Weather and Climate Extremes 3 (2014) 95–106

Contents lists available at ScienceDirect

Weather and Climate Extremes

journal homepage: www.elsevier.com/locate/wace

Drought preparedness in Brazil

Ana Paula A. Gutiérrez [a], Nathan L. Engle [a,*], Erwin De Nys [a], Carmen Molejón [a], Eduardo Sávio Martins [b]

[a] The World Bank Group, 1818 H Street NW, Washington DC 20433, United States
[b] Fundação Cearense de Meteorologia e Recursos Hídricos (FUNCEME), Avenida Rui Barbosa, 1246-Aldeota, Fortaleza/Ce CEP: 60.115-221, Brazil

ARTICLE INFO

Article history:
Received 12 September 2013
Received in revised form
18 December 2013
Accepted 22 December 2013
Available online 9 January 2014

Keywords:
Drought policy
Water resources
Climate change
Resilience
Adaptation

ABSTRACT

Large portions of Brazil's Northeast have experienced an intense and prolonged drought for the majority of 2010–2013. This drought, along with other droughts that have hit the South in recent years, has sparked a new round of discussions to improve drought policy and management at the federal and state levels. To assist with these efforts, the World Bank recently conducted a series of evaluations on national and sub-national drought preparedness measures and approaches across five country case studies. This particular article presents the Brazilian case study. The work draws from interviews with key experts and stakeholders, as well as document analyses, and focuses on preparedness measures and approaches at the national and one sub-national case; the state of Ceará. The analysis shows that although there is a rich history of drought management throughout Brazil, there are short-term and long-term gaps and opportunities on which decision makers might consider focusing to improve monitoring, forecasting, and early warning systems, vulnerability/resilience and impact assessments, and mitigation and response planning measures.

1. Introduction

Climate variability and extreme weather events threaten many populations throughout the world, and evidence indicates that in many of these regions, the variability and extreme events are increasing (Blunden and Arndt, 2012). Perhaps nowhere else is the change in weather and climate regimes more noticeable than in the water sector (Kundzewicz et al., 2007). The World Bank's recent "4 degree report" indicates that droughts, for example, will likely increase in severity in southern Africa, the United States (U.S.), southern Europe, Brazil, and Southeast Asia, amongst other areas, translating to increasing evapotranspiration and dry periods, reductions in arable land, and ultimately greater food insecurity (World Bank, 2012a). The likely intensification of extreme droughts from climate change in Brazil and many regions across the planet has magnified the importance of proactive measures to increase resilience to the expected impacts.

In the case of drought, *drought preparedness*, and the policies which facilitate its implementation, can increase adaptive capacity and resilience of water resources management (Engle, 2012). Proactive drought preparedness and risk management measures can also purportedly help reduce economic losses and costs associated with more reactive disaster response and recovery. Moreover, because a society's approach to drought management is instructive for how it might manage climate change, recent drought events around the world provide windows of opportunity to evaluate and subsequently begin to lay the building blocks for improving climate change management and preparedness.

Within some regions of Brazil, particularly the semi-arid Northeast, an ongoing drought (i.e., for the most of 2010–2013, with little relief in between) is the worst in recent decades, if not the past 100 years; proving devastation to some agricultural, livestock, and industrial producers. As with many nations, Brazil has historically addressed water scarcity during times of shortage and droughts through emergency response and large water infrastructure works projects (Malgalhães and Martins, 2011). Despite decades of infrastructure and technical fixes to water management (which have certainly helped to buffer against water shortages and have facilitated considerable economic growth throughout Brazil), significant impacts from water shortages have persisted. There have been recent efforts to shift Brazil away from reactionary drought response and sole dependence in the long-term on infrastructure solutions to mitigate drought impacts (e.g., through improved monitoring, decentralization and democratization of water resources management, etc.), and there is a growing interest in improving coordination and institutionalizing these elements into a coherent drought policy, both at the national and sub-national levels (Malgalhães and Martins, 2011).

As an example at the federal level, during the recent drought, the Civil House of the Presidency created the Integrated

* Corresponding author. Tel.: +1 202 473 8809.
E-mail address: nengle@worldbank.org (N.L. Engle).

http://dx.doi.org/10.1016/j.wace.2013.12.001
2212-0947

Committee to Combat Drought to monitor and coordinate actions for drought response in the semi-arid region, and the Ministry of National Integration (MI) is leading a work group to discuss and design a National Drought Policy proposal. At the state level, the government Ceará created its own Committee to Combat Drought in order to coordinate the various emergency activities and respond to the effects of drought with the participation of local, state, and federal institutions, municipality officials, smallholder farmers, and agriculture companies, among others. Nevertheless, much work remains to be done to increase resilience and improve drought preparedness throughout Brazil.

As decision makers consider crafting these and other future policies to foster drought preparedness in Brazil, it is important to exercise prudence and not repeat mistakes from the past. This paper presents a case study on drought preparedness in Brazil, and highlights gaps and opportunities as decision makers consider improving drought policies and programs. The work draws from interviews with key experts and stakeholders, as well as document analyses, and focuses on preparedness measures and approaches at the national and one sub-national case (i.e., Ceará).[1]

It is important to note that the Brazil cases presented here are part of a larger study being conducted by the World Bank that evaluates drought preparedness across other national and sub-national case studies (i.e., Australia, Mexico, Spain, and the United States). The purpose of the study is to provide international lessons and good management practices for Brazil as the country considers improving its drought policies and programs. This cross-country analysis is currently being drafted as a separate publication to complement this stand-alone Brazil case.

2. Background

2.1. Climate change and implications for the water sector

Freshwater systems throughout Brazil and much of the world will experience significant stress as a result of climate change, including diminished and altered timing of runoff, saltwater intrusion from sea-level rise and storm surge, and increased variability and extreme events (i.e., droughts and floods) (Kundzewicz et al., 2007; Bates et al., 2008; Intergovernmental Panel on Climate Change, 2012). Droughts, in particular, are anticipated to increase in frequency and intensity in the Northeast of Brazil under climate change (World Bank, 2013). In general, droughts are conditioned by the occurrence of El Niño, but the observation of more extreme climate variability over the past five decades reveals that its incidence and consequences are increasingly linked to human action (Viana, 2013).[2]

Superimposing droughts and climate change upon pre-existing stresses will combine to place intense pressure on freshwater availability and quality in Brazil and other areas throughout the world. Such increases in extreme droughts from climate change has piqued interest among natural resource managers, farmers, development practitioners, researchers, and policy makers to understand the extent to which these changes will impact water resources, food production, incomes, and livelihoods. These decision makers are also contemplating the most appropriate choices they can make to prevent, respond to, learn from, and adapt to these new risks, vulnerabilities, and opportunities.

2.2. Drought management and its role in helping to understand the climate change management

As with the phenomenon of drought, climate change manifests over longer time scales, is difficult to define with respect to impact attribution, and is a “creeping” phenomenon (i.e., it is not well-detected until it is advanced and widespread). While there are obvious differences (e.g., climate change impacts involve much more than prolonged dry periods), the manner in which a nation, community, or individual decision maker approaches droughts through governance, institutions, policies, and choices reflects how a society might approach the problem of climate change. Hence, the recent widespread manifestation of drought crises around the world may reveal the extent to which societies will be successful in managing climate change, as many of the mechanisms for effectively preparing for and responding to droughts run parallel to the tools and procedures for readying a society for climate change.

2.3. Role of drought preparedness for increasing resilience and adaptive capacity

Drought preparedness involves monitoring and forecasting, vulnerability/resilience and impact assessments, and mitigation and response planning and measures (Wilhite et al., 2005). These drought preparedness measures are similar to the World Bank′s work on disaster risk management, which is divided into five pillars (see Fig. 1, below). The framework mostly deals with pre-event actions that can be taken in order to reduce human, environmental, and economic impacts.

