*Policy Sciences* **36**: 101–123, 2003.



# A tale of two policies: The politics of climate forecasting and drought relief in Ceará, Brazil

MARIA CARMEN DE MELLO LEMOS
*University of Michigan*

**Abstract.** This paper evaluates the use of climate-based information in drought mitigation in Ceará, Northeast Brazil. It examines two policies – a seed-distribution program (*Hora de Plantar*) and the Emergency Drought-Relief Program – that use climate information produced by FUNCEME (Ceará's Foundation for Meteorological and Hydrological Resources) to implement drought planning. It argues that, in politically charged policy-making environments, the use of climate forecast information may go beyond its problem-solving function to influence broader issues of accountability and democratization. In Ceará's politically charged environment, technocrats rely on scientific information about climate to insulate policy-making from both political 'meddling' and public accountability. However, insulation afforded by the use of climate information has played different roles in the policy areas examined in this study. While in drought emergency-relief planning the use of climate information critically contributed to the democratization of policy implementation, in agricultural planning, it worked towards further insulating decision-making from public accountability and client participation. Thus, the use of climate information is context-dependent, that is, the distribution of costs and benefits associated with information use in policymaking depends on the social, political, and cultural context in which information producers and users work. Moreover, climate information can be used in ways – positive or negative – significantly different from the use that information producers intended.

## Introduction

Can science save Northeast Brazil? In this region, castigated by recurrent drought, policy-makers have implemented a wide range of policies to mitigate the extreme physical and social effects of dry climate. Yet, most of these policies have failed to reduce the vulnerability of subsistence farmers to drought.[1] Recently, the emergence of new scientific tools for climate monitoring and prediction (especially the El Niño-Southern Oscillation – ENSO forecasts) has stimulated the design of a new class of proactive drought policies based on the availability of seasonal climate forecasts with a lead-time of up to a year in some regons.[2] Since the early 1990s, the government of Ceará, one of the poorest states in the Northeast, has sought to use seasonal climate forecasting information produced by FUNCEME (Ceará's Foundation for Meteorological and Hydrological Resources) to implement several governmental policies and programs in the areas of civil defense, water management, and agriculture.[3]

How has climate information been used in drought planning in Ceará? This study argues that, in Ceará, the implications of the use of climate information may go beyond its contribution to problem-solving and have an impact on

broader issues such as public accountability and democratization of the public policy-making process. Whereas a few scholars have called attention to equity issues linked to the use of seasonal climate forecasting (Pfaff et al., 1999; Glantz, 1996), the literature on the politics of prediction use, especially in less developed countries, is surprisingly sparse.[4]

This study evaluates the use of climate-related information, in particular seasonal climate forecasting in two programs. The first program, *Hora de Plantar* (Time to Plant) – implemented by Ceará's Secretary of Rural Development (*Secretaria de Desenvolvimento Rural* – SDR) – focuses on the distribution of high-quality seed among subsistence farmers in Ceará. In principle, the program uses climate information to establish a fixed planting calendar in which seed is distributed to farmers based on the application of a climate-soil model.[5] The assumption underlying this program is that small farmers lack the technology to make the best possible choices in an unpredictable environment. The decision to maintain the planting calendar is motivated by policy-makers' beliefs that, if left to their own devices, farmers 'waste' the high quality seeds by either planting too soon or eating the seeds when faced with a food shortage. The second program, Emergency Drought-Relief – implemented by Ceará's Civil Defense (*Defesa Civil*) – uses climate information provided by FUNCEME to assess the level of need for emergency funds in each *município*[6] in the state. For the past ten years, the program has comprised three main actions: the monthly distribution of food baskets (*cestas básicas*) among needy families, the creation of emergency work fronts, and the supply of potable water to communities in distress. Since 1997, at the onset of a drought, the state Civil Defense employs a *município*-level monitoring system based on quantity and distribution of rainfall, vegetation indexes, yield losses, and social tension episodes to establish a triage ranking for government response (Ceará, Governo do Estado do, 1997).

These two programs will be evaluated focusing both on policy outcome and on their potential impact on broader processes of decision- and policy-making in the context of Brazil's young democracy. Regarding policy outcome of both programs, this study seeks to assess, first, seasonal climate forecasting's contribution to problem-solving; and second, which – and how – different social actors are negatively affected or benefit from policy outcome. Regarding the impact of both programs on democratization, it aims at understanding the role of seasonal climate forecasts in promoting or hindering processes that characterize democratic policy-making, such as accountability, transparency, societal participation, and equity. By analyzing the interaction between state-level technocracies, scientific institutions, and policy clients in the context of these two programs, this study intends to contribute to the understanding of the co-production of science and policy. More broadly, it seeks to illuminate the role scientific knowledge may play in technocratic decision-making and democracy.

It is important to emphasize that it is not this study's claim that seasonal forecast producers are unaware of or do not care how clients use their product – although that still may be the case in some instances. Rather, this discussion is

intended to provide climate forecast producers with empirical examples of the many, and sometimes unwarranted, uses of forecasts in different policy systems. Only if we understand how decisions are made, both at the policy and societal levels, will it be possible to implement policies that not only effectively mitigate negative consequences of climate-related phenomena but also promote democratic values such as fairness, transparency, accountability, and legitimacy in policy-making.

Both programs have been hailed as successful policy-making. *Hora de Plantar* is frequently cited as an example of the tremendous potential for the application of seasonal climate forecasting in policymaking and as evidence of the kinds of positive outcome this type of tool can produce in less developed countries (IAI, 1994; Moura et al., 1992; Golnaraghi and Kaul, 1995; Glantz, 1996). Similarly, Emergency Drought-Relief has been described as 'a radical departure from the past' (Tendler, 1997: p. 46) in which Ceará's new progressive state government managed to avoid traditional patterns of clientelism and corruption in drought planning. The next section provides a brief description of drought planning in Ceará and suggests that, despite the substantial progress achieved by recent state administrations, there is still much to be done to decrease the vulnerability of the poor to drought.

## The politics of drought planning in Ceará

*Ceará, Northeast Brazil.* Ceará lies on the northern coast of Brazil and is one of the nine states that form the region known as Northeast Brazil, or *Nordeste*. The majority of the state falls within the semi-arid region of the Northeast known as the *sertão* (hinterland), where most of the rainfall is concentrated within a three- to four-month period between December and March (Ceará, Governo do Estado do, 1995: p. 22). This period corresponds roughly to the state's planting season and is popularly known in the region as 'the winter,' despite corresponding to Brazil's summer months.

Ceará is one of Brazil's poorest states, having a population of 7 million people, of which 67 percent live in urban areas (IPLANCE, 2000). Despite high levels of poverty all over the state, for the past ten years, Ceará has been undergoing a remarkable political and socio-economic change that has critically affected its socio-economic indicators. In 1997, for example, while Brazil was growing at 3.2 percent a year, Ceará's growth rate was 4.5 percent. Table 1 illustrates the evolution of several socioeconomic indicators in Ceará between 1987 and 1997.

Although Ceará has traditionally been an agricultural state, this sector has been increasingly losing its prominence to industry and service. Today, the agricultural sector accounts for only 5.3 percent of the state's GNP, but it employs 39.7 percent of its labor force (IPLANCE, 2000). Thus, while agriculture has lost economic importance, it still carries tremendous social significance within the state's policy-making machine.

