7.3 OK-FIRST: THE OKLAHOMA EXAMPLE OF PREPAREDNESS TO MITIGATE THE HUMAN IMPACTS OF SEVERE STORMS

Dale A. Morris* and Kevin A. Kloesel
Oklahoma Climatological Survey
University of Oklahoma
Norman, OK 73019

1. INTRODUCTION

Recently, impacts from human-produced and natural disasters have received considerable attention. In particular, efforts such as the StormReady program and Project Impact (sponsored by the National Weather Service [NWS] and the Federal Emergency Management Agency [FEMA], respectively) have demonstrated that stakeholders from the federal government through the community level must be involved in successful mitigation programs. In addition, effective communication among cognizant agencies is paramount to reducing losses from disasters.

Since 1996, the Oklahoma Climatological Survey (OCS) has actively supported the state's public safety community through an outreach program known as OK-FIRST. To date, some 140 municipal, county, and statewide agencies (fire departments, law enforcement, and emergency management; Fig. 1) have improved their access to modernized weather information through OK-FIRST. The customized access to real-time weather information provided to the local agency by OK-FIRST has helped make local officials more conversant with the meteorological community. The on-going training component of OK-FIRST has continually encouraged the local agencies to become proactive rather than reactive when dealing with weather-impacted situations. This paper briefly describes the OK-FIRST program and provides anecdotal evidence of the benefits such a program can have in the mitigation of the impacts of storms.

2. DESCRIPTION OF OK-FIRST

OK-FIRST was developed as an "all-hazards" system. A review of several weather-related disasters including excessive heat, flooding, and severe weather (Morris et al. 2001, 2002) indicated that communication between the meteorological community and local officials had often been problematic in both the pre- and post-modernization eras of the NWS. In addition, conversations with local officials revealed that they often are interested in periods of non-severe weather that may adversely impact their operations. Notable examples include winds and rain that may hamper rescue and recovery efforts following terrorism events and other disasters (e.g., Oklahoma Department of Civil Emergency Management, 1995). Based on the perceived lack of inexpensive, modern, weather information available on-demand by the public-safety community through a system designed principally for their use, OCS initially developed the OK-FIRST system to consist of a set of interactive analysis tools and a set of training materials and case studies. The analysis tools provided base data and algorithm output from the network of WSR-88D radar units located around Oklahoma; surface observations, summaries, and derived products from the Oklahoma Mesonet (Brock et al 1995); and text products from the NWS.

By design, most of the communities served (Fig. 1) are rural. More than 65% of the participating towns have populations less than 10,000. This rural focus resulted, in part, from the fact that many of these communities needed a "jump-start" to get into the information age. A scaleable system that adequately served rural areas with their lack of infrastructure could be easily fine-tuned to serve urban jurisdictions. In addition, economically challenged rural areas may suffer more serious effects from a weather disaster than their metropolitan counterparts.

The agencies that participate in OK-FIRST were chosen through a competitive application process because typically more applications were received than training facilities and funding levels allowed. Participating agencies usually have authority to activate whatever storm warning systems the local community might have in place (storm sirens, cable television override, radio broadcasts via scanners and commercial stations, paging systems, and the like). Even so, both municipalities and counties may have emergency managers, with the county emergency manager having jurisdiction in unincorporated areas of the county. In other communities, a fire or police official may have the local warning authority; the emergency manager may be

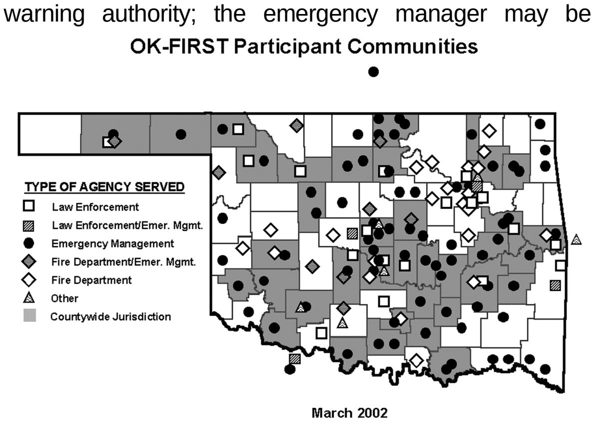

Figure 1. Locations of communities that participated in OK-FIRST as of March 2002. The symbols indicate whether the agency is involved in law enforcement, fire service, and/or emergency management. When an agency has a county jurisdiction (e.g., a county emergency manager or sheriff), the county is shaded.

