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*Policy Integration for Boundary-Spanning Policy Problems: Climate
Change Mitigation and Adaptation Policy*

**Adaptation to climate change and policy interactions in Brazil's
semiarid region**

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Abstract: This paper analyzes the emergence of Brazil's climate adaptation agenda and discusses its divergences regarding the climate mitigation program and the missed goal of the National Adaptation Plan to promote the integration of sectoral agendas. Additionally, drawing on on-the-ground surveys and analyses of institutional documents, this paper examines the combinations of policy instruments that have helped rural populations in the semiarid region of Pernambuco adapt to climate events. It draws on a sociopolitical approach to policy integration, especially the analysis of policy processes affecting decisions and patterns of coordination.

Keywords: *adaptation to climate change; policy integration; policy mix; Brazil; semiarid region*

Introduction

Climate projections predict important variations in temperature and precipitation for the Brazilian biomes, especially in the semiarid zones of the Northeast (Magrin et al., 2014). Although drought events are recurrent in the region, an increase in precipitation variability and a decrease in groundwater recharge are expected (IPCC, 2014; MMA, MI, & WWF, 2017). Meanwhile, the continued degradation of natural vegetation has led to losses in the quality of local ecosystems and soil, which, along with the effects of climate change, has been accelerating desertification and salinization processes (MMA et al., 2017). These dynamics will likely produce a series of socioeconomic impacts. A recent drought episode (2012–2016) generated socioenvironmental and economic costs, such as reduced agricultural and livestock production, as well as reduced water levels in reservoirs for human supply, animal feed, and power generation (De Nys & Engle, 2014). Increasingly extreme weather events can compromise the resources and responsiveness of societies.

This scenario highlights the need to implement adaptation policies that consider increases in climate variability and promote the capacity to minimize, prepare for, and recover from its



potential effects. Brazil has developed climate policies since the 1990s; however, the adaptation agenda has only recently entered the policy debate. Likewise, several adaptation policies have been recycled from other sectors without actually considering climate projections. Moreover, given the cross-sectoral nature of climate challenges, more integrated approaches to policy are often considered key to reducing social vulnerability and promoting adaptive capacity (Adelle & Russel, 2013).

Different systems have different sensitivities to disturbances and have unequal potentials to adapt to change and guarantee access to resources (Turner et al., 2003). In this context, regionalized analyses of the formulation and implementation of climate policies are needed, including the different combinations of instruments implemented in each territory. Shedding light on the implementation of regionalized policy mixes to climate adaptation as well as on their effective incorporation of climate risks can provide analytical elements for improving subnational planning.

This paper analyzes the emergence of Brazil's climate adaptation agenda and discusses its divergences regarding the climate mitigation program and the missed goal of the National Adaptation Plan to promote the integration of sectoral agendas. Additionally, drawing on on-the-ground surveys and analyses of institutional documents, this paper examines the combinations of policy instruments that have helped rural populations in the semiarid region of Pernambuco adapt to climate events. It draws on a sociopolitical approach to policy integration, especially the analysis of policy processes affecting decisions and patterns of coordination. It also aligns with Dupuis and Biesbroek (2013) regarding indistinctness in defining and operationalizing adaptation policies. In this regard, the article begins by critically discussing the scope of policy instruments considered in the National Adaptation Plan, and it subsequently analyzes the implementation of these instruments and programs at the territorial level.

Emergence and consolidation of the adaptation agenda at the national level

Agenda setting: From mitigation to adaptation

The establishment of climate policies in Brazil has been historically aligned with the evolution of this agenda in the international arena. The country's diplomacy has played a proactive and influential role in the international climate regime. Brazil hosted the 1992 Rio Conference, which led to the United Nations Framework Convention on Climate Change (UNFCCC); Brazil was also the first country to ratify the convention (Friberg, 2009). The country's foreign policy advocated for what became the prevailing understanding of the Kyoto Protocol, highlighting the responsibility of industrialized nations (Annex 1) to take the lead in reducing greenhouse gas (GHG) emissions, given their greater contribution to global warming since the industrial revolution (Vieira, 2013). Moreover, the Brazilian government often reiterates its role as a major initiator of the clean development mechanism (CIM, 2008; Friberg, 2009).

Nevertheless, subsequent administrations in the 1990s and early 2000s steadily resisted efforts to include in the clean development mechanism carbon credits for "avoided deforestation," which would benefit the forest-rich countries in Annex 1 (Vieira, 2013). This position was consistent with Brazil's example of a fast-growing developing economy that mostly relied on renewable energy sources (hydropower and biomass), although it was marked by increasing rates of deforestation. Brazil's Ministry of External Relations (called Itamaraty), which historically led international environmental negotiations, was not receptive to the idea of establishing clear targets for reducing GHG emissions to tackle deforestation (Vieira, 2013). The Inter-ministerial Commission on Climate Change was created in 1999; it was chaired by the Ministry of Science and Technology and worked closely with Itamaraty. However, the Ministry of Environment was conspicuously absent from the decision-making processes (Friberg, 2009).

This situation only changed in the late 2000s when, in 2007, Brazil began to reformulate its response to climate change. The government announced in 2008 its National Plan on Climate

Change, outlining a voluntary deforestation reduction target (CIM, 2008). In 2009, the National Policy on Climate Change (PNMC) was launched and voted into law (Law 12.187/2009), pledging to voluntarily reduce GHG emissions¹. This commitment became nationally compulsory and mostly relied on emission reductions in the Amazon (Gallo & Albrecht, 2018). In 2009, the National Forum on Climate Change (FBMC) and the Brazilian Panel on Climate Change (PBMC) were created. These were accompanied by sector-based plans for mitigation through deforestation control. In parallel, developing countries' delegations to the COP-15 (2009) and COP-16 (2010) have advocated for establishing a credit market mechanism aimed at reducing emissions from forest loss and degradation (REDD+).

Despite Brazil's more accommodating position on deforestation control since 2006, following the country's steady reduction in deforestation rates, it was only at the Copenhagen meeting of 2009 that Lula da Silva's administration finally distanced itself from Itamaraty's entrenched position. According to Vieira (2013), this position was slowly and only incrementally revised due to powerful resistance from domestic stakeholders, such as private and public actors in agribusiness, as well as high-ranking civil servants, especially in the foreign policy establishment. In addition, growing transnational pressures from state and nonstate actors, combined with increasing domestic activism by NGOs and environmental public bodies, also contributed to the achievement of compromises by the Lula administration.

Therefore, the intertwining of international debates and domestic politics has influenced Brazil's position in the international arena and its national strategies. This explains why mitigation has dominated the climate policy scene in Brazil since the beginning and why it targeted deforestation control in the Amazon region at a later stage.

