

News coverage of drought impacts and vulnerability in the US Carolinas, 1998–2007

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Abstract Regional newspaper coverage from 1998 to 2007 is examined to expand our understanding of the complexity of drought impacts and vulnerability in the Carolinas. Coverage at the height of two droughts reports drought effects extending beyond first-order impacts on broadly recognized sectors, such as agriculture, livestock, and water supplies to recreation and tourism and impacts on businesses, manufacturing, and households. Impacts were accompanied by social controversies with near-term and long-term planning and development implications. Key concepts in vulnerability analysis were used to structure the review of vulnerability reporting. The coverage of differential vulnerability, although limited, identified individual, household, local, and cross-scale factors that influenced the severity of impacts. Articles also highlighted additional interacting stresses in some sectors contributing to the severity of impacts experienced. An elaborated understanding of drought impacts and vulnerabilities is a necessary, early step in advancing efforts to developing a risk-based drought management approach.

Keywords Drought · Vulnerability · Impacts · Southeastern US

1 Introduction

Drought is the most expensive, widespread, and enduring natural disaster in the United States. Estimated annual impacts range between \$6 and \$8 billion dollars (FEMA 1995; Lott and Ross 2006). Entire regions are affected and droughts may continue over many years, sometimes over a decade. The effects of drought begin in natural systems and extend deeply into society. The research challenges posed by the spatial and temporal scale and broad-reaching scope of droughts undoubtedly contributes to the gap between our knowledge of drought impacts and vulnerability and those associated with other natural disasters. The increasing magnitude and complexity of drought impacts and the likelihood of greater intensity and frequency of drought due to climate change are contributing to a

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growing need for more detailed impact and vulnerability information that identifies whom and what is at risk and which investments may decrease vulnerability (Wilhite and Pulwarty 2005; IPCC 2007; Wilhite et al. 2007; Karl et al. 2009). Improving this understanding is an essential step toward establishing a stronger risk-based approach to drought management (Wilhite et al. 2000).

The decade from 1998 to 2007 in the Carolinas offers a useful opportunity to explore drought impacts and vulnerabilities in greater detail. It lends insight into the range of drought impacts in the Southeast, a region which, until recently, thought of itself as water rich, rather than drought prone. Both the history and the geography of the region place it in direct contrast to Western states where the impacts and responses to drought occur in the context of long historical struggles over agricultural viability, ranching interests, and water rights. The decade also encompasses two severe drought episodes with intervening years of recovery. This time frame captures impacts of the 1998–2002 drought that deepened over years to exceptional drought status in many parts of the region and cost over \$1 billion dollars in impacts outside of agriculture, a recovery period, and the 2007 drought that reached also exceptional drought status in some areas, although within only 1 year (US Drought Monitor 2009).

Within the US context, drought impacts are seen as increasingly complex and rising costs suggest vulnerability is also increasing (Wilhite et al. 2007). While economic losses suggest the magnitude of drought impacts, they do not capture the broader spectrum of impacts or provide insight into the linkages that allow drought impacts to reach deeply into society. This analysis draws on newspaper coverage to increase our understanding of the complexity of drought impacts in the Carolinas, their breadth, variability, and linkages to broader social processes and debates. It then draws on vulnerability concepts to guide an investigation of drought vulnerabilities within and beyond the usual focus on agriculture. The analysis considers both vulnerabilities existing within regions, sectors, and households and vulnerabilities arising from the interplay of drought and other external stressors.

This paper begins with a review of issues and approaches to drought impact reporting and vulnerability analysis. Then the methodology is explained and the analysis and findings are presented in two sections, the first examining the temporal pattern of coverage and the second addressing the types of impacts. These drought impacts are reviewed, focusing on the diversity of impacts represented. Then, coverage of vulnerability is analyzed for the insights offered into the fuller scope of drought vulnerability in the region.

2 Monitoring drought and drought impacts

Among natural hazards, drought poses distinctive challenges to definition, documentation, and understanding of the physical events, the impacts, and the associated vulnerabilities. At a general conceptual level, a drought is a protracted period of precipitation deficit that results in damages to a variety of systems—ecological, agricultural, water supply, social, and others. Operational definitions, which allow people to define the beginning, end, and intensity of a drought, specify which climate variables and timeframes to be considered (NDMC 2006). These determinations are often made with respect to disciplinary interests such as meteorological, hydrological, agricultural, or socioeconomic consequences (NDMC 2006). A variety of standard indices exist to support operational drought definitions. A variety of indicators and indices, each with particular strengths and weaknesses, are used to capture short-term rainfall deficits important to agriculture and long-term deficits affecting hydrology, fire risk, and other drought sensitivities (Steinmann et al. 2005). For example,

analysis presented in a later section reports on both the palmer drought severity index (PDSI), which reflects soil moisture supply conditions, and the palmer hydrological drought index (PHDI), which is designed to capture hydrological impacts, such as declining reservoir or groundwater levels. These indicators, with their different foci, are not always in agreement on severity and may indicate different starting and ending dates for a drought.

Many limitations on the availability of impact and vulnerability information can be traced to the challenges posed by the unique physical characteristics of drought as a hazard. Drought is sometimes called a “creeping” hazard because it can emerge slowly as deficits gradually add up over periods lasting from months to years. Throughout its duration, the severity of the drought may wax and wane due to seasonal influences, contributions of tropical storms, or brief periods of higher rainfall which may improve soil moisture conditions but not have significant influence on groundwater levels. Higher order impacts, such as susceptibility to fire, may persist after the drought itself has ended. Interactions with other stressors, such as insect outbreaks in agriculture, may exacerbate the impacts of the drought itself. Drought may also affect large regions, posing institutional issues of collecting comparable data. Each of these issues contributes to the difficulties of detecting and documenting drought impacts.

Effective identification and monitoring of the social impacts of drought must address the difficulty in defining the beginning and end of drought, the sometimes subtle emergence of effects, potentially long lag times, and interactions with other stressors. It must also consider the wide diversity of potential impacts on society. From farms to cities and industries and from recreation to public health and safety, the impacts involve multiple interacting human–natural systems, which spread the impacts from parts of the natural system to linked social systems, such as agriculture and municipal water systems.

A fuller accounting of the social costs of drought hazard, and any associated efforts to reduce vulnerability, requires at its base a more comprehensive approach to documenting impacts and understanding of the types of harms caused. The economic impacts of natural disasters are generally better tracked and recorded than other impacts, except mortality. Still, the economic impact reporting on drought has significant shortcomings. In the United States, many federal and state agencies collect information on drought impacts to support their missions and reporting needs, such as drought disaster payments or fire fighting costs; however, this is a fragmented approach. Currently, there is no comprehensive national drought impact database or integrated, routine collection of drought impacts at national, regional, or state levels (Wilhite and Buchanan-Smith 2005). The consequences of this situation are illustrated in an effort by the National Drought Mitigation Center to document the economic impacts of the 2002 drought. They drew on existing data and encouraged additional reporting. Looking across multiple states, they found that systematic data collection only occasionally extended beyond agriculture to represent losses due to tourism decline, timber loss, wildfire damages, or municipal government expenditures (Hayes et al. 2004). The information they were able to compile demonstrated “the haphazard and incomplete nature of these estimates, which represent a variety of methodologies” (Hayes et al. 2004).

In 2005, in an effort to address the need for more detailed economic and other impact information, the National Drought Mitigation Center established the web-based Drought Impact Reporter (Wilhite et al. 2007). Impacts are coded into six categories—agriculture, water/energy, fire, social, environment, and other—and by county, if that information is available. The database draws heavily on newspaper reports, with individual and agency

reports being relatively small contributors. The newspaper coverage begins to fill that void in drought impact reporting, but it is not a systematic monitoring system.

