Evaluating national drought policies
A comparative analysis of Australia, Brazil, Mexico, Spain and the United States

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Resumo

Este artigo desenvolve enfoque de três pilares relacionados à preparação para as secas e faz uma revisão das políticas nacionais de secas de Austrália, Brasil, México, Espanha e Estados Unidos. O artigo considera como esses países têm levado em conta este enfoque original para avaliar a extensão em que eles têm tomado ou estão tomando medidas direcionadas àquestão da vulnerabilidade às secas. O artigo analisa a experiência histórica e institucional de preparação para as secas nesses cinco países e os compara de acordo com a moldura apresentada neste estudo.

Abstract

This paper develops a three pillars framework of drought preparedness and reviews the national drought policies of Australia, Brazil, Mexico, Spain and the United States according to this original framework for evaluating the extent to which countries have taken or are taking measures to address drought vulnerability. It analyzes the historical and institutional backgrounds of drought preparedness in these five countries, and compares them according to the framework presented in this study.

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Introduction

Due to the specific characteristics of drought events, policies that aim to improve a country's preparedness level have to be able to deal with climate-related challenges as well as the social and economic circumstances of affected regions. With extreme weather events becoming more common in the coming years, drought prone regions that already have to deal with climate challenges could become even more vulnerable with regards to social and economic conditions (IPCC, 2012). The high social and economic costs associated with droughts – stemming from increased evapotranspiration, reductions in arable land, and ultimately greater food insecurity (WORLD BANK, 2012a) – as well as its characteristic slow-onset occurrence, makes it even more urgent that policymakers understand how to implement proactive measures to deal with those events.

Given these important challenges associated with droughts, there has been an international call for developing national drought policies[4] . In addition, there is a growing consensus around the importance of drought preparedness principles that help countries incorporate proactive mitigation and planning measures into a national policy (WILHITE *et al.*, 2000). Despite these efforts, there are only a few concrete examples of national policies or strategies around the world from which policymakers can learn (WESCOAT, 2009).

The work presented in this paper proposes to fill this knowledge gap by doing a comparative analysis of five countries – Australia, Brazil, Mexico, Spain and United States – and developing an original framework for evaluating the extent to which countries have taken or are taking measures to address drought vulnerability. At these higher scales of decision making, drought preparedness involves monitoring and forecasting, vulnerability/resilience and impact assessments, and mitigation and response planning and measures (WILHITE *et al.*, 2005). These "three pillars" of drought preparedness encapsulate the principles that guide the framework presented in this paper.

4 For example, the High Level Meeting on National Drought Policy (HMNDP), that took place in Geneva, Switzerland, in March 2013, was organized by the World Meteorological Organization (WMO), the Secretariat of the United Nations Convention to Combat Desertification (UNCCD) and the Food and Agriculture Organization of the United Nations (FAO), in collaboration with a number of UN agencies, international and regional organizations and key national agencies.

The paper is organized as follows: Section 1 below discusses the analytical framework utilized by the paper to evaluate national drought preparedness (that can also be transferable for implementing proactive drought preparedness programs) and the methodology implemented to collect the data for this study. Section 2 reviews the background of the five countries included in the analysis, focusing on the context surrounding their most recent droughts. Section 3 presents an overview of the main institutions related to drought preparedness in each country and reviews the results according to the framework adopted in the paper. Section 4 compares the countries' advancements based on the paper's three pillars framework and methodology. Finally, a brief conclusion summarizes the lessons learned from this comparative analysis.

1. Framework and methodology

1.1. Theoretical framework

The work presented in this paper relies upon a framework for drought preparedness that has been consolidated from various literatures, as well as from dialogue with and presentations from international drought experts (i.e., WILHITE *et al*, 2014 and BAZZA, 2001). The framework is organized into "three pillars" and is applied in this paper to evaluate institutional progress related to drought preparedness in different countries. The three pillars are: 1) monitoring and early warning/forecasting; 2) vulnerability/resilience and impact assessments; and 3) mitigation and response planning and measures (see Figure 1).

These drought preparedness measures are similar to the World Bank's work on disaster risk management (WORLD BANK, 2012b). According to this framework, disaster risk management (DRM) is defined as "risk identification; risk reduction; preparedness; financial protection; and planning for disaster recovery" (WORLD BANK, 2012b, p.10). In the framework presented here, aspects of financial protection are considered part of mitigation strategies. In addition, the UN International Strategy for Disaster Reduction and the Hyogo Framework for Action (UN/ISDR, 2007) also presents similar elements with regards to DRM that can be adapted for a drought risk reduction framework. Although DRM approaches have often neglected drought-related crises because of its particular slow-onset, gradual occurrence nature, the implementation of the three pillars framework can help officials operationalize DRM principles into drought management. What distinguishes the proposed framework is the interconnected analysis that considers the natural event, aspects of social and economic vulnerability, and political action. The framework,

as depicted in Figure 1, below, supports efforts that move away from reactive, crisis management approaches and focuses on pre-event actions.

The first pillar refers to monitoring and early warning systems that are the foundation of all other elements of proactive drought policy and management. It includes the integrated monitoring of relevant indicators (e.g., precipitation, temperature, evapotranspiration, seasonal weather forecasts, soil moisture, streamflow, ground water, reservoir and lake levels etc.) and the use of appropriate indices through a coordinated effort by individuals, institutions, and information systems. It requires the integrated analysis of the data with concrete tools that can be used by decision makers. According to the UN-Water Proceedings of the Regional Workshop on Capacity Development to Support National Drought Management Policies for Latin America and Caribbean Countries (UNW-DPC Proceedings): "A drought-monitoring system is important since it allows for early drought detection, improves response (by being proactive), 'triggers' actions within a drought plan, is a critical mitigation action and forms a foundation of a drought plan" (UNITED NATIONS. Proceedings, 2014, p. 34). The objective of this pillar should be to improve the quality of the information and to address the issue of subjectivity influencing the climate monitoring and forecasting systems.

Secondly, risk assessment is "the process of identifying, quantifying, and ranking the vulnerabilities in a drought scenario, which means the assessment of threats from potential droughts to the population, infrastructure and environment. Other aspects are also involved in the assessment, namely the socio-economic and institutional analysis, the estimation of the duration of the exposure to droughts through weather forecast and the definitions of minimum capacities and measures to be taken" (UNITED NATIONS. Proceedings, 2014, p. 40). The second pillar, therefore, allows stakeholders to engage in a dialogue before the occurrence of droughts so that priorities can be negotiated based on "who" (stakeholders) and "what" (economic sectors) is vulnerable to drought. In addition, indicators and impacts reporting procedures established through these assessments can help improve the timing and expediency of planning and management once a drought hits. And third, tracking impacts can provide critical information for monitoring and evaluating the socio-economic benefits and costs of drought preparedness so that communities can work to strengthen capacity and resilience.

Finally, mitigation and response planning involve proactive measures to increase a community's coping capacity as well as response measures that support the principles of risk reduction. First and foremost, this third pillar includes an operational drought response plan that has pre-negotiated triggers and actions for when and how different sectors should respond to mitigate the drought impacts. Importantly, based on the vulnerability and risk assessment and linked with the monitoring/early warning systems in the first pillar, short and long term structural

measures "should address the root causes of vulnerability, so that their implementation results in increasing capacities to cope with drought and reducing impacts" (UNITED NATIONS. Proceedings, 2014, p. 45). In this sense, having elements of the plan that can be implemented in 'non-drought' times is important for building long-term resilience and drought preparedness. Developing proactive policy approaches to droughts takes significant effort and commitment in terms of planning and institutional coordination. The process of improving integration and articulation of responsibilities requires leadership and guidance at the highest levels of decision making. Related to this, it is important to build upon and strengthen the institutions at different levels to develop dedicated and sustained staff and capacity for managing droughts.