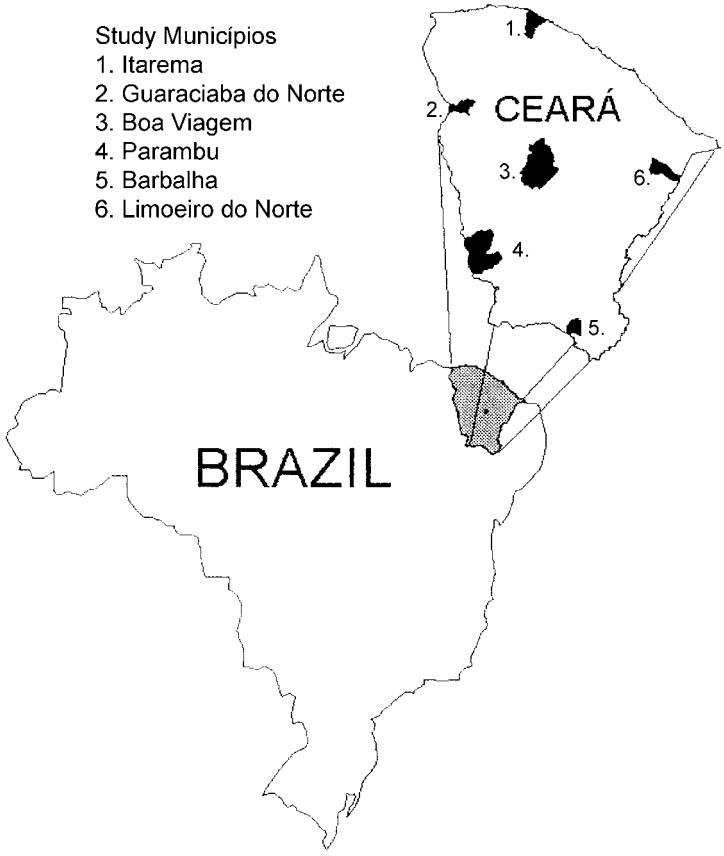


*Fig. 1.* Map of study area.

*Table 1.* Evolution of the main socioeconomic indicators in Ceará (1987–1997).

| Indicators | 1987 | 1997 |
|---|---|---|
| Infant mortality rate | 137.0[a] | 40.0 |
| Population with monthly income below minimum wage (%) | 33.5[b] | 19.9 |
| Illiteracy (% of population over 7 years old) | 43.3 | 31.7 |
| Level of education (% of population between 7–14 years old) | 56.7 | 95.0 |
| Households with piped water (%) | 31.5 | 53.3 |
| Households with electricity (%) | 53.1[c] | 75.6 |
| Households with garbage collection (%) | 28.0 | 49.0 |

*Source*: IBGE/PNAD, SEDUC, SESA, Government of the state of Ceará, 2000.
[a] 1986.
[b] The rate for 1997 is 42/1,000.
[c] 1985.

*Drought-Relief and Policy-making in Northeast Brazil and Ceará.* In Northeast Brazil, reports about devastating drought episodes trace back to the first Jesuit missionaries, who arrived in this region in the late 1500s. From 1877–1879, a severe drought resulted in widespread famine in which approximately 500,000 people (four percent of the Brazilian population at the time) died and three million migrated from the region (Villa, 2000: p. 83). More recently, the drought of 1979–1983 affected eighteen million people, and the government (local, state, and federal) spent approximately US$1.8 billion on emergency programs (Magalhães et al., 1988: p. 293).[7]

For over a century, local and federal governments have attempted to alleviate the negative effects of drought in this region.[8] In 1856, Emperor Pedro II of Brazil created the first governmental commission to study the drought problem in the Northeast and make policy recommendations. Because drought at the time was perceived mostly as a consequence of water shortage, the solution focused on the construction of massive waterworks – especially reservoirs – which would both alleviate water scarcity and employ large numbers of impoverished local residents. Additionally, the Commission recommended the construction of railways and the creation of the first meteorological observatories in the region. By 1910, Northeast Brazil had 124 rain gauges and four hydrometer stations installed. Although different governments sought to implement a wide range of drought-related policies, for many years the expansion of the water supply system remained the focal point of drought planning in the Northeast. Between 1884 and 1983, the National Department of Public Works and Drought Relief (*Departamento Nacional de Obras e Combate às Seca – DNOCS*), built 1,121 dams, exceeding 15 billion cubic meters of water capacity (IBGE, 1984, cited in Pessoa, 1987).

Moreover, from the 1950s until the 1990s, the state of Cerará also invested substantially in cloud-seeding research and experiments designed to increase rainfall over the region. In the 1970s, the state bought three planes and carried out cloud-seeding experiments regularly.[9] Although there was scarcely any documented success, cloud-seeding became a powerful political tool, since it conveyed the idea of government 'action.' Indeed, it was common for politicians to request that 'seeding campaigns' be carried out in their regional strongholds, especially around election time. According to a local policy-maker, 'The sound of the airplane flying over their regions became more important than the rains they were supposed to bring.'[10] When FUNCEME phased out the program in the 1990s, the agency's president was harshly criticized for selling two of the cloud-seeding planes (Lemos et al., 2002). Hence, since the beginning, despite the devastating social impacts of droughts, policy-making favored a techno-scientific approach that focused on expanding the availability of water, rather than focusing on anti-poverty policies that would have decreased the vulnerability of poor rural populations to climate events.

In the 1960s and 1970s, the policy focus started to change, at least on paper. Federal and state governments created several programs aimed at addressing different aspects of vulnerability to drought (including agrarian reform and

industrialization). However, most of these programs met little or no success.[11] Much of the policy failure can be traced to 'the drought industry' – as the drought-relief public policy-making apparatus is known in Brazil. Early on, powerful local groups captured the drought-relief policy apparatus, which mostly benefited large landowners and local political bosses (Goldsmith and Wilson, 1991; Tendler, 1997; Villa, 2000). Perhaps the most emblematic examples of the drought industry are the federally funded emergency work fronts that paid poor, dislodged subsistence farmers less than minimum wage to work on the construction of public works (e.g., dams, irrigation channels, or roads) – either on private or public land. Historically, these fronts have been a powerful bargaining instrument for local political bosses who, through classic clientelism, exchange placement in work fronts for votes. Moreover, such fronts mostly benefit large landholders and fail to create a sustainable economic program that might mitigate long-term vulnerability to drought.

During the 1987 drought – in the context of Ceará's first openly reformist government – drought planning underwent dramatic change.[12] Rather than short-term emergency actions mostly benefiting large landowners, the state government decided to focus on long-term projects associated with communities. A wide range of new programs emphasized rural development and alleviation of poverty through agrarian reform, creation of irrigated zones, development of hydrographic microbasins, rational water management, development of micro- and small businesses in the interior, education, basic rural health and sanitation, agro-industry, rural extension, creation of food security programs, community development, etc. (Magalhães, 1991: p. 33). These programs encouraged more community involvement in the decision-making process. However, as with other policies in the past, many of these initiatives never survived the planning stage, while others either only partially achieved their goals or failed altogether. Although these programs intended to strenghten the resistance of the rural population to drought by stabilizing production for the small farmer, here again implementation mostly concentrated on the increase of water supply instead of longer-term redistributive policies. Consequently, large segments of Ceará's poor remain significantly vulnerable to climate variability (Lemos et al., 2002).[13]

Despite overall disappointing results, one exception was the implementation of Emergency Drought-Relief. For the first time, Ceará's government created a centralized structure for drought response that coordinated the efforts from all areas of the state government (Carvalho, 1993). This structure, organized under the state department for Social Action (*Secretaria de Ação Social – SAS*), was a departure from the clientelism-infested policy structure of the past. The most innovative aspect of the new policy approach was the creation of local, community-based emergency committees and the design of new criteria for the kind of works and workers that would qualify for funding (Tendler, 1997). The new Community Action Groups (*Grupos de Ação Communitária – GACs*) became focal points for decision-making regarding Emergency Drought-Relief. In contrast to previous programs, where local politicians controlled relief funds and

used jobs as political currency, the GACs (coordinated by local extension agents) were administered by representatives of several sectors of society, e.g., the Church, rural labor unions, city council representatives, landowners associations, state officials, and professional associations. Tendler (1997: p. 50) describes the workings of the new GACs:

> 'In a process that was quite unusual for rural Brazil, the GACs would deliberate in weekly meetings over a set of two lists submitted by each village or community in the *município*, the villages ranging in size from five to 200 families. One list ranked a set of projects desired by that particular community; the other ranked those families hardest hit by the drought and most in need of employment and relief supplies.'