3 Vulnerability to drought

Documenting impacts is a critical first step, but an insufficient basis, for addressing vulnerability to drought. Vulnerability defined here, following Turner et al. (2003), is the degree to which a system, subsystem, sector, or social group is likely to experience harm due to exposure to a hazard, either a perturbation or stressor. Assessing vulnerability following this definition begins with an understanding of the system as representing coupled human and environment processes and specifying who is vulnerable, to what hazard, over what time period, and what type of losses should be evaluated. While many natural hazard vulnerability analyses focus on economic loss, physical injury and deaths, both because of the importance of these losses and the availability of data sets, there is increasing recognition of a broader spectrum of societal costs, such as decline of household well-being, community resilience, and impacts on businesses (e.g., Wisner et al. 2004; Norris et al. 2008; Zhang et al. 2009). In droughts, mortality and injury are less common, but the significance of economic damage and other impacts may be greater because of their frequency, the larger areas affected, the often longer durations involved, and secondary consequences associated with water use restrictions. Characterizing the scope of these socially relevant losses to drought has received little attention to date. Yet defining the losses and the differences in distribution and vulnerability to be addressed is an important consideration in risk-based management efforts where the questions are not simply how safe is safe enough, but importantly how fair, acceptable, and tolerable is the management design (Kasperson 1983; Rayner and Cantor 1987; Renn 2004).

Reducing vulnerability requires developing an understanding of the interactions of multiple social and environmental processes, which affect both the internal status of those at risk and the external circumstances surrounding the hazard event (Chambers 1989; Wisner et al. 2004). The internal characteristics reflect the status of the group or system of interest and its assets, e.g., the ability to access resources and entitlements (Sen 1981), such as the depth of a household's well, or household financial status. Poverty is not synonymous with vulnerability, but it often signals a lack of access to resources which contributes to vulnerability (Dow 1992; Adger 2006). The external characteristics are those factors and processes outside the system (sometimes called "drivers" or "dynamic pressures"), which include policies, programs, and market dynamics, and have their roots in international political and economic systems, patterns of social and power relationships, and other social processes that result in uneven access to assets and opportunities (Wisner et al. 2004). In vulnerability assessment for hurricanes, floods, and earthquakes, racial and ethnic minority status is used as an indicator of vulnerability because it is often related to processes of social marginalization as well as lack of access to resources due to education, language, or economic limitations.

Although many aspects of vulnerability are still a matter of debate and investigation (Fussel and Klein 2006; Eakin and Luers 2006; Smit and Wandel 2006; Adger 2006; Kasperson et al. 2006), there is general consensus among researchers that these factors, processes, and their interactions shape the overall vulnerability along three dimensions: exposure; sensitivity, the degree of harm likely from exposure; and, resilience, the ability to adapt and recover from impacts (Adger 2006; IPCC 2007). The long duration of drought in comparison with most other natural hazards makes Rose's (2007) additional distinction

between static and dynamic economic resilience particularly useful. Static economic resilience encompasses both the inherent and adaptive capacities that contribute to maintaining function while dynamic resilience refers to actions which are part of long-term processes including rebuilding and recovery (Rose 2007).

Applying these broad concepts to drought requires identifying hazard specific factors, processes, and measures of loss. The factors and processes influencing the degree of drought vulnerability can be placed within standard categories, although they involve specific measures, some of which are not relevant across all hazards. These categories are biophysical, e.g., soil type or water source; demographic and health, e.g., age or existing respiratory illness; individual perception and decision-making, e.g., experience of past events or overconfidence; social relations, e.g., level of political influence; economic status and relationships, e.g., poverty or debt burden; technological systems, e.g., level of excess capacity in the reservoir; and institutional design and capacity, e.g., availability and design of assistance programs (after Dow 1992). These categories overlap with aspects of the five types of capital (human, social, physical, financial, and natural) identified in the sustainable livelihoods approach as assets, which are an important consideration in vulnerability assessment (see Wisner et al. 2004 for discussion). The categorization used here, with a greater focus on hazards, places additional emphasis on institutional design, individual perception and decision-making and potential health impacts.

The interactions of these processes and the potential interactions with additional stressors is a critical consideration in all hazard vulnerability (Turner et al. 2003), which is again exacerbated by the duration of droughts. For example, low prices for agricultural produce compound the losses associated with the poor harvest and limbs felled by an earlier hurricane provide fuel for more intense fires during a drought. As suggested by the agricultural price example, a second major challenge is that many of these processes and factors operate across multiple social scales, with conditions and decisions on one level having implications for vulnerability at other scales. The duration and the fluctuating intensity of drought also contribute to variable impacts. The seasonality of systems and the potential for non-linear impact or tipping points in response to impacts both argue against assuming linearity in the impacts relationships. Indeed, the activation of responses at broader levels may contribute to the tipping point in societal action (NSF ACERE 2009).

Despite the broad exposure and high costs of drought in the United States, there is a relatively small number of studies investigating drought vulnerability. These studies identify a diverse set of factors influencing perceptions, expectations, and experiences of vulnerability largely within agriculture, but the sum of these effects still leaves many unanswered questions about the spatial, temporal, and social distribution and major processes shaping vulnerability even in this sector. A GIS-based investigation of the spatial pattern of agricultural drought vulnerability in Nebraska focused on key variables of climate, soils, land use, and access to irrigation. It found the highest vulnerability in situations that combined heightened exposure due to a very high probability of seasonal crop moisture deficiency and sandy soils with greater sensitivity of non-irrigated cropland and rangeland (Wilhelmi and Wilhite 2002). Drought impacts on Wisconsin dairy farmers in 1988 included crop loss, decline in income, feed shortages, and increased indebtedness. There were no differences among the farmers in terms of impacts reported; however, the age of the farmer, farm acreage, years in operation, herd size, drop in net farm income, and access to all farm income significantly influenced whether farmers purchased hay and feed, reduced their herds size, changed feed type, or reduced the amount of feed and whether they believed that their farms would survive continuing drought (Cross 1994). Examination

of perceived drought vulnerability among residents of San Joaquin Valley region of Kern County, CA found the highest levels of concern among agricultural managers followed by agricultural laborers (Keenan and Krannich 1997). Among agricultural owner/operators concern was greater among those with the highest levels of acreage under production. Comparison of agricultural and ranching vulnerability on either side of the US–Mexico border demonstrated the roles of class, ethnicity, access to resources, and state involvement in the dynamics of vulnerability (Vásquez-León et al. 2003). Exploring vulnerability and adaptation to climate variability over 100 years in Arizona revealed a dynamic interaction between climate and changes in organizational and technological factors over time which served to increase adaptation and reduce vulnerability among farmers, ranchers, and emerging urban populations (Finan et al. 2002). Also working in Arizona, Collins and Bolin (2007) trace the historical emergence of vulnerability to water scarcity, a stress similar to drought, at a regional level, at a finer scales use GIS to examine the intersections of biophysical and social vulnerabilities. The overlay of this demonstrated a complex mosaic of biophysical and social interactions shaping vulnerability. One other urban drought vulnerability study finds that residential growth in suburbs of Boston is increasing the sensitivity of these areas to drought (Hill and Polsky 2007). These studies frame the complexity of drought vulnerability for agriculture, but even such information on coping is not yet available for many drought sectors.

Notwithstanding the long engagement with droughts in the United States, there is still substantial work to be done on reporting systems and research needed to inform planning and mitigation efforts. This analysis contributes to those efforts by focusing on the Carolinas, a less studied part of United States and identifying the scope of first and higher order impacts which might be addressed in a risk-based drought management effort. It then reviews factors and processes identified as contributing to vulnerability in sectors and social groups. Combined these efforts present an enriched view of the complexity and management challenges presented by drought in the Carolinas.

4 Methods

This study relies on coverage in regional newspapers to document the scope of impacts on the Carolinas and identify drought vulnerabilities facing the region. Newspaper coverage provides a useful, but imperfect, source of information about many events (see Earl et al. 2004; Ortiz et al. 2005). Newspaper data has previously been used to investigate the temporal pattern of drought and impacts (Changnon and Easterling 1989; DeGaetano 1999) and in support of a vulnerability analysis outside the United States (Tänzler et al. 2008). The newspaper data is particularly useful in this effort because, unlike programmatic or agency reporting on drought, newspapers aim to capture issues of local and regional salience, which are important to this effort to understand the breadth and complexity of drought impacts beyond the limited formalized reporting currently available.