The interaction among the three pillars illustrated in Figure 1 means that drought planning should be viewed as an ongoing process (WILHITE *et al.*, 2005) that has its foundation on a solid monitoring and early warning system, which is linked to the evaluation of a region's vulnerability and exposure, on through to policy and management action triggers and long-term planning and investment decisions that are, in turn, based on previously negotiated action plans.

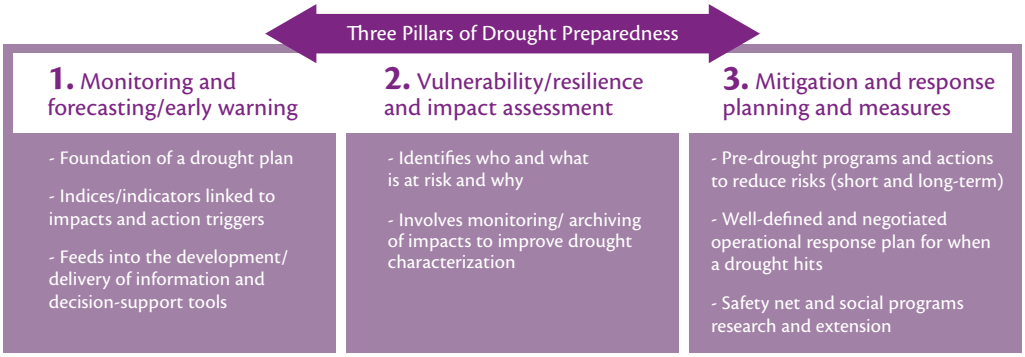

Figure 1. The three pillars of drought preparedness that support more proactive approaches to drought events. Source: World Bank.

1.2. Data collection and analysis

The evaluations in this article draw from a rapid World Banks assessment that included document analysis (e.g., legislation and government reports) and literature reviews, as well as semi-structured interviews to evaluate drought preparedness (based on the framework outlined above) in five countries. The countries were selected by the World Bank team to provide as much learning potential as possible for understanding a wide range of drought preparedness

approaches in countries that have faced recent and significant drought risk. Interviews were conducted in person and over the telephone with 18 key informants for the Australia case, 24 key informants for the Brazil case, and 5 key informants for the U.S. case. For the Mexico and Spain case, telephone interviews were conducted with 6 and 14 key informants, respectively. Data collection took place in January-April 2013, which does not fully reflect eventual changes in the countries' policies since then.

Interviewees were selected according to the following criteria: 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. Informants were contacted via email, and then upon affirmation of participation, the study team emailed the checklist for the participant to complete sometime before the interview. The checklist allowed for a quick numerical snapshot of the extent to which drought preparedness mechanisms were currently being implemented, which served as cues for probing questions during the interviews. In addition, 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[5].

The interviews focused on particularly innovative ideas or important elements of case examples to offer lessons (both positive and negative experiences) from which decision makers might consider adopting when perfecting their own drought preparedness policies and make recommendations. The study team evaluated the interviews to identify recurring themes and lessons/recommendations that participants deemed especially important or relevant.

2. Background

The five countries analyzed in this article have a long history of drought events, and the most recent events reveal what has changed and what still needs to be done in dealing with severe crises in each country. Australia has one of the only national drought policies in the world. The country's history of extreme climate variability and experience in responding to droughts, such as the 1997-2009 "Millennium Drought" in the southeastern areas of the country, combined with the prolonged drying in the southwestern areas from the 1970s to present day, provide examples of how it has managed extensive dry periods. Given the predominance of medium

5 The checklist and interview questionnaires are available upon request.

and large farms, with good infrastructure and market access, the country has been able to move its drought policy towards building individual resilience. The Millennium Drought (1997-2009) affected large portions of eastern Australia and the significant river basin area known as the Murray Darling Basin (MDB). Analyses of the Millennium Drought indicate that this event was unprecedented for the MDB compared to all other droughts recorded since 1900, and included a 13 percent reduction in rainfall and an estimated 44 percent reduction in streamflow across large areas of the MDB (CSIRO, 2010).

In Brazil, vast regions of the country are currently engulfed by a multi-year extreme drought. In areas like the semi-arid Northeast, the recent drought (2010-present, but most severe during 2012-2013) has been one of the worst in the past decades (CEARÁ, 2013). The impacts have been acute during 2013 in terms of water availability, leaving dams and streams completely dry, causing a lack of drinking water, and proving devastating to some agricultural and industrial producers. The recent drought in the Brazilian semiarid reveals the accumulated effect of many previous droughts not only in the economy, but also "exacerbate many social problems through the indebtedness of farmers, migration, disease, and malnutrition, among others" (GUTIÉRREZ, 2014). The region of São Paulo, on the other hand, is also currently going through a water crisis that has been threatening the water supply of more than 6 million people. Rainfall in the area of the *Cantareira* reservoir system has been the lowest on record and the level of the reservoir is down to 7.1% of capacity (The Economist, "São Paulo's water crisis").

A significant portion of Mexico is characterized as arid and semi-arid; primarily the Northern states of the country. During 2012, the drought in Mexico was severe. Overall, more than 50 percent of the country was affected by an extreme event (DELGADO *et al.*, 2012). The deficiency of precipitation started in 2010 and extended up to 2012. The Standardized Precipitation Index (SPI) values were close to -2.5 across much of Mexico and positive temperature anomalies and negative precipitation anomalies were much higher than recent years (MAGAÑA and NERI, 2012). Effects were devastating, with the national economy having losses estimated in US$ 1.46 billion for agriculture alone (ESCALANTE, 2012). Other losses included economic, environmental and social impacts (DÍAZ *et al.*, 2012).

The two most recent major droughts in Spain affected a large portion of the Iberian Peninsula in 1991-1995 and 2004-2007. The period of 1991-1995 was extraordinarily dry in most of the center and south of the Peninsula (including the Júcar river basin), and most drought management was performed through royal decrees backed by "exceptional situations". For the most part, actions were designed and planned reactively as the drought developed. About 12 million people were affected by human water consumption restrictions and the losses in the agricultural sector were estimated between 250,000-375,000 millions of USD per year for the period of 1992-1995

(ESTRELA, 2006). The following severe drought in 2004-2007, was managed quite differently. Through a more proactive manner, managers generally mitigated its effects, resulting in minimal significant human water consumption impacts, mainly through crop irrigation restrictions (ESPANHA. Ministerio de Medio Ambiente, 2008).

For the United States, the year of 2012 was one of the hottest on record. A widespread and intense drought that was born out of these high temperatures and significant rainfall/snowpack deficiencies resulted in one of the most severe droughts that the U.S. has experienced in 50 years. As it rapidly accelerated in July, August, and September at least 65 percent of the country was engulfed by some level of drought (i.e., moderate, severe, extreme, or exceptional) (NIDIS, 2013), and over half of U.S. counties had been designated as agricultural disaster areas (i.e., nearly 1,600 counties in 32 states)[6].

3. Results

Here, we highlight the findings of the analysis by presenting the institutional context for drought preparedness in each country, focusing on the fundamentals of previous and present drought policies and how they evolved over time. In the associated tables for each country, we focus on how these institutional structures and policies can be considered a starting point for developing the three pillars framework.

