

Water implications by mitigation scenarios for the Brazilian energy sector

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Introduction

Water and carbon emissions do not always have a direct trade-off because restrictions on water availability occur at local level, while emissions should be globally restricted. (Wallis *et al.*, 2014). Therefore, the technological choices of a low carbon scenario are not necessarily compatible with the regional water reality, which may aggravate a situation of water stress or be limited by it (IEA, 2016).

The Paris Agreement pledges to achieve the goal of meeting the below 2°C target. And the 1.5°C Special Report indicates a dramatic emission reductions by 2030 and carbon neutrality by around 2050 that implies an unprecedented transformation of energy, land, urban, and industrial systems, including measures to achieve “negative emissions” by removing carbon from the atmosphere.

Therefore, to achieve energy security and larger share of renewables, implications in the water security aspect must also be evaluated. This proposal seeks to identify and analyse the complex and intricate relation between water and energy, and how mitigation scenarios may impact the Brazilian energy sector and water resources. We assess Brazilian energy sector water use (withdrawal and consumption) across a 1.5°C and 2°C climate mitigation scenarios in the national integrated optimization model for national energy and land-use systems, BLUES (*Brazil Land-Use and Energy Systems*) model (Koberle, 2018).

Methodology

The Brazilian contribution of cumulative amount of CO_{2e} for the period 2010-2050 was obtained through the global model COFFEE (*Computational Optimization Framework For Energy and the Environment*) (Rochedo, 2016). The Brazilian carbon budget was estimated at 18 GtCO₂ (1.5°C) and 24 GtCO₂ (2°C). The emission budgets were introduced in the national BLUES model. Thus, three scenarios were simulated:

- Baseline scenario,
- 1.5°C scenario
- 2°C scenario.

Outputs for the energy sector were analyzed and the water use (withdrawal and consumption) was quantified for each scenario

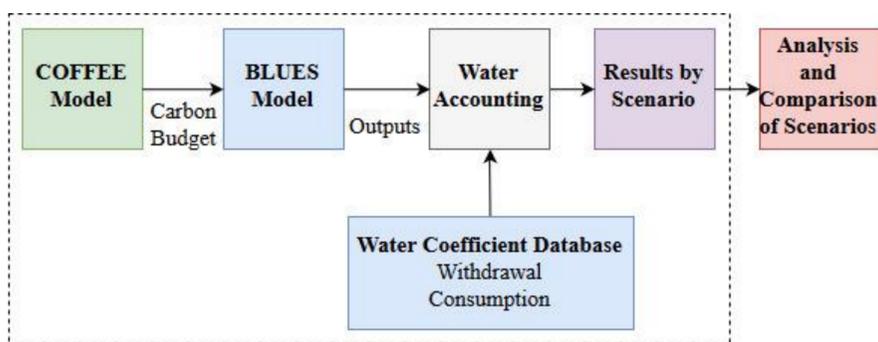


Figure 1: Methodological Procedure

We defined water coefficients for each energy technology. The water accounting was done exclusively for the energy sector, therefore the portion of water needed for crop irrigation is not accounted for. Non-consuming water users, such as hydropower, were also not included in the analysis. The type of cooling system employed on thermal power plants has a significant impact on the water consumption and withdrawal. Two processes were identified: once-through cooling (OC) and wet cooling tower (WCT). We assume a variation of the distribution of the cooling systems technology during the long-term period.

Table 1: Distribution of the cooling systems during the long-term period

Cooling system	2010	2030	2040	2050
Once-through (OC)	90%	70%	60%	50%
Wet cooling tower (WCT)	10%	30%	40%	50%

Results

Figure 2 shows the total water withdrawal and consumption through 2020 - 2050 in all scenarios. 1.5°C Scenario has the largest withdrawal and consumption by 2050. However, the 2°C Scenario has the lowest water use by 2050. This occurs because 2°C Scenario has more power production based on hydropower and wind power generation (non-consumptive users) than the other scenarios.

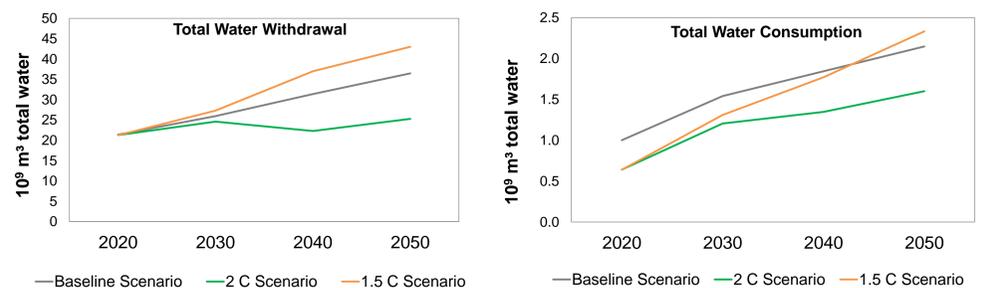


Figure 2: Total water withdrawal and consumption by mitigation scenario

Figure 3 shows power sector and biofuels production as water users by 2050. Power sector demand more quantity of withdrawal and has low consumption, this is related to the increase of CHP based on bagasse generation and the OC systems in all thermal power plant mix. On the other hand, biofuel production has the most intensive water consumption. This impact could be even higher if the water used on irrigation of biomass were allocated to energy sector.

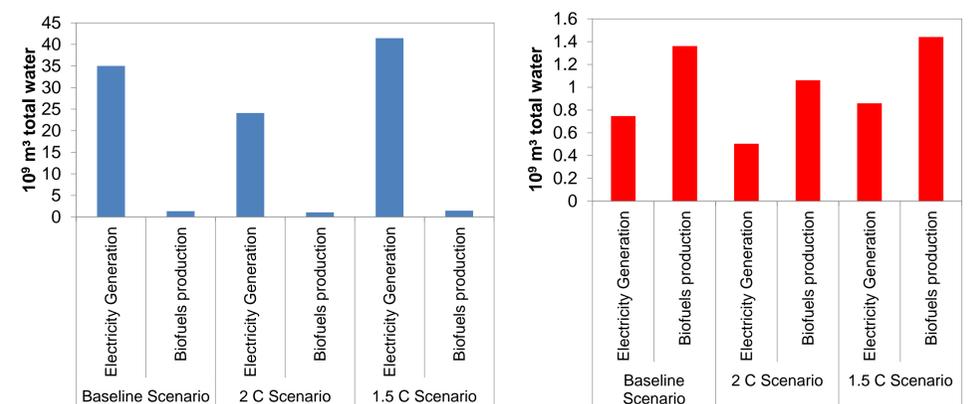


Figure 3: Water withdrawal and water consumption for power generation and biofuel production in Brazil by 2050

Discussion and Conclusions

This unique and complex energy matrix with high presence of renewable sources could lead to water use conflict situations.

We find that water withdrawal and consumption vary significantly across scenarios. The mix of technologies on the energy sector for a 1.5°C scenario increases the water vulnerability and environmental impacts due to greater consumption levels.

The increasing incorporation of biofuels to the Brazilian energy matrix represents the greater impact in terms of consumption. Meanwhile, the type of technology employed can cause a vulnerability situation specially for the power generation.

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