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Vulnerability to Climate Change: a Regional Perspective of Demographic and Socioeconomic Impacts

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I. Introduction

The objective of this paper is to present the state of the art in the discussion about the relationships among demographic dynamics, economic dynamics and climate change, as well as the impacts, on vulnerability profiles, of the adaptive capacity of the population, in the case of Brazil. The article seeks to answer the following questions: what is known about the effects of climate change in Brazil? What do we still need to know? How can public policies reduce vulnerability and enhance the population's capacity to adapt to these changes? A central issue in this discussion is the effort to pursue the development of integrated and interdisciplinary methodologies in building scenarios useful for informing public policy and regional planning. Based on this discussion, issues will be raised for a future research agenda on the subject, within Brazilian demographics.

II. Policies for Adapting to and Reducing Vulnerability to Climate Change: Urban, Rural or Regional?

The intense urbanisation process witnessed in Brazil in recent decades has produced various modes of territorial organisation that challenge the design of policies that, traditionally, deal with 'urban' and 'rural' areas as distinct spatial units (Barbieri et al., 2009). Policies for adapting to the impacts of climate change should consider these changes and, in particular, the increasingly strong liaison among such spaces via flows of people and economic goods. In this sense, regional policies should overcome the simple dichotomy between rural and urban areas and consider the differences and similarities between different Brazilian regions.

Several studies have discussed the difficulties inherent in accurately establishing the boundaries of 'rural' and 'urban' areas (Halfacree, 2004). The common point in this discussion is the fact that the definition of the area should take into account the specific characteristics of each location, such as infrastructure and service conditions, social and economic organisation, land organisation and political and administrative characteristics (Barbieri et al., 2009). However, the main elements in the integration of spaces and the formation of different regional spaces are flows of people, goods and services.

That is why we cannot equate—or treat similarly—the official definitions of rural and urban areas used in the Amazon and in the south-east of the country, and focus only on adaptation policies at the national level. Moreover, even within regional spaces, there are regional sub-spaces whose heterogeneity requires the design of differentiated policies. In this sense, urban or rural policies for adapting to climate change, which focus on reducing the vulnerability of the population, should be adequate to capture the ways through which rural changes affect urban dynamics, and vice versa. This requirement is particularly true considering the impact of climate change on socioeconomic and demographic dynamics, as discussed later on, in which the flows of people and economic assets are potentially altered due to exogenous shocks brought on by climate change.

Policies that seek to promote socioeconomic development and environmental sustainability, under a regional perspective and within a scenario of climate change, are incipient or have low penetration in Brazil, particularly in the Amazon (Barbieri et al, 2009). Although several policies with immediate effect, such as government programmes to transfer income (BPC and *Bolsa Família*, for example) have been designed and implemented with the objective of alleviating poverty and providing better living conditions, one must focus on long-term policies that deal with the structural conditions that perpetuate poverty, social inequality and differences between rural and urban environments, especially in a climate change scenario.

III. The Potential Socioeconomic Impacts of Climate Change: Recent Brazilian Studies

The multifaceted nature of vulnerability requires adaptation strategies that include the development of long-term policies that translate into short-term results or actions. The short-term impacts of climate variations should be thought of as separate from long-term and long-lasting effects, such as direct impacts on the economy, but society must have mechanisms in place to mitigate temperature shocks on the mortality risk of the most vulnerable groups—as seen in France in 2003.

In this sense, Hultman and Bozmoski (2006) suggest an approach to reduce vulnerability and facilitate adaptation, including three factors: a) decentralised decision-making authority, moving towards more disaggregated (local and regional) levels; b) expanded protection mechanisms against environmental degradation; and c) transfer or diversification of the risk over time, space and different institutions.

In Brazil, the potential climate scenarios in the coming decades have increased the interest of researchers from many fields on the consequences for the economy and for the welfare of the population. We highlight four recent academic studies that seek to link the climate changes projected to occur by the end of the century with the economic, demographic and health dynamics in Brazil, using a regional perspective:

Confalonieri et al. (2005) sought to establish the foundations for developing methodologies for analysing vulnerability to climate change in Brazil, at a time when climate scenarios specific to Brazil had not yet been produced.

