

Irrigation Policy: Water Use and Socioeconomic Contributions in Brazil

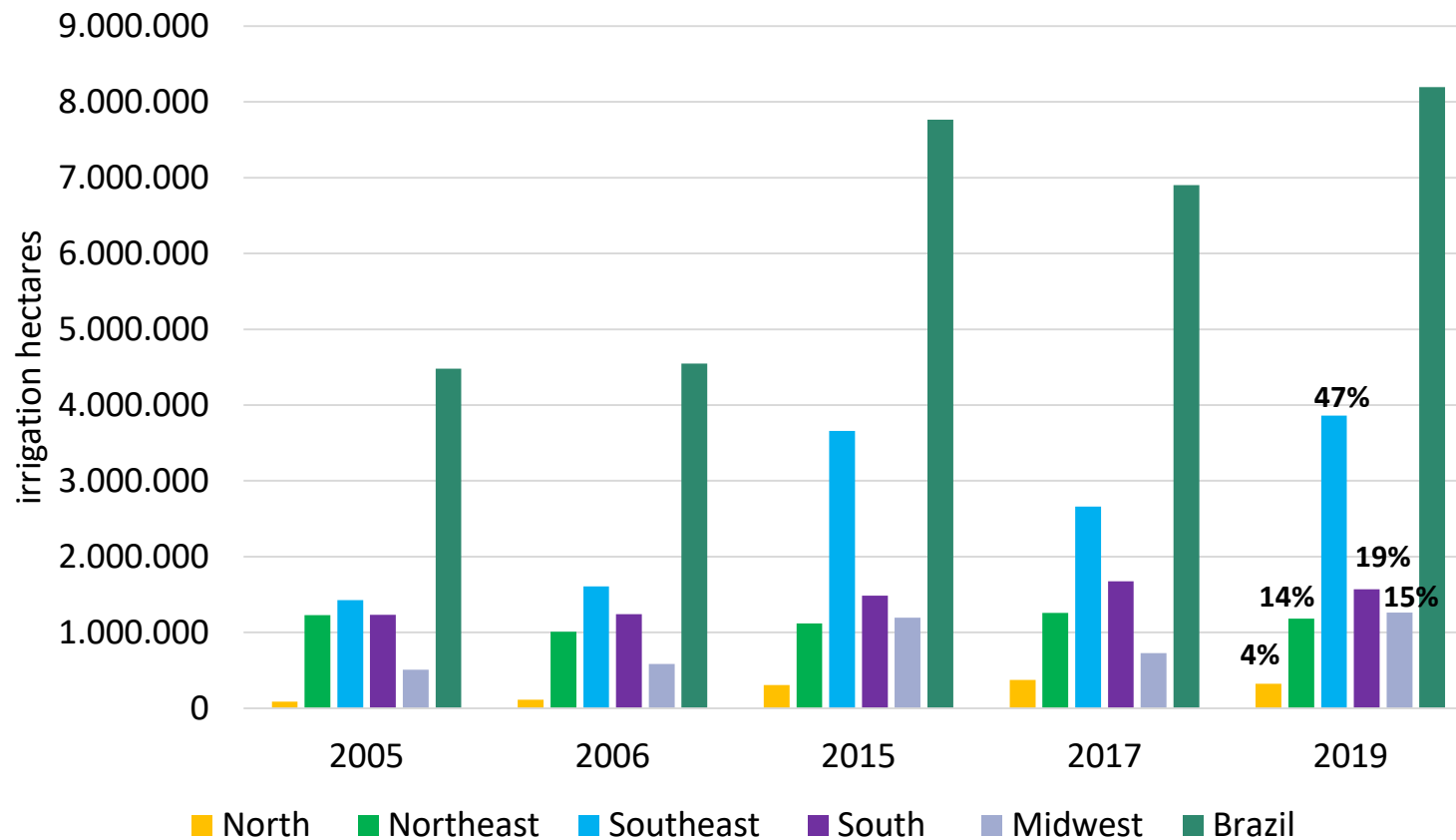