3.1. Australia – institutional context

Water institutions, management, and planning are technically separate from the national drought policy, but still represent a critical element of drought preparedness in Australia (although not framed in the context of drought preparation and response). States and territories have constitutional responsibility for water, and in most rural regions, have developed water sharing plans which define how water is shared amongst users which include extractive users (e.g., irrigation activities, consumptive pool, stock and domestic) and the environment. State and territory governments make annual allocation announcements that identify how much water is available for use after taking into account the annual inflows from rainfall, dam storage levels (current and expected), and any commitments to water which were made from the previous water year that have yet to be delivered to users. Entitlements (separate from land) provide

6 United States Department of Agriculture, Economic Research Service, 2012. "U.S. Drought 2012: Farm and Food Impacts".

perpetual shares to a prescribed resource. Both the entitlements and any annual allocations made by state or territory governments against the entitlements are able to be traded in separately defined water markets. During the recent drought, the well established water markets within the southern connected MDB afforded greater flexibility to water users to manage their irrigation businesses through either using entitlement or allocation trade markets.

Prior to the 1990s, Australia relied on reactive, relief-based programs to address droughts (i.e., the Natural Disaster Relief Arrangements). In 1992, Australia introduced its national drought policy, which remains one of the only national drought policies in the world. This policy is specific to agriculture, and represents the beginning of a shift in drought management that aimed to prioritize self-reliance and risk management over reactive mechanisms amongst agriculture producers. Despite the intention of self-reliance, however, some of the drought programs introduced, particularly under the Exceptional Circumstances (EC) policy, tended to institutionalize less proactive behavior amongst many farmers (PRODUCTIVITY COMMISSION, 2009). Not only was the EC process relatively lengthy, many have criticized it as a disincentive to proactive and whole-farm risk management because it encouraged many farmers to hold out taking preemptive measures (e.g., selling off livestock, diversifying cropping, etc.) and instead wait for federal support. Finally, the EC process was criticized as a specific response to droughts because it was often triggered in situations resulting in reductions in income that are were necessarily tied to drought conditions (i.e., "exceptional circumstances" were not truly "exceptional"). In 2008, after over a decade into the Millennium Drought, the federal government embarked upon a national review process to evaluate the efficiency and effectiveness of Australia's drought policy and associated programs, which resulted on a framework for a "new package" of drought programs to improve proactive risk preparedness for farmers and their businesses and replace the EC arrangements.

3.2. Brazil – institutional context

The Federal Constitution of 1988, which extended the public domain over water, initiated in Brazil a new period of management and control of water resources. Along with the principles set out in the Constitution, the 1997 National Water Law, and the National System of Water Resource Management, Brazil aimed to improve planning with regards to water and to define it as a limited resource with economic value. The National Water Law established the River Basin Committees, introducing the idea of decentralization and public participation, and including federal, state and municipal government representatives, user groups, and members of civil society in the task of managing the country's water resources (Federal Law nº. 9433, 1997). The National Water Agency (ANA) was created in 2000 to implement, control and evaluate the management instruments created by the National Water Law.

Despite these advances in water management, Brazil does not have a national drought policy, and government interventions have been characterized as reactive and uncoordinated. The National Civil Defense System, which is responsible for preventing and mitigating disaster situations, commands the government actions against droughts. The System is part of the Ministry of Integration (MI) and composed by the National Council of Civil Defense, state civil agencies, and municipal agencies. Efforts to improve infrastructure have been led by the National Department of Works against Drought (DNOCS), but those have not been able to displace emergency response. The adoption of measures such as water tank trucks, rain-fed water cisterns construction, well drilling and recovery, dam and pumping station construction have been mostly insufficient for dealing with severe crises. Institutions such as the Superintendence for the Development of the Northeast (Sudene) and the Bank of the Northeast (BNB) developed drought policies within the context of regional development policies, but these projects were not able to move towards a proactive approach and have become less relevant.

There is a growing interest in Brazil to shift away from reactionary to a proactive approach and to develop more cooperative responses among these various institutions (MAGALHÃES and MARTINS, 2011). The National Action Program to Combat Desertification and Mitigate the Effects of Drought (PAN-Brazil 2004), elaborated under the Interamerican Institute of Cooperation for Agriculture (IICA) technical cooperation, led by the Ministry of Environment (MMA) with the guidelines of the United Nations Convention to Combat Desertification (UNCCD) is an important example. During the recent drought of 2010-2013, MI led a work group to discuss and design a National Drought Policy proposal.[7] To this end, MI is currently endeavoring to shift the paradigm in Brazil toward making investments in proactive approaches to droughts.

3.3. Mexico – institutional context

To understand drought management in Mexico, one must first understand the institutional framework of the water sector. Mexico's current water governance system is multi-layered and multi-faceted in order to match different water users and uses in the country that operate at different government levels. Drinking water, irrigation, hydropower, and environmental needs are managed at federal, state, municipal, and basin levels (OECD, 2013). The main federal institutions

7 The MI work 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, it has engaged stakeholders from civil society, as well as from the public and private sector in a broader consultation on the national drought policy in the beginning of 2014.

and agencies involved in water resources are: (1) The National Water Commission (Conagua), a de-concentrated body under the mandate of the Ministry of Environment (Semarnat) and serves as the main actor in water policy; (2) Semarnat, which formulates and conducts national policy, contracts, concessions and permitting related to natural resources, ecology, environmental sanitation, water, environmental regulation of urban development, and fisheries; and (3) the Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food (Sagarpa), responsible for achieving more efficient and productive water use in agriculture. State Governments have responsibilities for planning and developing infrastructure for water resources; additionally, they can formulate their own state-level plans for water. 13 River Basin Organizations (RBOs) serve as technical, administrative, and legal decentralized bodies of Conagua and formulate regional water policy (OECD, 2013). Finally, 26 River Basin Councils (RBCs – Consejos de Cuencas) are bodies of mixed integration that coordinate the support and technical assistance, between Conagua and the water user organizations at the basin or hydrologic region level (ESTADOS UNIDOS MEXICANOS. Ley de Aguas Nacionales, 1992).

Formal planning for extreme climatic events resides mainly within Conagua. The Commission is tasked with the formulation of plans to address conditions during drought periods, and therefore it is the agency that has been in charge of drought-related actions in the country. Government responses to water scarcity have been limited to emergency support in order to address each crisis as it unfolds. These actions did not follow a standardized procedure, and thus were creating a culture of dependency on relief measures among the affected people and not reducing their vulnerability in the long term (MAGAÑA and NERI, 2012). The situation is currently changing, however, since the government recently launched The National Program Against Droughts (Pronacose), which seeks to address, monitor, prepare for and mitigate impacts associated with droughts in the national territory, as described in Table 3. Within its objectives, the Program is tasked to improve integrated water resources management, at the basin council level, under water scarcity scenarios, following a proactive and preventive approach (MEXICO. Pronacose, 2013).

3.4. Spain – institutional context

Spain has 25 river basin districts, each comprised of water usage systems, or sets of rivers and inter-related hydrogeological units (both surface and ground waters). River basins that cross the borders of autonomous community jurisdictions[8] are deemed intercommunity basins, and are managed by hydrographic confederations, or River Basin Authorities (RBA). River basins that are fully contained within an autonomous community are labeled intracommunity basins,

8 Autonomous community jurisdictions are similar to states or provinces.

and are managed by the autonomous communities themselves. For each intercommunity basin, there is an RBA which is an autonomous public organization that works closely with the Ministry of Agriculture, Food and Environment (Magrama)[9], and its organizational structure has representatives from different regional and central administrations, water users, NGOs, and other stakeholders.