As in the international arena, climate adaptation concerns have only recently been included in Brazil's climate policy agenda. Such agenda setting followed the adoption of the 2010 Cancun Framework for Adaptation at COP16, which recommended the establishment of national adaptation plans. Brazil's National Plan for Adaptation to Climate Change (NAP) was launched in 2016 with the objective of promoting the management and reduction of climate risk. As will be discussed below, while this effort mostly represented a national-level

¹ By 36.1% to 38.9% in relation to 2020 projections.

response to international debates, it has been gradually integrated into the narratives and projects of local actors in the semiarid Northeast, especially those who had engaged in the debates surrounding the Convention on Desertification since the 1990s.

Formulation of the National Adaptation Plan

The formulation of Brazil's NAP encouraged a cross-sectoral approach and involved various actors. In 2013, a working group jointly coordinated by the Ministry of the Environment and the Ministry of Science, Technology, and Innovation was established, composed mainly of technicians and members of the ministries. In addition to public institutions, representatives of organized civil society and the private sector participated in the meetings. The scientific community contributed to the process through the FBMC, the Climate Research Network, and the National Center for the Monitoring and Alerting of Natural Disasters (Cemaden) (Rodrigues Filho, Lindoso, Bursztyn, & Nascimento, 2016).

The final NAP document asserted the objective of ensuring the implementation, in a coordinated manner, of risk-management strategies, primarily in the areas of food, water, and energy security (MMA, 2016b). Eleven sector-based and thematic strategies defined national priorities in relation to the country's vulnerabilities: Agriculture, Biodiversity and Ecosystems, Cities, Natural Disasters, Industry and Mining, Infrastructure (Energy, Transport, and Urban Mobility), Vulnerable Populations, Water Resources, Health, Food and Nutrition Security, and Coastal Areas.

However, an analysis of the reports of the working group meetings shows that, although the plan was built on the basis of a two-year participatory and cross-sectoral process, the final document favors sectoral agendas to the detriment of integration mechanisms. It is a stacking strategy that juxtaposes sectoral and thematic agendas in a single framework, with low practical emphasis on mechanisms to promote interaction among institutions, actions, and goals.

The ambition to articulate sectoral agendas was clear in the initial debates. The specific agreed-upon objectives of the plan included i) producing and disseminating knowledge, ii) coordinating institutions, and iii) identifying and providing measures to promote climate

adaptation. Faced with redundancy in its initial objects and those of the previously created Cemaden (identifying information gaps and disseminating knowledge regarding climate disaster prevention), the goal of the NAP was updated to include strengthening institutional coordination and attracting international funds (GT Adaptação, 2013a). This is illustrated by a statement by one of the facilitators of the working group:

The role of the Plan and our objective here is to identify the actors, processes, and institutions and to centralize the various institutions in a single action, so that we can join forces, not multiply actions. [We] seek to clearly define the responsibilities of each one and the limits of their actions (GT Adaptação, 2013a, pp. 14–15).

While announcing a cross-sectoral objective, the NAP adopted a strategy oriented toward mainstreaming climate adaptation into other sectoral agendas, guiding, for example, the incorporation of resilience criteria into other government policies and plans: “*Our job then becomes that of contaminating other agendas*” (GT Adaptação, 2013b, p. 4). In this context, sectoral particularities were preserved in the formulation of the Plan, which prioritized the definition of soft guidelines and the dissemination of adaptation measures (GT Adaptação, 2013b). This is reflected in the text of the final document:

[The NAP] seeks to influence public policy instruments and/or government programs with the objective of mainstreaming the guidelines and instruments of the National Policy on Climate Change and this Plan in order to increase coherence between public policies (MMA, 2016a, p. 18).

The idea of promoting a more integrated policy strategy, based on a territorial development approach, was discussed during the first year of debates. Nevertheless, the working group was unanimous in the understanding that each sector had its particularities, and, therefore, each sector would define its territorial perspective. Therefore, the document was written based on the argument that each sector had its “*own understanding of vulnerability and appropriate adaptation,*” and each chapter/sectoral strategy should “*seek to define their own vulnerability in terms of exposure, sensitivity, and adaptive capacity and to present their particular territorial and social dimensions of vulnerability and adaptation*” (GT Adaptação/MMA, 2014, pp. 3–4).

The result of these soft, mainstreaming-oriented and sectoral approaches was a plan with low integrative potential and a text whose chapters were written by different actors and based on distinct perspectives and concepts of adaptation. For instance, the notion of *climate-smart agriculture* is found in the chapter on Agriculture, according to which, to promote food security, climate change adaptation and mitigation, and the country's trade goals, it is necessary to significantly increase the per area productivity of food and pasture cultivation systems (MMA, 2016b). Meanwhile, the chapter on Food and Nutritional Security highlights the role of agroecology as opposed to the concept of climate-smart agriculture:

Agroecology is an alternative model as opposed to new models that have emerged as solutions to address the negative effects of climate change, under the label of “smart agriculture” [...] which are often highly dependent on agricultural inputs, machinery, and equipment (MMA, 2016b, p. 228).

This position forms a dialogue with a debate in the literature (Bennett et al., 2014; Loos et al., 2014) that problematizes the often narrow definition of climate intelligence, focusing on productivity and local or short-term efficiency and not the resilience of socioecological systems, which is promoted by the agroecology movement. The presence of both concepts in different chapters of the NAP suggests a lack of programmatic coherence.

Missed opportunity for policy integration

Along with the launch of the NAP in 2016, a technical group of a permanent and consultative nature was established to promote coordination between institutions and monitor the implementation of the plan (Ministerial Decree n°150/ 2016). However, the group has met only once since the plan was launched. Another group in charge of developing a monitoring system was created in 2017. It reported that only a limited number of initiatives was initiated in the first two years of the NAP's implementation (MMA, 2017).

Most of these ongoing initiatives correspond to the development of research. This is consistent with the agreement among the members of the group regarding the lack of knowledge about climate adaptation in Brazil and the need for vulnerability studies in various sectors (GeX-CIM, 2013). Regarding concrete measures to promote climate adaptation, they

mainly consisted of existing programs that substantially contributed to the agenda. Figure 1 summarizes the main instruments aimed at the rural sector.

Figure 1: The rural policy programs related to the National Adaptation Plan, and their main objectives



Source: Authors (based on NAP)

According to Dupuis and Biesbroek (2013), the scope of the measures and instruments that should be regarded as climate adaptation is difficult to trace. Adaptation policies are often multisectoral and multitarget, and are integrated into already-established policy sectors (mainstreaming). In this fuzzy context, Dupuis and Biesbroek proposed crossing parameters—such as the substance (purpose) and intention (issue solving) aspects of policy instruments—to define the scope of climate adaptation policy. This reasoning assumes that a highly intentional policy would have projected or perceived climate change impacts as a

starting point for policy development and decision-making. Moreover, these policies should contribute to reducing climate change vulnerability—that is, they should be substantial.

