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DOES “COMMON BUT SHARED RESPONSIBILITY” PRINCIPLE APPLY IN BRAZILIAN MICROREGIONS? A HUMAN DEVELOPMENT INDEX AND GREENHOUSE GAS EMISSIONS ANALYSIS

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Does "Common but shared responsibility" principle apply in Brazilian microregions? A Human Development Index and Greenhouse gas emissions analysis

Abstract

We used the Microregional Human Development Index (MicroHDI) and the equivalent carbon dioxide (CO_2eq) emissions to investigate if Brazilian microregions have been developing under the "common but shared responsibility" principle. The results present discrepancy between North-Northeast and South-Southeast development over time. We find that North and Northeast microregions, the least developed, are less intensive in emissions than Southeast, and so the referred principle does not verify in Brazil. A fairness allocative mitigation proposal may be required to lead the country into a more equitative emissions distribution.

1. Introduction

The "common but shared responsibility" principle of the 1992 United Nations Framework Convention on Climate Change (UNFCCC) comprises the consciousness of the public feature of the resulting externalities of environmental degradation and that certain risks affect all nations on earth. It suggests the historical culpability of developed societies by the current environmental degradation, as well as its current capacity to deal with these problems. Using the propositions of Costa et al. (2011), we took this theoretical framework into microregional scale to verify if the pattern that Brazilian microregions develop and release greenhouse gases (GHG's) are in accordance with the related principle.

2. Methods

In Equation (1), the MicroHDI ($d_{i,t}$) for the microregion i ($i=1,\ldots,558$) in time t ($t=1990, 2000, 2010$) was assessed as the Municipal HDI (United Nations Development Programee – UNDP, 2014) weighted population average of municipality (m) belonging to the microregion (i); $MHDI_{m,t}$ is the MHDI of municipality m ($m=1,\ldots, n$) in time t; $Pop_{m,t}$ is the total population.

$$d_{i,t} = \frac{\sum_{m=1}^{n} \left[MHDI_{m,t} \left(Pop_{m,t} \right) \right]}{\sum_{m=1}^{n} Pop_{m,t}} \forall m \in i \qquad (1)$$

Equation (2), a logistic function, presents the estimated MicroHDI ($\tilde{d}_{i,t}$). The parameters were estimated by ordinary least squares for nonlinear regression and used to design the MicroHDI for the years 1991 until 2050.

$$\tilde{d}_{i,t} = \frac{1}{1 + e^{-a_i t + b_i}} \, . \qquad (2)$$

We used the carbon dioxide equivalent (CO_2eq) to associate the gases emitted into a single variable ($e_{i,t}$) through the global warming potential of 310 for N_2O and 21 for CH_4 (Brasil, 2013). Equation (3) shows estimated CO_2eq emission $\tilde{e}_{i,t}$ in tons $(km^2)^{-1}$ in the microregion i in year t ($t = 2000, ..., 2010$); $\tilde{d}_{i,t}$ is the estimated MicroHDI assessed by equation (2). From the coefficients and owning $\tilde{d}_{i,t}$ for the years between 1991 and 2050, we designed the CO_2eq emissions of each microregion i for the period t ($t=1991, ..., 2050$) and multiplied by the microregion's area to access total emissions.

$$\tilde{e}_{i,t} = e^{h_i \tilde{d}_{i,t} + g_i} \qquad (3)$$

To credit robustness to the estimations only the estimates for the microregions whose regressions in equation (3) which both coefficients were statistically significant at 10% significance and whose $R^2 > 0.9$ were selected as sample. Among the 558 Brazilian microregions, 436 were held, representing 78.28% of total and 81.36% of observed emissions in 2010. Figure 1 shows geographically the sample microregions (a), Brazilian regions (b) and states (c).

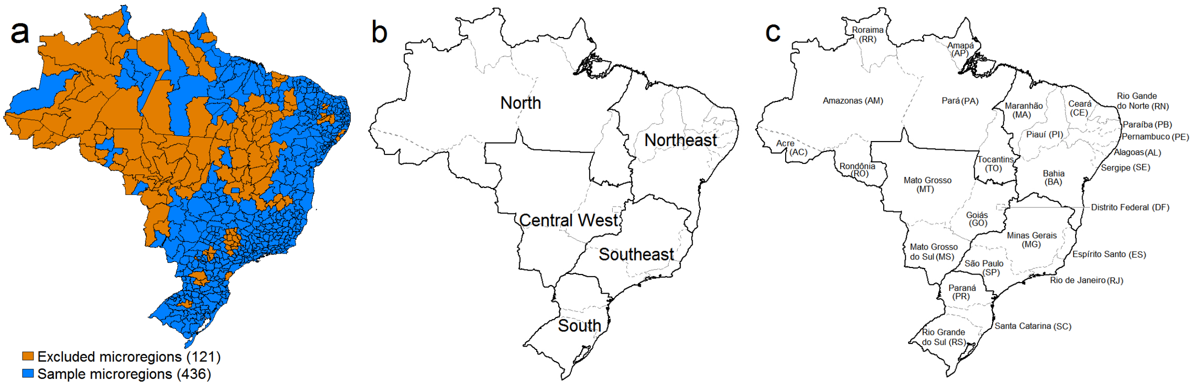

Fig. 1. (a) Sample microregions; (b) Brazilian regions; (c) Brazilian states.