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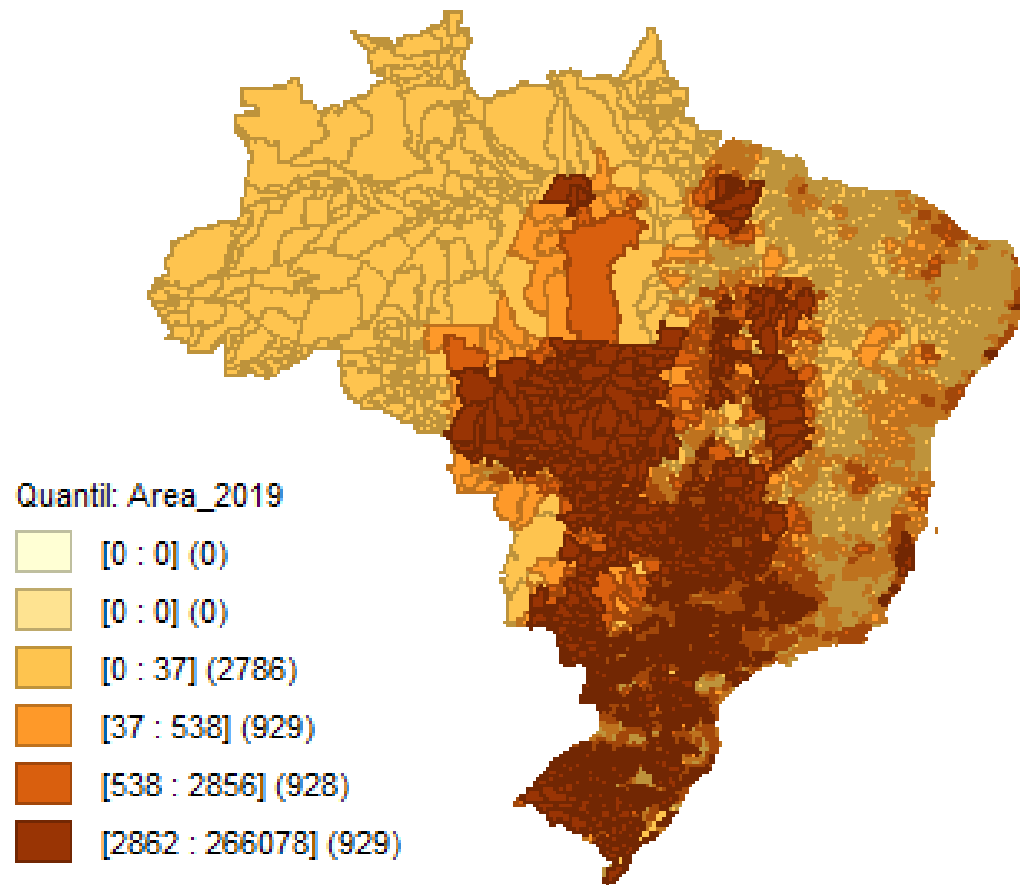