In the Brazilian case, the NAP was built on the assumption that several existing policies would substantially contribute to promoting climate adaptation, although they had not been purposefully designed from this perspective. In some cases, climate risks were not effectively incorporated, as will be discussed below. Furthermore, the NAP coordination capacity was undermined by several political factors. These are mostly related to i) the path dependence in Brazilian politics regarding existing climate institutions, ii) the rigid formulation of multiannual budgets, and iii) the traditional role of federal institutions in designing policies expected to have local impacts.

First, even though the elaboration of the NAP showed an ambition to establish an integrated strategy and a platform for coordination, the result was a plan structured by stacking existing policies and instruments from sectoral agendas. Some transversal themes were considered, such as “vulnerable populations”; however, the text evolved toward a sectoral structure based on the argument that since the National Climate Change Policy referred to sectors, the NAP should adopt the same rationale (GeX-CIM, 2013; GT Adaptação/MMA, 2015a). Moreover, the reports indicated that there was an initial attempt to include a transversal chapter to discuss the synergies between guidelines, but the debate evolved into the question of how cross-cutting initiatives would support sectoral strategies (GT Adaptação/MMA, 2015c).

Second, including the plan guidelines in the public budget remained a sectoral decision that faced current multiannual budget allocation rules, as confirmed by the excerpts below:

The multiannual budget plan controls partial deliveries [of the NAP], but it respects the main goals and actions of each sector, with their long-term plans, as observed in the sectoral plans. Each sector will have its own planning horizon, specific to each area and theme. The NAP will be this “patchwork”, respecting the particularities of each theme/sector (GT Adaptação, 2013b, p. 5).

The Ministry of Environment highlighted the difficulty of inserting synergic actions in the multiannual budget and how to reflect the NAP in the budget. [...] In addition, the Ministry of Planning pointed out that the budget reflects a short- and medium-term timeframe while the NAP addresses long-term actions. [...] Finally, the National Water Agency pointed out that,

based on the principle of mainstreaming, most of the actions should appear in each sectoral budget (GT Adaptação/MMA, 2015a, p. 5).

Each sector should assess the relevance and timeliness of including climate change adaptation initiatives in its proposals for the multiannual budget plan 2016-2019 (GT Adaptação/MMA, 2015b, p. 4).

Third, this paper argues that since synergies and oppositions between policies materialize in the territories, there is a need for regionalized approaches. Coordination mechanisms cannot be understood in isolated terms; they depend on patterns of local appropriation, political force interactions, resource allocation, and modes of financing/disbursement. The NAP was designed mostly by ministry representatives at the national level. There was an intention to promote local consultation meetings during the elaboration process, but such meetings did not take place because of budget cuts (GT Adaptação/MMA, 2015b, p. 4).

Note that the political and economic crisis that hit Brazil in the mid-2010s and led to the impeachment of President Dilma Rousseff in 2016 weakened all environmental institutions since the governing coalition that assumed office was critical of those policies. For instance, in exchange for political support, the Brazilian government under Temer's right-wing administration (2016–2018) signed provisional acts and decrees that lowered environmental licensing requirements, suspended the ratification of indigenous lands, reduced the size of some protected areas, and facilitated land grabbers (Rochedo et al., 2018). Despite the crisis, the rationale of the NAP followed a pattern of elaboration led by the bureaucracy of each sectoral ministry.

The next section draws on the interactions among policy instruments considered in the NAP for the rural sector when they materialized at the regional level.

Unpacking the adaptation policy mix for the semiarid region

Territorializing the mix

The previous section showed that the NAP was elaborated based on the objective of mainstreaming adaptation into sectoral policies. It brought together a set of instruments not designed for adaptation but still expected to make a substantive contribution to vulnerability

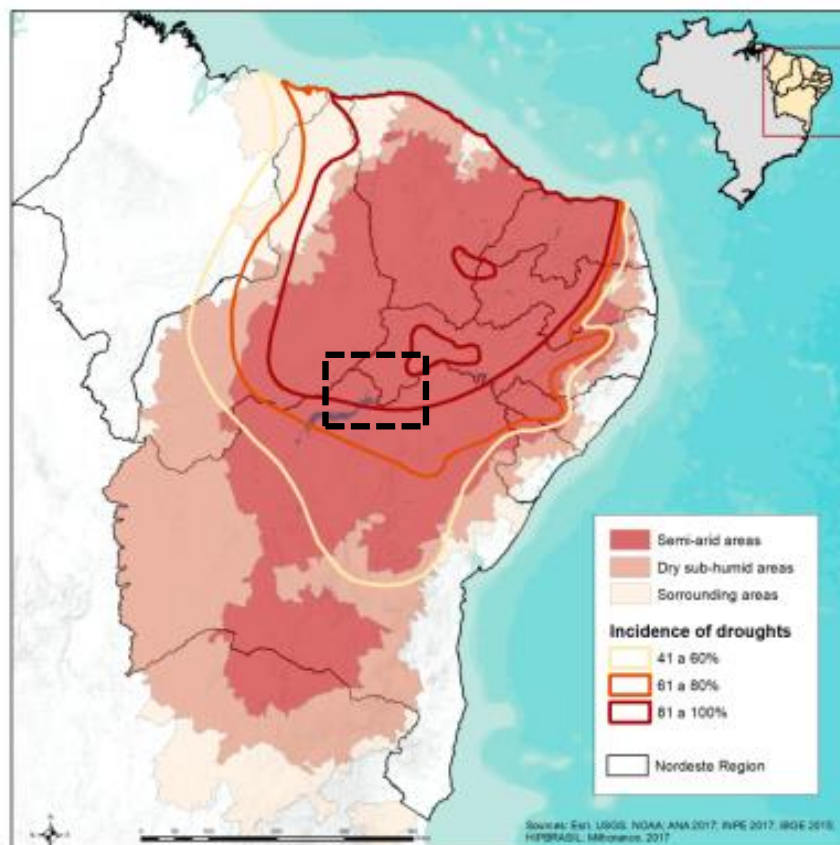
reduction—“contributive” policies, as Dupuis and Biesbroek (2013) call them. In this context, Brazilian policy practice followed Henstra’s (2016) analytical framework by identifying policy instruments that served the objectives of adaptation policy, regardless of whether they were deployed as discrete initiatives or integrated into other policies that contributed to adaptation as a secondary outcome. It may be argued that they showed some degree of intentionality as they were recycled and presented as a means of promoting climate adaptation.

Although this may not resolve the conceptual fuzziness of adaptation, it reflects the practices of a policy field that is still consolidating and relies strongly on incremental change. What makes the analysis more complicated is that several policies contribute to climate adaptation only when other conditional, complementary, and consistent instruments are effectively connected to them, thus creating a policy mix. As defined by Flanagan (2011), a policy mix is the result of combining not only policy instruments but also the processes from which the instruments emerge and interact. The fragilities of individual instruments are expected to be compensated for by combining complementary ones (Ring & Barton, 2015).