Instituting proactive drought preparedness and risk management approaches can purportedly pay dividends in the form of more resilient water systems and communities, fewer economic losses, and improved disaster response and recovery. Through drought preparedness efforts, as facilitated by national and state drought policies and planning mechanisms (Sivakumar, 2011; Wilhite, 2011; UNCCD, FAO, and WMO, 2012a, 2012b), the

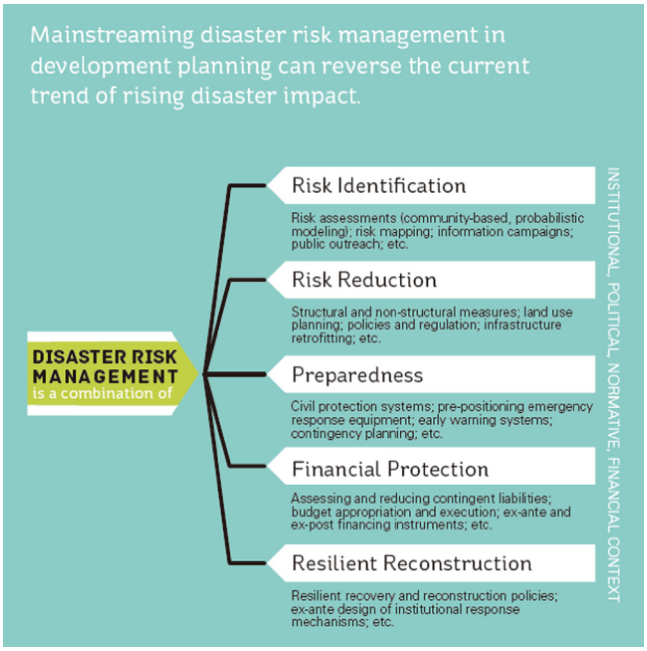

Fig. 1. World Bank's disaster risk management framework.
Source: World Bank, 2012 (World Bank, 2012b).

[1] The complete Brazil case includes two sub-national cases that were selected specifically to demonstrate a diversity of climates and drought management approaches (i.e., dry/semi-arid in the case of Ceará and wet/sub-tropical in the case of Rio Grande do Sul), and thus to ensure greater applicability of the results. Due to space limitations, only one sub-national case is presented in this paper, Ceará.

[2] The Atlantico Dipole phenomenon also plays an important role in the climate of the Northeast, which can interact with El Niño. Between 1950 and 1995, for example, 20 percent of El Niño years were marked with above average rainfall in Northeast of Brazil.

emphasis shifts from ad hoc drought relief and response to proactive risk management (Hayes et al., 2004).

2.4. Climatic conditions and recent drought events

Brazil has a variety of climates, ranging from tropical in the center-north to temperate in the south, and from humid at the north part of the Amazon region to semi-arid *sertão* region in greater part of northeastern Brazil. Such droughts are often related to the El Niño Southern Oscillation (ENSO) phenomenon. The positive ENSO phase, known as El Niño, is normally related to droughts in the northern part of the country, including the Amazon Rain Forest and the semi-arid Northeast, within which the State of Ceará is located. The negative ENSO phase (La Niña) normally intensifies the drought spells in southern Brazil.

The recent drought (2010–2013, but most impactful during 2012–2013)[3] in the Northeast has been one of the worst in the past 100 years (Ceará, 2013), especially during 2013 in terms of water availability, proving devastating to some agricultural, livestock, and industrial producers.[4] It has caused a lack of drinking water in residential wells, and left dams and streams completely dry. By April 2013, some 880,000 rural farmers had received federal assistance through social support programs. The impacts of the recent drought, as well as many previous droughts, are not only manifested throughout the economy, but also exacerbate many social problems through the indebtedness of farmers, migration, disease, and malnutrition, among others.

In Ceará specifically, temporal and spatial variability of rainfall is among the highest in the world, having a concentrated rainy season from February to May, accounting for about 70 percent of the annual rainfall. The current multi-year drought started with a dry year in 2010, followed by a relatively normal year of rainfall distribution in 2011 (with good agricultural production), and then a very dry year in 2012 and the beginning months of 2013. Even though rainfall was relatively higher than average between May and July 2013, which helped to alleviate some of the impacts to the livestock and agricultural sector, the first half of the year was in the below average category. The hydrological systems are still far below normal, with many key reservoirs below 15 percent capacity. The drought has been attributed to the occurrence of two coupled atmospheric phenomena: (1) an slight increase in the sea surface temperature, between 0.5 °C and 1.5 °C in the Central and East Equatorial Pacific Ocean, which indicates an ENSO phenomenon; and (2) the conditions in the Atlantic that were not favorable to rain in the region (i.e. a positive Atlantico Dipole and lighter warm air to Brazil's north).

As shown in Fig. 2, which represents a particularly acute period of the recent drought from March–May 2012, precipitation amounts across nearly the entire Northeast were classified as dry, very dry or extremely dry. Moreover, during this period, which is normally the rainy season, precipitation was observed at 299.2 mm, which is 50.7 percent below its historical average during these months (606.4 mm). Specifically in Ceará, this caused a devastating situation, which by the end of May 2013 had led to 175 out of 184 municipalities declaring situations of emergency for 180 days; 39 of them lost at least 90 percent of their crop harvests, estimates of grain production pointed to a reduction of 81 percent, and the main products of rain-fed agriculture (i.e., beans and corn) suffered losses of 87.3 percent and 92.9 percent, respectively, when compared to that of 2011 (Ceará, 2013).

Fig. 3 shows the monthly average rainfall from 2008 to present for Ceará. For reference, the "average year" is included in each figure.[5] In terms of meteorological drought, the figure shows that the 2012 drought was the most severe, followed by the 2010 drought (again, in terms of meteorological drought). However, it should be noted that 2010 followed a rainy year, 2009, while the current 2013 drought follows the most severe meteorological drought in the past 40–50 years (i.e., 2012). Thus, in terms of severity and subsequent impacts, the 2013 drought can is considered more severe than the 2010 drought.[6]

2.5. The institutional history and context for drought management in Brazil

2.5.1. National

Brazil began to focus on mitigating against droughts after a particularly harsh event from 1877-79. In 1886, under a monarchy with a strong central government, the construction of the first reservoir, or *açude* (the Portuguese word for dam), represented the start of the institutional design for building infrastructure to address droughts. Hence, it is important to understand the evolution of drought policy construction from the perspective and associated phases of water management. The initial phase is recognized by the creation of the Inspection Agency for Works against Drought (IOCS), in 1909, with a strong emphasis on building infrastructure for water distribution throughout the Northeast. It later became the Federal Inspection Agency for Works against Drought (IFOCS), and then finally the National Department of Works against Drought (DNOCS), which is the current agency under the MI. DNOCS served as the primary governmental agency building infrastructure in the region, such as roads, dams, bridges, ports, railways, hospitals, and hydroelectric facilities.

In the 1930s, a new cycle of sequential droughts led to the Water Code (1934), which became the milestone for the classification and use of water resources, with emphasis on the use of the country's hydraulic potential, but also with principles for multiple water uses, with concern for water quality and economic value. Then, in the early 1950s, several key federal government supported institutions to foster water and economic development were introduced, such as the creation of the Bank of Northeast Brazil (BNB) to help regional economic development through subsidized credit to farmers in the region. Also, integrated actions for water infrastructure, in response to the severe drought of 1958, were institutionalized with the creation of the Superintendence for the Development of the Northeast (SUDENE). SUDENE was abolished several decades later, but in 2001 it was re-introduced as the Agency for the Development of the Northeast (ADENE) and then, in 2007, recreated as SUDENE under the MI.