Still, the biases in newspaper data are relevant to the analysis presented here. There are two major categories of bias that may affect news coverage; these affect selection of stories to cover and description of stories (Earl et al. 2004). Selection bias in the stories covered is influenced by many factors including editorial judgment as to “newsworthiness,” and factors such as the intensity of the event, attention to controversy, sponsorship of an event, the significance of the actors involved, location characteristics, and frequency of related events (Earl et al. 2004; Ortiz et al. 2005). Internal characteristics of the media organization also pose possible sources of selection bias such as profit motivations, the

participation in issue attention cycles that focus on an issue for a period, and the political climate (Earl et al. 2004; Ortiz et al. 2005) as well as routines in media reporting activities, responsibilities to cover a beat, limits to page space, reporters' time, and related issues (Earl et al. 2004; Ortiz et al. 2005). Many of these sources of bias operate at the individual newspaper level with papers devoting different levels of resources, so their reporting on issues maybe more or less extensive and detailed. Description bias addresses the veracity of the reporting from the empirical details of an event to the omissions, potential misrepresentation, and the framing of an event through the reporters' or commentators' impressions (Earl et al. 2004). The character of individual newspapers also heavily influences this type of bias.

This study follows several recommendations in limiting the potential affect of biases (Earl et al. 2004; Ortiz et al. 2005). It seeks to reduce bias associated with practices of individual newspapers by relying on 13 newspaper sources, including the Associated Press wire service, and taking a regional, rather than a local perspective on an issue. Among these newspapers, it draws on the full population of stories rather than sampling from coverage. The discussion also acknowledges issues of selection and description bias in reporting the findings. The effect of bias is further limited by the attention given to identifying the full array of losses and factors influencing vulnerability in addition to frequency of reports.

The data set includes 1,088 articles and 2,269 coded drought impacts from the 13 regional sources. To identify the articles, we searched the LEXIS-NEXIS database, both headlines and text, for all articles including the words "drought" or "droughts" published between January 1, 1998 and December 31, 2007. The focus on the term "drought" rather than including expressions such as "low precipitation" or "dry spell" is viewed here as a justified threshold criteria for inclusion of an article in the study (also see Tänzler et al. 2008.) The newspapers and percentage of stories contributed include: AP (Local and Regional), 13%; Chapel Hill Herald (Durham, North Carolina), 3%; Herald-Journal (Spartanburg, South Carolina—not available for the full period), 0.4%; Morning Star (Wilmington, North Carolina), 15%; News & Record (Greensboro, North Carolina), 12%; News and Observer (Raleigh, NC), 20%; Star-News (Wilmington, North Carolina), 8%; The Charlotte Observer (Charlotte, North Carolina), 7%; The Herald (Rock Hill, South Carolina), 11%; The Herald-Sun (Durham, North Carolina), 7%; The Post and Courier (Charleston, South Carolina), 8%; The State (Columbia, South Carolina), 2%; The Sun News (Myrtle Beach, South Carolina), 2%; Winston-Salem Journal (Winston-Salem, North Carolina), 3%. We then reviewed those articles and removed all cases in which drought was used as a metaphor, such as 'home team wins, ending long drought' or stories which addressed drought in other regions. Duplicate stories from the AP wire services were also eliminated.

The analysis was conducted using NVIVO 7, a qualitative analysis software, to code newspaper coverage into a database of multiple, searchable categories. The coding process involved four major steps (see Neuendorf 2002 on content analysis). Existing literature and knowledge of regional impacts were used to initially identify 34 major categories based on potential impacts (Wilhite and Buchanan-Smith 2005). An automated text search and tagging function, or autocoding, was used for keywords, such as crop, water supply, fire, tourism, to initially populate those categories. Findings of each automated search were then individually reviewed. This individual review of articles returned by automated search involved reading each hit and considering the context of references to drought impacts. It allowed for verification of the accuracy of autocoding, that the reference did address a specific type of drought impact, and facilitated identification of additional search terms

appropriate for impacts in major categories. In several cases, impact searches were run a second time with additional keywords, and articles were again individually reviewed and added to the impact database. For example, crop impacts were also searched by names of specific crops including hay, tobacco, burley (a type of tobacco), cotton, and others.

The individual review of each impact returned by autocoding also involved two other evaluations. The descriptive context for each impact was reviewed to determine whether it provided any information on vulnerabilities or multiple stresses interacting to influence the impact. Relevant descriptions were coded both by impact type and by category. The category of “vulnerability” was defined to include descriptions of factors and impacts differentially affecting the exposure, sensitivity, or resilience of a social group, subgroup, or other entity, such as a city or water system. The term vulnerability has many synonyms and forms of expression; therefore, it was possible to further verify the findings of this context review of impacts. The terms vulnerable, vulnerability, sensitive, sensitivity, resilience, struggle(d), difficulty, victim(s), and better off were searched with NVIVO and the articles returned were also individually reviewed to assure that they matched the category definition. The category “multiple stresses” included descriptions of interactions of drought with other stressors that altered impacts. The final population of the “multiple stresses” category was based on the individual review of the reporting of impact coded to determine whether the article identified more than one factor contributing to the degree of impact.

The interactions of multiple stresses, impacts on industries and municipalities, and instances of conflict were also identified through the review of initial impact categories and supplemented autocoding searches. Further searches for detailed sector specific information relied initially on autocoding of keywords from these articles. This coding was also manually reviewed. Finally, all coding was reviewed by a second researcher also focusing on drought impacts, who suggested changes to coding. Initial coding consistency was over 97%. Cases in which coding differed were reviewed and corrected as appropriate.

Analysis of the data addresses three topics. First, it briefly presents the time series of impact reports, noting the contrasts between the complexity of the timelines of the case study and that offered by a generalized impact sequence model. It then addresses the scope of impacts reported with the goal of enriching understanding of the risk management challenge. The discussion concludes with an analysis of reports on vulnerabilities among social groups and sectors.

5 Drought impacts

In April 1998, the Charleston Post and Courier ran an AP story under the headline, “Prepare for drought, forecasters warn” (AP 1998). That warning, based on a strengthening La Nina, preceded a 4-year drought 1998–2002, but it could have been a more general warning for the decade. A decade of impacts demonstrates the wide reaching implications of drought across the Carolinas. The accompanying qualitative detail reveals the complexity of interactions as increasing drought stress uncovers connections among biophysical, economic, and social systems. Figure 1 shows the broad scope of impact categories with those reported over 70 times each represented separately and all of those reported fewer than 60 times (or <3%) grouped under “other.” As droughts extend over longer periods of time, the focus of attention and scope of impacts is expected to shift from meteorological conditions to social and political conflicts (Fig. 2 reproduced based on

Fig. 1 Drought impacts reports in the Carolinas 1998–2007

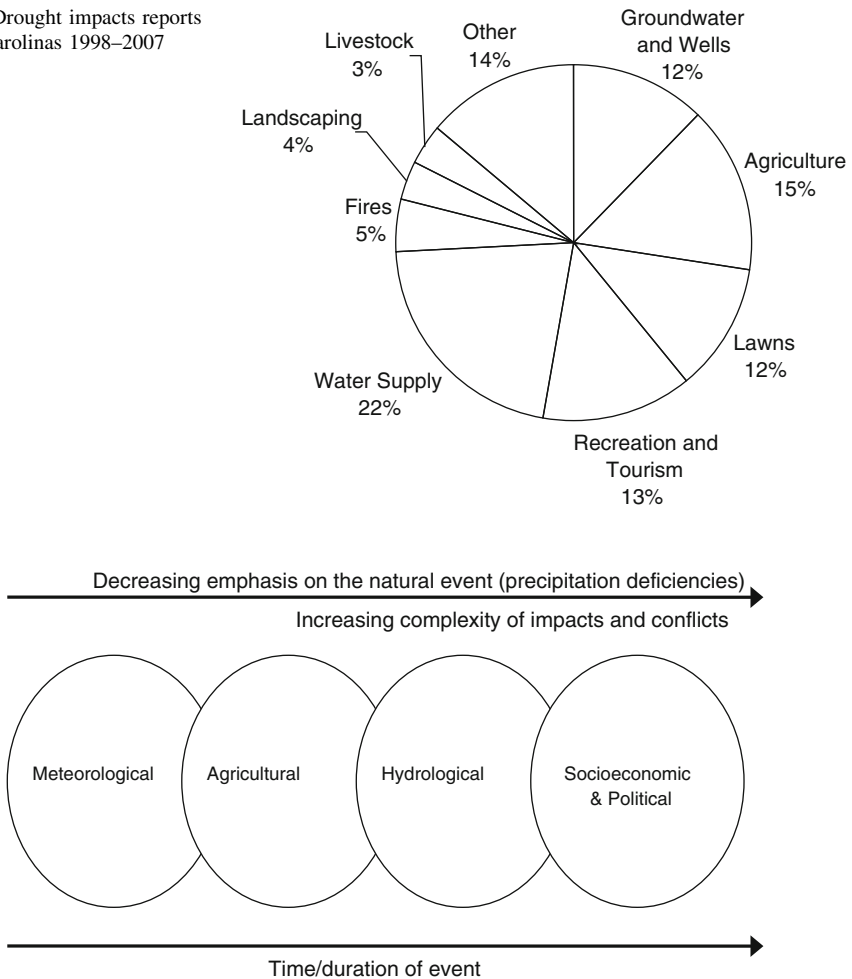


Fig. 2 Natural and social dimensions of drought (Wilhite and Buchanan-Smith 2005)

Wilhite and Buchanan-Smith 2005). A generalized model cannot be expected to capture the many possible timelines of drought events. Comparison of this generalized sequence with the pattern of impacts reported provides insight into the dynamics of drought impacts.