The Water Framework Directive (WFD) 2000/60/EC (EUROPEAN PARLIAMENT and COUNCIL OF EUROPEAN UNION, 2000) is the legislative framework for Community action in the field of water policy. The WFD focuses on improving and protecting the status of water bodies across Europe so that, among other reasons, it may help in mitigating the effects of droughts. In Article 4, section 6, the WFD establishes the environmental objectives in exceptional circumstances, such as droughts, allowing temporary deterioration of water bodies. This issue was taken into account by the Drought and Water Scarcity Management Committee (set up in November 2003), giving recommendations about how to develop it.

Historically, Spain has managed droughts as emergency situations (reactively), but management of the 1991-1995 drought represented a tipping point. After this crisis, droughts ceased to be treated reactively as emergency situations and came to be considered proactively in the context of longer-term planning processes (i.e., as scenarios for which the potential effects could be fully prevented). Legislatively, this turnaround was marked by Law 10/2001 of the National Hydrological Plan (Article 27), which set the basis for risk-based drought management, including drought as a scenario in the country's overall hydrological planning[10]. Formally, a national law established the National Indicators System, Special Drought Management Plans (SDPs) at basin level including the recommendations of the Drought and Water Scarcity Management Committee (for example, including recuperation measures after the droughts), and Emergency Plans (EPs) to suppliers of cities greater than 20,000 inhabitants. The National Indicators System, through the National Drought Observatory, started operations during the first year of the 2004-2007 drought and proved effective during the height of the 2004-2007 drought. The Special Drought Plans (SDPs) were also approved during the drought.

9 The RBA structure is the following: Chairman, General Secretariat (for general functions), Water Commission (management of the public hydraulic domain), Technical Directorate (construction and management of the infrastructure) and the Hydrological Planning Office, which is in charge of, among other functions, the Special Drought Plans.

10 It is worth noting that the particular article that requires these risk-based approaches is only mandatory for intercommunity basins, not intracommunity basins.

3.5. United States – institutional context

In general, the federal government regulates water quality in the United States, while water quantity is handled by the states (WRIGHT, 1998). Past experience with water availability and regional development goals (i.e., broadly the Eastern U.S. and the Western U.S.) have dominated water policy designs. In the water-scarce regions of the West, management has relied upon the prior appropriation doctrine, which emphasizes that the first to claim stake on the water owns the rights to that water (REISNER, 1986). This identifies water as a property right, and creates incentives for using these rights (i.e., using the water). In the water-abundant regions of the East, water management has relied upon the riparian doctrine, which indirectly allocates water according to land ownership and limits land owners to use water 'reasonably' (WRIGHT, 1998; DEASON et al., 2001; FORT, 2003).

This demarcation in responsibility and approaches to water rights is complicated by a complex overlay of competing jurisdictions, laws, and bureaucratic missions at various scales. At the federal level alone, jurisdiction spans a significant number of Congressional committees, sub-committees, cabinet-level departments, agencies and White House offices (DEASON et al., 2001). The U.S. Bureau of Reclamation (USBR) - mainly in the Western U.S. - and the U.S. Army Corps of Engineers (USACE) - mainly in the Eastern U.S. and Pacific Northwest – were responsible for initiating and implementing massive federal infrastructure and engineering projects over the past century. This emphasis towards large infrastructures has shifted in recent years toward nonstructural approaches, namely demand management, technical assistance, recycling and effluent reuse, improving efficiency of delivery and conveyance, and integrated management. Still, the role of the federal government has been relatively limited with respect to water supply decisions (FORT, 2003).

The U.S. does not have a coherent and comprehensive national drought policy. Instead, drought management is inextricably tied to the "states'-rights-driven" system, described above, which is supported by a complicated patchwork of federal involvement. Drought management is traditionally handled by states through supply and demand management and by federal disaster relief and recovery programs (mainly agriculture and livestock) (HAYES et al., 2004). Only recently have decision makers at the state level begun to implement proactive drought mitigation plans (WILHITE *et al.*, 2005).

Table 1. Drought preparedness in Australia.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• "The Monitor", a system that continues to exist today, mainly serves as a database of information and a collection of resources for stakeholders to evaluate climatic, production, biophysical, and economic information for areas throughout Australia. • The Water Act of 2007 instituted legal water reforms, including the consolidation of water data and information, analysis, and standardization into the Bureau of Meteorology (BoM). • The national government provided historical amounts of funding for this initiative and required states and other 'named' entities to report information and work with the BoM on data integration and interoperability. Moreover, it made available AUD$80 million over five years to the states to develop individualized water data transfer formats using Open Geospatial Consortium standards and establish databases, telemetry, and Doppler monitoring to merge the disparate systems into one automated system administered by the BoM. • This effort, housed under the title of Australian Water Resources Information System (AWRIS), increases the prospects of combining hydrological and meteorological data collection and analysis • BoM and the Commonwealth Scientific and Industrial Research Organization (CSIRO) are working with the water sector to operationalize seasonal 3-month forecasts at 300 sites across the country.	• The EC process specifically incorporated the evaluation of drought impacts to justify its application and the subsequent assistance that the declaration enables. • The impacts are evaluated within a region to verify on-the-ground conditions based on farm-specific agronomic and stock status, water supplies, environmental impacts, and income levels (ABARES, 2012) • While the overall procedure is viewed as useful for understanding drought impacts, it reportedly does not systematize a process or set of indicators to continually monitor and record impacts and assess vulnerability and resilience, nor does it build capacity or develop an iterative network of drought impacts reporting. • "The Monitor" online resource allows for individuals to generate region- and community-specific reports, comparisons, and analysis across various indicators that are most relevant to the decision maker. • It does not include a user reporting system to verify and identify impacts reporting on-the-ground, nor does it provide a composite drought indicator that can integrate and place the other indicators into context (i.e., the user really needs to know the very specific indicator they wish to monitor).	• Australia reformed its national drought policy with the intention of finally promoting self-reliance and individual resilience by designing programs targeted to farmers that are not dependent upon the EC system. • In May, 2013 the Commonwealth, state and territory ministries signed the Intergovernmental Agreement on National Drought Program Reform, which identified the five measures of the "new package" and defined roles and responsibilities, indicators and performance benchmarks, monitoring and reporting mechanisms, and principles to guide 'in-drought' decision making to ensure that the choices of a state are with the drought reform/Agreement. • The five measures are: farm household support payments, farm management deposits and other taxation measures, a national approach to farm business training, coordinated and collaborative provision of social support services, and tools/technologies to inform farmer decision making. • This "new package" and the corresponding Agreement and state policies represents Australia's new national approach to drought programs; a response that no longer involves defining droughts based on indicators and maps, but rather on constant attention to building individual resilience and risk management through the package of farm and social support programs.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• Current 10-day forecasts show considerable skill, but seasonal forecasts (particularly the winter/ pre planting forecasts) and longer-term climate change projections need improvement. • The national government invested heavily in developing a uniform hydrological modeling platform and other water management tools and resources through an effort called eWater, which is developing and deploying a sophisticated platform called "Source" to improve water decision making. • Since 2008, Australia has been increasing the emphasis on preparedness and risk management and away from formal drought 'stages' and 'triggers'.		• While crop insurance mechanisms exist in Australia, multi-peril, weather-indexed, and other commercial or government insurance instruments are not well developed throughout the country. The Australian, state and territory governments have agreed through the Standing Council on Primary Industries that government-subsidized multi-peril crop insurance should not be pursued in Australia. However, there is current interest both from within and outside of Australia in developing these products, as noted by recent studies and reports on the topic.

