used remotely for mineral commodities (see map). The operation phase is the combustion of the bagasse and generation of electricity by steam. 99% of the total water loss during this phase occur on-site due to evaporation from the boilers.

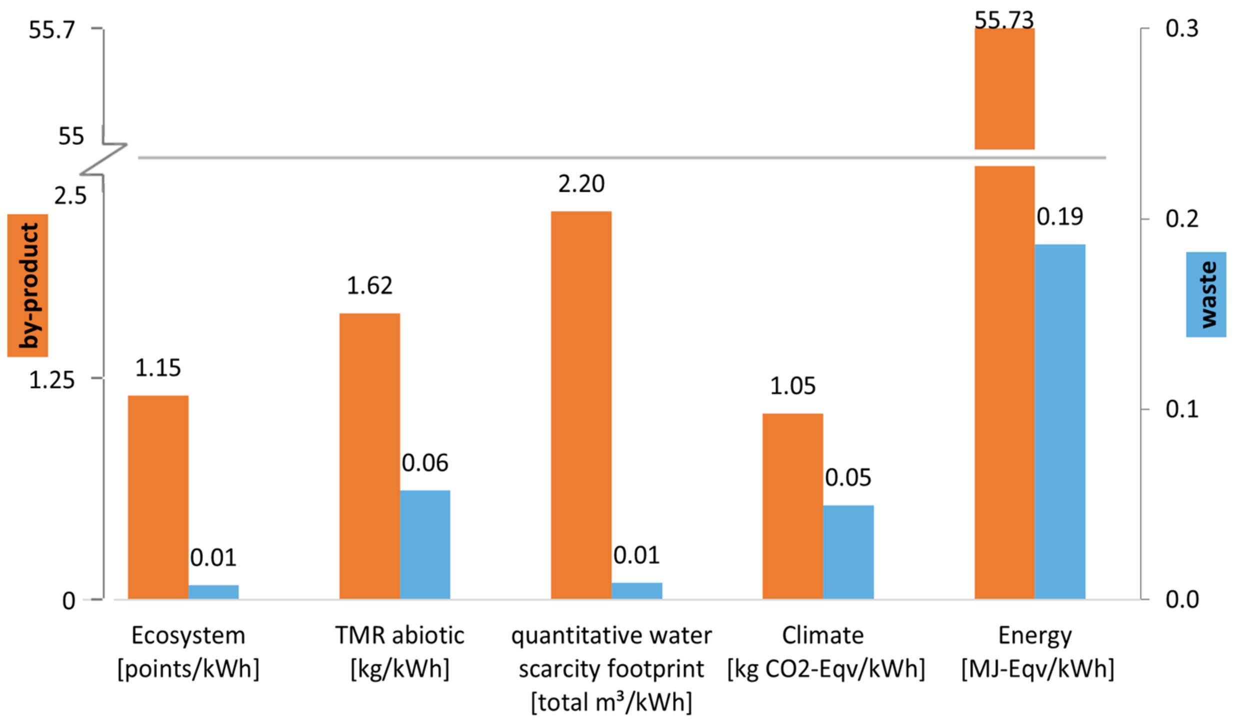
The qualitative WSF, the sum of virtual water needed to dilute aluminium emissions, outnumbers by far the quantitative part with 176 L/kWh.



ENVIRONMENTAL SUSTAINABILITY ASSESSMENT (ESA)

The ESA evaluates the sustainability of burning sugarcane bagasse for electricity production and upstream supply chains against the background of potential global environmental impacts.