Motivation

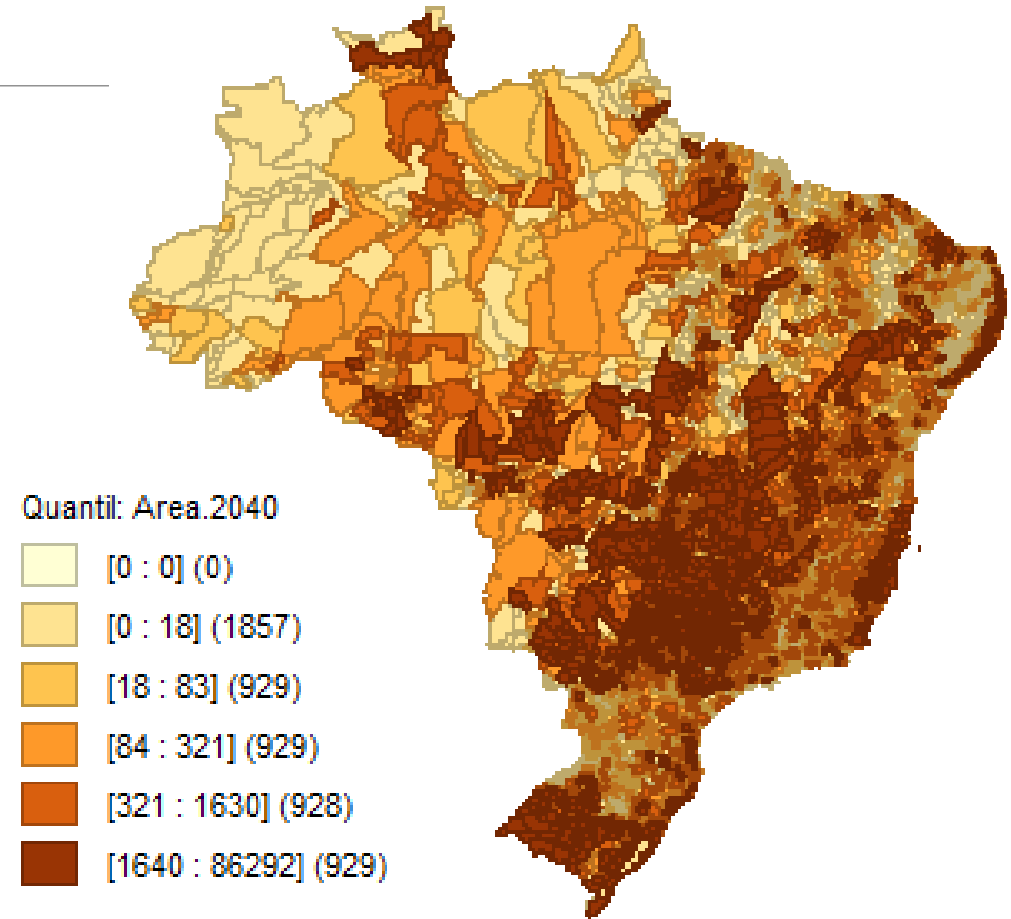


- ❖ Brazil had 8.2 million irrigated hectares (Mha);
- ❖ Potential to increase irrigated agriculture to 15.6 Mha;
- ❖ Brazil has about 12% of world's
The distribution of water is not homogeneous across regions;
- ❖ The water use has been growing;

How does the expansion of irrigated agriculture impact water usage and socioeconomic variables?