In addition, government emergency programs cancelled large-scale public works projects in an effort to reduce the widespread displacement of workers and separation of families. Work projects shifted from individual, private properties to public services, except for hydrological projects where property owners agreed to allow the entire community access to the water (Magalhães et al., 1991).

Despite these improvements, what these different drought-related policies in Ceará share is a strong emphasis on solutions that fail to address the structural economic and social inequalities. These inequalities critically shape the way different groups are vulnerable to climate-related phenomena. Indeed, vulnerability to drought in NE Brazil is more than a climate-related issue; it is the consequence of historical patterns of unequal distribution of wealth, land, and power that date back to Brazil's colonial times. Thus, vulnerability-reducing policies should necessarily address such inequalities. For example, evidence from household surveys shows that vulnerability of subsistence farmers to drought is critically affected by non-farm income, especially pensions and remittances (Lemos et al., 2002). This suggests that policies directed to diversifying household income could more effectively decrease vulnerability to drought. Despite such evidence and widespread belief that rainfed subsistence agriculture is neither economically nor environmentally sustainable, in Northeast Brazil (where at least four in every ten years are affected by drought), policy-makers have favored 'technical fixes' rather than implementing re-distributive policies. The underlying rationale is that such policies would decrease the dependence of poor households on governmental programs, which, in turn, would erode the electoral base of those politicians who rely on clientelistic practices of exchanging goods and services for votes. Accordingly, because long-term adaptive policies might challenge the power structure of the region and therefore meet with strong political opposition, the use of sophisticated science-based policy tools might provide policy-makers in Ceará with a politically 'palatable' alternative.[14] In this sense, seasonal climate forecasting may be just one among many tools allowing *técnicos*[15] in Ceará to avoid policies that would challenge politicians' established power base, especially in rural strongholds.

In this context, it is not surprising that policy-makers in Ceará's highly politicized policy-making environment would favor a technocratic decision-making approach to *Hora de Plantar* and Emergency Drought-Relief. From Ceará's *técnicos* point of view, the advantages of technocratic decision-making are many. Because policy tools originate in 'hard' research science – therefore requiring technical expertise for their use – they can insulate policy-makers from political meddling and from powerful interest groups trying to influence policy implementation and outcome. In Northeast Brazil, for example, it is common for local mayors to try to pressure Emergency Drought-Relief *técnicos* to rank their *município* as requiring high priority to receive federal funds earmarked for droughts mitigation. It is also common for individual politicians to exchange eligibility to public services for votes. Other characteristics of technocratic decision-making might also appeal to Ceará's *técnicos*. First, technocratic decision-making is understood as increasing legitimacy and feasibility and reducing dissent (Jasanoff, 1990; Ezrahi, 1990). Second, technocrats believe technical insulation will decrease the vulnerability of policies to criticism from non-technical people and politicians (Steel et al., 1993).[16] Finally, scientific decision-making holds the promise of value-free decisions about public policy, therefore bypassing the messiness of dialogue and negotiation (Jamieson, 2000). Technocratic decision-making, however, may defy basic precepts of democracy by limiting the number of participants and policy alternatives, while creating an oligarchy of technocrats unaccountable to elected officials and clients (Etzioni-Halevy, 1983). Indeed, when trying to gain political advantage, groups with opposing interests may be tempted to exaggerate or distort information when that information serves to support the interests of one group over another. In this process, information is not neutral in terms of power relationships and institutions. As technical analysis becomes more prominent than other informational input (including opinions and interests of non-technical sources), it may 'squeeze out other forms of information, decisionmaking routines, and claims' (Healy and Ascher, 1995: p. 13).

Both perspectives permeate the Ceará case study, since the very same reasons that attract policy-makers can alienate other important actors in the policy-making process, such as policy clients. The next section examines the use of seasonal climate forecasts in *Hora de Plantar* and Emergency Drought-Relief, taking into consideration not only policy outcome but also its potential to go beyond policy solutions to affect democratization.

## Technocratic response to drought: *Hora de Plantar* and Emergency Drought-Relief

In principle, both *Hora de Plantar* and Emergency Drought-Relief use a wide range of science-based information, including climate forecasts. Indeed, as mentioned earlier, the draw of science-based policy tools as a means of insulating decision-making from a highly politicized policy environment is high. In

Ceará, many of the essential qualities people associate with science (e.g., thoroughness, objectivity, the search for truth, and rationality) are also the most desirable characteristics of efficient and effective policy-making. These qualities are sought after by state-level policymakers, especially *técnicos*. In Brazil and other Latin American countries, the tradition of technocratic policy-making goes back to the XIX century, when, in an attempt to modernize the newly independent countries, governments 'imported' *técnicos* from Europe to build a much-needed local infrastructure. These *técnicos* were often considered more desirable than local personnel, not only because of their superior European education but also because of their perceived lack of a political agenda, a fact that suited local political elites who wished to govern unchallenged. However, by the 1930s, a strong and increasingly autonomous bureaucracy had emerged, based on the multiplication and expansion of both public and private organizations. While in the classic Weberian model politicians and bureaucrats play very distinct roles – that is, politicians make policy decisions and bureaucrats implement them – in Brazil, the line between politics and bureaucracy has been purposely blurred under the guise of improving 'efficiency' in policy-making. The underlying assumption was that politicians, because of their vulnerability to electoral politics, may fall prey to special interests and clientelistic relationships, which, in turn, could lead to biased policy decisions. Bureaucrats, on the other hand, because they are bound by their expertise and, in principle, should have no political agenda, are much more qualified to make the 'best' policy decisions and implement them efficiently. Thus, in order to be able to do their jobs properly, bureaucrats needed to be protected from politics and politicians. However, even within the same government structure, all bureaucrats were not created equal. Because some sectors of the state bureaucracy had become targets for politicians who used jobs for political bargaining, they were not expected to function at the same level of efficiency as other agencies where expertise, not political patronage, was the main criterion used to select employees. Hence, some sectors – recognized as technocracies – experienced special treatment within the bureaucracy.