Table 2. Drought preparedness in Brazil.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• In Brazil, drought monitoring and early warning is supported by an array of various Ministries and agencies responsible for *Weather forecasting, Water resources information, Agrometeorological information and Research.*	• At the national level, vulnerability/ resilience assessments have not been formalized, nor have the networks for monitoring and evaluating associated vulnerability indicators.	• In response to the current Northeast drought, the Civil House of the Presidency spurred the creation of an interministerial committee [i.e., The Integrated Committee to Combat Drought] to monitor and coordinate actions for drought response in the semi-arid region, carried out by the federal, state, and municipal governments.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• In 2014, in partnership with the Interamerican Institute of Cooperation for Agriculture (IICA), the National Institute of Meteorology (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. This will promote the integration with national and international meteorological systems and propel greater ownership of INMET products by conventional users and farmersWithin the scope of the National System of Natural Disasters Prevention, actions are being undertaken collaboratively by the Cenad and the National Center of Monitoring and Early Warning on Natural Disasters (Cemaden) in order to build a Monitoring System, integrating products (tablets, mobile, web) and applications. • Cemaden is also responsible for periodic analyses of hydro-meteorological risks, and also develops research and products for the evaluation of impacts in agricultural areas. • Other entities of the Ministry of Science, Technology and Innovation (MCTI) are also responsible for research and development related to the Brazilian Northeast. • Most recently, the World Bank has supported efforts to specifically develop a Drought Monitor map and network for Northeast Brazil that integrates federal efforts and support with support within and across the nine Northeast states.	• On impacts reporting, thanks to the strong collaboration with states and academia, National Center of Disaster and Risk Management (Cenad) 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.Specifically on drought, the Atlas gathers official data on the recurrence of the event, between 1991-2010, which sum up to 1,340 official records, affecting almost all municipalities in the state. In spite of 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.). • A current World Bank supported initiative in Brazil will produce a state-of-the art impacts and cost analysis on the 2010-present Northeast Brazil drought. This effort will help demonstrate and disseminate methodologies for costing the impacts of droughts and for conducting vulnerability and risk assessments for droughts.	• Even though the Civil House Committee is able to provide immediate relief through the emergency actions, it is a temporary instrument that could be better integrated into the dialogue of policy construction that is being conducted by other ministries (such as the Ministry of the Environment [MMA] and MI). • The World Bank is supporting more proactive planning and management through the implementation of several pilot studies in Northeast Brazil to develop operational drought preparedness plans. There is potential for scaling-up of these pilots to other similar contexts, or more broadly to state and regional planning.

Table 3. Drought preparedness in Mexico.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• The National Meteorological Service (SMN), which is also part of the National Water Commission (Conagua), is in charge of providing forecasts and climate information to support the decision making process and keep the general public informed • Mexico participates in the development of the North America Drought Monitor (NADM), which is a cooperative effort between nations and drought experts in Canada, Mexico, and the United States and monitors drought across the continent on an ongoing basis. • The NADM has been implemented over the past decade and a half, and provides both a product in the form of a monthly drought status map and a process for gathering, synthesizing, and verifying drought conditions. Like the US Drought Monitor, the NADM is not a forecast, but rather a point in time indication of the severity of drought based on historical climate. • In addition to cooperating in the NADM effort, the SMN delivers twice per month the Mexican Drought Monitor (MDM) that characterizes drought status at National and State levels, as well as at the scale of 13 River Basin Organizations, 26 River Basin Councils, and number of municipalities. • The allocation of resources has not yet met the needs for enhancing the technology and infrastructure for delivering modern hydro-meteorological services. Upgrading SMN is a priority for Mexico. This will require substantial scientific knowledge, data and advanced numerical models for atmospheric phenomena.	• The Ministry of Environment (Semarnat) has an online tool to disseminate information related to climate change which is equipped with two displaying modules: by each State, and each productive sector (i.e., water, agriculture, health, energy, tourism, and forests) • In addition to the systems developed by Semarnat, the Ministry of Interior through the National Center for Disaster Prevention (Cenapred) has developed the Analysis and Display System for Risk Scenarios (Saver) and the National Risk Atlas (ANR); these tools bring together information from different data bases in order to asses threats, vulnerability, and risks at the national, regional, state, and municipal levels • Through these tools it is possible to simulate disaster scenarios, make recommendations on timing of responses, and establish prevention and mitigation measures, not only for hydro-climatological risks but also to other risks (e.g., geological, chemical, sanitary, ecological). • Overall, these tools have been praised as an excellent idea with potentially comprehensive scope. However, it is not clear how often are these maps updated, as the information is relatively static in the Semarnat tool. It also does not include economic impact information and interactive features. Because the tool is not interactive, users or agencies cannot upload information to the system, and all information displayed is provided only by Semarnat.	• Some of the response measures Mexico has embarked upon specifically during droughts include temporary employment to those working in affected agricultural areas, livestock reduction, and forage storage programs. Nonetheless, these efforts have proved insufficient. • Despite these drawbacks, Mexico has been successful in supporting effective post-disaster interventions. An example of such attainment is The Natural Disasters Fund (Fonden), which is an instrument for the coordination of intergovernmental and inter-institutional entities to quickly provide funds in response to natural disasters. • The Government of Mexico has recently prioritized coordinated measures and actions to identify and analyze risks, as well as prevent and mitigate weather related hazards. Specifically, an interdepartmental coordination effort was initiated in response to a Presidential Agreement that creates the Inter-secretarial Commission for Drought and Flood Management to formulate a national drought policy and strategy. • This Commission represents a broad interagency effort, and is chaired by Semarnat, with Conagua as the technical secretariat. As part of a new National Program against Droughts (Pronacose), a sub-program titled "Drought Prevention and Mitigation Measures Program" (DPMMP) was recently launched to produce a manual/guidebook for drafting plans that define basin-specific measures to address droughts, and to help basins implement these plans.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• Mexico has begun to make advancements in this category. For instance, in 2010 the Government, with World Bank support, launched the National Program for the Modernization of SMN to ensure that meteorological services are improved.		• The planning process is currently in the early stages of implementation, and follows a participatory approach involving representative stakeholders from various sectors of society, for each of the 26 River Basin Councils (RBCs). The RBC's and the state Governors are responsible for the selection of the planning members, and the design, implementation, monitoring, and evaluation of the DPMMP. Conagua provides statistical and hydro-meteorological information, and supports technical analysis related to water supply and demand. Additionally, every basin council has technical guidance from a selected university.