Policy mixes assume different forms and directions depending on the territory in which they are implemented and the politics involved in each process. This section draws on the case of Brazil’s semiarid region (Figure 2) to analyze the implementation of “contributive” policy mixes for climate adaptation and to shed light on the (missing) connections between policy instruments. Furthermore, it examines each policy mix according to its effective incorporation of climate risks.

This study focused on the microregion of Petrolina, located in the submedium region of the São Francisco basin. The region faces climatic challenges, as previously mentioned. Moreover, about 70% of the territory is composed of crystalline basement, which increases the salinization of water obtained through wells and reduces the quality of soil irrigated with this resource. Finally, the presence of less suitable soil patches, such as *neossolos*, reduces agricultural potential (Castro, 2018; CBHSF, 2015; MMA et al., 2017). In addition to agriculture, the continuous reduction of precipitation affects the generation of hydroelectric power, and the trend has been the imposition of operational restrictions (Milhorange, Mendes, et al., 2019).

Figure 2: Location of the study area in the Northeast semiarid region



Source: Authors (based on ANA 2017, IBGE 2015, INPE 2017)

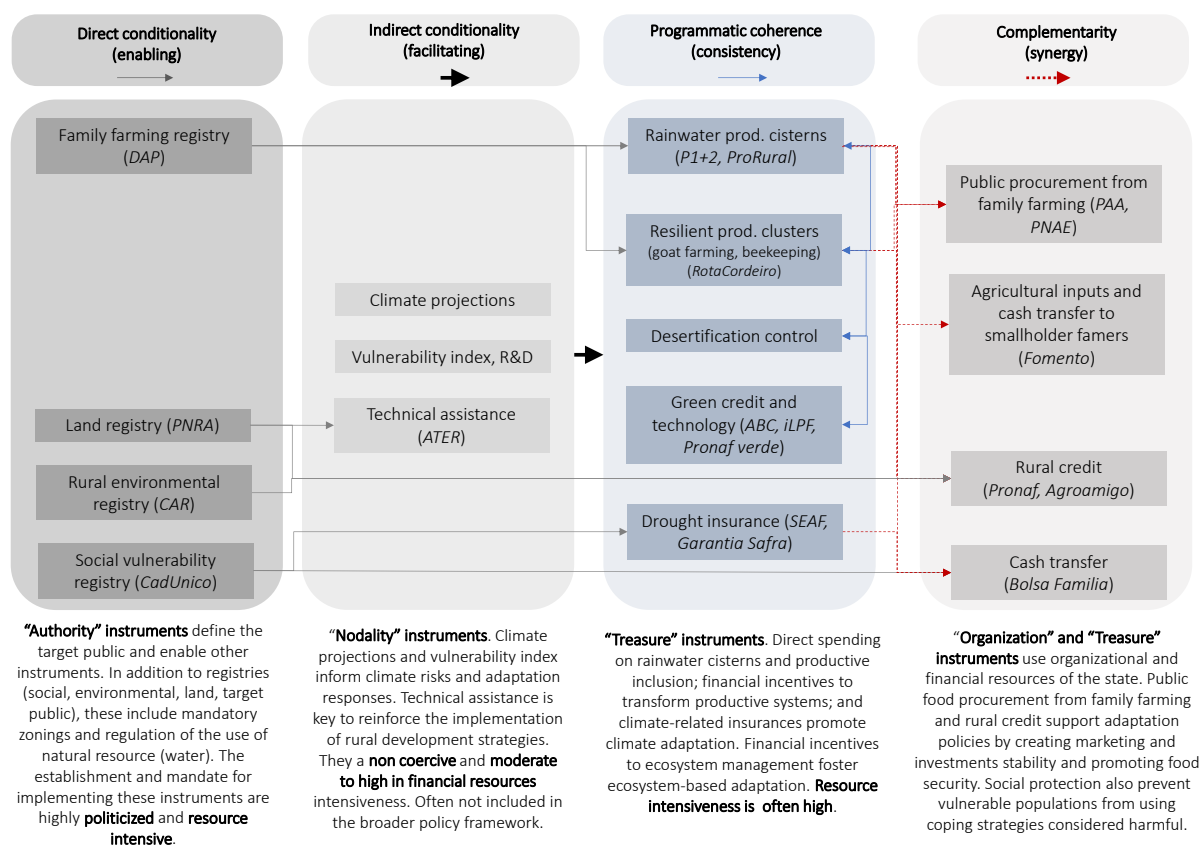
Mapping adaptation programs and instruments

A policy mapping of the main instruments contributing to climate adaptation in the semiarid region (and mentioned in the NAP) was carried out. The incidence of public investment in the municipalities of the state of Pernambuco was assessed, and an initial analysis was performed of the policy interactions related to the adaptation of rainfed farming and rural populations. A preliminary list of programs was defined and discussed during the fieldwork. Forty interviews were conducted between September and December 2018 with public, private, and civil society organizations involved in the implementation of these programs at the local, regional, and federal levels.

The typology of interactions was defined based on a literature review and on empirical research in Brazil (Milhorance, Sabourin, & Bursztyn, 2019), as shown in Figure 3. The

figure also connects the policy interactions categories to the Hood and Margetts' (2007) instrument typology (i.e., “nodality,” “authority,” “treasure,” and “organization”), adapted to climate policy by Henstra (2016).

Figure 1: Typology of policy interactions (conditionality, coherence, complementarity), including examples from the Pernambuco semiarid region and the types of instruments typically present in each category of interaction