From the end of the 20th century to the beginning of the 21st, a period of management and control was initiated upon the reform of the Federal Constitution, in 1988, which created a national system of water management and the definition of criteria for granting water use rights. Particularly important was

[3] There is an important technical distinction between two Brazilian Portuguese concepts that relate to drought: *estiagem,* which is related to the reduction in rainfall, the delay of the rainy periods, or lack of rainfall provided for a particular season, in which the loss of soil moisture is higher than its replacement; and *seca,* which from the meteorological point of view, is a prolonged *estiagem*, characterized by a sustained reduction of existing water reserves. *Seca*, as a disaster, is also considered a social phenomenon, characterized as a situation of poverty and economic stagnation, arising from the impact of the drought event. In this situation, the local economy does not have the ability to generate financial reserves or store food and other inputs. For the purpose of this Brazil case study, the definition of drought will follow the rationale under the definition of *seca*.

[4] In 2013, reservoir levels were extremely low, with the exception of the very large reservoirs. There were serious restrictions to water supply to some municipalities, and pasture availability was diminished due to the late arrival of the rain.

[5] The average year is a statistical concept and reflects the fact that the monthly rainfall of such year is computed as the mean of the rainfall that occurs in that particular month.

[6] Based on data provided by FUNCEME.

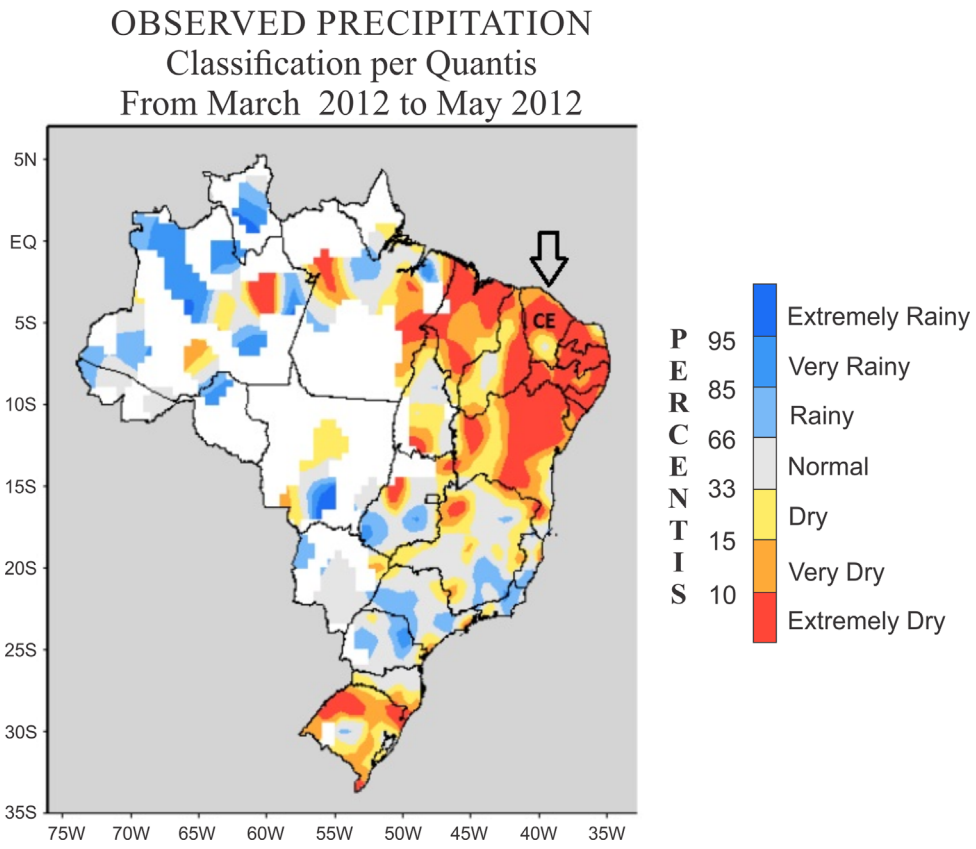

Fig. 2. Precipitation in Brazil from March 2012 to May 2012; Ceará is indicated by the arrow.
Source: INMET.

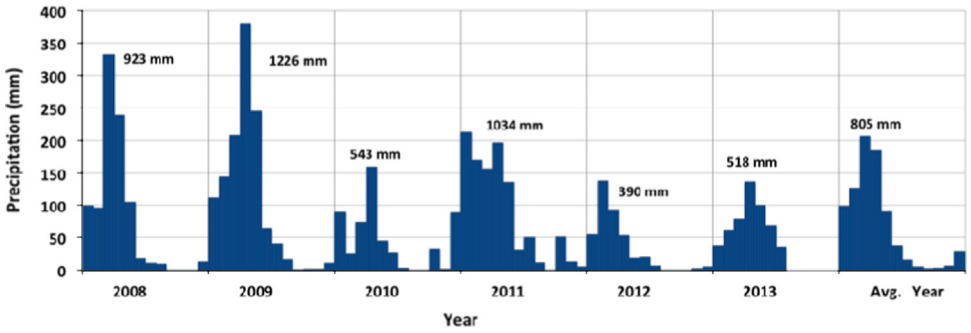

Fig. 3. Monthly average rainfall for Ceará from 2008-present (for each year, January-December is depicted from left to right). The "average year" is depicted to the right for reference.
Source: Data provided by FUNCEME.

the installment of a National Policy of Water Resources, as well as the creation of the National System of Water Resource Management and the National Water Agency (ANA) as an implementing and coordinating institution of the National System. ANA belongs above all to the Federal Government, yet it has duties that transcend the federal domain. As per the Constitution, water is a limited natural resource and an inalienable public good that belongs either to the Federal or the state government.[7] ANA and the deliberative agencies of the Water Resource Management System (i.e. councils and committees), basin agencies, and other entities involved (e.g., civil society stakeholders) are the organizations entitled to award Federal and State water use permits or *outorga* (the Portuguese word for water permits/grants). The instrument of a grant is applied to ensure the user has effective access to water, as well as to perform quantitative and qualitative control of the resource.

While these stages of water management are important for understanding Brazil's approach to drought policy, it is also important to acknowledge the existence of two very different worlds in which drought is experienced in Brazil. On one hand, there are many people who have reliable access to water because they are connected to the perennial water systems. People within these communities are the direct beneficiaries of the above-mentioned evolution of water policies and projects, which serve as a form of drought management. On the other hand, there are

[7] Water belongs to the Federal Government when it is in lakes, rivers, and streams within its territory, or when it crosses through more than one state, serves as boundaries with other countries, or extends to or comes from foreign territories. Surface water or groundwater, flowing, emerging, or in storage belongs to the State, with the exception of those waters deemed 'federal' (e.g., held in a reservoir constructed by a federal agency, such as DNOCS).

the diffuse populations and rain-fed farmers who still have no reliable access to water, but instead have been dependent on piecemeal mechanisms to address water scarcity and droughts. For this second group, drought management has been done over the years either reactively (e.g. rain-fed water cisterns construction, well drilling and recovery, dam and pumping station construction, and social safety net mechanisms such as *Operação Pipa*, *Bolsa Estiagem*, *and Garantia Safra*, elaborated upon in the discussion section below), or to a lesser extent proactively (e.g. building resilience at the farm level, work on drought resilient crops by the Brazilian Agricultural Research Corporation (EMBRAPA), etc.). These mechanisms and the general public policy in the semi-arid regions of Brazil that stresses "coexistence" with droughts and water scarcity realities have not been substantially modified to address the existing scenario (e.g., increasing water demands and heightened drought conditions from climate change). Moreover, the water supply programs to diffuse populations still lack the ability to meet the currently observed needs, let alone anticipated needs from these future stresses.

Despite this long and detailed institutional history in managing and adapting to droughts in Brazil, the extent of the impacts from the current Northeast droughts indicates that there is still a need to improve preparation and response measures, keeping in mind that there cannot be one "blueprint solution". Rather, it is imperative to recognize the heterogeneity and local context of each municipality and community, and to come up with context-specific solutions for access to water for human consumption, agriculture, animal grazing, and food security.