Table 4. Drought preparedness in Spain.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• One of the tools established by the legally mandated National Hydrological Plan was the National Indicators System to predict situations of drought and assess their severity. RBAs regularly compile information about stored volume in reservoirs, fluvial total discharge, rainfall variables, and other parameters to inform the indicators. • Through the Directorate-General for Water, Magrama keeps the National Indicators System up-to-date by posting monthly reports with maps, graphs, and statistics reflecting the data sent by the RBAs on the website of the National Drought Observatory. • Spain has promoted and supported automatic data acquisition systems for hydrological and water quality-monitoring in most of the river basins	• The National Indicator System includes implicit vulnerability/ resilience assessments in order to establish drought status. However, impact assessment has not been formalized. • After the drought of 2004-2007, the former Ministry of Environment (currently titled the Ministry of Agriculture, Food and Environment) prepared a report to assess the management of that drought with a recompilation and analysis of the characteristics of the drought, the National Indicator System, the main problems identified, and the measures adopted in terms of infrastructure and management.	• Spain has developed many of the strategic measures with a long-term view to address droughts. Those measures are mainly included in the National Hydrological Plan Act (2005), the Irrigation National Plan (2002), and in the Water Quality National Plan (2007). Still, when a drought situation is declared as emergency status in a basin or in part of a basin, the national government approves a royal decree to regulate the management of this emergency, under the "exceptional situations" designation. • This declaration of "exceptional situation" establishes a Permanent Drought Committee (which is a misnomer, because it is temporary) to lead the process of drought response and recovery and places into action the measures defined in the SDP.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• The Special Drought Management Plans (SDPs) include the Hydrological Indicators System (HIS) as the tool of monitoring the drought status for each water usage system within the basin. The HIS serves as a reference for the adoption of mitigation measures, including rules to operate *water usage systems* and the *pu*blic hydraulic domain, based on threshold values that determine the corresponding drought status. Each RBA sends the data of the indicators monthly to the National Drought Observatory in order to update the National Indicator System. • In one of the most advanced basins, the Júcar Basin, the Standardized Operative Drought Monitoring Indicators (Sodmi) uses real-time information provided by the Automatic Data Acquisition System on the state of stored volume in reservoirs, piezometric levels, fluvial total discharge, and rainfall. The indicators are validated constantly with both historical drought data and simulation models using Aquatool, a generalized tool, or Decision Support Systems Shell (DSSS) produced by the Water Engineering and Environmental Institute of Valencia University (IIAMA-UPV) to develop Decision Support Systems (DSS) for integrated water resources management. • Strong academic participation and commitment has helped sustain institutional memory and also catalyze the development of critical monitoring, forecasting, and decision-support tools, such as Aquatool (which is being expanded and implemented in all of the Basins).	• In river basins, there are different components of vulnerability/ resilience and impact assessment. In the Júcar's SDP, environmental issues are considered in both types of assessments, although complementary studies are needed. There is also a specific section with a general bibliographic review about the description and assessment of the vulnerability of different water uses (i.e., water supply, irrigation and hydroelectricity) and the socio-economic and environmental impacts produced by water reduction during droughts. Aquatool allows basin management optimization, aquifer flow modeling, drought risk assessment, economic assessment, water quality simulation, and ecological flows analysis; all of which contribute to understanding vulnerability/resilience and potential impacts. • In the basins, there is room to improve environmental surveillance protocols; particularly those used to determine the environmental impacts caused by water restrictions during periods of drought.	• The national government is also part of these Permanent Drought Committees and is in charge of the management of any measure related to River Basins (e.g., modification in inter-catchment allocations). • The districts are supposed to develop and implement strategic measures with a long-term view during normal circumstances to avoid reactively managing the droughts as they occur. Such measures are mainly included in the Basin Hydrological Plans. • In theory, the strategic measures are required to be updated every six years, but plans currently in operation were those approved in 1998. By 2013, almost all Basin Hydrological Plan have been updated, so there is an opportunity to improve technical features of the plans and make them more realistic, particularly in terms of estimation of water resources. • In terms of response, the Spanish Water Act empowers the RBAs to establish management rules for both dams and aquifers during droughts and to limit the use of the public hydraulic domain temporarily.

Table 5. Drought preparedness in the U.S.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
• The U.S. Drought Monitor (USDM) has been a pioneering effort implemented over the past decade and a half, and provides both a product in the form of a weekly drought status map and a process for gathering, synthesizing, and verifying drought conditions. • The USDM is not a forecast, but rather a point in time (i.e., snapshot) indication of the severity of drought based on current and historical indicators. • The iterative process to develop the weekly map involves back-and-forth between expert teams and also "ground-truthing" of drought impacts and indicators via a network of over 350 federal/state government and academic/university partners. • Partnering agencies, such as the National Oceanic and Atmospheric Administration (NOAA), U.S. Department of Agriculture (USDA), and others produce seasonal climate, streamflow, and soil moisture forecasts in parallel (but not directly linked) to the USDM, that help decision makers understand future drought conditions. • Another important national effort in drought monitoring, early warning, and forecasting is the National Integrated Drought Information System (NIDIS), which represents a national-level effort to convey pertinent drought information to practitioners at various stages of the drought management and preparedness process. The web portal, developed through NIDIS, provides information on indicators, databases, forecasts, impact tracking, partnership opportunities, research initiatives,	• The National Drought Mitigation Center (NDMC), also one of the USDM authoring partners, hosts an online tool and searchable database for reporting and archiving drought impacts, the Drought Impact Reporter. This information is available to any individual or agency, which can be used to monitor impact information over a period of time and by sector. Data on drought impacts can also be input into this database by users. • Related to vulnerability assessment, NIDIS has taken a proactive approach to generating dialogue with communities, experts, and decision makers on priorities and vulnerabilities that should be monitored and evaluated with respect to droughts. • U.S. National Climate Assessment (NCA) and NOAA's Regional Integrated Sciences and Assessments (RISA) initiatives also seek to provide important drought and climate impacts and capacity building for vulnerability and resilience assessments.	• While the 'Stafford Act' officially includes drought as a phenomenon for which the President can declare a "major disaster", assistance does not necessarily address needs during extreme drought conditions, and there is no universally agreed upon definition spelled out in federal policy. • The Federal Emergency Management Agency (FEMA), the usual lead during a disaster situation, does not play an active role during droughts; rather the traditional de facto lead for managing droughts has been the United States Department of Agriculture (USDA). • Federal coordination across institutions and various sectors has been piecemeal, and there is little authority or incentive to pursue proactive drought mitigation policies at the national level. • Nevertheless, the federal government still plays an important role. Perhaps the most significant safety net is the federal crop insurance program, administered by the Risk Management Agency (RMA) of the USDA. • Other targeted programs are in place for helping specific communities and sectors, made available after county-wide disaster designations are declared. • The Obama Administration activated a new inter-agency framework, the National Disaster Recovery Framework (NDRF), born out of 'Presidential Policy Directive 8' (UNITED STATES, Federal Emergency Management Agency, 2011). • Although still limited to presidential declarations and directives (and thus subjected to administration turnovers), drought coordination and responsibilities mobilized through the NRDF have represented the most formalized and proactive federal effort on drought in the past few decades.

Monitoring and early warning/ prediction	Vulnerability/resilience and impact assessment	Mitigation and response planning
and other various tools and services to aid decision making. Furthermore, NIDIS has engaged in building local drought monitoring, forecasting, and vulnerability assessment capacity with local communities, river basins, states, and regions throughout the U.S.		• The Executive Order (E.O.) "Preparing the United States for the Impacts of Climate Change," signed in November 2013 directs Federal agencies to modernize Federal programs to support climate-resilient investments; manage lands and waters for climate preparedness and resilience; provide information, data and tools for climate change preparedness and resilience; and plan for climate change related risk, establishing an interagency Council on Climate Preparedness and Resilience, chaired by the White House and composed of more than 25 agencies. Agencies are directed to consider the recommendations of the State, Local, and Tribal Leaders . • The interagency National Drought Resilience Partnership is part of the President's Climate Action Plan. The Partnership intends to enhance the efforts of Federal agencies that are working with communities, businesses, and farmers and ranchers to build resilience to drought on the ground.

4. Discussion and Analysis [11]

The three pillars framework, discussed in section 2, serves as a useful guidance for comparing the implementation of various drought preparedness policies and measures across countries. The analysis of each country's experience also provides important lessons that can be applied (and adjusted) to different contexts. Below we analyze the advances made by each country that were discussed in Section 3 above and the challenges that still have to be dealt with for improving the drought preparedness principles encompassed in the three pillars framework.