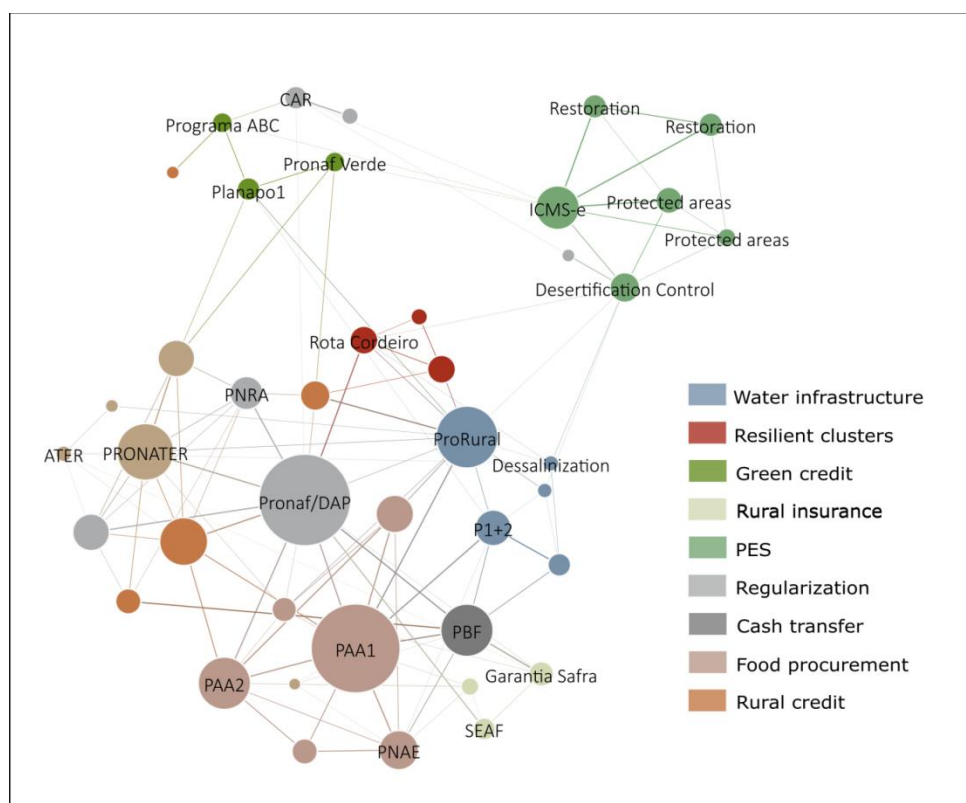
Source: Authors, based on (Henstra, 2016; Hood & Margetts, 2007; Milhorange, Sabourin, et al., 2019)

Although this method provides a static picture of the policy landscape, we share the assumption that policy integration is a political process that occurs over time (Candel & Biesbroek, 2016; Flanagan et al., 2011). A more precise picture of the mix is shown in Figure 4. In addition to the type of positive interaction (consistency, complementarity, conditionality) and its intensity, the volumes of financial resources spent were used as a proxy to define the

weights of interactions.² Therefore, the weights of the interactions among programs took into account the type of interaction and the approximate volume of resources relative to the rest of the resources invested in other programs in the same group of instruments.

This is expected to renew the representation of policy interactions in a given territory and to highlight the centrality or intermediateness of the instruments in the interaction system. It is interesting to note that complementary and conditional instruments (food procurement, technical assistance, regularization) are key in connecting other climate instruments and are central to structuring the mix. The distinct types of instruments will be detailed below.

Figure 2: Policy mix representation using network analysis and financial data, by type of instrument



Source: Authors, based on data from *Portal da Transparência*

² The weight of each interaction type was scored as follows: consistency=1, complementarity=2, indirect conditionality=1, direct conditionality=2. This was multiplied by the index of financial resources (1 to 4), based on funds disbursed in each program between 2013 and 2017 were considered. The programs/projects were separated into groups according to the type of instrument to avoid asymmetric comparisons in terms of the resources invested (e.g., between the construction of energy infrastructure and the transfer of income to families). In each group of instruments, the programs were divided into four classes according to their position in the distribution of the volume of resources in that series (descriptive data statistics).

Core adaptation instruments

Core adaptation policy instruments are directly related to adaptation objectives. They most often include the treasure instruments of direct spending, financial incentives, and insurances.

The first group of instruments that are contributive to climate adaptation in the Pernambuco semi-arid region comprises financial incentives through conditional credit to transform productive systems. The Low Carbon Agriculture Plan (*Plano ABC*) is the main federal government strategy for promoting climate mitigation and adaptation in the agricultural sector. Its objectives include expanding areas with integrated systems (e.g., integrated crop-livestock-forest systems, pasture recovery, agroforestry systems, no-till). In addition to technology transfer, the plan provides a line of credit that aims to support rural producers in the incorporation of low-carbon technologies in production systems. In Pernambuco, the degradation of pastures has been the main motivation for producers to invest in integrated systems and also the main credit modality accessed under the ABC Program (see Table 1).

Table 1: Credit operations for low carbon-agriculture in Pernambuco (R\$)

Agricultural Year	ABC Program (Environment line)	ABC Program (Pasture recovery)	PRONAF Eco	Total: Submedium São Francisco	Total: Pernambuco
2012/2013	-	-	1,270,807	1,270,807	4,568,227
2013/2014	-	249,900	74,970	324,870	1,695,591
2014/2015	-	1,160,001	-	1,160,001	4,410,850
2015/2016	-	505,000	-	505,000	2,025,524
2016/2017	-	-	-	-	30,594
2017/2018	239,917	100,815	-	340,732	1,743,074
Total	239,917	2,015,716	1,345,777	3,601,410	14,473,860

Source: Directorate of Agribusiness/SIAGRO/Bank of Brazil

Nonetheless, access to *green* credit lines remains low owing to political and institutional constraints that will be discussed later. Moreover, the ABC program is more suitable for medium- to large-sized farms than for small farms, which mainly access a specific credit line for family farmers (the National Program for Family Agriculture Support - Pronaf). The Pronaf “Eco” line promotes investment in the implementation, use, recovery, or adoption of environmental and forestry technologies at lower interest rates (2.5% a year for eco projects

and 4.6% for forestry in 2018). Despite the growth of agroecology in the region, the credit lines are mainly traditional (so-called Pronaf B).

A second category of instruments that became major adaptation strategies in the region includes direct spending on the dissemination of decentralized water infrastructures, especially rainfall cisterns and small dams. In Pernambuco, the installation of productive cisterns was mainly carried out by civil society organizations based on public calls from the former Ministry of Social Development and Ministry of Agrarian Development, within the scope of the “One Land Two Waters” program (*PI+2*) and by public actors within the scope of the Pernambuco-state programs of support to rural producers (e.g., ProRural and More Productive Pernambuco).

These initiatives have also been followed by the distribution of agricultural kits combined with technical assistance (often oriented towards agroecology through *Ecoforte Program*) and desertification control strategies. Note that the dissemination of rainfall productive cisterns served as a gateway for the promotion of agroecological practices, even though this was not the initial objective. This occurred thanks to the proactive role of the civil society organizations in charge of the projects.

These programs were based on a territorial development approach and followed a strategy that became known as the “living with the semiarid” paradigm—a family farming development approach characterized by decentralized and participatory governance (Lindoso, Eiró, Bursztyn, Rodrigues-Filho, & Nasuti, 2018). It aims to deal with climate events, even if such initiatives precede the climate adaptation agenda (Machado, 2018). Local civil society, assembled around a territorial network called the Semiarid Articulation (ASA), played a key role in promoting this paradigm, especially after the Third Session of the United Nations Conference against Desertification in 1999. The document resulting from this convention proposed interrupting drought regulation policies, rooted in the objective of transforming semiarid regions into green agro-export landscapes and in the concentration of water in large reservoirs. This perspective, historically led by institutions such as the public autarchy of the Sao Francisco Valley (Development Company of São Francisco and Parnaíba Valleys—Codevasf), was criticized for not considering the real causes of local vulnerability, such as unsustainable productive systems and limited access to land.