CEDEPLAR/FIOCRUZ (2008) evaluated the social and economic impacts of climate change on populations located in the north-east region—particularly the most vulnerable populations—and the consequences for public health and internal migration in the north-east.

Economia da Mudança de Clima no Brasil
(The Economics of Climate Change in Brazil) (2010) aimed to assess the economic consequences and social and environmental implications of the climate change scenarios in the country, as forecast for this entire century.

Finally, **Confalonieri et al. (2011)** have enabled the creation of quantitative health and socio-environmental vulnerability indicators for each municipality in the state of Rio de Janeiro, in light of projected climate changes.

CEDEPLAR/FIOCRUZ (2008) and *Economia da Mudança do Clima* (2010) used scenarios from the *Instituto Nacional de Pesquisas Espaciais* (INPE – National Institute for Space Research) and the Brazilian Agriculture Company (EMBRAPA) as basic information[1] about the consequences of the scenarios A2 and B2[2] for agriculture in the north-east, especially the availability of land for the region's major crops. Based on these scenarios, a general computational equilibrium model was devised that generated economic scenarios for income, employment, output and household consumption in emerging scenarios, with and without climate impacts on agriculture. According to the proposed model, such impacts can be both direct (such as a decrease in the supply of arable land) and indirect (such as the impacts of reductions in land supply on other economic sectors).

The economic scenarios showed possible direct impacts in rural areas (e.g. a decrease in the supply of arable land) and indirect impacts in rural or urban areas, by measuring the impacts of a reduction in agricultural activities on other sectors of the economy. Climate change in the north-east would lead to an 11.4 per cent reduction in Gross Domestic Product (GDP) in relation to the expected GDP growth in the trending 2050 scenario, in the IPCC A2 scenario (Barbieri et al., 2010). The percentage loss is equivalent to about two years' worth of economic growth in the region, based on the performance witnessed between 2000 and 2005. Table 1 shows the impact of climate change effects on the growth of GDP, compared to the scenario without climate effects.

Table 1
Effect of Climate Change on State Economic Activity:
State Average Annual Percentage Change Relative to Trend, North-East Region, 2010–2050

	Scenario A 2 (average 2010–2050)			Scenario B 2 (average 2010–2050)		
Unit of the Federation	**GDP**	**Employment**	**Consumption**	**GDP**	**Employment**	**Consumption**
Maranhão	-0.2	-0.11	-0.33	-0.1	-0.05	-0.03
Piauí	-0.4	-0.17	-0.39	-0.2	-0.11	-0.06
Ceará	-0.4	-0.17	-0.43	-0.3	-0.14	-0.14
RN	-0.2	-0.07	-0.03	-0.1	-0.06	-0.03
Paraíba	-0.4	-0.25	-0.51	-0.3	-0.17	-0.2
Pernambuco	-0.5	-0.21	-0.46	-0.3	-0.17	-0.17
Alagoas	-0.2	-0.08	-0.29	-0.1	-0.04	0.02
Sergipe	-0.1	-0.01	-0.19	0	0.02	0.08
Bahia	-0.2	-0.07	-0.26	-0.1	-0.04	0.04

Source: CEDEPLAR/FIOCRUZ (2008).

The simulation exercises involving economic scenarios that consider the effects of climate change were used to build scenarios of net migration and net migration rates. Since climate shocks affect the availability of farmland and livestock husbandry areas, the agricultural sector would experience the greatest effect on production capacity over the coming decades, thus compromising income generation and employment. Work opportunities in other regions and less-affected sectors of the economy would become more attractive, leading to migration and movement of capital around the country.