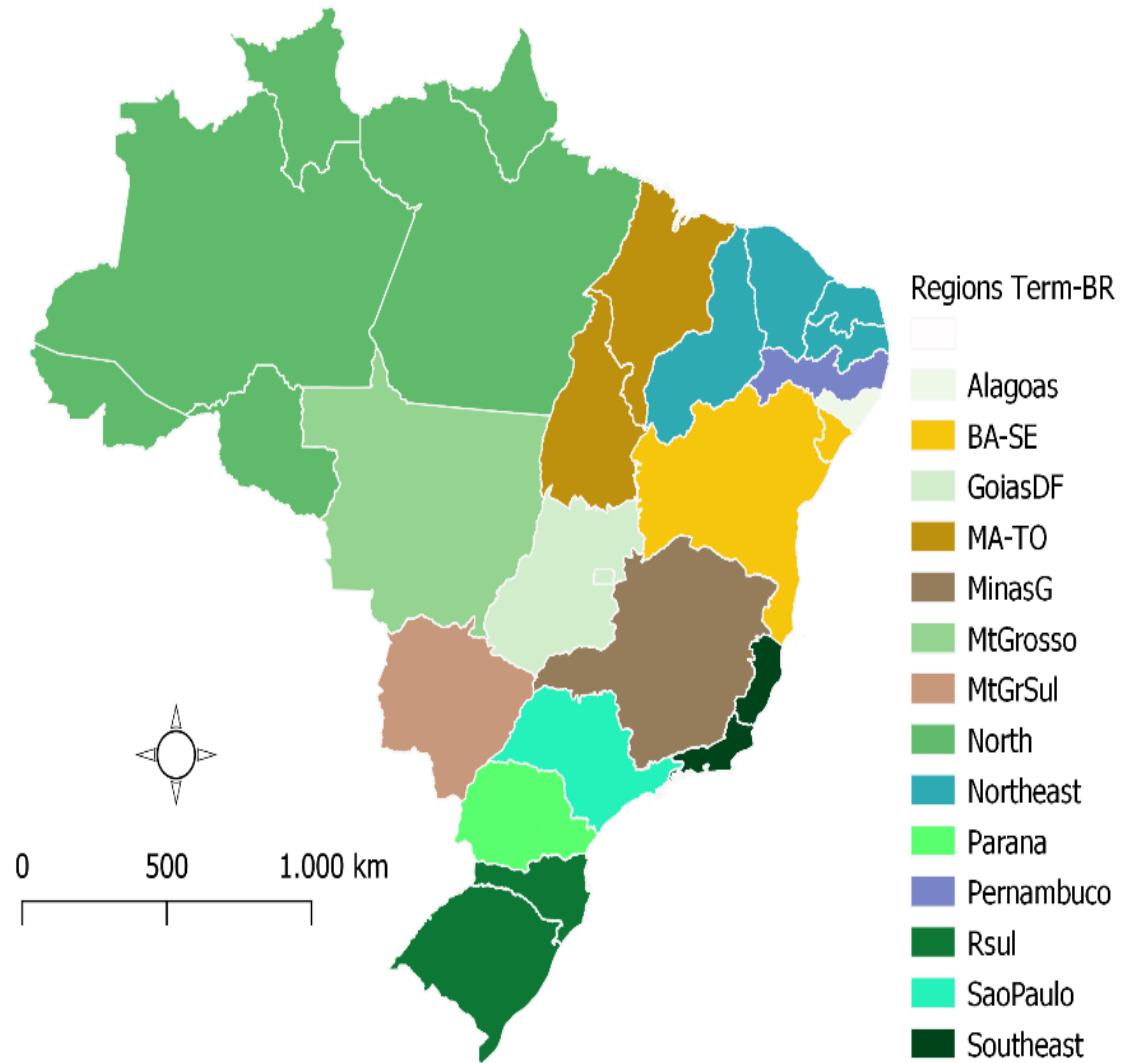
Irrigated hectares (2019) = 8.195.391



Potencial irrigable areas: 15.619.141

TERM-BR

- TERM-BR inter-regional, multi-period, bottom up, general equilibrium model.
 - Positive relation between investment and profit rate;
 - Relation between wage growth and regional labor supply.
- Distinguished 14 Brazilian regions (Brazil has 27 states).
 - 36 productive activities;
 - 10 households



Water use database - Agriculture

Table 1. Crops and groups in the TERM-BR model

Agriculture activity	Main crops in each group	Irrigation System	System Efficiency	Losses (%)
Rice	Rice, Oats, Rye, Triticale	Inundation system	60%	40%
Corn	Corn	Central Pivot	85%	15%
Cotton	Cotton	Central Pivot	85%	15%
Sugarcane	Sugarcane (Fertigated and Irrigated)	Reel system	80%	20%
Soy	Soy	Central Pivot	85%	15%
Temporary Crop	Garlic, Peanuts, Potatoes, Onions, Peas, Beans, Tomatoes, Cassava	Microirrigated (Drip irrigation)	95%	5%
Permanent Crop	Citrus, Coffee, Apple, Banana, Coconut	Microirrigated (Drip irrigation)	95%	5%
Forestry and Silviculture	Acai, Palm Tree	Microirrigated (Drip irrigation)	95%	5%

Technical coefficient in product level (physical coefficient – Mm³).

Water use database

Table 2. Water uses estimated for year 2015

Users	m ³ /s estimated in year 2015	% water use
Agriculture	569.8	63%
Livestock	130.0	14%
Industry	63.9	7%
Services	130.0	14%
Household consumption	20.8	2%

Productivity Differential database

Production growth depends: irrigated, non-irrigated and crop productivity in each area

$$K_{ji} > K_{jn}$$

K_{ji} productivity of irrigated activity
 K_{jn} is the productivity of non-irrigated

Policy Simulation

➤ BASELINE

First step: We updated macroeconomic variables and irrigated areas from 2015 to 2019;

Second step: Economy was projected until 2040 using GDP of 1.9% per year.