Figure 3 shows a time series of monthly impact reports from 1998 to 2007 mapped against the Palmer Drought Severity Index (PSDI) and Palmer Hydrologic Index Values (PDHI). The reported monthly index values are the average of 15 climate divisions in the Carolinas (NCDC 2008). The positive values, indicating wet conditions, and negative values, reflecting dry conditions, range from extremes of 4.1 to -4.1 over the decade. The impacts ($n = 2269$) are reported by the number of articles mentioning an impact. As expected, the first impacts reported concerned familiar major sectors—crops, grazing land, and lawns—reflecting their sensitivity to upper level soil moisture depletion. But, in the summer of 1998, stories about water systems and conflict centered on the problems of Greensboro, North Carolina, a particularly vulnerable water system due to rapidly growing

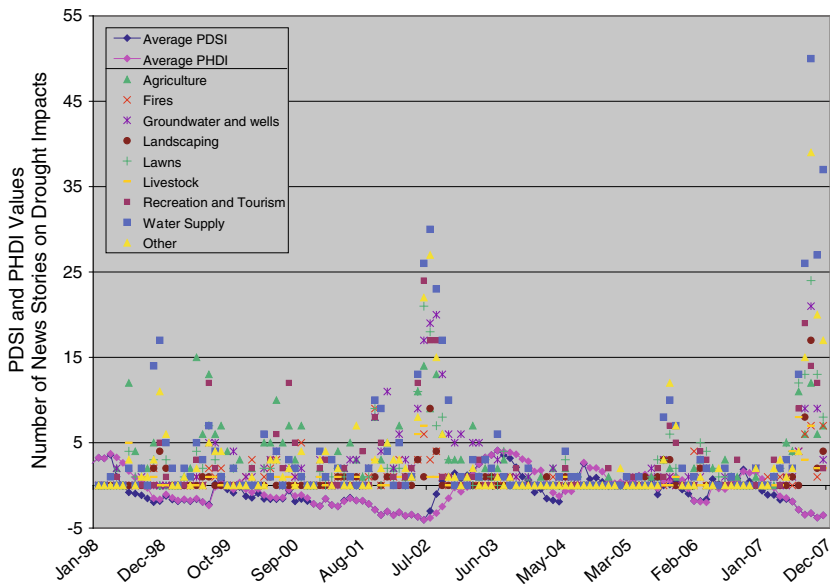


Fig. 3 Time series of drought intensity and impact reports in the Carolinas, 1998–2007

population and dependence on a relatively small watershed, which found itself facing severe shortages. This case illustrates how vulnerability can result in a compressed timeline of impacts in an area. As the drought continued to deepen, other major impacts began to be reported, also in expected sequence with stories about fire impacts and declining surface water and well levels in other communities appearing in the late summer of 1999. But, beginning as early as December 1998, impacts of drought on recreation and tourism were also being reported and coverage of impacts and conflicts outside the better known sectors continued to appear occasionally. The number of articles published on drought first peaked in the fall of 2002, which marked the most severe drought since the 1950s, and again in late 2007.

While the duration of drought can certainly contribute to the intensity of impacts, in this case, the levels of reporting peaked with timing of greatest drought severity. It is not clear, however, to what extent the abrupt increase represents greater perceived newsworthiness and/or the related secondary consequences and conflicts that arise when the severity of the drought triggers local use restrictions. This second management stage of drought impacts is an important threshold that might be elaborated in a basic model as it reflects a change in the causality resulting in impacts. As the drought became more intense, newspaper coverage expanded to include many “other” stories of social conflicts and impacts outside the major sectors. At the height of both the 2002 and 2007 drought, the number of these more diverse “other” stories published at the height of the drought was exceeded only by coverage of water supply concerns. Reporting during the most intense drought levels revealed more linkages between the hydrometeorological conditions and societal impacts and vulnerabilities than appeared under lesser stages or longer durations. The articles covered minor conflicts among neighbors and communities over water use, planning, and water rights and major interstate conflicts over water rights. In addition, these stories revealed impacts beyond agriculture and water supplies in sectors not commonly

considered in drought planning, like shrimping, crabbing, and manufacturing. Subsequent sections discuss these “other” stories in greater detail.

Following the 2002 drought, Fig. 3 also shows a stretch of relatively little drought coverage. While this news coverage mirrored the phase of apathy in the hydro-illogical cycle, efforts such as federally mandated hydropower relicensing on major interstate river basins during the period meant that many decision makers continued to engage the lessons of the 1998–2002 drought (Carbone et al. 2008). These response activities and some reports of lagging effects of the drought signal the continuing social consequences and responses, extending beyond the physical end of the drought, where the timeline does not represent broader adaptation processes.

The rapid onset of severe conditions beginning in the summer of 2007 brought drought quickly back to the forefront of coverage of impacts across sectors. Again, the sequential progression of the basic model was compressed with many types of impacts being reported almost simultaneously. At the height of the drought, reporting addressed numerous types of impacts, giving considerable attention to the breadth of challenges posed by the drought.

Interestingly, although the intensity was similar and the duration was shorter, there was more news coverage at the height of this 2007 event than there was in 2002. Perhaps this pattern reflects the event frequency bias noted by Ortiz et al. (2005) due to its proximity in time to the 1998–2002 drought or the broad national attention given to drought impacts and threats to Atlanta. It may also reflect the greater intensity and salience of the event to local interests, an increase in secondary consequences resulting from use restrictions, and the expansion of reporting issues provided as the event became more severe. The effort to determine the effect of these multiple influences, however, is beyond the scope of this paper, where the greater emphasis is on the diversity and social interlinkages contributing to complexity of impacts and understanding of factors contributing to vulnerability. The following discussion examines the breadth of issues addressed and the scope of controversies in order to better characterize the complexity of impacts.

6 Diversity of drought impacts

Well-known major sectors dominate in the coverage with the articles (Fig. 1) providing additional detail on costs and uncertainties within them. It also shows recreation and tourism as a major impact sector. Higher order impacts arising from the design of drought response strategies appear as an important category involving considerable expense and controversy. A number of impacts potentially involving large subsets of the population or involving substantial expense receive fewer mentions, but reinforce concerns that drought impacts are underestimated. Some reports attribute a higher frequency of events, which may have multiple causes, to drought. The relative contribution of drought to these events, such as foundation shifts, is not explored here, but those synergistic effects are recognized as one of the challenges in improving accounting of drought impacts.

Agricultural impact coverage reports diversity within this sector from livestock to cotton, tobacco, corn, soybeans, sod farming and fruit and vegetable production. Unlike drier regions of the United States, where a drought may mean no rainfall for months, in the Carolinas the timing of limited rainfall during a drought can benefit or harm different crops. Each of these crops has different sensitivities to moisture availability throughout its growing period and these periods differ. Consequently, agriculture is among the first sectors represented in reporting and coverage appears throughout the growing and harvest seasons.