This had been particularly the case in the 1960s and 1970s when political leadership (both democratically elected and authoritarian) attempted to insulate technocratic organizations as a strategy to increase efficiency in promoting develoment. Thus, leaders purposely singled out some agencies – especially the ones responsible for economic policy-making – and provided them with resources (both human and financial) and regulations that followed them to perform at a higher level of competency than other sectors of the government. Nunes and Geddes (1987: p. 104) define Brazil's bureaucratic insulation as 'the capacity [these] organizations have to maintain their organizational integrity and to pursue their own goals.' Such technocracies also operated from decentralized agencies (public and mixed enterprises and autonomous entities) that were relatively insulated from practices such as clientelism, nepotism, spoils systems, and corruption (Nunes and Geddes, 1987). However, bureaucratic insulation also rendered these agencies virtually unaccountable to other parts of the state

as well as to society. Thus, while in the short run bureaucratic insulation can incrase decision-making capacity and promote effective implementation of policy, in the end it can erode critical processes essential to democratic policy-making, such as accountability, transparency, social participation, and equity. While most of the literature examining technocratic insulation and policy in Brazil has focused on either economic policy-making at the national level or state-engendered insulation (Nunes and Geddes, 1987; Geddes, 1990; Steel et al., 1993; Schneider, 1993; Centeno and Silva, 1998), less attention has been paid to the actions of mid-level, state technocracies, whose power is rooted in their technical expertise. The application of scientific information such as seasonal climate forecasting, in principle, provides policy-makers with an apolitical tool that serves as the basis for a technocratic model of policy-making historically grounded on Brazilian tradition. Furthermore, as a policy tool, climate forecasting holds the promise of mitigating and preparing for natural hazards that were previously perceived as unpredictable. In both senses, policy-makers may perceive the emergence of science-based tools as a highly desirable policy option. Yet, in Ceará, technocratic insulation might become increasingly untenable in the context of political reform and democratization. Moreover, attempts to insulate the process can backfire and produce exactly the opposite effect, that is, excessive politicization of the policy process and unwise discrediting of specific policy tools. That may be true in at least one of the cases analyzed below.

*Hora de Plantar.* To forecast seasonal climate in the Northeast, FUNCEME uses a 'conceptual model' that summarizes and evaluates the different sets of phenomena affecting the region's quantity and distribution of rainfall.[17] To build its forecast, FUNCEME *técnicos* calculate the probability of how each of the phenomena will affect rainfall for the rainy season (February–May). Each phenomenon is then classified as 'neutral,' 'favorable' or 'unfavorable.'[18] FUNCEME then releases the prognosis of the season, first to the government and later to the media.

The *Hora de Plantar* program, started in 1989, has relied heavily on climate and soil information provided by FUNCEME. The program starts with the acquisition of high-quality seeds and their distribution to regional centers, where they are stored until the determined 'time to plant.' Each head of a farming household receives enough seed to plant a maximum of two hectares. To qualify for the program, subsistence farmers register with the local rural exension agency. In exchange for the selected seeds, farmers 'pay' the government with grain harvested during the previous season (the same amount as the seeds they receive) or receive credit to be paid the following year (Ceará, Governo do Estado do, 1997). Although the program is not mandatory, many poor households depend on government seed, especially in years of uneven rainfall distribution – when farmers might have to plant twice in the same season after their first crop fails. Government seed is also critical during multiple drought years, when farmers run out of their own seeds after several years of crop failure.

Since 1992, The Secretary of Rural Development (SDR) has used a computer-based soil humidity model developed by FUNCEME (Andrade, 1995) to organize seed distribution. This mathematical model, used to calculate soil humidity, incorporates seven main physical parameters: soil type, daily precipitation, evaporation, maximum water retention capacity of the soil, water infiltration capacity, run-off, and water percolation. Data collection begins with FUNCEME's monitoring of rainfall daily at 184 rain stations located in each *município* within Ceará. Then FUNCEME *técnicos* enter the data into the model, which calculates the level of soil humidity and its ability to retain enough moisture for plant growth (Andrade, 1995). From the model, FUNCEME establishes the number of days that it will take for the soil to lose the moisture gained from the last rainfall. FUNCEME then maps the *municípios* whose soils can retain eleven days of moisture and sends this information to the SDR, which, in turn, authorizes seed distribution for these *municípios* (Andrade, 1995).[19] Here it is important to emphasize that, despite the fact that seasonal climate forecasts are not included in the model, there is a widespread perception among FUNCEME and SDR's *técnicos* and *Hora de Plantar* clients that seed distribution is directly connected to FUNCEME's forecasting. Indeed, FUNCEME's *técnicos* claim that forecasting information affects the criteria for seed distribution because in years of below-average rainfall forecast, the number of required moist days can be reduced so that farmers can take advantage of any opportunity to plant.[20] In other words, in such years, SDR *técnicos* become less conservative and are more willing to reconsider their requirement for the conventional eleven-day period of moisture, since the latter might not occur at all. Critics of the model, however, contend that the program's insistence on maintaining such a strict planting calendar is inconsistent with current levels of skill – that is, the ability to predict temporal and geographical distribution of rainfall for a given region – available for Northeast Brazil. At such levels, seasonal climate forecasts are virtually useless for the kind of precise information required to decide on a specific day and region for seed distribution.[21]

From the subsistence farmers' point of view, *Hora de Plantar* has many shortcomings. First, it is onerous – both in terms of resources and time – to comply with the program's requirements. Many times farmers have to take several costly trips, first to register, and then to pick up seed. Because the distribution process can take days and the planting window is short (around eleven days), it may not be worthwhile for small farmers to participate in the program. Second, even at a discount price, it is expensive for some very poor farmers to participate in the program. Finally, farmers strongly resent *Hora de Plantar*'s planting calendar and its imposition over their own best judgment. When asked why they had stopped participating in *Hora de Plantar*, approximately 20% of the subsistence farmers interviewed in the six municípios offered 'wrong' distribution time as the number one reason, second only to availability of their own seeds (30%).

Because for many subsistence farmers the *Hora de Plantar* program is the only source of seed – especially after a multi-year drought when farmers'

capacity to store seeds from previous yields dwindles – SDR's distribution process can become very damaging to farmers, particularly when it rains and farmers have no seed. Both extension *técnicos* and the union leaders of rural workers, interviewed for this study, agree that it is a 'worst possible scenario' because, in such a case, many farmers perceive this situation almost as a sinful 'waste' of precious rain. In the words of one farmer, 'Many times I will prepare the land *in the dry* [meaning even before the first rains fall to soften the soil and make the use of a manual or animal traction plow easier] because this way I am showing God my faith that He will send us rain.' Moreover, because there are not many available work alternatives outside of the farm (and thus no opportunity cost for staying on their land), farmers often prefer planting and losing to not planting at all. According to one farmer, 'Even if I plant and lose, at least I have a chance. When I don't plant, I know for sure I won't have anything to eat.' For this reason, many rainfed subsistence farmers will initiate planting even if they do not have much hope of incoming rain. Therefore, although the result is the same – lost crops, in most cases, farmers prefer to plant and lose rather than not to plant and be surprised by rain. At great sacrifice, whenever they can, most farmers store their own seed (which otherwise could be comsumed as food) from one season to the next, so as not to depend on *Hora de Plantar.*[22]

By keeping the planting calendar, SDR is, in essence, deciding for farmers when it is the best time to plant. SDR's *técnicos* believe that their methods are consistently superior to those of farmers who, if left to their own devices, either waste the seeds by planting at the 'wrong' time or eat them in periods of food shortage. Although there might be cases of farmers eating or selling the seeds, SDR's argument is weakened by the fact that most farmers do save their own seed from one year to another. According to one farmer: 'When SDR says we eat the seed, it shows no respect for the farmer. If we save two liters of our own seed no matter how bad our condition is, why would we eat the government's seed? If a farmer believes he has to plant in a certain time, he has to be respected.' Table 2 shows the declining level of participation in *Hora de Plantar* in the six *municípios* studied.