➤ POLICY SIMULATIONS

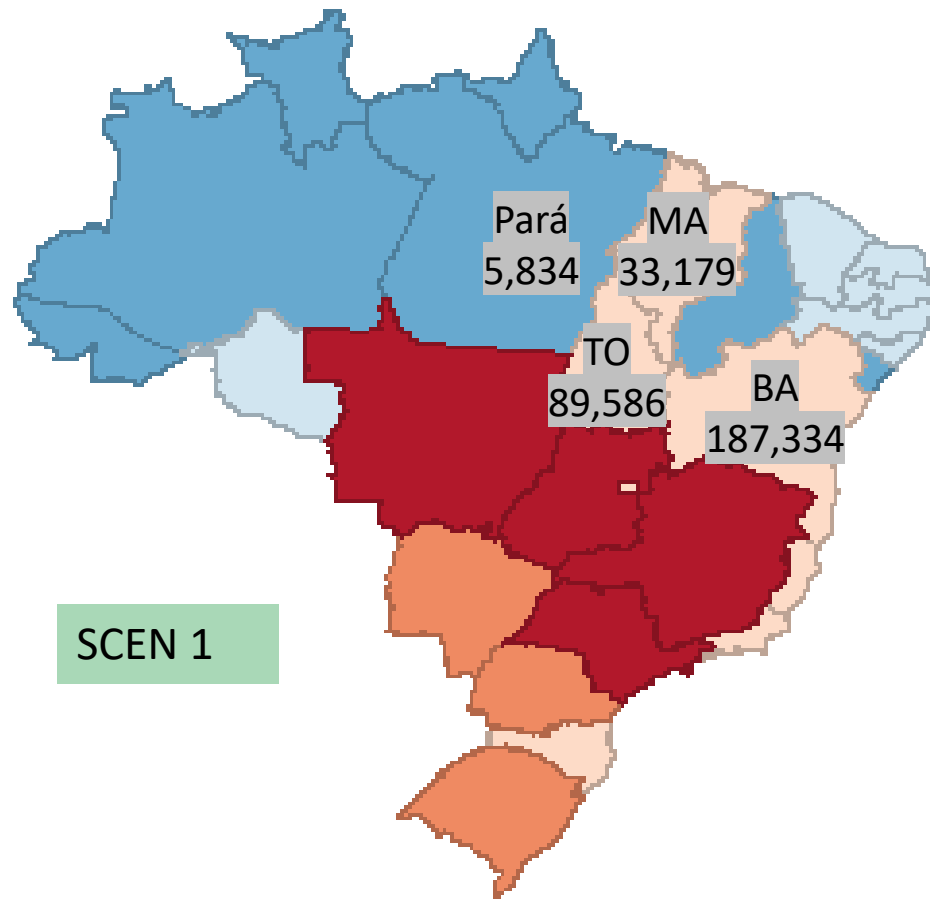
Two scenarios:

SCEN 1: advanced by 8 Mha across the country (404,000 hectares per year);

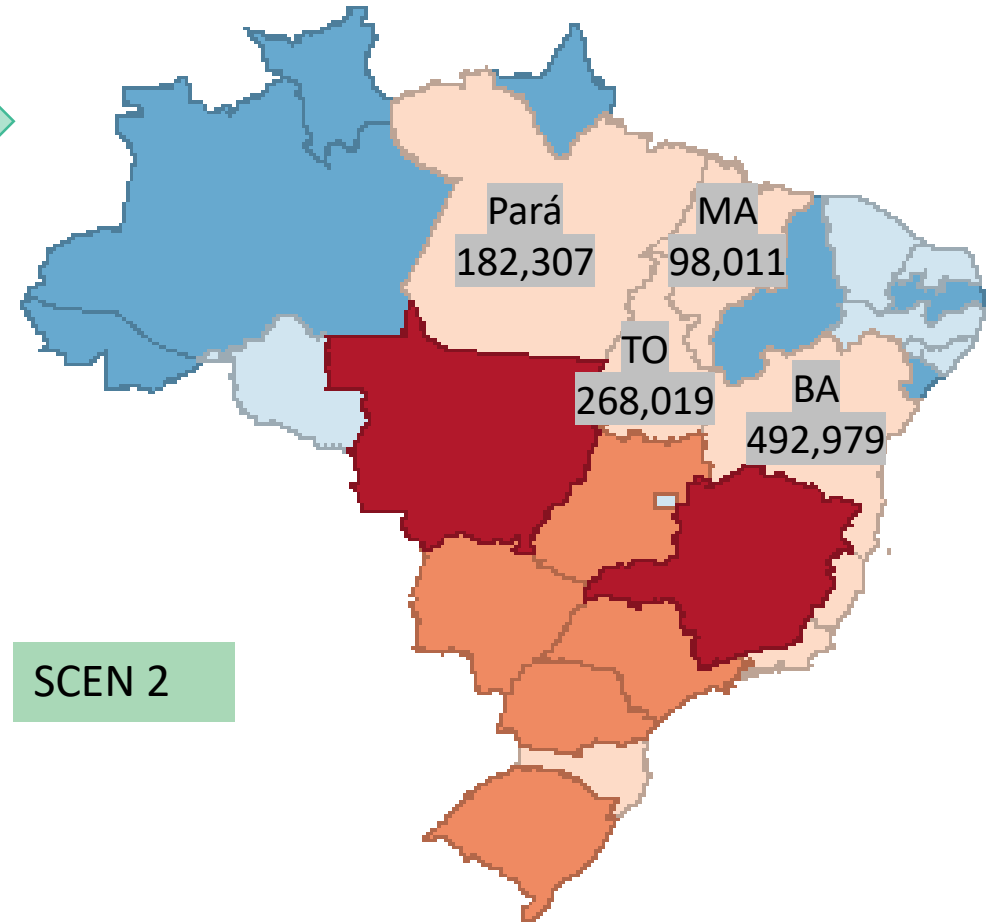
SCEN 2: irrigation in Brazil would advance by 10 Mha (500,000 hectares per year).