Table 6 below provides a snapshot of each country's stage in terms of drought policies at the time of this research. The plus signs (+) indicate the level of emphasis within each pillar (with a maximum of 3 plus signs) compared to the other countries of the study, and the arrows indicate if there is an overall increasing or decreasing emphasis on activities, programs, and/or policies.

11 The White House. 2013. "Introducing the National Drought Resilience Partnership". Available at: <*https://www.whitehouse.gov/blog/2013/11/15/introducing-national-drought-resilience-partnership*>.

Table 6. Current level of drought preparedness according to the three pillars framework.

	Monitoring and early warning/prediction		Vulnerability/resilience and impact Assessment		Mitigation and response	
Australia	++	ê	++	é	++	é
Brazil	+	é	+	é	+	é
Mexico	+	é	+	é	++	é
Spain	++	é	++	é		+++
United States	+++		++	é	++	é

4.1. Monitoring and early warning/prediction

Australia ++ ê | Brazil + é | Mexico + é | Spain ++ é | United States +++

The analysis based on the three pillars framework indicates that each of the 5 countries in this study has some type of drought monitor (in operational or experimental phase), making the first pillar the furthest developed aspect of the drought preparedness approach.

Australia has made significant progress with regards to the monitoring and early warning/prediction pillar in terms of data and information available, but as observed in the previous section, seems to be moving in the opposite direction of the other countries with respect to using triggers and stages not only for guidance in the implementation of various mitigation actions or policy, but also toward helping individuals make decisions that are based on a risk management approach. The country believes that there are limitations with defining drought stages and triggers, particularly that it might force trade-offs with individual resilience building efforts. Several of the individuals interviewed for this project highlighted possible inefficiencies and politicization of having policy responses triggered by drought stages, while others in support of triggers emphasized that these inefficiencies and political aspects are even more likely in a world without triggers and drought stages, as informed by more objective monitoring of water, weather, and climate conditions.

Brazil has significant scientific and technical knowledge and expertise in meteorological, climatological, and hydrological monitoring and forecasting. These capabilities, however, are not always well-integrated within and between states and monitoring/forecasting communities of practice and networks have not been well-institutionalized. The major challenges in Brazil are related to the need to 1) systematically identifying the reforms that are necessary to address these

limitations and integrate across administrative levels (e.g., between municipalities, states, and the federal government), and 2) translating the information into usable tools and products that make it into the hands of decision makers (from individuals up to state/national levels), and to fostering and maintaining a network of technical experts that can institutionalize drought monitoring processes. Another challenge is the need for improving data collection and information organization. These challenges are being addressed by the current National Drought Monitor project.

It is essential to improve the meteorological and climate forecasting capabilities in Mexico to better respond to the challenges faced in a changing climate. This will require substantial scientific knowledge, data, and advanced numerical models for atmospheric phenomena. Mexico has begun to make advancements in this category through the launch of the National Program for the Modernization of SMN, mentioned in Table 3 above. However, the Mexico case shows that it is not sufficient to have a fine-tuned meteorological service if the results and recommendations given by the institutions cannot be translated into more informed decision-making. Therefore, institutions in charge of seasonal climatic forecasts and investigations require sufficient leverage over and access to high-level dialogue with policy makers in the country.

Spain has made important advances in the process of designing an adequate monitoring and early warning system. The following key issues need to be considered: 1) Institutional networking: The cooperation and coordination between the different stakeholders involved in drought management is fundamental for sharing of information, which should be supported formally by the institutional/legal framework; 2) An adequate net of data collection equipment and technologies to get accuracy information in real time; 3) Institutional capacity to design the necessary indicators, threshold and triggers, being the existence of River Basin Authority a key element. The use of the decision support system Aquatool to help guide decision-making and planning has provided important support for drought management at the regional level.

At the national level in the United States, USDM and NIDIS are exceptional examples of what a coordinated network of individuals, institutions, and information systems might resemble, and are particularly impressive because of how much they have been able to accomplish by leveraging very minimal funding. The United States case illustrates that building this network of monitoring stations and equipment, technical capacity and models, and coordination between the various inputs can take at least a decade, although it certainly does not need to take this long if sufficient resources and time are committed to the effort. Actively engaging decision makers throughout the process of building this monitoring and forecasting technical foundation and network provide an effective mechanism for securing 'buy-in' and trust for the overall importance of implementing longer-term proactive drought mitigation and risk-based

management measures. The patchwork of success in the U.S. indicates that there is much more work to be done – efforts that would likely be catalyzed by more dedicated resources and targeted funding tranches.

It is important to note that in comparison to Australia, the other four cases analyzed in this project provide the opposite message with respect to this particular mechanism. It is expected that drought monitoring related triggers will always evolve with time and experience as they are only guides (i.e., there is not a perfect 1-to-1 correlation between a trigger (index or indicator value) and an impact and, generally, several indices and/or indicators will be used for a particularly region or impact and they will likely not always agree. Therefore, striking the right balance between 1) drought monitoring, stage declarations, and triggers, and 2) individual risk management, will take careful consideration and deliberation for decision makers.

4.2. Vulnerability/resilience and impact assessment

Australia ++ é	Brazil + é	Mexico + é	Spain ++ é	United States ++ é

Across the five countries in the analysis, the second pillar of drought preparedness is the least developed. The reduced level of investment in this aspect highlights that emphasis should be placed in the assessment procedure, making sure all relevant parties have incentives to participate in the process.

In Australia, particularly in Southern Australia, clear methods for characterizing the current climate and the threats from climate change have been important in supporting the development of a perspective of permanent assessment of drought risks, which also involves standardizing water supply and demand by developing a measurable metric and adhering to it to help guide decisions.

Brazil still needs to invest in longer-term measures related to developing vulnerability assessments. 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. Notwithstanding the development of the Brazilian Atlas of Natural Disasters (1991–2010), it would be important for future assessments to include climate change projections in States and Regions.

The Mexico experience regarding the online Semarnat tool is a useful example of how important it is to understand vulnerabilities and potential impacts of climate change in order to inform a drought policy. However, it is also essential to engage communities and relevant stakeholders in the vulnerability and impact assessment process, and currently it is unclear how involved the various parties will be. Furthermore, a participative approach to understand vulnerability will help in shaping the response plan according to the stakeholders' ideas, which would make it easier to implement the plan, as people involved would likely feel "ownership" over the plan. Importantly, the processes to evaluate vulnerabilities could establish a network for future drought preparation and response.

One of the gaps identified in managing droughts in Spain is the lack of specific protocols to assess the economic impacts of droughts and the adoption of compensation measures. Compensation measures in the Spanish system are currently limited to suppressing taxes and fees through extraordinary measures adopted at the national level. Moreover, drought evaluation and compensation mechanisms are neither regulated nor standardized. On the whole, drought management plans have helped improve water resource management from the environmental standpoint, by taking into account ecological streamflows and monitoring environmental parameters, among other factors. Still, the analysis conducted for this project shows that there is continuing need to improve environmental surveillance protocols; particularly those used to determine the environmental impacts caused by water restrictions during periods of drought.