Residential landscaping, forest fires, and surface and groundwater water supply system issues were also among well-known and commonly reported impacts. Stories of municipalities and water systems struggling to cope with severe water shortages, increased demands, and implementation of voluntary and mandatory restrictions appeared. These articles commented on additional costs and complications related to both immediate crises and longer term planning. Many of these communities rely on water sales as part of their annual budget revenue, but the consequences of budget losses were not reported. The complexity of impacts and response which surfaced involved institutional, economic, and technological systems needed to facilitate coping and adaptation strategies. Efforts involved regionalization in purchasing water from other municipalities; making long-term investments in wells, pipelines, and other infrastructure; new efforts in leak detection; and changing maintenance strategies. Greensboro, NC was the focus of a great deal of coverage because of the early drought impacts on its water supply, the ensuing public controversy over perceived management failures, and their long-term and ultimately successful effort to establish a new reservoir.

Perhaps less frequently identified as a major category of impact is “recreation and tourism.” This category encompasses impacts on boating, fishing, hunting, golf, parks use, use of fireworks and other recreation and represents 13% of the total impacts. These sectors identified loss in sales, visits, and additional costs which are difficult to track. For example, some fishing tournaments were canceled, marina operators paid to have boat ramps extended, boats were damaged by debris and stumps in shallow waters, fishing camps and small stories reported decline in business, golf courses altered irrigation practices or closed, hunters were forced to adjust to new wildlife conditions, and use of fireworks was banned. The Lowe’s Motor Speedway developed contingency plans to guarantee sufficient water to allow them to “keep the toilet flushing” for major stock car races (Williams 2001). The significance of drought impacts on recreation and tourism in South Carolina was also a major finding of interviews addressing the 1998–2000 drought (Knutson and Hayes 2001). These reports suggest recreation and tourism in the region may be more sensitive to drought impacts than previously considered.

Attention to landscaping often focused on second-order impacts and points of controversy related to the design and implementation of water use restrictions. The landscape or “green industry” includes enterprises ranging from nurseries, lawncare, irrigation installation, and wholesalers to garden supply stores. This enterprise, along with carwashes, pressure washing, and swimming pool maintenance, is affected because these uses are given lower priority than public health and safety-related needs, such as adequate water pressure for fire fighting and water supplies for basic household needs. Therefore, they are often more the subject of restrictions. Some individual businesses estimated a 10–75% drop in business and seasonal losses of up to \$400,000 (Withers 2002; Swensen 2005).

Three main points of controversy arose over restrictions. The design of ordinances is a factor in how these higher order impacts of drought are distributed among businesses. For example, under the headline, “Landscapers Complain Rules Wilt Business,” Binker (2002) reported,

‘The green industry in Greensboro is suffering,’ said Mark Peters, owner of the Piedmont Carolina Nurseries and a leader of a local landscaping coalition. ...Many who spoke said that their industry would suffer under the current rules while other businesses are only subjected to suggested cutbacks until later stages of the law take effect. ‘We have some inconsistencies in our ordinance that we need to work on,’ said council member Tom Phillips.

The differences in the ways communities approached drought regulation also raised discussions. Numerous stories addressed impacts on landscaping and the tremendous variation in water restrictions by locality. Some localities have rules restricting watering of established commercial and residential landscaping while others offer exemptions for watering plants in commercial stock, landscaping that is under warranty, and residential vegetable gardens. The basis for these differences is not always clear. The amount of water use by the green industry and water-consuming businesses became another point of discussion as people wanted proof of significant benefits if they were to make significant sacrifices.

Finally, these restrictions do not necessarily reflect short-term drought conditions most relevant to the success of landscape installation. In some cases, restrictions are designed to allow long-term recovery of groundwater levels and may remain in place after rainfall increases. Therefore, the timing of ending restrictions on businesses and homeowners is also a point of active discussion.

As the time series showed, the greater the drought intensity, the more coverage addressed impacts outside of the major well-known areas. The category “other” includes 16 impact categories that were mentioned fewer than 60 times each, but combined capture 14% of the total. Among the 16 other categories of impacts, the average number of reports was 19 and the median was 7. The array, and the more specific examples, illustrates another aspect to the increasing complexity of drought impacts raised by Wilhite and Pulwarty (2005). These comprise impacts on ecosystems, industries, non-fire impacts on forests, air-quality, quarries, insect outbreaks, fall leaf colors, shrimping and crabbing, sinkholes, well drilling, building foundations, carwashes, debates over growth and development, and other social conflicts. A few of these reports identified benefits associated with the drought including increased business for well drillers, good weather and decreased delays for construction projects, unexpectedly high counts of rare species in one wildlife inventory, and some combinations of drought and rainfall resulting in better leaf-peeping for tourists. Other reports showed mixed impacts. For example, local restrictions banning car washing at home and/or specifying that to remain in operation, commercial car washes needed to recycle a fixed percentage of their water resulted in a boost in business for some, temporary closure for others, and concerns about job loss. However, the majority of impacts reported are negative. These reports raise issues often not addressed in the limited formal reporting of drought impacts.

Among impacts are several which by their nature may influence more people than is apparent by intensity of the reporting, such as air-quality, insect outbreaks, and shifting building foundations. Only two articles linked drought to poor air-quality conditions—one because of forest fires and increased particulate matter in the air and a second addressing high temperatures and elevated ozone levels. Insect and fungal outbreaks affected many trees including red and white oak, cherry laurel, cypress, pine timber plantations, and gardens. Although timber is one of the largest sectors of the regional economy, these topics were covered by fewer than ten articles. Only two articles addressed the fact that clay soils in parts of the region can expand and contract resulting in foundation cracks or fireplaces pulling away from the side of the house and creating a risk during fire season.

“My (call) volume is up 200 percent, and it’s due to this drought,” said Mark Beckham, owner of foundation repair service Ram Jack of Charlotte. Instead of the typical 10 or 12 calls a day, he received 30 one day last week. “We have people reporting right now that they are literally hearing the brick crack,” he said. “It holds on as long as it can, then lets go” (Norwood 2007).

According to foundation repair companies interviewed, repairs usually cost under \$10,000, but they are not typically covered by homeowners insurance (Norwood 2007).

Industrial impacts also received limited coverage, although references suggested substantial issues. Pepsi Bottling Ventures, in Raleigh, NC reported modifying operations to reduce water consumption by 20% (AP 2005). The South Carolina State Drought Committee heard evidence that industries along the Great Pee Dee River were spending millions to maintain operations (Collins 2002). Other drought impacts affected the harvest of resource-related industries such as forestry, shrimping, and crabbing. A firm supplied between 150 and 200 portable toilets to Statesville, NC firms facing a 40% mandatory cut in municipal water use (Clary 2002). Textile operations, pulp and paper mills as well as the service sector and a variety of smaller firms experienced these additional expenses. These types of impacts and costs are not systematically tracked, recorded, or reported, but these examples suggest that the aggregated total of impacts to business and industry may be considerable.

Drought prompted numerous conflicts ranging from the small scale and relatively short-term to long-term issues. There were neighbors reporting water use violations; shoreline property owners concerned about low lake and reservoir levels; debates over impacts of neighboring mining operations and city wells adjacent to private wells; disagreement over the design and implementation of water use restrictions; and concerns over city leadership and management of water supplies, particularly in Greensboro, NC. Discussions of regional economic and population growth demands included disagreements over the environmental impacts of new water supply infrastructure proposals; the implications for the pace of residential and economic development; and when to end local drought restrictions on various businesses and residential uses, including potential barriers to new water hookups for development (Eisley and Bracken 2007). These discussions influenced statewide debates on smart growth and assurance of adequate groundwater supplies (Biesecker 2002). They also provide background to a law suit, now being handled by the US Supreme Court, by South Carolina against North Carolina for its approval of an interbasin transfer (US Supreme Court 2009). Two North Carolina cities, Concord and Kannapolis, proposed an interbasin water transfer, withdrawing water from the Catawba River and discharging it to the Yadkin River. The strategy was designed to support economic development in the upper reaches of the Catawba watershed. In the context of recent droughts, the proposal galvanized opposition downstream.