*Table 2.* Rates of participation in Hora de Plantar by Município.

| Município | Previous participation % HH | Participation in 1997 % HH |
|---|---|---|
| Limoeiro do Norte | 56 | 37 |
| Barbalha | 67 | 47 |
| Parambu | 43 | 21 |
| Boa Viagem | 64 | 54 |
| Itarema | 53 | 43 |
| Guaraciaba do Norte | 44 | 42 |
| Total | 54 | 41 |

At first glance – especially considering the limitations of the soil-climate model – it seems to make little sense for SDR to assume the risk of making such a high-stake decision. However, a closer look reveals that SDR does not have much to lose. First, farmers and their families, who may face food shortage at the end of the season, bear the worst consequence of failure. Second, although SDR has been the target of some criticism, it is FUNCEME – which the media, policy-makers, and the public in general have consistently blamed for their 'wrong' forecasts – that withstands the worst of the negative publicity concerning failure (Lemos et al., 2002).[23] Indeed farmers often believe FUNCEME is responsible for both lack of seeds and lack of rural credit. In interviews, bank managers and extension agents admitted offering FUNCEME's forecasts as the reason for denying credit and seeds to farmers.[24] So much is at stake when basing decisions on FUNCEME's climate forecast that, to avoid social unrest, a member of the state's legislature proposed forbidding the agency to publicly release this information. In addition, in 1997 the state legislature held hearings on FUNCEME's work. During these sessions, a few representatives questioned the need for the agency's existence. Consequently, it is not surprising that FUNCEME has become increasingly reluctant to divulge the forecast (Lemos et al., 2002). In the past few years, the agency has attempted both to distance itself from *Hora de Plantar* and to devise new methods of information communication that stress the probabilistic character of climate forecasting.[25] Although SDR has the ultimate responsibility for generating and enforcing the planting calendar, it has been able to 'shift the blame' to FUNCEME. Yet, while this strategy may shield SDR in the short run, it has been tremendously detrimental to FUNCEME and has significantly eroded the public's trust in forecasts in general. Farmers interviewed for this study often reported that, upon receiving FUNCEME's forecast, they are inclined to believe that exactly the opposite forecast will be true. For example, according to one farmer, 'Every time FUNCEME tells us it is going to rain, I know there will be a drought coming.' During the three years of drought that coincided with the field research for this study, many different versions of this type of statement were heard in interviews. In this study's survey sample, only seven percent of the farmers interviewed declared they believed FUNCEME's seasonal forecasts (Lemos et al., 2002).

In sum, through its use of climate information, *Hora de Plantar* insulates program implementation not only from outside interference but also from its clientele. On the one hand, farmers resent *Hora de Plantar*'s imposition of a planting calendar and correctly argue that, although they are not allowed to make the decision whether or not to plant, they are the ones bearing the consequences. On the other hand, although SDR is able to 'shift the blame' of failure to FUNCEME, it does so at the expense of the credibility of seasonal forecasting information. In 2001, SDR decided to change Hora de Plantar by de-coupling seed distribution from the soil/climate model. Now, seeds are made available to farmers at the beginning of the season, and it is the individual farmer who then decides the best time to plant (Lemos et al, 2002).

*Emergency Drought-Relief.* The second program analyzed in this study – Emergency Drought-Relief – has been undergoing change since the 1979–1983 event, when the Northeast's mostly outdated and clientelistic policy-making apparatus proved unable to mitigate the severe effects of drought. As discussed in the previous section, it took the election of a progressive governor in Ceará in 1987 to deepen the reform of the state emergency response system by creating a community-based program. Since then, the program has gone through further changes that consolidated and expanded its community-based approach.

The political implications of the distribution of emergency relief resources are three-fold. First, work fronts have traditionally played an important political role in Ceará's rural areas. Usually the last means of survival for many poor families, the work fronts have been the target of much criticism and controversy. As mentioned earlier, these fronts have been a powerful bargaining instrument for local political bosses who, through classic clientelism, exchange votes for placement in work fronts. In addition, much of the construction work carried out by the fronts would either be located withing properties belonging to powerful individuals (e.g., water reservoirs and dams) or would directly benefit the interests of the powerful (e.g., roads, water channels, etc.). Similarly, the distribution of water trucks and food baskets was often used for political and economic gain. The costs of trucking water can add up quickly, since most of the communities in distress are located far from urban centers or water sources. In many cases, tank trucks are contracted out, and in the past, local governments would bill the state government for the distance traveled by each truck. To make matters worse, there was little monitoring, so the billing system was greatly vulnerable to fraud and abuse. Finally, under official emergency status, local governments dramatically increase not only the amount of their budgets through the injection of federal and state emergency funds but also their discretion over them. Therefore, local elites have a keen interest in keeping unchallenged their ability to declare emergencies and to distribute locally the relief resources.

The new system, which started in the late 1980s but was constantly changed throughout the 1990s, improved the old clientelistic model in several ways. It democratized local instances of decision by installing *município*-based committees that are responsible for identifying the neediest families in each drought-affected community. By the early 1990s, the coordination of these committees was transferred to Civil Defense *técnicos*, who supervised their workings and closely monitored the implementation of emergency fronts. Community representatives in the committees – now called COMDECs (*Comitê de Defesa Civil*) – generate a list, ranking the families of each community according to need. These lists are then prioritized within the *município* and used as a basis for the distribution of jobs, food baskets, and water trucks.

The transition from the clientelistic model to the new more democratic COMDECs, however, was not smooth. Although, since the beginning, the Civil Defense agency had the governor's support in reforming the system, in

practice, implementation proved complex. Not surprisingly, local political bosses fiercely resisted Civil Defense's new model and attempted to undermine it, either by capturing local committees and trying to control their membership or by directly lobbying the governor to curb the *técnicos*' actions in their strongholds.[26]

Although Civil Defense *técnicos* are quick to praise the governor for resisting such pressure, they soon realized they needed more than the state government's support to deal with the day-to-day politics of resource distribution in Ceará's many *municípios.* One particularly difficult task was to challenge local political bosses on their turfs – some of them many times removed from the direct sphere of influence of the state government. On the one hand, *técnicos* were mostly perceived as outsiders, so their mandate tended to dissipate in the context of local politics. On the other hand, the governor's reliance on these local politicians for electoral support places the *técnicos* in a delicate position.

It is in this context that the use of science-generated information, especially climate information, played a critical role in facilitating the implementation of Civil Defense's new approach to drought emergency relief. Indeed, Civil Defense *técnicos* were able to shield themselves under the cloak of science to challenge the old clientelistic model.

A particularly innovative initiative was the creation, in 1997, of a need-based ranking for emergency relief of all the *municípios* in the state. *Técnicos* from Civil Defense established a series of criteria to rank *municípios* according to their vulnerability to drought and need for emergency relief. These criteria included rainfall quantity and distribution, runoff, yield losses by *município*, vegetation index, and social unrest. All of the data used in this model – with the exception of the social unrest and crop yields – is provided by FUNCEME. Here again seasonal climate forecasts, although not directly used in the model, are described by *técnicos* as 'background' information that warns them of the need to activate their local capabilities to implement the Emergency Drought-Relief. Despite its limited current use of climate forecasts, high-rank policy-makers at the Secretary of Planning and Civil Defense expect that, in its next incarnation, the program will be able to rely substantially on this kind of information to plan for drought. A new proposal to restructure the Emergency-Drought-Relief program calls for implementation of an integrated system of permanent response, the main goal of which is to decrease vulnerability to climate variability. In this case, seasonal climate forecasts have the potential for contributing to early preparation and budget planning.

After *técnicos* from Civil Defense establish the ranking of *municípios* according to need, they prioritize the implementation of emergency relief. Next, the *municípios* at the top of the ranking are allowed to declare drought emergency, which, in turn, qualifies their local governments to receive relief resources.