The weakest element of drought preparedness in the United States is undoubtedly the vulnerability and risk assessment component. While laudable efforts and goals exist to develop these capabilities (e.g., at the national level through NIDIS, USDM, and NDMC), consistent guidance and systematic methods for evaluating, reporting on, and creating policies around drought/water/food systems vulnerability and risk are lacking. Through several pilots, NIDIS has learned that discussing vulnerabilities and possible impacts as an initial step in a community engagement process allows decision makers to operate more efficiently during a drought because the region and stakeholders have already engaged in the difficult topics of impacts and trade-offs, usually during times of non-drought (i.e., when cooler heads prevailed). It also allows for important trust, networks, and autonomy/ownership of the problem to take shape; ultimately catalyzing drought response.

While recently countries have been investing in improving their capacity to estimate who and what is most vulnerable to droughts, this aspect is still the most challenging task for improving drought preparedness across all five cases. This reveals the complexity of this specific pillar, which includes environmental and socio-economic concerns and requires the engagement of stakeholders in a dialogue before the occurrence of droughts in order to negotiate priorities.

4.3. Mitigation and response

Australia ++ é	Brazil + é	Mexico ++ é	Spain +++	United States ++ é

The recent policy reform in Australia provides a useful model for developing a coordinated national drought policy within a federal system. The current reform has prioritized the 'process' in building a shared vision for drought programs and a diverse set of principles to guide drought policies that will subsequently be adopted by the states; the principles are intended for informing decisions that might conflict with national goals (e.g., the desire of a particular state to fall back on declarations during a drought, when the Commonwealth and other states are broadly committed to moving beyond the EC process). The deliberative and iterative process has engaged the states to develop and commit to basic principles so as not to undermine efforts between states, and has done so with the flexibility for different regions and states to prioritize certain elements of the principles and framework to meet their particular needs.

Several people interviewed for this study suggested that the decision to focus financing and resources on a pilot study (in Western Australia) has built broader support for the programs through demonstration and evidence-based outcomes. Moreover, it was perceived as a wise decision because it dampens the potential political backlash and resistance to overhauling national drought programs. It is equally important that the programs were made flexible, with the intention that they could be adapted to meet the needs of other regions then scaled up to the national level. Australia's shift toward self-reliance is also coupled with a social safety net approach that is independent of drought status. Rather than having triggers that initiate certain government support mechanisms, the approach shifted to implementing broader social programs in rural areas. This allows for consistent prioritization on helping vulnerable communities, which in turn helps to shift the perception of one of drought response and relief to whole-farm risk management (of which drought is just one element).

In Brazil, although there is a significant array of institutions dealing with drought, the articulation between the Federal, State and Municipal levels lags in efficiency and promptness. Moreover, the tendency is to develop and deploy programs that respond to the droughts rather than developing strategic and proactive risk-based management approaches to mitigating the droughts in the first place (i.e., other than the traditional large water infrastructure works). There also 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.). In addition, 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. Furthermore, guidelines are nonexistent on how states and municipalities should act in preparedness and mitigation of droughts.

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 and municipalities largely depend on federal resources and lack adequate funding mechanisms of their own. Therefore, it is important to strengthen the institutions at different levels to build real and sustained capacity for managing droughts. 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, 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 social capital networks.

The Mexico case shows that the national level should play an effective articulating role among all the institutions related to natural disaster management (including droughts), making sure that each agency has clear tasks, that all aspects of the disaster are covered, and that there are no major overlaps that dilute agencies' responsibilities. In this sense, Mexico is quite innovative with respect to its establishment of the Inter-secretarial Commission for Drought and Flood Management. Given the important place for these issues on the political agenda, the Commission is expected to have positive results on drought policy making in Mexico.

Although safety nets and subsidies from the government are needed after a disaster has occurred, future Government investments should focus more on the drought planning and mitigation side. The Mexico case provides an excellent example of drought mitigation and response planning reform in the making. Developing a drought plan is fundamental to reduce vulnerability and therefore the impacts of drought event. Plans should involve all of the relevant stakeholders, a point that is even more important when water resources become scarce, such as in the case of droughts. The new initiative of the Mexican Government related to the DPMMP, which uses a participatory approach, guarantees all stakeholders participation, ensures issue understanding, and supports the entire process with technical knowledge, seems to be a comprehensive and adequate strategy to tackle drought impacts in the country.

Special Drought Management Plans at river basin level are the main instruments to manage droughts under a proactive (instead of emergency) approach in Spain. This change in strategy has taken over a decade to come into effect. Most of the experts interviewed for this project emphasized that the main elements that have made this instrument particularly useful include: 1) A drought monitoring protocol that is defined based on the basin's characteristic supply, demand, and vulnerability to drought - including a system of objective indicators with threshold values for each drought status that are specific to each *water usage system*. Technical and human resources to define and manage droughts are also key to the SDPs' success; 2) A series of measures to mitigate the impacts in each specific *water usage system* associated with each drought status defined by the indicators system, as well as a system that clearly defines who does what and when, promoting coordination and transparency between the main drought stakeholders. At the same time, however, coordination with the municipalities responsible for managing and implementing certain measures needs to be improved; and 3) Mechanisms or instruments that facilitate the incorporation of lessons learned, for instance, by post-auditing the management of the drought, and updating the plan after a drought.

The Hydrological Plans are important tools of planning in Spain, in which realistic estimation of water resources and demands is needed. One of the main critiques of these Plans and also the National Hydrological Plan is related to the overestimation of the available water resources, and thus the over-allocation of water rights concessions. In addition, it is also important to revise and update water rights concessions, and water allocation, and maintain control of the *public hydraulic domain* and eradicate illegal extractions and discharges.

The implementation of the NDRF during the 2012 U.S. drought highlighted the critical role that a national government can play in coordinating the multi-faceted components of drought management. While legislation might be the most concrete method for compelling coordination, in the U.S. it was executive action and leadership that took the reigns during a critical drought period to advance a more risk-based and resilience-building focus. This process took convening stakeholders together to understand how to leverage and make more flexible existing policies and also how to fill the policy gaps or shortcomings. The federal government seems to have initiated and implemented a consistent, iterative, and transparent process and plan for drought preparation and response mechanisms through the NDRF. However, whether the process and coordination continues will ultimately be the test of its effectiveness for drought preparation and response.

This study has also found perhaps the greatest differences between countries with regards to the third pillar. While mitigation in Spain relies on river basin level planning, and the United States is based on state and municipal level community plans, Australia has moved towards building

farmers self-resilience. Mexico is making efforts recently to move towards river basin drought preparedness planning, and Brazil is starting to develop mitigation plans (but are still in the experimental phase).

Conclusion

Despite focusing on very different countries, with different geographic conditions as well as social and economic contexts, the approach presented here allows for the identification and evaluation of national policies according to three key tools within these three pillars that are fundamental to drought preparedness: a drought monitor, mechanisms for identifying vulnerabilities and/or report impacts, and drought preparedness plans. Despite having different degrees of maturity in each country of the study, some element of these were present in all countries. In addition to developing the three-pillar framework, this paper has applied the framework's methodology to a cross-country comparison of drought preparedness in five different contexts.

Since the countries in the study have not been developing their specific drought policies according to this framework, however, it is also possible to notice that the links between the three pillars is often not strongly connected. One policy recommendation that can be derived from such conclusion is the importance of developing each pillar according to an integrated framework.

It should also be noted that the development of proactive approaches in these countries has taken a long time, and is an ongoing process. It was necessary to build upon previous experience and institutional architecture to advance the conversation. Most importantly, the shifts from previous reactive measures often took place in strategic moments of severe droughts when political support could be gathered around an extreme situation of crisis. Moreover, political will and leadership was a central factor in the countries' ability to take advantage of these windows of opportunity.

Finally, future multi-country comparative research would benefit from including other countries in the analysis, as well as from a more focused attention to specific aspects of each pillar.

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