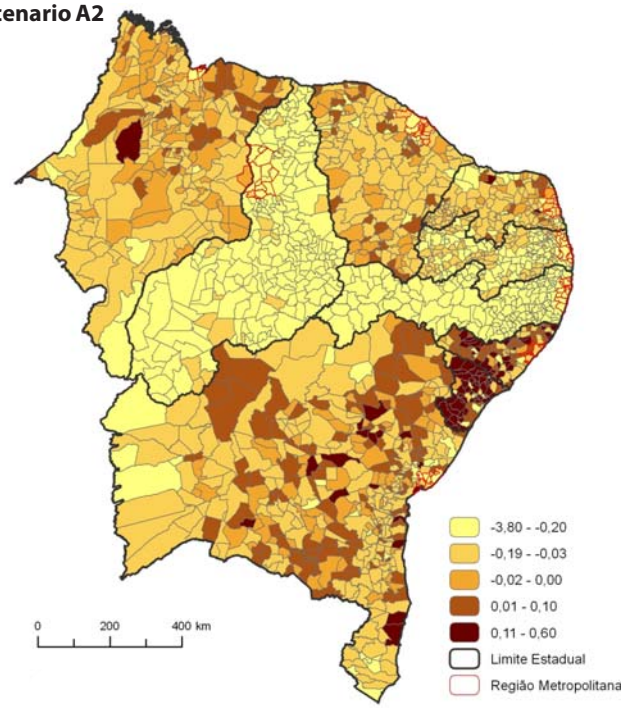
Table 2 shows the basic results of the impacts of climate change on local migration flows. Generally speaking, we can suggest that climate changes in scenario B2 would not lead to a dramatic process of population redistribution, at least not in the given time period, between 2030 and 2050.[3] In the A2 scenario, the impact would be quite significant in the process of population redistribution in the north-east, through an increase in emigration from the region. Between 2035 and 2040, the results show a net loss of 246,777 people in the north-east; between 2045 and 2050, the net loss would be 236,065 people. The migration level projected in the A2 scenario is about 18 times higher than in the B2 scenario projections for 2035–2040, and 11 times higher than in 2045–2050. Given that the impact of scenario A2 on migration is larger than the trend and B2 combined, the final impact on the reduction in the total population in the north-east would be more evident.

The impacts of the A2 climate scenarios on migration were also estimated at the municipal level, as shown in Map 1. The net positive rates are primarily concentrated, albeit at relatively low levels, in the south of the north-eastern regions, notably in Alagoas, east and west-central Bahia and certain municipalities in central and northern Maranhão, in the north and south of Ceará, in Rio Grande do Norte and in Sergipe. The north of the north-eastern region also experiences most of the negative rates, except for some municipalities in central and northern Maranhão. In the north-east, there is an intense process of population loss in Piauí (basically due to the losses in small municipalities with fewer than 25,000 inhabitants) and Pernambuco, followed by Paraíba.

The state of Piauí experiences one of the greatest impacts of climate variations. For example, in the north-east as a whole, the share of GDP attributable to agriculture is 8.4 per cent; in Piauí, this share rises to 10.3 per cent (average for 1999–2005).

As climate impacts affect predominantly agricultural activities, Piauí tends to bear a greater impact. And yet this is the most fragile agricultural economy in the north-east. If we consider climate impacts, the shock to Piauí becomes clear.

Net Migration Rates in the North-East Region, 2050, Scenario A2



Source: CEDEPLAR/FIOCRUZ (2008).

Queiroz and Barbieri (2009) showed that the north-eastern municipalities will suffer the greatest impacts of climate change and also have the worst social indicators in the region, measured by the low average education rates, concentration of families living below the poverty line, greater household dependence on government transfers, and low access to basic infrastructure (water and sewage).

Individuals and institutions have low capacity to prepare for and respond to the potential effects of climate change. These groups also exhibit a greater tendency to remain in their places of origin, due to their inability to recuperate the costs associated with migration, and may become the group most vulnerable to climate change.