Here, climate information provides Civil Defense *técnicos* with sufficient weight to face political challenge to their programs from local politicians. According to one *técnico*, the creation of the ranking has enabled him to challenge local mayors' claims of distress by confronting them with detailed

compilation of crop losses, rainfall distribution, and runoff. The satellite pictures showing crops and vegetation and the computer-generated maps showing rainfall distribution are particularly compelling as 'proof' why such a *município* is not getting help or why another one has the priority. 'Now, when they come knocking at my door and I show them the numbers, it is not I anymore saying "No."'[27]

The different behavior of SDR and Civil Defense can be partly explained by their different approaches to drought planning. Both SDR and Civil Defense recognize that their reputations hinge on their ability to implement policy that addresses the devastating effects of drought in Ceará. Their means for implementing it, however, are markedly different. Whereas Civil Defense strives to promote inclusionary approaches, SDR alienates its clientele and shifts the blame for failure to FUNCEME.

While SDR is a highly hierarchical institution, Civil Defense follows a much looser pattern of organization.[28] On the one hand, Civil Defense *técnicos* are very open and candid about the difficulties of changing the distribution of emergency relief in the state. They take great pride in their work and consider themselves almost as crusaders for the governor's reformist approach. They are fiercely protective of their program, and recent changes introduced by the governor – who transferred control of the program from Civil Defense to the Secratary of Planning – have left many of them disappointed. They resent the hierarchy of the new system and fear for the future of the program.

On the other hand, SDR mid-level técnicos were more careful not to contradict higher ranked technocrats within the agency. Most of the *técnicos* interviewed were agronomists transferred from SDR's extension agency. Other SDR personnel involved in *Hora de Plantar* were also interviewed, especially extension agents responsible for registration of farmers and distribution of seeds at the local level. Their demeanor was more relaxed than *técnicos* in the capital, and their commitment to the clientele was higher. For example, many of the local extension agents disagreed with SDR's policy of keeping the planting calendar. An extension agent argued that his greater 'experience' with farm work and with the rural way of thinking, as well as his witnessing of farmers' difficulties, had convinced him that farmers should be able to make their own planting decisions. In his view, which was shared by other extension agents, SDR should increase resources at the field level so that extension agents could provide better support and advice to farmers, enabling them to make better informed decisions at their own discretion. Even SDR mid-level *técnicos* – who were much more careful about the kind of information they volunteered – pointed out that, in cases of high uncertainty, they thought it better to let small farmers make their own decisions about when to plant, based on their experiences and local conditions. As mentioned above, in 2000, SDR decided to authorize the distribution of seeds directly at the beginning of the rainy season, before the release of FUNCEME's forecast, leaving the farmers to decide when to plant.[29] Still, a few higher ranked technocrats at SDR remain convinced that early distribution of seed is a 'waste.'[30]

## Conclusions

Going back to the question I asked at the beginning of this article, I find that more important than establishing whether science can 'save' Northeast Brazil, is understanding ways in which science, in particular climate-related information, can positively affect public policy-making processes in Northeast Brazil and other drought-ridden regions of the world. Hence, even if science does not hold the key to the solution of Northeast Brazil's drought problem, it can surely play a role in the design of policies that not only mitigate drought's negative effects but also reinforce positive values, such as public accountability and the democratization of decision-making processes.

Considering the two dimensions of societal benefits proposed at the beginning of this article – climate information's value in improving drought policy-making and climate information's role in positively affecting broader processes of decision- and policy-making within Brazilian politics – the programs evaluated here fared substantially differently. This evaluation suggests that, despite policy-makers' enthusiasm for seasonal climate forecasting as a policy tool, its use was mostly described as 'background information,' with little evidence of actual use in pro-active planning for mitigating and responding to drought in Ceará. Yet such finding does not invalidate the potential of climate forecasts to play an important role in future drought policy-making, especially in the context of Ceará's new integrated program for planning and responding to drought. Other kinds of climate information, such as rainfall distribution and quantity, were found to play a substantive role in a policy-maker's ability to implement policy, both in agricultural planning and in emergency drought-relief planning. As to climate information's effects on broader processes of decision- and policy-making in Ceará, the two programs analyzed in this article tell different stories.

The first program, *Hora de Plantar*, distributes high-quality seeds to rainfed subsistence farmers according to a planting calendar based on a soil-climate model that establishes the 'best time to plant' in different geoclimatic regions of Ceará. Despite model limitations and high levels of client dissatisfaction, policy-makers responsible for program implementation believe in the superiority of their methods over the best judgment of farmers. Although it makes little sense for technocrats to make risky planting decisions for farmers, the rewards for SDR are two-fold. First, the agency bears little risk for its decisions, since the farmers and their families are the ones most vulnerable to famine in case of crop failure. Moreover, by shifting the blame for failure to FUNCEME and its forecast, SDR defuses criticism concerning its implementation of the program. Second, SDR is able to insulate its policy-making process from outside meddling, especially from clients. However, such insulation comes at the expense of both FUNCEME's and forecasting information's credibility. From the SDR's point of view, as long as the program had not negatively affected the agency, there was little inventive to reform it. The fact that SDR has changed its distribution methods, after the results of this study were presented to the community in 2000, reinforces this point.

The second program, Emergency Drought Relief, has undergone significant change in the past decade. From a clientelism- and corruption-infested program, it is now considered one of the best examples of Ceará's new progressive politics. However, the extent and reach of such changes were not easy to accomplish. Although the program had the state government's support, its implementation in the context of day-to-day local politics was constantly challenged by the pattern of clientelistic politics historically dominant in drought-relief policy-making in the Northeast. Here the use of climate information critically enhanced the ability of Civil Defense *técnicos* to democratize emergency relief implementation, both in terms of community participation and equitable distribution of resources.

Five conclusions of broader significance can be drawn from this discussion. First, the Ceará case demonstrates that, in politically charged policy-making environments, the use of climate forecasting information may go beyond its problem-solving function to influence broader issues of accountability and democratization, especially in less developed countries. Indeed, climate information can be used in ways – positive and negative – significantly different from the use information producers intended. Thus, in the *Hora de Plantar* program, while climate information producers in Ceará hoped their work would be used as a tool to improve pro-active drought-relief policy-making, it was used to impose a planting calendar that ignores clients' interests and insulates policy-making from public accountability. In the case of Emergency Drought-Relief, climate-related information contributed to support policy-makers' efforts to rid drought-relief policy-making from clientelistic, rent-seeking practices. The Ceará case further suggests that the value of the information is only partially dependent on its skill since, even at low skill, climate information can be used to further policy agendas not necessarily associated with the original goals of the information producers. These findings question the assumption that better forecast use will undoubtedly follow improved skill. This does not mean that improved skill will not make for better information use in drought planning; rather it suggests that even at improved skill, information can be ill used if utilized not as an enhancement but as a palatable substitute to other policies more likely to decrease the vulnerability of poor farmers to climate variability.

Second, different from the Brazilian traditional technocratic model – in which insulation is engendered mostly through political leadership, in the cases examined here, government support was necessary but not sufficient to guarantee policy implementation. Thus, in circumstances where the political leadership is vulnerable to electoral politics (i.e., democracies), science-based information may function as a critical factor, enabling policy-makers to avoid political meddling and corruption of policy-intended goals. Consequently, in some cases, science-generated policy tools may be pivotal in enhancing agency capacity to implement public policy.

Third, the use of technical and scientific information provides technocrats with a unique opportunity to 'shift the blame' of policy failure elsewhere. For

example, because climate forecast information is highly uncertain, policy failure can always be attributed to information's lack of spatial and temporal skill. Although this position suggests a paradox between technocrats' beliefs in the superiority of science-based information and their willingness to blame it for failure, their rationale is justified by what they perceive to be the risks of working at the frontier of scientific knowledge. Furthermore, technocrats can always argue that the solution to the shortcomings of these tools may be further funding for research to improve the information.