7 Drought vulnerability

Although news coverage addressed a wide array of impacts, differential vulnerability within any sector or group received comparatively little attention, particularly outside the major sectors of agriculture and water supply. While these few articles present a fragmented view of vulnerability, they are valuable as indications of processes deepening and extending impacts. Coverage of vulnerability reflects the internal dimensions, contributing to differences in the severity of drought impact within social groups and sectors, some of which have very limited abilities to cope and recover. The external vulnerability factors are reported as either additional stresses resulting from markets or decisions at higher scales. Relationships extending across scales are often used to enhance resilience by providing safety nets through transferring money, technological assistance, or other resources during times of need. Both the social and biophysical processes contribute to the dynamic nature of drought vulnerability in coupled human–natural systems and challenges to be confronted

in management. Articles reference vulnerabilities falling into all analytical categories discussed in the background section: social relations, economic status and relations, technological systems, biophysical systems, demographic and health, institutional design and capacity, and individual perception and decision-making. The following section uses these distinctions and categories in discussing vulnerabilities of households and individuals, municipal, and economic sectors.

8 Households and individuals

The significance of social relations and economic status on the distribution of drought impacts was raised with respect to ability to cope with the additional water supply costs and drought-related slowdown in some job sectors. Poverty was highlighted in two articles about Orange County, North Carolina, which reported assistance programs designed to help poor households cover the costs of water. The Chapel Hill-Durham Wal-Mart donated 1,500 gallons of bottled water to the Interfaith Council and Orange Congregations in Mission, two non-profit groups that provide services, food, and clothing to people in need (Velliquette 2002). These groups prepared to provide drinking water to low income families in the event their wells ran dry and they were unable to replace them or they were unable to afford rate increases. OWASA, the county utility, also collects donations from customers to provide temporary assistance for county residents who are struggling to meet their water and sewer bills. Subsequent research identified numerous communities that confronted this problem under distinctive local circumstances and capabilities.¹ A new USDA funded program focused on individual wells was established in 2007. The program was administered by the Southeast Rural Community Assistance Project, Inc., a private non-profit promoting the development of affordable water and waste water services to improve the quality of life for low income rural residents.

Rural areas are less likely to have access to centralized water supplies and more likely to have higher poverty rates. In North and South Carolina, rural to urban poverty rates in 2007 compared at 16.9 to 13.2% in North Carolina and 19.2 and 13.8% in South Carolina (USDA 2007a, b). Other stories highlighted the relative advantage of some households and communities, with some households in other areas spending estimated thousands of dollars to drill private wells for landscape irrigation in order to avoid watering restrictions enacted by municipal water systems (Price 2007).

Around Charlotte, North Carolina, impacts on the lawn care business meant that many employers hired fewer workers or reduced their hours. This sector hires seasonal and part-time labor, often from minority communities. One journalist contacted Wayne Cooper, honorary consul of Mexico in Charlotte and reported “he’s heard from Latino workers who aren’t getting as much work as they have in past years. For some, work has dried up by half. He expects the trend to continue into the fall” (Baldwin 2007). There was also concern about job loss in the car wash sector, although reporting did not offer further details, these are also low income jobs (AP 2005). The low wages and minority status of workers in these sectors suggest that coping with job loss may particularly difficult with few resources to fall back on. While these groups are generally thought of as vulnerable in other natural disaster vulnerability assessments, these reports point to linkages between

¹ The author interviewed 10 water systems and community service agencies in western North Carolina about their experiences with failure of household wells and how individuals coped as part of a preliminary investigation for another project.

environmental conditions, employment conditions, societal response, and vulnerability that merit further investigation with respect to drought.

Age and health-related sensitivities were linked to drought only twice although air quality issues are not uncommon, particularly near urban areas. Air-quality alerts warned sensitive populations to limit physical activity and outdoor exposure due to either elevated levels of particular matter resulting from forest fires or elevated ozone levels. These are major categories of public health vulnerability, but not clearly associated with drought impacts in the reporting.

9 Municipalities

For many small-to-medium-sized communities and water systems in the Piedmont of North Carolina aspects of municipal management and biophysical settings beyond climate variability contributed to greater drought vulnerability. In looking at the sector, some suggest that smaller towns with fewer customers to bear the costs tend to struggle with maintaining aging pipes and increasing treatment costs, although some are finding relief by joining larger regional systems (Mitchell 2005). In addition, in this region, many communities depend on relatively small surface water sources and did not have access to the major water supplies needed by their growing populations. The case of Greensboro highlighted institutional issues including how a lack of drought planning and low water rates coupled with rapid population growth contributed to the crisis in 1998 and ongoing difficulties in later years.

Economic stresses originating outside the communities compounded drought management challenges for municipalities. For North Carolina community water systems, implementing drought restrictions resulted in decreased municipal revenue at the same time the state was reducing monies provided to the communities.

Their budgets were already suffering because the state has been withholding sales-tax revenue to ease its own budget problems. Now, the towns also have to absorb more expenses for finding water and are losing millions of dollars in revenue from water customers, thanks to heavy conservation. ‘We’re the only business I know of that’s telling its customers to buy less,’ said Cherryville Fire Chief Jeff Cash (Price and Hennessy-Fiske 2002).

Some communities also faced additional expenses, such as purchasing water, drilling wells, or investing in pipeline and reservoir projects, to continue to provide adequate water service. Higher water rates were also adopted by some communities to cover their expenses.

Local government officials had other concerns. Following a drought summit in 2002 in North Carolina, a reporter quoted local officials observing that:

Officials from several local governments in the Piedmont were startled to learn ... that there’s little financial help available from the state and federal governments: From an official standpoint, a drought isn’t considered a disaster like a hurricane or flood. But several local officials said that in practical terms there is no difference. “This really is just like dealing with a hurricane,” said Statesville City Manager Rob Hites, who knows hurricanes and floods all too well, having also worked in Southport and Lumberton [NC]. (Price and Hennessy-Fiske 2002)

Other drought-related costs in communities manifest in post-drought periods. In years following drought, combinations of ice storms, late frost, strong winds, and heavy rains on drought-weakened trees resulted in more branches splitting and breaking and trees toppling in saturated soils (e.g., Schreiner 2003). These damaged trees represent another of the relatively small but widespread expenses that are difficult to directly attribute to drought. Because falling limbs can cause deaths, injuries, or damage, homeowners and municipalities are reluctant to ignore them. Reporting does not discuss how these municipal budget impacts influenced the provision of other community services or the community debt.

10 Economic sectors

Many articles addressed the impacts on farmers, and some offered observations about causes of differences in the severity of impacts. Farming in the Carolinas covers a wide range of enterprises including livestock, feeding operations, fruit trees, produce farms, and major row crops, such as corn, cotton, and tobacco.

Although there are many stresses on farming, three characteristics of farm operations were reported to contribute to greater or lesser vulnerability. The use of irrigation, though it has increased, is not yet employed on many farms. According to the US Department of Agriculture, the percentage of farms with irrigation in 2007 was 4.4 and 5.7% in North Carolina and South Carolina, respectively (USDA 2007a, b). For those with irrigation, it increased farmers' resiliency to water shortage but not to fuel costs (Holleman 2007; Mitchell 2007). Another interview suggested that more diversified produce operations were also more resilient (Martinez 2003). Among livestock operations, as pastures became inadequate to support herds, farmers sold livestock and/or began to feed hay. Hay is more expensive and often needs to be supplemented with higher protein feed, such as corn. Similarly, higher prices for corn meant that providing this feed for livestock was not an easy decision for some and was not within the budget for all (Goldberg 2007). The smaller livestock operations, which did not have land to grow hay, reportedly struggled more with costs of hay and its transport (Norman 2002). Assistance programs helped locate and transport to the most affected regions and farmers (Norman 2002).

In July 2003, under the headline "Better season for farmers," the impacts of the 1998–2002 drought were still a concern. Strawberry sales fell in 2003 as heavy rain followed on drought years, financial assets were further depleted and debt burdens increased.

John Vollmer, president of the 300-member Strawberry Growers Association of North Carolina, said some have had to cash out their IRAs and borrow against life insurance policies to pay bills. And, Michael Brown, a loan officer in the agency's Johnston County office, said few of the new applicants were looking for money to expand. Rather, he said, they needed help paying off years-old purchases for such things as fuel and fertilizer. (Martinez 2003)

From a local perspective, farmers suggested more can be done to provide drought assistance. While agriculture has the strongest drought assistance programs, some felt that the safety net of loans needed to be supplemented as years of drought resulted in growing debt rather than achieving recovery.