2.5.2. State of Ceará

Ceará is among the poorest states in Brazil, as the climate and the recurrent droughts in the state traditionally allowed only precarious subsistence farming and extensive animal grazing. Of the more than eight million people living in Ceará, 75 percent live in urban areas. Many of those remaining outside the cities are dispersed and disconnected from perennial water supplies. This makes these communities extremely vulnerable to droughts. As the dams in these areas are small and somewhat precarious, they generally do not retain enough water to provide a buffer for extended periods of drought; much less for drought periods that last for multiple years. The abandonment of such dams is a serious problem in the semi-arid region, leading to degradation of the dam walls, deforestation, increased soil erosion, silting of reservoirs, inappropriate uses of water, poor sewage drainage, and the build-up of garbage and pesticides in the water sources. Combined with droughts, these factors contribute to a lower availability of high-quality water, which, in turn, increases the cost of water treatment (where there is treatment in the first place). In addition, due to a major rural exodus, which contributed in large part to the rapid growth of the Fortaleza Metropolitan Region during the last 70 years, providing water to the increasing population has been a serious challenge.

The adoption of new water management policies between 1987 and 1996 helped making Ceará a pioneer of water resource management in Brazil. Until the beginning of a water reform process in the early 1990s, the issue of water scarcity, exacerbated by unpredictable rainfall and recurrent drought, was treated as essentially a supply problem to be resolved through massive construction of reservoirs and related water infrastructure. As a result, Ceará has a large water infrastructure network and is considered a pioneer in the region. Without water storage infrastructure in Ceará, all rivers would be ephemeral across the 12 major state watersheds. The state's experience has directly influenced federal guidelines on modern water resource management in the past two decades, mostly through embracing decentralized and participatory management, defining water as a finite and fragile resource and as an economic good, and implementing integrated water management with the river basin as a planning and implementing unit. Likewise, Ceará helped pioneer the same management instruments later instituted by the federal law including state and basin water resource plans, bulk water use permits, bulk water charges for exercising these permits, and a water resource information system

Whereas these actions mostly target the extension and management of the perennial water system, it is important to also mention the One Million Cisterns Program (P1MC) initiative,[8] which has existed since 2003. The P1MC was created and led by the Articulation of the Brazilian Semi-arid (ASA), which gathers around one thousand NGOs to strengthen the role of civil society in building participatory processes for sustainable development. In partnership with the Ministry of Social Development and Combat to Hunger (MDS) and the Foundation of the Banco do Brasil, the P1MC triggers joint action among communities for sustainable coexistence with the semi-arid ecosystem through the involvement and empowerment of families. The program's goal is to benefit about 5 million people across the region with potable water for drinking and cooking, through the construction of cisterns, which all together form a decentralized infrastructure with the capacity to supply 16 billion liters of water.

3. Framework and methods

3.1. Evaluating drought preparedness

Drought preparedness can increase adaptive capacity and resilience,[9] because it moves beyond the traditional reactive approach that has resulted in reduced self-reliance and limited coordination across institutions and sectors (Engle, 2012; Hayes et al., 2004). The characteristics that constitute effective drought preparedness are different depending on the scale at which one is evaluating it, as well as the sector of interest. The evaluation presented in this case study focuses on drought preparedness broadly at the national and state-level sub-case, with an eye toward the water and agriculture/livestock sectors. At these higher scales of decision making (i.e., national and state/river basin), drought preparedness encapsulates three basic categories; monitoring and early warning/prediction, vulnerability/resilience and impact assessments, and mitigation and response planning and measures (Wilhite et al., 2005).

3.2. Data collection and analysis

The evaluation draws from document analysis and literature reviews, as well as semi-structured interviews to assess drought preparedness. For the Brazil case, interviews were conducted in person and over the telephone with 24 key informants. Criteria for interviewee selection included; (1) proven expertise in water, climate, and/or drought management, and (2) diversity of perspectives, including officials from national, state, and local government agencies, water and climate related non-governmental organization (NGO) leaders, technical experts, professional association executives, and/or industry representatives. Once identified, key

[8] These refer to rain-fed cisterns, which individually are able to store 16,000 l of water, enough for a family of five to have water for drinking and cooking for a period of 6 to 8 months.

[9] Resilience is defined for this study as the ability to absorb and withstand disturbances, the capacity to adapt and learn, and the capability to rapidly recover and flexibly reposition to new opportunities.

informants were contacted via email, and then upon affirmation of participation, the study team emailed a checklist for the participant to complete before the interview. The checklist served dual purposes. First, it allowed for a quick numerical snapshot on the extent to which drought preparedness mechanisms were currently being implemented (i.e., from 0 to 3, 0=none,1=minimum, 2=some/average, and 3=maximum, based on the factors outlined in Table 1), which served as cues for probing questions during the interviews. Second, sending the checklist beforehand allowed the participants to become familiar with the types of information in which the project team was interested with respect to drought preparedness and policies.

During the interviews, the team gathered information on the status and effectiveness of past and current drought preparedness and policies, as evaluated against recent extreme droughts. Most importantly, the interviews focused on particularly innovative ideas or important elements of the national or sub-national case examples to offer lessons (both positive and negative experiences) from which decision makers in the Federal, regional, state, and local levels might consider when perfecting their own drought preparedness policies. The study team evaluated the interviews to identify recurring themes, policy gaps and lessons/recommendations that participants deemed especially important or relevant.

4. Evaluation and discussion

This section describes the most important drought preparedness mechanisms in the Brazil national and sub-national Ceará case, as gathered from the interviews and document reviews, and also as illustrated during recent drought events. The information for each of the cases is presented in the format of the analytical framework categories i.e., (1) monitoring and early warning/

Table 1
Emergency actions associated with the Casa Civil's Integrated Committee.

Sector	Program	Deccription and responsibility
Water delivery	Operação Carro-Pipa, or operation water delivery trucks	These are under responsibility of the MD, more specifically the National Army, and coordinated by the SEDEC/MI. From 2011 until April 2013, the MI disbursed US$ 325 million and hired 4649 water trucks, which have supplied more than 3 million people in 763 municipalities in the Northeast. For a municipality to receive carros-pipa, it has to be under a situation of emergency and have a Municipal Coordinating Organization of Civil Defense (COMDEC). Yet, in the most vulnerable and distant rural communities where communities lack operational capacity for a COMDEC, carros-pipa are oftentimes either opportunistically used by candidates and public servants as instruments of political campaigns to gain votes, or deployed by local firms (i.e. *pipeiros*), which have historically used drought episodes to sell either water trucks or raw water for high prices. In these cases, the water is sometimes polluted, exposing people, mostly children and the elderly, to gastrointestinal and dermatologic diseases.
	Rain-fed water cisterns construction for human supply and for production[a]	Part of the *Water for All* Program which is under the *Brazil Without Misery* policy and has the goal of universal water access and use by populations in extreme poverty. It is under coordination of MI (DNOCS and CODEVASF) and MDS under the *Cisterns Program*. NGOs are involved in this process, mainly through the ASA, which along Federal intervention, has spurred the construction of a network of 400 thousand cisterns, since 2003, for human supply, through P1MC.[b]
	Well drilling and recovery	Under the responsibility of SEDEC/MI. The diagnosis on the need and where depends upon the Integrated Committee to Combat Drought and the information provided by the MI.
	Building dams, aqueducts and pumping stations	Under responsibility of DNOCS, SUDENE, and CODEVASF.
	Installing deep wells of large flows in sedimentary basins	Done to initiate a strategic network of permanent sources of water supply, and wells in crystalline rocks in the most drought prone municipalities. This is under the Geological Service of Brazil/MME (CPRM or former Research Company on Mineral Resources).
Support to Farmers	Garantia-Safra	Granted to farmers affected by the drought, with income up to 1.5 times the minimum wage, who joined the program and lost at least 50 percent of the production of maize, beans, rice, cassava, and cotton, or were not able to plant, due to climatic conditions. Between 2011 and 2013, it has helped around 769 thousand farmers in 1015 municipalities. It is under coordination of the MDA.
	Bolsa Estiagem	Created in July 2012, has assisted more than 880 thousand families in 1316 cities of the Northeast. It consists of a benefit up to US$ 760 and is disbursed in monthly tranches of US$ 40. It is granted to smallholder farmers with income of up to two minimum salaries, and those who did not join the Garantia-Safra in 2011/2012, but are registered in the Cadastro Único of Social Programs (e.g. Bolsa Família of the federal government). It is an emergency tool covering the area of intervention of SUDENE. For other drought affected municipalities under an emergency or calamity state, the benefit is of US$ 200. The program is under coordination of the MI.
	Selling maize for animal feed at subsidized prices	Granted to producers acknowledged by the National Program of Family Agriculture (PRONAF) and located in municipalities declared as in public calamity. It is under responsibility of the Ministry of Finance, the Ministry of Planning, and of the National Company of Supply (CONAB), linked to the Ministry of Agriculture, Livestock and Supply (MAPA).
	Expanding emergency credit lines to farmers, traders, and industry sectors	Available in the municipalities declared as in emergency or public calamity since December 2011, which are under the jurisdiction of SUDENE. The credit line uses resources of the Constitutional Fund for Financing the Northeast (FNE/SUDENE) and is administered by the Bank of the Northeast (BNB).
	Renegotiation of the debt of farmers	Also available to those located in municipalities in situations of emergency and recognized as such by the Federal Government. This is also carried out by BNB.
Support to municipalities	PAC equipamentos	The provision of backhoes, bulldozers, loaders, bucket trucks, and water trucks to affected municipalities for structural actions.
	Funds transfers	Simplifying the transfer of funds.