A third group of instruments promoted in Brazil's semiarid region is the provision of grants for promoting local productive clusters that are considered more resilient to climate risks, such as goat farming. The federal and state programs consistent with these objectives (*Rota do Cordeiro* and other individual initiatives) were not designed as climate adaptation measures. However, the last episode of drought (2012–2016) led to the loss of many cattle and to an increasing emphasis on goat farming, followed by a reduction in cattle ranching, despite its cultural relevance in the region. Moreover, planting of fodder palm have been widespread in pastures, which requires irrigation during periods of intense drought, so the use of water from wells (often brackish) has gradually expanded. This practice poses maladaptation challenges to the maintenance of soil quality and should therefore be accompanied by adequate management (drainage) and new research activities.

A fourth group of instruments consists of the promotion of emergency actions in response to drought events. Several interviewees mentioned climate-related grants to smallholders (*Garantia Safra*) as a strongly disseminated instrument. These grants consist of cash transfers to assure a minimum income for family farmers in municipalities systematically subject to crop loss due to drought. The municipal agriculture secretariat, along with rural extension institutions (IPA), conducts the registration and auditing of the program. For crops such as corn and beans, grants have been systematically requested, acting as safety nets, since production is often lost during drought years.

These four categories of instruments are consistent with each other in terms of promoting productive inclusion, hydric security, and changes in agricultural systems in the rural semiarid zones of Pernambuco, Brazil. This paper argues, however, that these cannot be implemented as standalone policies. Their outcomes depend on combinations with other programs and instruments, following an interaction system based on different categories.

Policy interactions categories

Policy instruments such as registries of target populations, environmental control, and land tenure titles, as well as mandatory geographic zonings, consist of instruments that may directly condition or enable other instruments. These are mostly composed of “authority instruments”, as shown in Figure 3. Considering that these instruments may authorize or limit

particular groups' access to public policies and investments, they are often much politicized. The mandate for issuing the certificates—such as the family farming declaration (Declaration of Ability to Pronaf, *DAP*)—is also an object of political dispute at the local level since it grants institutional and political power to the organizations in charge. Finally, bureaucratic problems with ensuring these certificates and titles may hinder the implementation of several other programs. Hence, these are decisive components in the policy mix.

Meanwhile, a distinct group of instruments establishes more comprehensive and indirect conditions for the accomplishment of another instrument. These include information-based and training tools (“nodality instruments”), such as technical assistance to smallholder farmers, which create the conditions for and reinforce the implementation of rural credit, sustainable changes in productive systems, and drought management on rural properties. These are seen as crucial tools for effectively implementing a number of rural policies; however, they are commonly not included in the institutional framework of the core adaptation policies.

Lastly, an additional group of instruments may contribute to leveraging the results of adaptation policies. Programs for public food procurement from family farming (e.g., the Food Acquisition Program (*PAA*) and the National School Feeding Program (*PNAE*)) use the organizational capacity of the state (“organization instruments”) to create a structured demand for locally produced food products and generate income for rural families. Although these do not directly contribute to promoting climate adaptation, they are interdependent with the productive inclusion and climate adaptation initiatives analyzed here and were mentioned in several interviews. They also consist of important markets for agroecological products (together with organic fairs). Farmers who are more vulnerable usually employ “conservative” production strategies to reduce climate-related risks, but these can become costly in terms of lost opportunities and revenues. Structured access to markets helps to circumvent such problems (Mesquita & Milhorange, 2019; Shiferaw et al., 2014; Vermeulen et al., 2012).

The same logic applies to social protection instruments such as conditional cash transfers (*Bolsa Familia*) (“treasure instruments”). Although these are not sufficient *per se* to increase the adaptation capacity of vulnerable populations, they reinforce adaptation policies by

promoting adaptation-generic capacities (Lemos, Lo, Nelson, Eakin, & Bedran-Martins, 2016). Social protection programs and a vast array of safety-net strategies related to cash, food, asset transfers, and insurance have been shown to produce socioeconomic transformations in the livelihoods of vulnerable populations (Mesquita & Bursztyn, 2016). Thus, these can be related to adaptation strategies.

Table 2 summarizes some of the interactions shown in Figure 3, as well as the challenges related to incorporating climate risks in the formulation of each group of instruments. These will be discussed in the next section, which will also shed light on positive experiences of integrating policy instruments to promote climate adaptation outcomes. The table also includes references to Dupuis and Biesbroek's (2013) work regarding the level of substantiality and intentionality of each group of programs.

Table 2: Policy interactions and climate risks in the adaptation policies for the semiarid region

Type of instrument	Core program	Related programs (policy mix)	Climate risk incorporation
Conditional credit to transform productive systems (financial incentive)	Green credit lines and technology (Programa ABC, iLPF, Pronaf Eco) High substantiality; high intentionality	Direct conditionality: environmental registry, land regularization.	Proactive. However, analysts suggest combining it with climate zoning and insurances to effectively incorporate climate risks.
		Indirect conditionality: technology development of farm-livestock integration (Embrapa iLPF); technical assistance.	
		Complementarity: no effective complementarity. It could include preferential market conditions.	
		Consistency: ABC is consistent with other green credit lines such as Pronaf Eco; however, the latter targets family farmers.	
Decentralized water infrastructure (direct spending on infrastructure)	Rainfall productive cisterns (P1+2, ProRural) High substantiality; medium intentionality	Direct conditionality: land regularization, family farming registry.	Proactive. These programs rely on the "living with semiarid" paradigm, so they incorporate climate risks. However, increasing climate variability may compromise water infrastructure, and good practices should be adopted.
		Indirect conditionality: technical assistance.	
		Complementarity: public procurement (PAA/PNAE) ensures the marketing of food products, and oriented credit/cash transfer ensures stable investment (Pronaf, Agroamigo).	
		Consistency: programs that promote goat farming (Rota do Cordeiro) and agroecology (Ecoforte, ATER agroecologia), desertification control.	
Resilient productive clusters (direct spending/grants)	Goat farming (Rota do Cordeiro, individual initiatives) High substantiality; low intentionality	Direct conditionality: Family farming registry.	Reactive. Goat farming is more adapted to semiarid climates. However, increasing climate variability has been considered in the programs' formulation, which is a reaction to recent drought events.
		Indirect conditionality: Technical assistance.	
		Complementarity: Public procurement (PAA/PNAE) ensures the marketing of food products, and oriented credit/cash transfer ensures stable investment (Pronaf, Agroamigo, Fomento).	
		Consistency: Most of the water infrastructure initiatives (P1+2, ProRural) are followed by technical assistance to promote more resilient agriculture systems such as goat farming (more adapted to semiarid climate), desertification control and agroecology.	