Additional stresses on agriculture affected both the sensitivity and resilience to drought impacts. Farmers' linkages to international agricultural markets added to the complexity of price forecasting and the associated uncertainty about the magnitude of losses and ability to

recover. Low milk prices affected return on investments. Cotton prices were influenced by the yield of harvest locally and other cotton producing states as well as the strength of the economy in importing regions, such as eastern Europe. During these drought periods, farmers were also coping with reduced federal production quotas for tobacco, a relatively high value crop, and increased competition from overseas (Romoser 2007).

The resilience of the golf industry was reportedly affected by recent history, the nature of tourism, and the weather. Tom Sponseller, President of the S.C. Hospitality Association, observed that South Carolina's tourism market is particularly vulnerable to weather because most tourists drive here rather than fly, so it's easy for them to change their plans if the weekend forecast looks grim (Ramsey 2003). Even as 2003 offered relief from drought expenses and closures, Terry Sedalik, Executive Director of the S.C. Golf Course Owners Association, said

'We're still recovering from 9/11. We're still recovering from the economy,' he said. 'And as much as we need the rain to recover from the drought, it's really coming at the wrong times' (Ramsey 2003).

In other parts of the tourism sector, perception of drought impacts and individual choices were seen as particularly important in making up for drought losses. Again, looking for assets and support from higher levels of government, business owners around Lake Marion and Lake Moultrie in South Carolina complained that the Department of Parks, Recreation, and Tourism did not provide enough advertising assistance to help them bring back tourists discouraged by drought in previous seasons.

11 Conclusion

Reporting on a decade framed by two extreme drought episodes brings to light a greater scope of drought impact and vulnerabilities in states generally thought of as water rich. The coverage provided by newspapers in this area is more indicative than comprehensive, but as a source that focuses on issues most salient to the region, it serves as a valuable guide for identifying issues for deeper investigation for understanding vulnerability and informing management debates as well as goals.

In the most exceptional drought stages, coverage revealed droughts resulting in complex impacts reaching across systems, sectors, social groups, and social scales. The progression of impact was accelerated under vulnerable conditions and extended beyond the technical end of drought in terms of both physical impacts and societal debates and consequences. Management interventions introduced a second, and sometimes controversial, stage of impacts for many. Newspaper coverage at the height of the droughts revealed a wider scope of impacts extending beyond familiar drought sensitive sectors and first-order impacts. Water scarcity and management strategies aggravated a variety of social conflicts, from design and enforcement of water restrictions to regional growth and long-term water resources planning and rights. The complexity of drought impacts was composed of broadening of impacts, social conflict over management strategies, diversity of local stresses and responses, efforts to regionalize water systems, multiple, diffuse impacts on businesses and households, and cross-scale interactions that exacerbated or ameliorated the overall vulnerability. These reports suggest greater economic and social costs of drought not captured by existing reporting systems.

Coverage, although it presented a fragmented picture, demonstrated the complex linkages in human–natural systems resulting in differential patterns of impacts for a natural

hazard that is distinctive for its slower development and longer duration. These stories raised multiple issues of vulnerability that are frontiers in vulnerability analysis generally and understanding of drought vulnerability specifically. It provided examples of all major categories of factors interacting and contributing to differential vulnerability among municipalities, sectors, and social groups, raising issues beyond agricultural livelihoods. It also illustrated the role of external and multiple stressors and changing social support programs in the dynamics of vulnerability. Economic and social marginal groups including the rural poor relying on private wells and minority populations depending on seasonal, low-wage jobs were both identified as facing job losses or inability to pay for water associated with drought. Small farms and small communities, with fewer assets, struggled with limited and changing resources and sought assistance from external groups, often located at higher governmental levels, in coping with drought impacts. The agricultural prices set by global markets introduced another dynamic capable of increasing the stress or resilience among affected farmers. Drought impacts extend beyond the end of the drought, into what can be a multiyear recovery. Some in the tourist sector believe that lingering impression of drought years may create a stigma that diminishes the number of return visitors and creates a long-term impact on their business. Communities and water systems coped with additional costs from investments in new water sharing infrastructure, and undescribed consequences of revenue shortfalls due to water conservation.

As drought management moves from crisis response to a risk management mode, it will be required to engage these complexities, vulnerabilities, and conflicts in a more systematic way. The reach of drought impacts in the Carolinas is broader than might be expected in the southeastern United States. The breadth of impacts suggests that the systematic monitoring and reporting desired for this hazard extend beyond standard categories and expand investigations of costs to homeowners, health, municipalities, businesses, including recreation and tourism. That need for further investigation clearly extends to the are of vulnerability assessment where existing research is very limited and even the piecemeal view offered by news coverage is suggestive of both unexplored and poorly understood connections. Influences on vulnerability span world markets, federal programs, state and local governments, as well as sequences of weather events. The external processes, both resources and stresses, virtually guarantee a dynamic vulnerability status over the course of a drought. The extent of vulnerability of low income and minority households, costs to homeowners, budget impacts on water systems, municipalities, and costs to business and industry all merit further investigation. Coping with drought, already a significant challenge, is among the most likely impacts of climate changes (IPCC 2007). Improving understanding of impacts and vulnerabilities are critical steps in pursuing improved climate adaptation.

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References

- Adger WN (2006) Vulnerability. *Glob Environ Change* 16:268–281
- AP, Associated Press (1998) Prepare for drought, forecasters warn. *The Post and Courier*, Charleston, SC
- AP, Associated Press State & Local Wire (2005) No rain in N.C. means drought conditions spread, worsen. November 15, 2005 Tuesday

- Baldwin A (2007) Lawn care industry thirsty for business: with fewer appointments, companies hiring fewer workers. *The Charlotte Observer*, Charlotte, NC, September 13, 2007 Thursday
- Biesecker M (2002) Triad is wasting water, study says researchers find urban sprawl increasing effects of drought. *Winston-Salem Journal*, Winston Salem, NC, August 30, 2002 Friday
- Binker M (2002) Landscapers complain rules wilt business. *News & Record Greensboro*, North Carolina, September 4, 2002 Wednesday
- Carbone GJ, Rhee J, Mizzell H et al (2008) A regional-scale drought monitor for the Carolinas. *Bull Am Meteorol Soc* 88(12):20–28
- Chambers R (1989) Vulnerability, coping and policy. *IDS Bull* 20(2):1–7
- Changnon SA, Easterling WE (1989) Measuring drought impacts—the Illinois case. *Water Resour Bull* 25(1):27–42
- Clary E (2002) With land dry, some Charlotte, N.C.-area businesses blossom. *The Charlotte Observer*, August 16, 2002 Friday
- Collins J (2002) Drought causes upstate streams to disappear. *The State*, Columbia, SC, August 20, 2002 Tuesday
- Collins TW, Bolin B (2007) Characterizing vulnerability to water scarcity: the case of a groundwater-dependent, rapidly urbanizing region. *Environ Hazards* 7:399–418
- Cross JA (1994) Agroclimatic hazards and dairy farming in wisconsin. *Geogr Rev* 84(3):277–289
- DeGaetano AT (1999) A temporal comparison of drought impacts and responses in the New York city metropolitan area. *Clim Change* 42(3):539–560
- Dow K (1992) Exploring differences in our common future(s): the meaning of vulnerability to global environmental change. *Geoforum* 23:417–436
- Eakin H, Luers AL (2006) Assessing the vulnerability of social-environmental systems. *Ann Rev Environ Resour* 31:365–394
- Earl J, Martin A, McCarthy JD et al (2004) The use of newspaper data in the study of collective action. *Ann Rev Soc* 30:65–80
- Eisley M, Bracken D (2007) Ban possible on new water tie-ins; Raleigh and Durham are weighing tougher water restrictions as supplies inch down. *The News & Observer Raleigh*, North Carolina, December 5, 2007 Wednesday
- FEMA, Federal Emergency Management Agency (1995) National mitigation strategy: partnerships for building safer communities. Federal Emergency Management Agency, Washington, DC
- Finan TJ, West CT, Austin D et al (2002) Processes of adaptation to climate vulnerability: a case study from the US Southwest. *Clim Res* 21:299–310
- Fussel HM, Klein RJT (2006) Climate change vulnerability assessments: an evolution of conceptual thinking. *Clim Change* 75:301–329
- Goldberg D (2007) Farmers worry over dry weather; gas prices, demand for ethanol affect corn prices negatively and positively. *Chapel Hill Herald*, Durham, NC, July 8, 2007
- Hayes MJ, Svoboda MD, Knutson CL et al (2004) Estimating the economic impacts of drought. I 2004. American Meteorological Association
- Hill TD, Polsky C (2007) Suburbanization and drought: a mixed methods vulnerability assessment in rainy. *Mass Environ Hazards* 7:291–301
- Holleman J (2007) Drought level sinks to severe: declaration sends signal to state that water conservation is. *The State*, Columbia, SC, September 6, 2007 Thursday
- IPCC, Working Group II (2007) Summary for policy makers. IPCC, Geneva
- Karl TR, Melillo JM, Peterson TC (eds) (2009) Global climate change impacts in the United States. Cambridge University Press, Cambridge
- Kasperson RE (1983) Acceptability of human risk. *Environ Health Perspect* 52:15–20
- Kasperson RE, Dow K et al (2006) Vulnerable peoples and places. In: Hassan R, Scholes R, Ash N (eds) *Millennium ecosystem assessment: conditions and trends*. Island Press, Washington, DC, pp 143–164
- Keenan SP, Krannich RS (1997) The social context of perceived drought vulnerability. *Rural Soc* 62(1):69–88
- Knutson CL, Hayes MJ (2001) South Carolina drought mitigation and response assessment: 1998–2002 drought. Natural Hazards Research Center, Boulder, CO
- Lott N, Ross T (2006) Tracking and evaluating US billion dollar weather disasters, 1980–2005. 86th AMS annual meeting, preprints CD [cited Sept. 20, 2009]. Available from <http://www1.ncdc.noaa.gov/pub/data/papers/200686ams1.2nlfree.pdf>
- Martinez A (2003) Better season for farmers. *The News & Observer*, Raleigh, North Carolina, July 11, 2003 Friday
- Mitchell H (2005) Hickory has more than enough water. *The Charlotte Observer*, Charlotte, NC, June 5, 2005 Sunday