[a] Each cistern is able to store 16,000 liters of water, enough for a family of five people have water for drinking and cooking for a period of 6 to 8 months.
[b] Over US$ 600 million have been spent on cisterns in Northeast Brazil in the last 10 years.

prediction; (2) vulnerability/resilience and impact assessment; and (3) mitigation and response planning.

4.1. National

4.1.1. Monitoring and early warning/prediction

In Brazil, drought monitoring and early warning is supported by an array of various Ministries and agencies, including

- *Weather and climate forecasting*: National Institute for Amazonian Research (INPA); the Center for Weather Forecasting and Climate Studies (CPTEC), which belongs to the National Institute for Space Research (INPE); the National Center of Monitoring and Early Warning on Natural Disasters (CEMADEN). All of these entities are linked to Ministry of Science, Technology and Innovation (MCTI). The National Institute of Meteorology (INMET) also performs weather and climate forecasting.
- *Water resources information*: ANA, within the MMA, captures water data from a hydrometeorologic network with 283 telemetric stations, 1075 fluviometric stations and another 981 rainfall stations, all of which are distributed across the 12 Brazilian Hydrographic Regions. The information is captured and processed in Data Collecting Platforms, in partnership with the satellites of INPE. It aims at improving the evaluation of energy potential and the realization of water balance in "almost real time", in order to improve control of water resources, to make current data available to society, and to provide a broad conceptualization of rational and multiple water use. ANA also recently signed a cooperation agreement with many states that has state agencies sending their data to ANA.
- *Agrometeorological information*: INMET and Agrometeorological Information System (AGRITEMPO) of EMBRAPA (Brazilian Agricultural Research Company) are linked to the Ministry of Agriculture, Livestock and Supply (MAPA). By 2014, in partnership with the Interamerican Institute of Cooperation for Agriculture (IICA) and the World Meteorological Organization (WMO), INMET expects to have innovative and consolidated technologies in the areas of weather forecasting, meteorological observations, storage and processing of data, modeling, simulation scenarios, climatology, remote sensing, monitoring, research, and development fully deployed. This will promote the integration with national and international meteorological systems and propel greater ownership of INMET products by conventional users and farmers (IICA, 2013). This effort presents an opportunity for also improving drought preparedness through better coordinated monitoring and early warning/forecasting.
- *Research*: Laboratories and Federal Universities are of great importance for national drought monitoring. Still, many of the most innovative efforts in this realm are at state level, such as: Ceará Foundation for Meteorology and Water Resources (FUNCEME); Centre for Meteorological and Climate Research Applied to Agriculture (CEPAGRI/UNICAMP); Institute of Astronomy, Geophysics and Atmospheric Sciences (IAG/USP); Institute of Meteorological Research (IPMET/UNESP); Technological Institute of Paraná (SIMEPAR), Centre for Information on Environmental Resources and Hydrometeorology of Santa Catarina (CIRAM), University Center of Study and Research on Disasters, in Santa Catarina (CEPED/UFSC), among others.

Despite the work of several federal and state agencies to develop monitoring/forecasting and early warning systems, the precision, coordination, and use of these systems needs further improvement in order to allow for more efficient and informed decision making. The atmospheric and oceanic field collection stations, as well as the models made possible by the data collection station are regarded as relatively high quality. However, as is often the case with translating data and information into decision support tools, scientists and researchers are often frustrated by the misinterpretations regarding the probabilities and statistics associated with the data and information. Moreover, there is an expressed need for a more comprehensive understanding of the institutional relationships and technical compatibility/interoperability within and between federal and state agencies with respect to meteorological, climatological, hydrological, and agricultural data, information, and tools. One recent study describes these relationships and capacities across several state and federal agencies. However, this evaluation, which focuses mainly on meteorological data and information, does not include all states, nor does it investigate other drought-relevant data and information (e.g., agricultural and hydrological).

Finally, there have been proposals over the past few years to institutionally integrate efforts, through an Agreement of Cooperation between INMET (essentially the equipment and data collection infrastructure) and CPTEC (essentially the technicians and tools developers). The ultimate purpose would be to build a Monitoring System, integrating products (tablets, mobile, and web) and applications, in collaboration with CENAD. Again, along with the INMET/IICA technological innovation initiative, bringing INMET and CPTEC together for the purpose of better institutional coordination represents an important opportunity to improve drought preparedness through monitoring and early warning. In this context, it would also be important to include ANA/MMA to ensure that hydrological data and information is also integrated.

4.1.2. Vulnerability/resilience and impact assessment

At the national level, vulnerability/resilience assessments have not been formalized, nor have the networks for monitoring and evaluating associated vulnerability indicators. Raising awareness of the importance of these exercises through participatory processes are under discussion, as noted above, and they still need to consider economic analyses on the costs and benefits of drought preparedness.

On impacts reporting, thanks to the strong collaboration with the states and the academia (e.g., CEPED/UFSC), SENAD recently produced the Brazilian Atlas on Natural Disasters. The aim of this work was to compile and make information available on the registered disasters in the country between 1991 and 2010, by producing 26 State Volumes and one Brazil Volume. Thus far, these publications are the first of this kind in the country, which were able to integrate historical records, enabling the elaboration of thematic maps and an analysis of the frequency of the observed patterns, the periods of highest incidence, and their relations with other global climate events. Gathering all needed nationwide information from 1991 onwards became a pioneering experience because, during the research period, it was not possible to find any systematized information or data base on disaster occurrence. From October 2010 to May 2011, CEPED researchers went to the 27 Brazilian capitals to gather all official data from the CODECs and SENAD to digitalize all relevant information using a portable scanner. This effort provides a benchmark of a historic overview of the occurrence and recurrence of disasters in the country and their specificities. Notwithstanding this result, it would be important for future assessments to include climate change projections in States and Regions, in order to support planning and management for drought preparedness and climate resilience.