Fourth, attempts to insulate policy-making can backfire and create exactly the opposite effect, that is, excessive politicization of the policy-making process and unnecessary discredit of science-generated information. By pushing for the use of experimental information as an operational tool, policy-makers and information-producers may compromise their problem-solving potential as skill improves. Thus, policy-makers and knowledge-producers must take stock of the costs associated with the 'operationalization' of predictive science. Decision-makers crossing the barrier between science and policy must be aware of the unwarranted and often negative consequences of such moves and their implications for the future.

Finally, the two cases examined in this article illustrate the importance of context – political, environmental, economic, and cultural – in the use of science-generated policy tools. In addition, they suggest that the value of such tools may go far beyond their inherent quality or ability to improve in terms of skill. Therefore, it is necessary for both information-producers and policy-makers to be keenly aware of the context whenever science-based tools are to be applied.

## Acknowledgements

Research for this article was funded by the Human Dimensions of Global Change Program, Office of Global Programs, National Oceanic and Atmospheric Administration (OGP/NOAA). I want to thank Roger Pielke, Jr. and Dan Sarewitz for their comments on an earlier version of the article and Don Nelson for putting the map and tables together. Finally, I want to thank three anonymous reviewers for their careful reading and valuable comments. The views expressed here remain my own.

## Notes

1. This research is part of a larger project to understand the use of seasonal climate forecasting in NE Brazil, funded by the U.S. National Oceanographic and Atmospheric Administration (NOAA). Field research was carried out from 1997–2001, by a team of graduate students and professors from the University of Arizona and the *Universidade Federal do Ceará* (UFC). We surveyed 480 households in six counties in the state of Ceará and conducted in-depth interviews with state- and local-level policy-makers and leaders, including the state Governor,

technocrats from FUNCEME, rural extension agents, water resource managers, civil defense employees, rural labor-union representatives, and journalists.

2. The ENSO is caused by large-scale interactions between the ocean and atmosphere. The term El Niño refers to a sequence of changes in circulations across the Pacific Ocean which results in altered weather patterns across the globe. Seasonal climate forecasts attempt to predict ENSO and other seasonal climate phenomena with a lead-time of up to a year in some regions. Other kinds of climate information relevant to this study include weather forecasts (prediction of climate patterns up to a week in advance), rainfall historical series (recorded rainfall within a period of time), and statistical models (prediction of rainfall based on the extrapolation of previous recorded rainfall).
3. FUNCEME, created in the 1970s, has a reputation for being a highly skilled and well-equipped regional meteorological center in tune with state-of-the-art technology available in the field.
4. For an exception, see Sarewitz and Pielke (1999) and Sarewitz, Pielke and Byerly Jr. (2000). For more on the application of climate forecasting in other less developed countries see, Roncoli et al. (2001), Orlove and Tosteston (1999) and Broad et al. (2002).
5. The model, called MUSAG, will be discussed in further detail later in this article.
6. A *município* is a political division within states that roughly corresponds to a U.S. county.
7. The most recent drought, from 1997 to 1999, resulted in approximately 80 percent loss of crop yields in some parts of the Brazilian Northeast, causing considerable social unrest. For example, in early 1997 in the town of Baturité, about 500 rural workers occupied the municipal capital building to demand water trucks for their communities and employment in work fronts. In José Milton Rocha, 'Prefeitura de Baturité é ocupada por agricultores,' *O Povo* (Fortaleza, Ceará), 8 March 1997.
8. These policies ranged from the conventional – such as the distribution of food baskets among poor families affected by drought – to the bizarre as exemplified by the importation of fourteen camels from Northern Africa to work as farm animals in Ceará in the late XVIII century. For an interesting description of the history of drought and government response, see Villa (2000).
9. Personal communication, August 1997.
10. Personal communication, August 1997.
11. For a critical review of some of these programs, see Magalhães et al. (1991) and Pessoa (1987).
12. For the past fifteen years, the state government in Ceará has gone from an entrenched oligarchy of a few traditional political families to the most progressive state government in the Northeast. The shift started in 1987 with the election of Tasso Jereissati as governor. Then came his succession by Ciro Gomes in 1991 and Jereissati's return to power in 1994, followed by his reelection in 1998.
13. Climate variability refers to the variation of climate patterns from season to season and from year to year.
14. It should be emphasized that even though Ceará has recently generated more progressive leaders, in order to win elections they still rely heavily on the electoral vote under the control of traditional political strongholds in the state's interior. In three of the last four gubernatorial elections (with the exception of 1990), votes from the interior have been critical since the winning candidates systematically lost in the capital city of Fortaleza (Moraes, 2000).
15. *Técnicos* or technicians are mid-level professionals whose work within the public policy apparatus is rooted on professional expertise.
16. In a comparative study of bureaucracies in the United States, Korea, and Brazil, Steel et al. (1993: p. 423) report that Brazilian civil servants have the highest level of support for technocracy, although their support for outside influence on policy-making (from elected officials and voters) was also high (66 percent an 73.4 percent, respectively).
17. Some of these phenomena are the El Niño-Southern Oscillation (ENSO), La Niña, the Inter-Tropical Convergence Zone (ITCZ), Ocean Surface Temperature (OST), wind conditions, and teleconnections.
18. For further detail FUNCEME's conceptual model, see Lemos et al., 2002.
19. *Hora de Plantar* distributes four kinds of seeds: corn, rice, and two kinds of beans – a fast

growing type more suitable to short growing seasons and a slower growing type with higher productivity and market value. Beans, corn, and rice are the principal crops of small farmers in the Northeast.

20. Personal communication, 1997.
21. In addition, critics have pointed out that the model relies on insufficient, outdated, and low-quality data, especially regarding soil surveying. For example, the soil map currently used in the model was put together in the late 1970s at a scale of 1 : 600,000 $km^2$ and is clearly too coarse for the kind of specific planting advice model-runners want to give out to farmers. Personal communication, 1997; 1998.
22. Personal communication, 2000.
23. FUNCEME scientists have repeatedly and unsuccessfully attempted to communicate the probabilistic nature of their forecast. By most accounts, the agency has been consistently hurt by bad publicity related to both seed and credit distribution.
24. In 1997, for example, it was reported in the media that, in a public protest in the city of Tauá, local farmers marched into the city central square carrying a coffin with FUNCEME's name on it. They wanted to 'bury' the agency after the local bank refused them credit, allegedly based on FUNCEME's forecast of low rainfall for the region.
25. In 2001 a new administration took office at FUNCEME. The agency's new president is committed to the need to adopt new approaches to communicate forecasts. Personal communication, 2001.
26. For example, one *técnico* pointed out that the situation can get so politically charged that Civil Defense official cars have to be disguised (usually they carry the agency's logo on their doors), so as to avoid problems and potential violence. Personal communication, 2000.
27. Personal communication, 1998.
28. This difference became clear when I tried to schedule interviews with both agencies. While I had no problem contacting and talking to Civil Defense técnicos as many times as I needed in the three years I carried out field work in Ceará, the process was much more complex regarding SDR técnicos. In my first contact with Hora de Plantar técnicos, I was unable to talk to them separately. The interview was carried out as a group, but most of the information was provided by the head of the division. When I tried to contact a new group of técnicos at a later occasion, I was referred to their superiors for a formal authorization.
29. SRD policymakers interviewed in December 2000 recognized that this decision was partically influenced by the findings of the University of Arizona/NOAA study, which were presented to policymakers and the public in a high profile workshop held in August of 2000 in Fortaleza, Ceará.
30. Personal communication, 2000.