- Mitchell H (2007) Farmers suffering as crops wither: soybeans and apples are stunted; pastures and grain for cattle are dying. *The Charlotte Observer*, Charlotte, NC, August 19, 2007 Sunday
- NCDC, National Climate Data Center (2008) National Climate Data Center
- NDMC, National Drought Mitigation Center (2006) Understanding and defining drought. National Drought Mitigation Center 2006 [cited August 7 2009]. Available from <http://drought.unl.edu/whatis/concept.htm>
- Neuendorf KA (2002) The content analysis guidebook. Sage, Thousand Oaks, CA
- Norman D (2002) A livelihood threatened: cattlemen lose money as drought limits feed. *Spartanburg Herald—Journal*, Spartanburg, SC, August 28, 2002
- Norris FH, Stevens SP, Pfefferbaum B et al (2008) Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness. *Am J Commun Psychol* 41:127–150
- Norwood A (2007) Cracked earth, foundations: drought conditions causing clay to give way, which can damage the homes above. *The Charlotte Observer*, Charlotte, North Carolina, October 25, 2007 Thursday
- NSF ACERE, Advisory Committee for Environmental Research and Education (2009) Transitions and Tipping points in complex environmental systems. National Science Foundation, Washington, DC
- Ortiz DG, Myers DJ, Walls NE et al (2005) Where do we stand with newspaper data? *Mobilization* 10: 397–419
- Price M (2007) Drilling to save lawns: residents pay to preserve landscaping but counties say groundwater supplies also suffering amid drought. *The Charlotte Observer*, Charlotte, North Carolina, October 11, 2007 Thursday
- Price J, Hennessy-Fiske M (2002) Towns desperate for water. *News and Observer*, Raleigh, North Carolina, August 11, 2002 Sunday
- Ramsey C (2003) Rain puts damper on South Carolina golf industry. *The State*, Columbia, SC, May 25, 2003
- Rayner S, Cantor R (1987) How fair is safe enough—the cultural approach to societal technology choice. *Risk Anal* 7:3–9
- Renn O (2004) Perception of risks. *Toxicol Lett* 149:405–413
- Romoser J (2007) Weather, price weed out more western NC burley tobacco farmers. *AP local and regional*, November 26, 2007 Monday
- Rose A (2007) Economic resilience to natural and man-made disasters: multidisciplinary origins and contextual dimensions. *Environ Hazards* 7:383–398
- Schreiner M (2003) Chancellor's documentary focuses on water shortage. *Morning Star*, Wilmington, NC, January 14, 2003 Tuesday
- Sen A (1981) Poverty and famines: an essay on entitlement and deprivation. Clarendon Press, Oxford
- Smit B, Wandel J (2006) Adaptation, adaptive capacity and vulnerability. *Glob Environ Change Hum Policy Dimens* 16:282–292
- Steinmann AC, Hayes MJ, Cavalcanti LFN (2005) Drought indicators and triggers. In: Wilhite DA (ed) *Drought and water crises*. Taylor & Francis, Boca Raton, pp 71–92
- Swensen E (2005) Drying up. *News & Record*, Greensboro, NC, November 15, 2005 Tuesday
- Tänzler D, Feil M, Kromker D et al (2008) The challenge of validating vulnerability estimates: the option of media content analysis for identifying drought-related crises. *Reg Environ Change* 8:187–195
- Turner BL, Kasperson RE, Matson PA et al (2003) A framework for vulnerability analysis in sustainability science. *Proc Natl Acad Sci USA* 100(14):8074–8079
- US Drought Monitor (2009) Drought monitor archives. National drought mitigation center 2009 [cited August 7, 2009]. Available from <http://drought.unl.edu/dm/archive.html>
- US Supreme Court (2009) South Carolina, Plaintiff v. North Carolina [cited September 20, 2009]. Available from <http://origin.www.supremecourtus.gov/docket/22o138.htm>
- USDA, US Dept. of Agriculture, Economic Research Service (2007a) North Carolina state fact sheet [cited September 20, 2009]. Available from <http://www.ers.usda.gov/Statefacts/NC.htm>
- USDA, US Dept. of Agriculture, Economic Research Service (2007b) South Carolina State fact sheet [cited September 20, 2009]. Available from <http://www.ers.usda.gov/Statefacts/SC.htm>
- Vásquez-León M, West CT, Finan TJ (2003) A comparative assessment of climate vulnerability: agriculture and ranching on both sides of the US-Mexico border. *Glob Environ Change* 13:159–173
- Velliquette B (2002) Free water to pour for those whose wells run dry; donations to help low-income people hit hard by drought. *Chapel Hill Herald*, Chapel Hill, NC, September 14, 2002 Saturday
- Wilhelmi OV, Wilhite DA (2002) Assessing vulnerability to agricultural drought: a Nebraska case study. *Nat Hazards* 25(1):37–58
- Wilhite DA, Buchanan-Smith M (2005) Drought as hazard: understanding the natural and social context. In: Wilhite DA (ed) *Drought and water crises*. Taylor and Francis, Boca Raton, FL, pp 3–29

- Wilhite DA, Pulwarty RS (2005) Drought and water crises: lessons learned and the road ahead. In: Wilhite DA (ed) Drought and water crises. CRC Press, Boca Raton, FL, pp 389–398
- Wilhite DA, Hayes MJ et al (2000) Planning for drought: moving from crisis to risk management. *J Am Water Resour As* 36(4):697–710
- Wilhite DA, Svoboda MD, Hayes MJ (2007) Understanding the complex impacts of drought: a key to enhancing drought mitigation and preparedness. *Water Resour Manage* 21(5):763–774
- Williams B (2001) Drought grips western half of state. *News and Observer*, March 17, 2001 Saturday
- Wisner B, Blaikie P, Cannon T, Davis I (2004) *At risk: natural Hazards, people's vulnerability and disasters*. Routledge, London
- Withers L (2002) Woes impact wallets; residents' attitudes about the years-long drought vary depending on whether rain helps or hurts their businesses. *News & Record*, Greensboro, NC, June 3, 2002 Monday
- Zhang Y, Lindell MK, Prater CS (2009) Vulnerability of community businesses to environmental disasters. *Disasters* 33:38–57

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