4.1.3. Mitigation and response

The federal government recognizes one of two special states that can be declared by an affected region during a drought event: (1) a Situation of Emergency (less severe); and (2) a State of Public

Calamity (more severe). Guidelines for the declaration of either indicate that their situation/state should be as short as possible, lasting only for as long as it is strictly necessary for reestablishing normality, and also only include the areas affected by the drought declaration. By definition, the Situation of Emergency is an abnormal situation provoked by disasters that cause damages and losses, which are grave enough for the local government to be partially unable to respond. The State of Public Calamity is an abnormal situation provoked by disasters that cause damages and losses, which are grave enough for the local government to be substantially unable to respond. Despite this differentiation, there is not a systematic procedure for how to make the declarations for the municipalities and what necessarily distinguishes between public calamity and emergency. The decision relies on whether or not there is local capacity to support municipal response action on the environmental, economic, and social impacts of the disaster.

The procedure of declaration of one of these states is, in a simplified way, as follows: The Mayor of an affected municipality declares the abnormal situation and sends a homologation request to the State Government. Once homologated by the state, the Federal Government (i.e. through the MI) must approve and decide the length and affected areas, as well as the disaster's severity level before the situation of emergency or public calamity takes effect. However, the classification of the disaster is really assessed on a case-by-case basis and there is no evidence of a real trigger or specific methodology to follow. In some cases, state and/or federal officials might make an official inspection to the affected areas to evaluate and confirm the impacts are occurring. Funds approved by the MI for relief actions to the affected areas are based on this severity and according to the available budget, on a case by case basis. Without a specific set of proven criteria on which to base the declaration, it is often very politically driven and can often also lead to poorly targeted responses.

Broadly on mitigation policies, there are several important efforts that could eventually be integrated into a more coherent drought policy framework. First, there are several programs that are related to a diversity of natural disaster, which are structured and implemented by the MI, most recently through the National Policy of Protection and Civil Defense. This law was passed after a series of particularly devastating flooding events from 2008–2011, which made it strongly focused on response (over mitigation) and, most importantly, towards landslide and flood risk events (over droughts). It has not been regulated by Decree and it does not give much specific treatment to drought. Nevertheless, it includes a set of instruments that potentially relevant to drought preparedness, including: (1) Financial Resources and Planning for Civil Defense, currently envisioned under the National Plan on Risk Management and Response to Natural Disasters (2012–2014), which is divided into four themes: prevention, mapping, monitoring and early warning, and disaster response,[10] and (2) National System of Civil Defense (SINDEC), led by the National Secretariat of Civil Defense (SEDEC).[11]

Another important step at the federal level is the National Action Program to Combat Desertification and Mitigate the Effects of Drought (PAN-Brazil 2004), articulated through the guidelines of the United Nations Convention to Combat Desertification (UNCCD) and elaborated and led by the Ministry of Environment (MMA), with IICA providing technical cooperation. Even though the aim is to turn the PAN-Brazil into a policy, it deals more with initiatives to address desertification than those relating to mitigating the effects of drought. Still, while it might not contribute significantly to mitigating the immediate effects of drought, it could be eventually integrated into drought preparedness efforts in the mid- and long-terms (i.e., through avoiding land degradation and improving land management).

Perhaps the most relevant federal activity in recent years related to drought preparedness, in parallel with these other efforts, is a work group led by the MI, specifically under its Secretariat of Water Infrastructure (SIH), to identify principles for a national policy to mitigate the effects of drought. This group is formed by agencies directly linked to the MI.[12] It was originally created to prepare a national drought policy diagnosis for the Brazilian participation in the High-Level Meeting on National Drought Policy (HMNDP), facilitated by the World Meteorological Organization, the Food and Agriculture Organization, and the UNCCD, in March 2013, in Geneva, Switzerland. The work group is still active and in response to the commitments made by Brazil during the HMNDP to embark on more proactive risk-based management of droughts. Even though it is expected that this MI process will define objectives as well as sub-regional and sector guidelines to address drought, the process is not directly linked to the actions to prevent desertification nor the processes associated with SINDEC and SEDEC (both described above). Although the MI has political representation in the National Commission to Combat Desertification, it has not internalized the importance of desertification within its institutional vision and actions. With regards to drought management, both Ministries (i.e., MI and MMA) have overlapping priorities, but ill-coordinated programs, which highlights the existing inefficiency in articulating a single and consistent drought policy design.

As discussed, the severity of the 2010–2013 Northeast drought has moved beyond the typical agricultural impacts in that it is also affecting the supply of water for human consumption. These impacts have spurred the need to attempt to coordinate joint relief efforts from the federal, state, and municipal governments to meet the needs of the rural populations in vulnerable situations. Therefore, in addition to the federal efforts just described above, the Civil House of the Presidency created an interministerial committee (i.e., Integrated Committee to Combat Drought) to monitor and coordinate actions for this specific drought response in the semi-arid region, carried out by the federal, state, and municipal governments. The Integrated Committee was created for the response to the recent drought event, and for as long as it lasts, has all member institutions as the official data providers for policy and decision making. It is important to note that this Committee does not have any formal relationship to the previously discussed National Commission to Combat Desertification and Mitigate the Effects of Drought (via the MMA) nor to the work group for a National Drought Policy (via the MI), which were officially created for policy making purposes. Even though the Civil House Committee is able to provide immediate relief through the emergency actions as presented below, it is an instrument of temporary nature that could be better integrated into the dialog of policy construction of the MMA and the MI work group; since, (1) mitigating drought

[10] The planning foresees an investment of US$ 9.4 billion until 2014, to benefit 821 municipalities in the country as part of the Growth Acceleration Federal Program (PAC2). Specifically on drought, the plan maintains some focus on infrastructure approaches through the investments in the construction of dams, pipelines, and urban systems of water supply in the semi-arid region of the Northeast.

[11] SEDEC coordinates the National Center of Disaster and Risk Management (CENAD) and has 26 State Coordinating Organizations of Civil Defense (CEDECs), as well as Municipal Coordinating Organizations of Civil Defense (COMDECs) that cover at least 80 percent of the municipalities in the country.

[12] The MI work group (led by SIH) dealing with the design of a National Drought Policy is integrated across the MI through the Secretariat of Regional Development (SDR); the National Secretariat of Civil Defense (SEDEC); the National Department of Works against Droughts (DNOCS); the Development Company of San Francisco and Parnaiba River Valleys (CODEVASF); and, the Superintendence for the Development of the Northeast (SUDENE).

effects is still a priority of the Presidency, and there is a window to raise attention to a development policy towards drought preparedness; and, (2) the Integrated Committee also gathers representatives of different Ministries, which could contribute to a comprehensive and sustainable drought policy design and implementation that includes aspects of prevention, in addition to those of mitigation. For example, the participation of other sectors linked to MMA, including ANA, can integrate efforts of recovery and conservation within drought mitigation and prevention actions, as well as with soil and water management in drought prone regions like the Northeast. Thus, it is important to better coordinate programs to correct (prevent) the drivers that aggravate drought impacts.

As part of the emergency actions in place through the Casa Civil's Integrated Committee, the most current tranche of funding totals US$ 4.5 billion, which is on top of the initial US$ 3.8 billion of the PAC 2 to be spread out among strategic fronts, described in Table 1.

It is also important to highlight that there are other institutional actions associated with the Integrated Committee, particularly the creation of an *Emergency National Force on Drought*, formed by CODEVASF, DNOCS, CHESF, ANA, BNB, and CPRM, and coordinated by the MI. Notably, this effort is not directly linked to the MI drought policy work group; rather it is part of the "action package" within the Casa Civil's Integrated Committee. Its immediate action is to increase monitoring, evaluate the status of water supply in the Northeast, and indicate measures to mitigate the low water levels in the reservoirs. ANA, more specifically, has been directed to monitor 44 major reservoirs in the Northeast and to perform scenario planning on the water levels, provide technical capacity, and improve monitoring and instrumentation of the reservoirs.