* historical average was 280,000 hectares per year

Scenarios



- Scenario 1 : local areas with new irrigated agriculture;
- 404 thousand hectares per year



- Scenario 2: further expands irrigated agriculture by an additional 2 million hectares under pasture;
- 500 thousand hectares per year

RESULTS

- SOCIOECONOMIC
- WATER USE

Socioeconomic results

National impacts. Prices, production and export in SCEN1 e SCEN2.
Percentage cumulative change in 2040 relative to the baseline

- Positive impact on national socioeconomic variables;
- GDP growth by 0.30% in SCEN1 and 0.36% in SCEN 2;
- Irrigation would increase real household consumption by 0.43% and 0.52%;
- Food prices will decrease.

Socioeconomic results

Table 6. National Impact. Price, and Consumption. Percentage cumulative change in 2040 relative to the baseline.

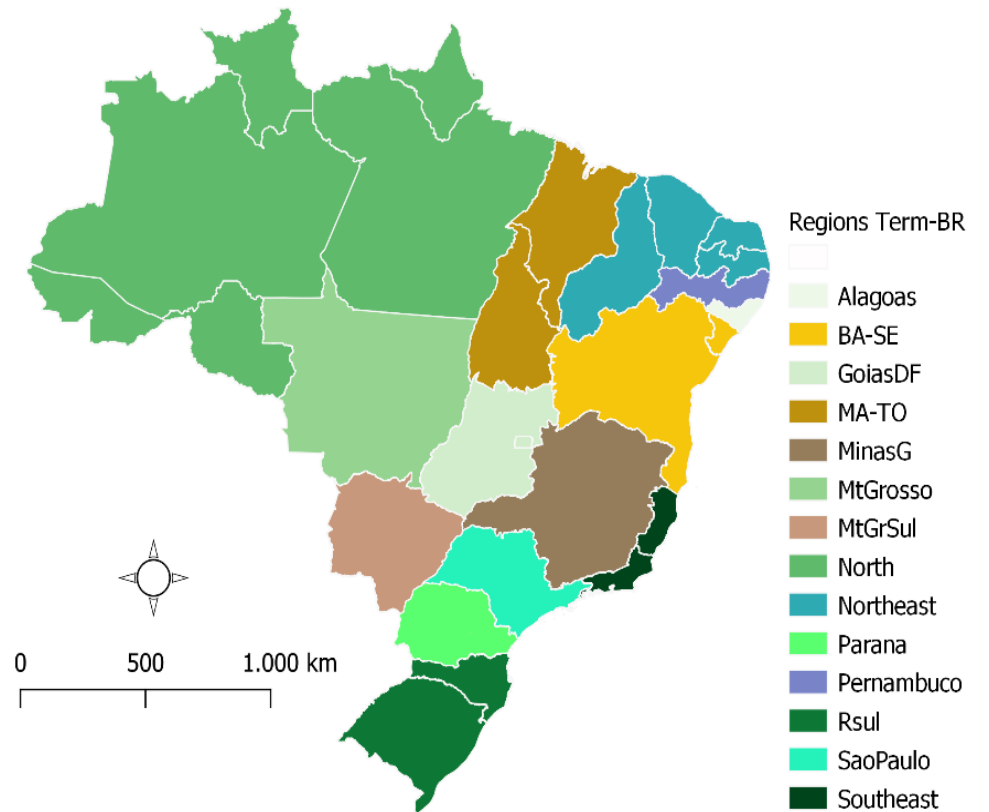
household	Food prices		Total consumption		Food consumption	
	scen 1	scen 2	scen 1	scen 2	scen 1	scen 2
POF1	-0.19	-0.22	0.14	0.23	0.18	0.28
POF2	-0.17	-0.20	0.30	0.42	0.30	0.41
POF3	-0.15	-0.18	0.36	0.46	0.33	0.44
POF4	-0.15	-0.17	0.38	0.47	0.34	0.43
POF5	-0.15	-0.18	0.42	0.50	0.38	0.46
POF6	-0.15	-0.17	0.43	0.50	0.37	0.44
POF7	-0.17	-0.20	0.49	0.57	0.40	0.48
POF8	-0.14	-0.17	0.47	0.55	0.38	0.45
POF9	-0.15	-0.17	0.49	0.57	0.41	0.49
POF10	-0.10	-0.11	0.47	0.55	0.41	0.48