In addition to the impacts on the economy and migration flows, the studies also discuss possible population health

Table 2
Net Migration, Net Migration Rates and Total Population by Scenario (Trend, A2 and B2) for the North-East Region, 2025–2030, 2035–2040 and 2045–2050

Scenario	Net Migration			Net Migration Rate (%)			Total Projected Population (millions)		
	2025–2030	2035–2040	2045–2050	2025–2030	2035–2040	2045–2050	2025–2030	2035–2040	2045–2050
Trend	-192,513	-203,925	-208,781	-0.29	-0.29	-0.29	65.340	68.559	70.350
A2	17,752	-246,777	-236,065	0.03	-0.36	-0.34	65.358	68.312	70.114
B2	-6026	-13,565	-20,603	-0.01	-0.02	-0.03	65.334	68.546	70.330

Source: CEDEPLAR/FIOCRUZ (2008).

problems in the north-east, and how changes in the age structure of the population may be important in defining the future conditions of socioeconomic and health vulnerabilities. For example, an ageing population may have lower adaptive capacity and less resilience to the impacts of climate variations. Moreover, the age structure of the population can have direct and indirect effects on the emission of pollutants, further aggravating the climate change scenario. In relation to health impacts, it was observed that the future increase in aridity and water and food scarcity may worsen the health situation and lead to migration, which is capable of not only spatially redistributing diseases but also of increasing the pressure on health services.

In terms of commonalities, the studies discussed above have mainly raised the question of whether possible reversals in regional socioeconomic dynamics, as functions of climate change, would imply a reversal in the trend of economic growth in regions most vulnerable from a socioeconomic standpoint, such as the north-east, leading to historical migration mechanisms in this region, associated with economic factors of attraction and expulsion, as well as environmental emigration factors. Strictly speaking, it can be concluded that climate changes, when affecting the economy, would motivate human migration in certain circumstances, particularly when other adaptation mechanisms fail. The repercussions on socioeconomic and health vulnerability, as well as adaptation capacity, are, accordingly, the result of the relationships between climate, economic and demographic dynamics, conditioned by political, institutional and cultural factors.

Flaws in the implementation of adaptation mechanisms pose risks to the welfare of populations and can contribute to increase the level of population vulnerability, particularly when associated with the migrant populations of lower socioeconomic status. Among the most vulnerable populations in the north-east are migrants from rural to urban areas, both to major north-eastern urban centres and to other areas of the country. Such migratory flows are driven by better economic conditions outside the region and by periods of severe drought in the north-east.

But even assuming the importance of distinguishing migration status as an important category for qualifying population vulnerability, and as an important mechanism for adapting to climate change, this relationship has not been discussed in sufficient depth in Brazilian literature. In particular, this discussion has focused on non-urbanised areas, with a more detailed regional focus. Population mobility, as an effective mechanism for adaptation to climate change, depends on the ability of vulnerable population groups to move across space, in search of better income and welfare opportunities, or on having mechanisms that facilitate adaptation to climate change in their places of residence. Particularly in the north-east of Brazil, rural–urban mobility has been widely used as a mechanism for reducing population vulnerability, reproducing a pattern seen in other parts of the world. Migration to medium and large cities, where higher income and resources are available, and which can generate economies of scale and agglomeration, can reduce vulnerability, assuming a minimum level of efficiency in accessing these resources and income.

IV. Prospects for Future Studies: a Research Agenda

Despite the discussion about the relationship between population mobility and socioeconomic vulnerability, it is hoped that migration as a function of climate change is partly concentrated on socially and economically vulnerable population groups (Barbieri et al., 2010)—for example, smallholder farmers who have no means of production or adaptation mechanisms in their production systems, or those who have sufficient means to relocate labour or capital in space, from a location with a greater risk to one with a lower risk to individuals and their families.

That said, adaptation policies in rural areas—and their links with urban areas—must inevitably go through an identification of the heterogeneity of degrees of vulnerability relevant to different population groups. In this sense, mobility can be both an attenuating mechanism for situations of vulnerability (in the case of a flight response in dangerous situations) and a generator of mobility, when it is restricted to population groups with more physical, financial and social capital, and immobility is a characteristic of the most vulnerable groups.

This discussion shows the need to identify and understand the potential migration pattern and the redistribution of populations sensitive to climate variations as inherent to the vulnerability profiles and the adaptive capacity of different sub-populations. The creation of economic opportunities and social inclusion, mediated by institutional factors such as income transfer policies, social security and qualification of human capital, may, even in the presence of exogenous shocks such as climate changes, minimise mobility as a voluntary adaptation mechanism available to populations.