Although there is a significant array of institutions and federal initiatives dealing with drought and disaster risk management in general and with the recent drought in particular, there could be improved articulation of responsibilities and integration between the federal, state, and municipal agencies. Moreover, there is a tendency to respond to the droughts rather than prioritizing strategic and proactive approaches to mitigating the droughts in the first place (i.e., other than the traditional large water infrastructure works). Institutional weaknesses are sometimes evident in terms of personnel and necessary capabilities to operationalize these proactive approaches. Changes of municipal governments with discontinuity of previous activities, disconnection with the population affected by the droughts, and changes in priorities make many regions even more vulnerable. Even though water management initiatives have been positively implemented by monitoring rainfall, building irrigation projects and dams, as well as assisting drought-stricken regions with water supply, the limited proactive planning has made structural works less effective. That is, it will likely be more successful moving forward if it is planned as an even more integrated and comprehensive development policy, placed into the context of current processes like the MI, Casa Civil, MMA, and SEDEC efforts, outlined above.

4.2. State of Ceará

4.2.1. Monitoring and early warning/prediction

The main stakeholders associated with drought monitoring in Ceará include

- The Ceará Foundation for Meteorology and Water Resources (FUNCEME), for monitoring and forecasting weather and climate.
- And the Water Resources Management Company (COGERH), and Superintendence of Water Works (SOHIDRA), which are both linked to the Secretariat of Water Resources (SRH).
- The Ceará Technical Assistance and Rural Extension Business (EMATERCE), for monitoring agricultural production and impacts, linked to the Secretariat for Agrarian Development (SDA).

Among other functions, SRH executes infrastructure projects and collects information on demand and supply within the basins, aiming at permanent control of water balances throughout the State. Currently, COGERH operates and manages, through an agreement with DNOCS, all major reservoirs in the State, accounting for over 90 percent of the state's water storage. Its work also involves the creation and support of Basin Committees, which integrate the bulk water users that, by 2012, accounted for 15,500 registered water users. COGERH publishes on its website current data for reservoir levels and rainfall in the state, based on a very strong collaboration with FUNCEME. There is also some collaboration between FUNCEME and EMATERCE with respect to agricultural drought.

Still, important challenges need to be overcome, mostly related to access to all data between state agencies, between the state and federal agencies, and in terms of increasing the use of the information and data by the local municipalities and cities. Currently, a partnership started in January 2012, between CPTEC, INMET, and FUNCEME expects to develop a suitable model to objectively integrate predictions from different federal and state institutions and produce a Northeast Drought Monitor (NEDM) for institutional and technical diagnosis of data and information services.[13]

4.2.2. Vulnerability/resilience and impact assessment

In Ceará, formalized drought vulnerability/resilience assessment is not very prominent beyond several academic institutions that have embarked on localized research projects. On impacts reporting and evaluation, specifically for the current multi-year drought, the State Legislative Assembly created, in March of 2013, a Special Committee to Accompany the Problem of Drought and Rainfall Prevision in the State of Ceará which, in July 2013, delivered a Partial Report of Activities that is meant to be turned into a technical opinion for policy making (Ceará, 2013). As with the National level, there is the Brazilian Atlas of Natural Disasters, Volume Ceará, created by the MI and the Center of Studies and Research on Natural Disasters from the Federal University of Santa Catarina (CEPED–UFSC). Specifically on drought, from 1991 to 2010 it has registered 1340 official recorded impacts across almost all municipalities in the state. Despite this piloting effort to integrate all data related to natural disasters in the state and the country, the Atlas is unclear on what is meant by *affected* (e.g. economically, environmentally, socially, health, cattle ranching, agriculture and/or water supply, etc.). Therefore, more clarity on definitions would be important in future iterations of the Atlas, as be including climate change predictions and their implications for water and drought management.

4.2.3. Mitigation and response

Despite recent coordinating efforts, there is not a clear drought institutional framework, nor a sustained mindset that people in the Northeast need to live in coexistence with droughts (i.e., the responses are mainly reactive, short-term, and suggest an element of being caught by surprise). Still, there have been a few pilot actions with a long-term view. After a very severe drought in 1998, the Hydro-environmental Development Project (PRODHAM) was implemented. PRODHAM is a multi-sector project in the semi-arid region to test the technical and social viability of soil and moisture conservation and to learn lessons

[13] This effort is also being supported by the World Bank.

from these experiences. As such, SRH used the technique of building successive dams of stones in order to retain sediments, involving local communities living in the area of this pilot to play a major role in order to mitigate both environmental and socio-economic degradation effects in four micro-basins. As a result, 3332 successive dams were built between 2001 and 2009, creating microclimates that ultimately provided increased reforestation, recovered riverine vegetation (47.6 ha), recovered degraded areas (5.3 ha), increased biological diversity by maintaining for longer periods the moisture storage in soils and reduced soil losses, and documented lessons learned. The Project was also a pioneer in building 27 underground dams to increase groundwater availability in the dry season

Even though the current drought is devastating the region, the existence of several programs has made people less vulnerable to drought, which include: (1) programs of social assistance since 2000 under the pioneering Zero Hunger Program (*Fome Zero*), which later integrated all social programs into *Bolsa Família*; (2) the construction of a network of 700,000 rainwater storage cisterns; (3) an increase in average household income; and (4) other social policies [e.g. rural retirement, the Food Acquisition Program (PAA), and the purchase of school meals (PNAE)]. These measures were not directly formulated as a response to the recent drought, but have served as tools to mitigate at least some of the devastating drought effects, especially in the Northeast. Overall, these programs have helped avoid a great social turmoil and have made possible decreasing migration rates from the countryside to the cities, as well as having dispensed the creation of work fronts (i.e. alternative income activities to unemployed people and farmers by building structural works during drought).

As mentioned, on the response, specifically upon the establishment of the National Integrated Committee, the Ceará government created its own Committee to Combat Drought in order to coordinate the various emergency activities and respond to the effects of drought. It officially involves local, state, and federal institutions, and works to coordinate the response and through weekly meetings to assess the drought situation. It attempts to "get ahead" of drought impacts through targeted and more coordinated activities. The Committee is still active because the reservoir levels are well below average for this time of year (i.e., the mean of water stored in Ceará dams is below 50 percent of their capacity).

Some of the actions of the Committee include the implementation of federal Programs, such as *Programa Garantia Safra.* Ceará is the state that has the maximum number of beneficiaries through this program, which reaches 240,000 farmers in the State. In 2013, the number of beneficiaries will be extended to 350,000 and the maximum value paid will be increased from US$ 350 to US$ 600. Another important action to minimize the impacts is the *Operação Carro-Pipa,* which has supplied water in 171 municipalities in the state through the Brazilian Army. Even though it becomes a key ally for water supply in dry periods, water is still used as currency for political interests and profit.

In light of the current activity in Ceará and at the federal level, it is imperative to take advantage of the political window of opportunity opened by the high level interest in this topic so as to better institutionalize any reforms that are developed.

5. Gaps and opportunities for drought preparedness and policy in Brazil

The gaps and opportunities are highlighted below in the three drought preparedness categories and also identified as either "shorter-term" issues, or those that can be more quickly addressed without the need for significant institutional or political reform, and "longer-term" issues, or those which will likely require more comprehensive measures and capacity building.

5.1. Monitoring and early warning/prediction

5.1.1. Integrating drought monitoring and forecasting data and technical capacity – longer term

Brazil has significant scientific and technical knowledge and expertise in meteorological, climatological, agricultural, and hydrological monitoring and forecasting. However, these capabilities are not always well-integrated within and between states and monitoring/forecasting communities of practice and networks have not been well-institutionalized. There is a need to systematically identify the reforms that are necessary to address these limitations and integrate across administrative levels (e.g., between municipalities, states, and the federal government). It is also important to improve the translation of the information into useable tools and products that make it into the hands of decision makers (from individuals up to state/national levels), and to foster and maintain a network of technical experts that can institutionalize drought monitoring and forecasting processes and products. Finally, there is also a perceived need to address the issue of subjectivity influencing the climate forecasting system.