Socioeconomic regional results

Table 7. Regional impacts. SCEN 1 and SCEN 2.

Region Term-BR	Real GDP		Real wage		Real Households		Real investment	
	CEN 1	CEN 2	CEN 1	CEN 2	CEN 1	CEN 2	CEN 1	CEN 2
Norte	0.04	0.38	0.33	0.63	0.21	0.51	-0.09	0.04
MaTo	0.16	0.53	0.35	0.64	0.20	0.48	-0.14	-0.04
Rnordeste	0.04	0.07	0.42	0.55	0.31	0.41	-0.05	0.01
Pernambuco	0.05	0.07	0.38	0.49	0.28	0.35	-0.13	-0.10
Alagoas	0.06	0.05	0.08	0.10	-0.29	-0.37	-0.19	-0.23
BahSerg	0.14	0.35	0.45	0.70	0.34	0.60	-0.12	-0.02
MinasG	0.50	0.58	0.65	0.76	0.59	0.69	-0.01	-0.01
SaoPaulo	0.14	0.13	0.45	0.50	0.39	0.41	-0.10	-0.15
Rsudeste	0.16	0.16	0.48	0.54	0.40	0.45	0.10	0.13
Parana	0.31	0.32	0.54	0.60	0.51	0.56	0.05	0.02
Rsul	0.34	0.34	0.51	0.55	0.46	0.49	-0.16	-0.22
MtGrSul	1.36	1.77	0.89	1.17	0.99	1.32	1.31	1.74
MtGrosso	2.62	3.33	1.45	1.84	1.38	1.75	0.53	0.69
GoiasDF	1.15	1.38	0.97	1.20	0.94	1.15	1.64	2.05