Public rural insurance (direct spending/grants)	Drought-related insurance (SEAF, Garantia Safra) Medium substantiality; medium intentionality	Direct conditionality: Family farming registry, social vulnerability registry.	Not adapted. These programs do not consider climate risks and recurrent loss of crops such as corn and beans. They consist of emergency measures, which became recurrent.
		Indirect conditionality: Technical assistance.	
		Complementarity: Social protection cash transfers (<i>Bolsa Familia</i>).	
		Consistency: The program is more consistent with social protection instruments than with productive and insurance strategies.	

Source: Authors, adapted from (Dupuis & Biesbroek, 2013) and interviews

Gaps and coordinating mechanisms

Insufficient regard for climate-related risks

As mentioned earlier, most of the instruments described here and considered in Brazil's NAP were not specifically designed to promote climate adaptation. Although they may contribute to adaptation goals, there are often some gaps in incorporating climate-related risks in the conception of each program. One of the main issues concerns rural insurance: the Crop Guarantee program has become an ongoing intervention, although it was conceived as an emergency response to drought. As summarized by a local manager, "*The Crop Guarantee addresses a disaster that we know will always happen, so it has to be reviewed.*" Moreover, the operational costs of releasing funds during each drought event are high. Therefore, prolonged drought requires differential and long-term planning based on climate projections (not climate history). Some interviewees also highlighted the need to better associate this program with structural actions for income generation and the promotion of water security.

A further initiative formulated for this purpose is Family Farming Insurance (SEAF), which establishes insurance against climate risks and promotes the use of appropriate technologies, natural resource management, and preventive measures against agro-climatic shocks. The program was reformulated, and as of the 2015–2016 harvest, it included the possibility of coverage for drought in irrigated crops in cases where public authorities issue a decree suspending the use of water (as happened in the Sao Francisco basin in 2016). Also, by contracting Pronaf's agricultural credit, family farmers have automatic access to SEAF. Despite the potential for climate adaptation and its integrated approach, this instrument has proven to be little accessed, and it was mostly unknown to the local managers consulted in Petrolina.

An additional challenge concerns the ABC credit line, which several analysts say should be combined with productivity insurance to reduce the perception of risk for investors (Observatório ABC, 2017). Nonetheless, the financial incentives for productive transformation have not been sufficiently attractive or updated. The financing conditions were sometimes less attractive than those of traditional lines (e.g., the interest rate of 8.5% in the 2016–2017 agricultural year as compared to the 5.25% rate). Other identified challenges include a lack of information about this line, high complexity and bureaucracy for access, and limited technical assistance (Observatório ABC, 2017). Likewise, the difficulty of including technological options more adapted to semiarid climates in the financing portfolio (owing to a lack of dialogue between technology and financial institutions) was mentioned by the interviewees. Lastly, the occurrence of increasingly prolonged droughts resulted in responses from financial institutions. The renegotiation of credit and the extension of deadlines during periods of drought have been constants (laws 13.340/2016 and 13.606/2018).

To conclude, the “living with semiarid” paradigm is one of the most innovative policy frameworks for dealing with cyclical droughts. However, there has been some debate concerning the need to update its strategies and options in accordance with the increase in climate variability. Some civil society organizations have already absorbed the debate, and some policy managers have revised particular aspects of policy interventions to include the risk of extreme drought. For instance, representatives of the Bank of Brazil Foundation, responsible for financing the implementation of productive cisterns, stated during the interviews that, owing to rainfall decreases, they decided to add a small financial amount to the final price of the cisterns, which was equivalent to one recharge with water-tank trucks. This refill is crucial for preserving the infrastructure, which must be kept moist to not be damaged.

Nevertheless, water-tank trucks have been a source of persistent clientelism between local elites and beneficiaries in the region (Bursztyn & Chacon, 2011; Eiró & Lindoso, 2015). According to Eiró and Lindoso (2015), although cisterns and other related programs, such as cash transfers (*Bolsa Família*), have increased families’ livelihoods and their ability to deal with climate shocks, they have not been sufficient to significantly increase families’ capacity to break the trend of dependence on local elites. Dealing with such local power dynamics will

remain an important challenge for the implementation of social and rural policies in the region, especially as long as material precarity and low access to resources essential to livelihoods remain. Adaptation policies should take this reality into consideration and search for additional strategies to incorporate risks related to the increase in climate variability and its political outcomes.

Permanence of political conflicts

Scholars have argued that instrument choice is not a technical but rather a political process (Henstra, 2016). The selection of particular instruments and the configuration of policy mixes affect interests and the distribution costs and benefits of a given intervention. For instance, integrating the principles and guidelines of the National Policy on Climate Change into other policies (as recommended by Law 12.187/2009) is a matter of political negotiation rather than a purely organizational challenge. The same argument may be applied to the aim to strengthen the climate adaptation agenda by empowering local governments for adaptation measures through the verticalization of the National Adaptation Plan.

A less common challenge in the implementation of climate adaptation policy mixes involves programmatic conflicts between different instruments. This happens when the pursuit of one policy goal cancels the achievement of another. For instance, access to funding for traditional agricultural inputs and pesticides to increase agricultural production, such as those for irrigation crops, is more flexible than the credit lines that promote the use of bio-inputs and agroecological techniques. This is the result of economic and political disputes in the Brazilian rural policy system. For instance, green and agroecology Pronaf credit lines formally exist, but they are not applied, being rarely promoted by official technical assistance and dismissed by banks, even public ones (Sabourin, 2018). Therefore, conflicts are inherent in cross-sectoral public actions and not simply the result of fragility in administrative processes.

An additional example concerns the conflict between the programs One Million Cisterns (*P1MC*) and Water for All (*Agua para Todos*). The first was launched by ASA and the former Ministry of Social Development in 2003; it was complemented in 2012 by the second, managed by the Ministry of National Integration. In the P1MC, participatory methodologies

and premolded plate cisterns installed by the program's beneficiaries were predominant while the Water for All program opted to change the method and use foreign-made polyethylene cisterns. This change created political divergences among the implementing actors; however, the Ministry of Integration held the arbitration power.

According to some Codevasf representatives and local authorities, plate cisterns require greater investment in maintenance because they are not resistant to thermal variations. This assessment is questioned by ASA members, who claim that the installation of plate cisterns is accompanied by collective discussions and training on issues relevant to the community, which does not occur in the process headed by the Ministry of Integration. Associated with a proposal for agroecological production, the plate cisterns are presented as a technical-political alternative for the development of rainfed agriculture in the semiarid region. Meanwhile, the productive cisterns were well received by family farmers, especially when associated with productive support strategies. Hence, the variations in policy formulation and integration represent responses to different perceptions, interests, and practices among implementing actors at all levels (Reichardt & Rogge, 2016).