3. Results

3.1 Temporal MicroHDI projection

Mean R^2 of regressions in equation (2) was 0.99. Northeast showed significant a_i and b_i at 10% level in all regressions whereas only 85% of regressions relating to the Southeast presented it. Even though there are regressions whose setting is not an ideal scenario, it was decided to keep them under analysis since the evolution of human development according to the logistic function is a fundamental assumption. The regressions average a_i is 0.059, Porto Nacional, in Tocantins state, has been presenting the faster development, while Guajará-Mirin, in Rondônia state, the slowest (Figure 2, a). Brazil will continue to develop maintaining a certain separation between the North-Northeast and the rest of the country; however, the trend of reduction in this inequality can also be observed (Figure 2; b, c).

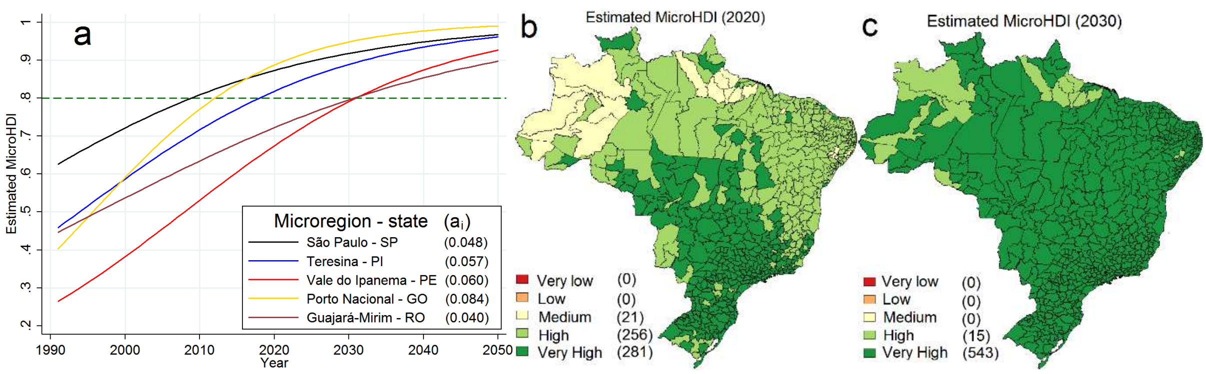

Fig. 2. (a) MicroHDI projections; (b) Estimated MicroHDI for 2020; (c) Estimated MicroHDI for 2030.

3.2 Estimated GHG emissions

The mean R^2 of the regressions in equation (3) was 0.99. The estimated Brazilian total emission in 2050 is 9.67 Gt CO2eq, representing a 59% increase over the observed value in 2010 and between 2011 and 2050 Brazil would release over 300 Gt CO2eq in the atmosphere. As may be observed in Table 1, higher h_i values were found in Central West and lower in North regions, as well as higher g_i values were observed in Southeast and lower in North and Northeast regions. It demonstrates that the Southeast has the grater positive associations between human development and emissions, insofar as a 0.1 $d_{i,t}$ increase is associated with approximately a 25.6% $\tilde{e}_{i,t}$ increase. In contrast, the North and Northeast have the lowest positive association between the variables; a 0.1 $d_{i,t}$ increase is associated with approximately a 21.5% $\tilde{e}_{i,t}$ increase.

Table 1. Mean of estimated coefficients and expected variation in emissions related to 0.1 increases in MicroHDI.

Mean	Brazil	North	Northeast	Southeast	South	Central West
h_i	5.74	4.40	5.64	5.95	5.84	6.33
g_i	2.08	1.95	1.95	2.26	2.09	2.01
$\Delta\%\tilde{e}_{i,t} = \exp^{(h_i/10)}$	23.1%	21.5%	21.5%	25.6%	23.2%	22.5%

4. Concluding remarks

Our results reveal that the theoretical concept that less developed societies may guide its development in more emissions intensive activities, if they choose to do so, have not been met Brazilian microregions. Development gains in the least developed microregions are less associated with increases in emissions than in the most developed ones. However, our methodological approach does not allow the conclusion of whether the Northeast could use more of a positive association between the variables or if the Southeast should use less of this correlation. Anyway, through the need of proactive action, it is expected that the Southeast reduce emissions, which could endorse the Northeast to develop based on more emitting activities and without letting the country's total emission falls apart its own outlined climate goals.

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