Water use impacts

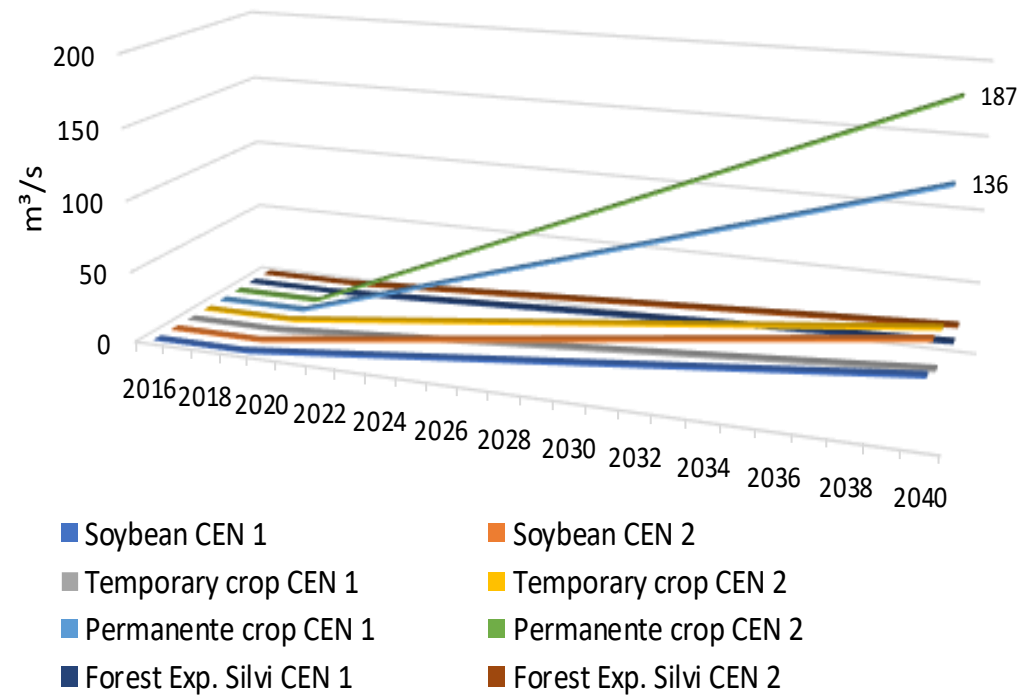
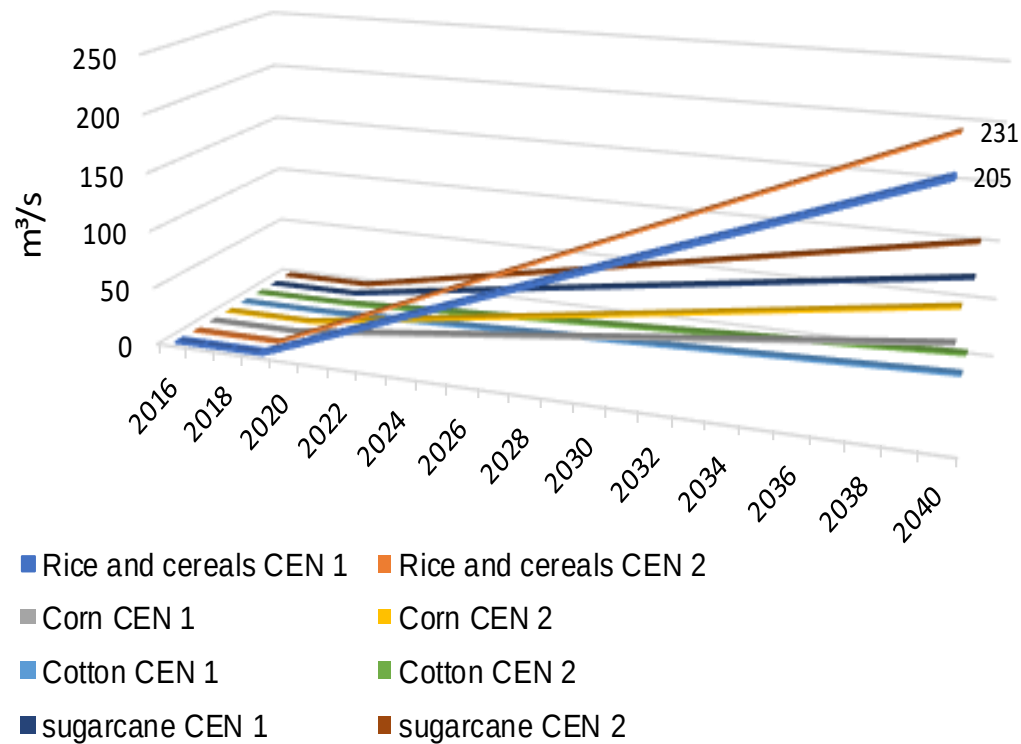


Water use impacts

- Water use would reach an additional 52% (24,310 Mm³ or 771 m³/s) in SCEN 1 and 66% in SCEN 2 (30,577 Mm³ or 970 m³/s) as a cumulative change by 2040 relative to the baseline.
- Brazil has an average water flow of 58,000 m³/s of surface water and an additional 13,000 m³/s of groundwater;
- The simulation results show an increase of 970 m³/s in SCEN 2, which would allow for the expansion of irrigated areas as simulated in Brazil.

Water use impacts

Figure 2. Crops national water use. Cumulative change in 2040 relative to the baseline in m³/s



Final remarks

- Semi-perennial crops such as soybeans, wheat, and corn (for example) normally require supplemental irrigation (Midwest region for example), especially in regions with lower environmental water availability or more adverse climates (Northeast region). Although all types of crops are expected to grow in absolute terms, their share will shift;
- Although our simulations account for areas with both surface and groundwater availability, the data used is quantitative and does not offer insights into water quality or the impacts on the hydrological cycle resulting from human activities.
- The CGE results indicate that the free movement of labor can have consequences for the wages and consumption in all most regions

Thank you
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