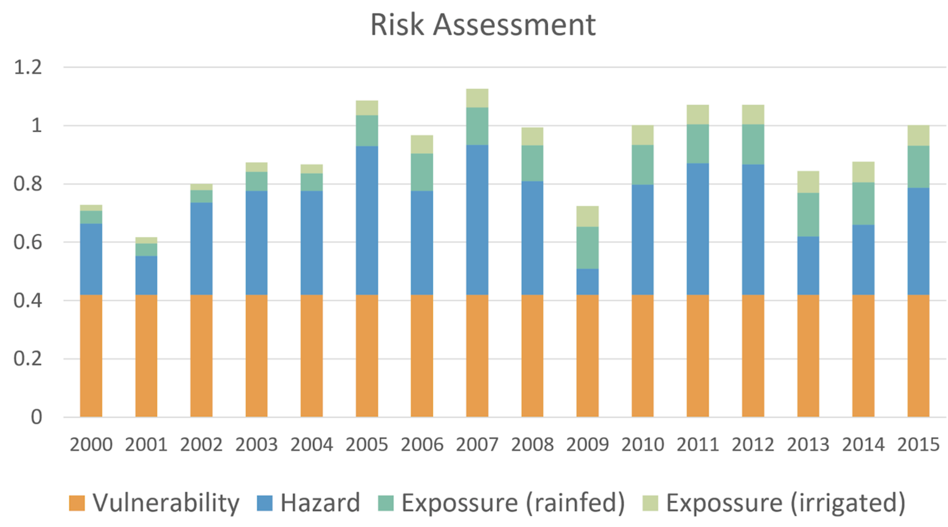
Different Life Cycle Assessment (LCA) indicators show that impacts of burning bagasse defined as a by-product of sugarcane processing are far higher than those of bagasse seen as a waste product. This can be related to the upstream supply chains attached to the by-product, as waste products are burden-free according to the chosen LCA-definitions. Gains in efficiency in the upstream supply chain may reduce the impacts.



DROUGHT RISK ASSESSMENT

The drought risk assessment was carried out considering hazard, exposure and vulnerability and applied to both the industrial and agriculture subsystems of the sugarcane-based electricity generation system. The hazard analysis shows that drought events are mainly triggered by dry spells, shifts at the start of the rainy season and high temperatures. The analysis considered the water need of ecosystems (ecological flow for the river, permanent preserved areas) and also sugarcane expansion scenarios. Results show that the lack of drought early warning systems and the absence of agriculture drought insurance schemes are the factors increasing vulnerability.

Water scarcity and stress are highest during the dry months. Reservoirs play an important role to reduce vulnerability in the region.



KEY FINDINGS

Sugarcane mill wastewater is used to irrigate the fields. It is mixed with vinasse, a liquid ethanol fermentation sub product rich in N, P and K. It reduces the WF and reduces the impact on the environment.

70 % of the sugarcane biomass is water, which is reused during its processing. It reduces the freshwater requirements significantly and thus also the industrial vulnerability of sugarcane-based electricity production to droughts.

As 99 % of the on-site WSF is due to water losses from the boiler system, this is a possible starting point for efficiency improvements.

The qualitative WSF is only considering aluminium emissions so far and needs further refinement to identify the largest hotspots. So far, it can be said that the contributions from upstream processes related to mining and waste disposal are enormous.

Sources:

1. OECD/FAO. *OECD-FAO Agricultural Outlook 2020-2029. Figure 5.4. Sugar production classified by crop;* OECD, 2020, ISBN 9789264317673.
2. Santini, G.A.; Barros Pinto, L. de; Ramos Queiroz, T. Cana-de-açúcar como base da matriz energética nacional. *Revista de Política Agrícola* 2011, *20.*
3. Operador Nacional de Sistema Elétrico (ONS). Capacidade Instalada No SIN 2020/2024. Available online: http://www.ons.org.br/paginas/sobre-o-sin/o-sistema-em-numeros (accessed on 15 September 2020)
4. Scarpare FV, Hernandes TAD, Ruiz-Corrêa ST et al. (2016) Sugarcane land use and water resources assessment in the expansion area in Brazil. Journal of Cleaner Production 133: 1318–1327. doi: 10.1016/j.jclepro.2016.06.074

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