Contingent and institutional mechanisms for coordination

Depending on the position of particular instruments in the policy mix (Figure 3), connection gaps may affect the outcomes of adaptation policies in different ways. These may include implementation deficits, procedural constraints, or issues with coordination among managers.

Almost all of the interviewees regarded deficits in technical assistance as a major obstacle to the achievement of several objectives (e.g., access to rural credit, productive conversion, water management, and desertification control). Technical assistance provision is also a means of integrating policy instruments, as it is responsible for disseminating information and helping farmers to participate in public food procurement, credit lines, and technological debates. However, technical assistance is barely included in the institutional framework of the policies. This is conversely the case with the *Agroamigo* Program, implemented by the Bank of the Northeast (BNB), which guarantees microcredit combined with one-off technical assistance. This has also been the case with the dissemination of plate cisterns, which

included technical assistance, often in agroecological practices, in its implementation framework.

Operational and organizational factors may also help promote higher policy integration. For instance, cross-referencing the databases of the conditional instruments—such as DAP (family farming national registry), CAR (rural environmental registry), PNRA (land tenure titles), and CadUnico (social protection registry)—could potentially contribute to integrating environmental, land, and productive policies. Gebara et al. (2019) showed that the failure to link CAR’s database with an agricultural data management platform that includes rural credit and animal transport permits is a key reason for the ineffectiveness of deforestation control in the Amazon region. While CAR enables improved environmental monitoring, it also allows access to subsidized credit for ranching. In the semiarid region, CAR is still not operational in conditioning rural credit or land tenure regularization. Land credit is automatically linked to the inclusion of beneficiaries in the DAP, which opens the door to a number of productive and social inclusion policies.

An additional source of operational constraint relates to the type of disbursement for direct spending. Most initiatives promoting the “living with semiarid” paradigm have been funded through calls for tenders and implemented by local civil society actors. However, after the political and economic crisis, which led to the impeachment of President Dilma Rousseff in 2016, the Ministry of Social Development and the Ministry of Agrarian Development were dissolved, and these funding categories were considerably reduced.

Moreover, the creation of a federal agency for technical assistance and rural extension (Anater) opened up the possibility of appointing technical assistance institutions based in any region of the country, regardless of their local experience. This decision could hamper the continuity and integration capacity of various actions since they rely on the proactive role of local organizations. Aside from technical assistance, financial constraints affected the implementation of water infrastructures by Codevasf, which became increasingly dependent on resources from parliamentary amendments, which are less stable and are reliant on political negotiations.

Finally, several interviewees confirmed that territorial development mechanisms (e.g., local municipal councils and territorial collegiate bodies) have the potential to coordinate

interventions and implement actors at the local level. They were created under a new generation of rural policies implemented during the 2000s with the aim of decentralizing public action and reinforcing ties of proximity between social agents in initiatives aimed at development (Bacelar, 2010; Delgado & Leite, 2011). Like other rural policies, these were also deactivated after the presidential shift in 2016. However, most of the local councils remained active despite the interruption in financial resources and this point deserves further analysis.

Conclusion

Climate change adds further challenges to an existing policy subsystem concerned with dealing with recurrent droughts in a socially and environmentally vulnerable region. This requires cross-sectoral and integrated policy approaches that deal with regional sensitivities to disturbances and unequal potentials to resist and adapt to change. This paper examined the emergence of a climate adaptation agenda in Brazil and the combinations of policy instruments that may contribute to climate adaptation in Pernambuco's semiarid region.

It was shown how and why mitigation, reflecting domestic politics and international negotiations, has dominated the climate agenda in Brazil, with a particular focus on deforestation control. Climate adaptation is a still emerging and internationally driven concern, crystalized by the launch of the National Adaptation Plan in 2016. The plan benefited from a two-year participatory and cross-sectoral process of formulation. However, the final document favored juxtaposed sectoral and thematic agendas, with low practical emphasis on mechanisms to promote dialogue. Several factors explain this result—the mainstreaming strategy intended to promote climate adaptation policy but also the path dependence of the Brazilian institutional and political environment.

The first led to the programmatic decision to keep sectoral agendas in the formulation of the plan instead of promoting transversal strategies. The objective of “contaminating” government sectoral plans with external objectives, such as environment and climate, has been widely promoted in different countries, but it shows several limitations in consistently overcoming sectoral conflicts and improving policy interplay. The second factor concerns Brazil's path dependence, considering the following: i) former climate institutions, as the

National Climate Policy, based on sectoral strategies; ii) the political struggle to include concrete adaptation initiatives in fixed multiannual budgets, which remained a sectoral decision; and iii) the traditional role of federal institutions in designing policies expected to have local impacts and interact with local politics.

In addition to the soft, mainstreaming-oriented, sectoral approach of Brazil's NAP, a lack of consistency between the different chapters of the plan has been detected. Most of them relied on existing programs and initiatives that were recycled to be showcased as adaptation policy. Notwithstanding the problematic aspect of defining the scope and ensuring the intentionality of adaptation policy—as it consists of a recent and incremental agenda—a number policies can be analyzed regarding their contribution to adaptation outcomes and attention to climate risks. This exercise was carried out in Pernambuco's semiarid region, shedding light on interactions within the policy mixes.

Four categories of instrument interactions were identified, suggesting that the position (or role) of each instrument in the policy mix implies different political/institutional weight, and its presence/absence may lead to different outcomes. First, consistency denotes programmatic coherence among instruments. This paper was limited to rural policies, particularly focusing on rainfed farming. However, if we include other policy mixes relevant to the region, such as irrigation policies and energy interventions, conflicts may be viewed in terms of consistency. Second, complementary instruments are those that contribute to leveraging the results of the core instruments of the policy mix, although they might allegedly be considered beyond the scope of the mix.

Third, conditionality instruments are crucial deadlocks in policy mixes since they might allow/hinder the implementation of a given instrument. Direct conditionality often comprises authority instruments and is, therefore, highly politicized in terms of formulation and implementation. Meanwhile, indirect conditionality represents different types of nonbinding instruments that strongly influence the results of policies. Their connections and gaps include both political and operational factors, but the instrument selections and the concrete interactions are not a technical but rather a political process that reflects interests and distributes the costs and benefits of a given intervention.

The same argument was used to present some successful mechanisms for coordination, such as local municipal councils and territorial collegiate bodies, which became highly relevant for coordinating interventions and implementing actors at the local level. These align with a political perspective promoted during the 2000s that relied on promoting a territorial development approach. Although this is no longer the line promoted by the federal government, it remained a persistent response to the new guidelines and an approach to promoting the policy integration of rural development strategies in the context of an increasingly variable climate. Finally, note that not only have territorial approaches been dismantled since 2016 but climate policies in general have been particularly criticized since the government shift in 2018. This has opened up a new climate-skeptical phase in Brazil's policy scenario, which will require further analysis regarding the outcomes of dismantling and resistance mechanisms.

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