In a global context, future scenarios that point to a worsening of the inequality between countries with disparate adaptive capacities may lead, in some regions, to major humanitarian crises and prompt international migration. In principle, such a scenario seems unlikely in Brazil, given the prospects for growth and socioeconomic development in the coming decades and the potential for adaptive capacity. However, a possible mismatch between these perspectives and the speed of environmental change can lead to a not-so-unimaginable scenario of 'forced migration', if we are not effective in reducing the profound regional inequalities and deep income gaps that exist in the country. ■

1. The scenarios were prepared by Pinto and Assad (2008).

2. Scenario A2 is marked by high energy consumption with changes in land use. Natural resources become more scarce. The result is a stronger impact on climate. Scenario B2 is characterised by lower energy use and smaller changes in land use. Resources are more abundant, and technological change is more diverse, resulting in a lower impact on climate.

3. The 'net migration' is the difference between people who have entered (immigrants) and those who have left (emmigrants) a given location, at any given time. The 'net migration rate' is the ratio between net migration and the population observed in a given location, over a given time period.

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References:

Barbieri, A., Domingues, E., Queiroz, B., Ruiz, R., Rigotti, J., Carvalho, J. and Resende, M. (2010). 'Climate change and population migration in Brazil's North-East: scenarios for 2025–2050', *Population and Environment*, Vol. 31: 344–370.

Barbieri, A. F., Montemór, R. L. M. and Bilsborrow, R. E. (2009). 'Towns in the jungle: exploring linkages between rural–urban mobility, urbanization and development in the Amazon' in A. de Sherbiniin, A. Rahman, A. Barbieri, J. C. Fotso and Y. Zhu (eds) (forthcoming), *Urban Population and Environment Dynamics in the Developing World: Case Studies and Lessons Learned*. Paris, CICRED.

CEDEPLAR/FIOCRUZ (2008). *Mudanças Climáticas, Migrações e Sáude: Cenários Para o Nordeste Brasileiro, 2000–2050. Relatório de Pesquisa*. Belo Horizonte, CEDEPLAR/FIOCRUZ.

Confalonieri, U. E. C. et al. (2005). *Análise da vulnerabilidade da população brasileira aos impactos sanitários das mudanças climáticas. Resultados obtidos*. Brasilia, PPA/Programa de Mudanças Climáticas, Ministry of Science and Technology, <http://www.mct.gov.br/index.php/content/view/50785.html> (accessed 1 May 2012).

Confalonieri, U. E. C. et al. (2011). 'Avaliação da Vulnerabilidade Municipal no Estado do Rio de Janeiro às Mudanças Climáticas', *Relatório de pesquisa 4*. Rio de Janeiro, FIOCRUZ.Halfacree, K. (2004). 'Rethinking "Rurality"', in T. Champion and G. Hugo (eds), *New Forms of Urbanization: Beyond the Urban–Rural Dichotomy*. Aldershot, Ashgate: 285–304.

Hultman, N. E. and Bozmoski, A. S. (2006). 'The Changing Face of Normal Disaster: risk, resilience, and natural security in a changing climate', *Journal of International Affairs*, 59(2): 25–41.

Margulis, S. and Dubeux C. B. S. (eds) (2010). *Economia da Mudança do Clima no Brasil: Custos e Oportunidades*. São Paulo, IBEP Gráfica.

Pinto, H. S. and Assad, E. (2008). 'Aquecimento Global e Cenários Futuros da Agricultura Brasileira', *Research Report Project FCO-GOF: PGL GCC 0214*. Campinas, Agritempo.

Queiroz, B. and Barbieri, A. (2009). 'Os potenciais efeitos das mudanças climáticas sobre as condições de vida e a dinâmica populacional no Nordeste Brasileiro', in D. J. Hogan and E. Marandola Jr. (eds), *População e mudança climática: Dimensões humanas das mudanças ambientais globais*. Campinas/Brasília, NEPO/UNICAMP–UNFPA.

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