## References

Andrade, F. C. (1985). *Modelo de Umidade do Solo para Atividades Agrícolas: Teoria e Prática*. Fortaleza: FUNCEME.

Broad, K., A. Pfaff and M. Glantz (2002). 'Effective and equitable dissemination of seasonal-to-interannual climate forecasts: Policy implications from the Peruvian fishery during the El Nino 1997–98,' *Climatic Change* 54: 415–443.

Carvalho, O., C. A. G. Egler, M. M. C. L. Mattos, H. Barros, J. de Anchieta Moura Fé and C. Nobre (1993). *Variabilidade Climática e Planejamento da Ação Governamental no Nordeste Semi-Árido-Avaliaçã da Seca de 1993.* Brasília: Secretaria de Planejamento, Orçamento e Coordenação da Presidência da República-SEPLAN-PR, Instituto Interamericano de Cooperação para a Agricultura (IICA).

Ceará, Governo do Estado do (1997). *Levantamento dos Atuais Indicadores Climáticos e Sócio-Econômicos referente aos Municípios do Estado.* Fortaleza, CE: Secretaria do Trabalho e Ação Social/CEDEC, Secretaria de Ciência e Tecnologia/FUNCEME, Secretaria de Desenvolvimento Rural/EMATERCE.

Ceará, Governo do Estado do (1995). *Sustainable Development Plan of Ceará, Brazil 1995–1998.* Fortaleza, Ce.

Centeno, M.A. and P. Silva, eds. (1998). 'The politics of expertise in Latin America,' in M. A. Centeno, P. Silva, eds., *Politics of Expertise in Latin America.* New York, NY: St. Martin's Press.

Etzioni-Halevy, E. (1983). *Bureaucracy and Democracy: A Political Dilemma.* Melbourne: Routledge & Kegan Paul.

Ezrahi, Y. (1990). *The Descent of Icarus: Science and the Transformation of Contemporary Democracy.* Cambridge, MA: Harvard University Press.

Geddes, B. (1990). 'Building "state" autonomy in Brazil, 1930–1964,' *Comparative Politics* 22 (2): 217–236.

Glantz, M. (1996). *Currents of Change: El Nino's Impact on Climate and Society.* Cambridge, England: Cambridge University Press.

Goldsmith, W.W. and R. Wilson (1991). 'Poverty and distorted industrialization in the Brazil Northeast,' *World Development* 19 (5): 435–455.

Golnaraghi, M. and R. Kaul (1995). 'The science of policymaking: Responding to El Nino,' *Environment* 37 (4): 16–44.

Healy, R. G. and W. Ascher (1995). 'Knowledge in the policy process: Incorporating new environmental information in natural resources policy making,' *Policy Sciences* 28 (1): 1–19.

IAI (1994). *El Nino-Southern Oscillation and Interannual Climate Variability*. Report of a Workshop to Develop the Scientific Agenda of the Inter-American Institute for Global Change Research (IAI). Lima, Peru: IAI.

IPLANCE (2000). *Anuário Estatístico do Ceará.* Fortaleza, CE: Secretaria do Planejamento.

Jamieson, D. (2000). 'Prediction in society,' in D. Sarewitz, R. Pielke, Jr. and R. Byerly, Jr., eds., *Prediction: Science, Decision Making and the Future of Nature.* Washington DC: Island Press.

Jasanoff, S. (1990). *The Fifth Branch: Science Advisers as Policymakers*. Cambridge, MA: Harvard University Press.

Lemos, M. C., T. Finan, R. Fox, D. Nelson and J. Tucker (2002). 'The use of seasonal climate forecasting in policymaking: Lessons from northeast Brazil,' *Climatic Change* 55 (4), 479–507.

Magalhães, A. R., H. C. Filho, F. L. Garagorry, J. G. Gasques, L. C. B. Molion, M. do S. A. Neto, C. A. Nobre, E. R. Porto and O. E. Rebouças (1988). 'The effects of climatic variations on agriculture in northeast Brazil,' in M. L. Parry, T. R. Carter and N. T. Konijn, eds., *The Impact of Climate Variations on Agriculture*. Dordrecht, Netherlands: Kluwer Academic Publishers.

Magalhães, A. R., J. R. Abreu Vale, A. Bezerra Peixoto and A. de Pádua Franco Ramos (1991). *Respostas Governamentais às Secas: Experiência de 1987 no Nordeste*. Fortaleza: Imprensa Oficial do Ceará.

Moraes, F. (2001). 'A volta da competitividade eleitoral' [Web Journal], *Conjuntura Política*, no. 20, julho 2000. Associação Brasileira de Ciência Política e Departamento de Ciência Política da UFMG, 2000 [cited July 13 2001]. Available from http://cevep.ufmg.br/bacp/julho020/moraes020.htm.

Moura, A. D., L. Bengtsson, J. Buizer, A. Busalacchi, M. A. Cane, P. Lagos, A. Leetmaa, T. Matsuno, K. Mooney, P. Morel, E. S. Sarachik, J. Shukla, A. Sumi and M. Patterson (1992). *International Research Institute for Climate Prediction: A Proposal.* U.S. National Research Council of the National Academy of Sciences-Advisory Panel for the Tropical Oceans/Global Atmosphere (TOGA) Program.

Nunes, E. de O. and B. Geddes (1987). 'Dilemmas of state-led modernization in Brazil,' in J. D. Wirth, E. de O. Nunes and T. E. Bogenschild, eds., *State and Society in Brazil: Continuity and Change*. Boulder, CO: Westview Press.

Orlove, B. and J. Tosteson (1999). 'Case studies in the application of ENSO forecasts: Lessons from Australia, Peru, Brazil, Ethiopia, and Zimbabwe,' *Environmental Politics Working Papers Series*. Institute of International Studies, University of California at Berkeley.

Pessoa, D. (1987). 'Drought in northeast Brazil: Impact and government response,' in D. A. Wilhite, W. E. Easterling and D. A. Wood, eds., *Planning for Drought*. Boulder, CO: Westview Press.

Pfaff, A., K. Broad and M. Glantz (1999). 'Who benefits from climate forecasts?,' *Nature* 397 (February): 645–646.

Pielke, Jr., R. (2000). 'Policy responses to El Niño 1997–1998,' in S. A. Changnon, ed., *El Niño 1997–1998: The Climate Event of the Century*. New York: Oxford University Press.

Roncoli, C., K. Ingram and P. Kirshen (2001). 'The costs of risks of coping with drought: Livelihood impacts and farmers' responses in Burkina Faso,' *Climate Research* 19 (2): 119–132.

Sarewitz, D. and R. Pielke, Jr. (1999). 'Prediction in science and policy,' *Technology and Society* 21: 121–133.

Sarewitz, D., R. Pielke, Jr. and R. Byerly, Jr., eds. (2000). *Prediction: Science, Decision Making, and the Future of Nature*. Washington DC: Island Press.

Schneider, B. R. (1993). 'The career connection: A comparative analysis of bureaucratic preferences and insulation,' *Comparative Politics* 25 (3): 331–350.

Steel, B. S., S. Davenport and R. L. Warner (1993). 'Are civil servants really public servants? A study of bureaucratic attitudes in the U.S., Brazil, and Korea,' *International Journal of Public Administration* 16 (3): 409–442.

Tendler, J. (1997). *Good Government in the Tropics*. Baltimore, MA: The Johns Hopkins University Press.

Villa, M. A. (2000). *Vida e Morte no Sertão.* São Paulo: Editora Ática.