5.2. Vulnerability/resilience and impact assessment

5.2.1. Expanding the role of international organizations – shorter term

Reportedly, there is difficulty in generating effective and sustained dialog between the states and municipalities. International organizations can play an important role in bringing external support to strengthen the role of institutions within the country that are working on these challenging issues across jurisdictions. For example, this strategy could be used to coordinate and plan participatory vulnerability and resilience assessment workshops with interested experts and stakeholders to produce priority indicators and mechanisms to monitor and evaluate impacts. In addition to helping convene the right stakeholders and experts, international organizations could also help to use the process to produce a targeted cost-benefit analysis on drought preparedness.

5.2.2. Improving data collection and information organization – shorter term

Currently, there is no national archive that provides comprehensive information on the effects of disasters for determining vulnerabilities and impacts trends, and eventually, whether natural disaster mitigation programs are proving to be effective in risk reduction. It would be particularly helpful to develop such a system that would ultimately integrate scientific and monitoring functions to support a broader drought policy.

5.2.3. Developing vulnerability assessments – longer term

Vulnerability and resilience assessments are important for proactive risk-based management for several reasons. First, they create a dialog amongst stakeholders before the crisis of drought hits so that priorities are discussed and negotiated during less emotive situations. Second, indicators and impacts reporting/tracking procedures established through these assessments can help improve the timing and expediency of planning and management once a drought hits. And third, tracking impacts (or lack thereof) can provide critical information for monitoring and evaluating the socio-economic benefits and costs of drought preparedness (i.e., making the cost-benefit analysis case for drought preparedness to policy makers). For these reasons,

emphasis on such assessments could improve drought preparedness in Brazil.

5.2.4. Improving economic and social impacts understanding – longer term

Despite the severe nature of the current drought situation in many regions throughout Brazil, higher-levels of decision making are often slow to react to the immediate and long-term needs of these regions. Developing mechanisms for real-time reporting of social and economic impacts, as well as developing robust economic analyses on the benefits of drought preparedness and risk management could help raise important attention regarding the severity of these and similar future situations.

5.2.5. Introducing climate change projections into impact assessments – longer term

There has been a great effort to provide the Brazilian Atlas of Natural Disasters (1991–2010) as a benchmark for an historic overview of the occurrence and recurrence of disasters in the country and their specificities. Notwithstanding this development, it would be important for future assessments to include climate change projections in states and regions in order to support planning and management for drought preparedness and climate resilience (i.e., learn from past disasters, but also utilize forecasts, scenarios, and projects of future conditions).

5.3. Mitigation and response planning and measures

5.3.1. Taking advantage of droughts to advance the conversation and facilitate learning and action, and conducting systematic reviews of where things are and where they need to be – shorter-term

Proactive, risk-based approaches do not develop overnight. Rather, the shift takes many years of bold intentions after a particular drought event, only to be effectively watered down in subsequent non-drought years. There appears to be overlapping drought related duties and responsibilities between MI (e.g., drought coordination and response through the Emergency National Force on Drought, as well as the drought policy discussion within the work group), MMA (e.g., desertification and adaptation to climate change), and Civil House of the Presidency (e.g., Integrated Committee during droughts), with limited coordination between the various efforts. The process of improving integration and articulation of responsibilities will require the leadership and guidance at the highest levels of decision making, however. The work group, the MI′s contributions to the HMNDP, and the current extreme droughts ravishing large portions of the nation, however, create a potential window of opportunity to raise this as an even greater national priority; particularly to gain the focused attention of the President and the Civil House of the Presidency. In Ceará, there is also a potential window for discussing a drought policy through the Integrated Committee to Combat Drought. Clarifying and better integrating these promising activities should be a priority. There is a chance that Brazil will find itself in a similar situation in the coming years, and decision makers should be ready to expediently evaluate, review, and improve.

5.3.2. Improving institutional memory and administrative continuity – shorter term

Related to the above point, it is important to strengthen the institutions at different levels to build real and sustained capacity for managing droughts. A lot of "reinventing the wheel" occurs within local municipalities after a change in political leadership; leaving these officials scrambling and struggling to protect their citizens during times of drought. In many areas that are not as familiar with droughts, there are few if any contiguous and ongoing policies for drought preparation and response. Finally, and perhaps most importantly, in many regions there can be rapid shifts from extreme droughts to extreme flooding, and thus, it might be worth considering coordinated policies that build climate resilience.

5.3.3. Designing robust and sustained social safety nets that reach into the heart of rural areas – shorter term

Investments are needed for reaching dispersed rural communities affected by droughts through social policies and relief mechanisms that provide continued development and commitment to these vulnerable populations. In some areas, such as in the case of Ceará, access to credit during droughts has been bureaucratic and piecemeal. Also, many rural communities have defense mechanisms to address droughts, but it is well understood that social capital and networks represent the main facilitative function for these informal coping mechanisms. There is a need to strengthen communities and reduce vulnerability to droughts by reinforcing and building from these social capital networks and community building opportunities.

5.3.4. Clarifying and integrating institutional responsibilities – longer term

There is a need to evaluate and provide clarity on the roles and responsibilities of the various institutions involved with drought preparedness (e.g., who is ultimately responsible for vulnerability assessments, monitoring, mitigation and adaptation actions, relief and recovery, etc.). For example, based on the interviews conducted for this study, the modern roles of DNOCS and SUDENE are unclear, and how these organizations overlap with or complement other institutions at the federal and state level is not well-defined. Also, various policy, planning, and management efforts being led by the MI, MMA, Casa Civil, and SEDEC, for instance, are reportedly not well-integrated despite a shared focus on droughts and/or disaster risk management. Again, better integration and articulation of responsibilities will ultimately need to be orchestrated by a lead individual and/or agency at the highest levels of decision making and also must win the buy-in from other decision making entities involved with mitigating and responding to droughts (e.g., other federal agencies, Congress, etc.).

5.3.5. Articulating the role of drought preparedness in the context of watershed management areas – longer term

The relatively new water reforms across Brazil do not directly address the issue of drought planning and management. A more coherent drought policy might benefit from focused consideration and clear definitions and responsibilities with respect to the role of river basin committees and management bodies in drought preparedness (e.g., drought stages and forecasts provided at the river basin scale, plans implemented by the Committees, etc.). Furthermore, guidelines are nonexistent on how states and municipalities should act in preparedness and mitigation of droughts.

5.3.6. Improving the currently limited, scattered, and usually reactionary financing mechanisms – longer term

The Brazilian system does not have robust and dedicated funding mechanisms to address droughts. There are opportunities to build from current existing broader social safety net systems and water charging mechanisms to fund drought preparedness, but these will require bold political action and could take a significant amount of time. Additionally, states largely depend on these dwindling federal resources and lack adequate funding mechanisms of their own.

6. Conclusion

The recent droughts that have hit Brazil are spurring a familiar dialog within the country to improve drought policy and management. In the past, this conversation has waxed and waned with respect to the drought cycle, with only incremental progress being made to foster more proactive risk-based drought preparedness approaches.

The drought currently affecting the Northeast, however, is the most intense and impactful in several decades. Along with the impacts and subsequent federal and state responses to these impacts, the increased attention worldwide to draft and implement coordinated national drought policies around the concept of drought preparedness, and national and international attention on building climate change resilience, Brazil has a unique opportunity to better institutionalize these proactive approaches to drought management that have thus far eluded some decision making processes throughout the country.

Acknowledgments

The work presented in this paper was conducted by the World Bank and funded in part by the Spanish Fund for Latin America and The Caribbean. The authors are grateful for comments on the manuscript from colleagues at the World Bank and also the input from two anonymous peer-reviewers.

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