*Corresponding Author's Address: Dale A. Morris, Oklahoma Climatological Survey, 100 E. Boyd, Suite 1210, Norman, OK 73019.
e-mail: dmorris@ou.edu; http://okfirst.ocs.ou.edu

inactive or have other duties. Because storm-warning authority rests with officials having different backgrounds (law enforcement, fire service, and emergency management), the officials sometimes have different needs, different levels of funding, and different levels of awareness. For example, the authors recently spoke at meetings of two different professional associations that had OK-FIRST participants as members. During both presentations, the attendees were asked about their familiarity with and use of the convective outlook products issued by the Storm Prediction Center (SPC). The overwhelming majority of attendees from one of the professions regularly used the convective outlooks, while in the other profession, only the OK-FIRST participants indicated familiarity with the convective outlooks.

In 1999, the OK-FIRST "information-support" system was augmented to provide new graphical products from the NWS. The new "decision-support" system also integrated additional instructional material with the analysis products. The goal of the enhancement was to help the local official to better diagnose current and future weather threats as well as to guide the official through the interpretation process of the relevant analysis products for a given situation to support local actions.

At about the same time, concerns by OCS and NWS staff and the participants themselves about potential misuse of the available products led to the implementation of a user-certification policy. Previously, access to the system was granted after a local official attended a weeklong data interpretation workshop. The workshop covered interpretation of the analysis tools and a set of hands-on laboratory exercises. The participants voluntarily could also attend refresher workshops that reviewed interpretation concepts and provided updated information on software and product enhancements. The user-certification policy required that the participants attend at least one refresher course every 18 months to maintain access to the system. The certification policy and the accompanying refresher workshops have ensured that local officials are kept apprised of improvements of WSR-88D algorithms and the development of newer NWS products such as the probabilistic guidance products issued by the SPC. In addition, the periodic refresher workshops provided a platform for OCS staff to receive invaluable feedback from the participants.

3. RECENT DISASTERS AND OTHER EVENTS IN OKLAHOMA

In the period from January 1999 through January 2002, every county in Oklahoma has been declared a disaster area by FEMA for weather-related events at least once, making the county's residents, businesses, and public entities eligible for various types of federal assistance including grants and low-interest loans (Fig. 2). Some counties have experienced *four to six* disasters in this relatively short period. Nevertheless, few of these disasters resulted in serious human casualties, with the notable exception of the 3 May 1999 tornado outbreak that resulted in over 40 fatalities (mostly from the Oklahoma City metropolitan area).

These recent disasters illustrate the importance of a multi-purpose (or multidisciplinary) decision-support system for public safety officials. Just as Oklahoma has recently experienced bouts of severe weather, two crippling ice storms, and drought with accompanying wildfires and followed by flash floods, most states are susceptible to multiple weather hazards.

3.1 The 3 May 1999 Tornado Outbreak

Many OK-FIRST participants had used the system successfully to warn their communities during tornadic storms prior to 3 May 1999. For example, the city of Moore was struck by an F2 tornado on 4 October 1998, when an outbreak of over 20 tornadoes hit the state. The storm spotter coordinator working in the Moore Emergency Operations Center (EOC) decided to move a storm spotter based on information provided via the OK-FIRST radar displays. This move placed the spotter in the proper location to provide the first visual knowledge of the wall cloud that eventually produced the tornado. This spotter's report – along with consultation with the NWS office in Norman – resulted in the activation of the local warning systems with at least ten minutes of lead-time. Although a dozen homes and apartment buildings were either severely damaged or destroyed, no injuries or fatalities occurred during this event.

Even with successes such as 4 October 1998, perhaps the decisions of OK-FIRST participants during the evening hours of 3 May 1999 best illustrate the capabilities of trained officials armed with modern weather information. On this night, after the F5 tornado hit the Oklahoma City metropolitan area, local media coverage justly was dominated by news of the Oklahoma City disaster. As a result, rural areas received a minimal amount of weather coverage. OK-FIRST participants in Logan, Kingfisher, and Lincoln counties kept their local communities advised of the danger and prevented loss of life. For example, before an F3 tornado hit the town of Stroud (population 2,758), information relayed by the Lincoln County emergency management office caused patients in the Stroud hospital to be moved into the hallways. The damage the hospital sustained eventually caused the hospital to be closed; however, the patients only sustained minor cuts. The rooms where the patients previously lay were found filled with debris including lumber and shards of glass.

As multiple F3 and F4 tornadoes tore similar paths through Logan County, local actions included moving rescue workers and an ambulance transporting a tornado victim out of the paths of subsequent tornadoes. Many other jurisdictions sent public safety officials to the Oklahoma City area to help with the metropolitan disaster. In multiple instances, these officials were instructed to alter their routes because additional super cells and tornadoes were located between their location and Oklahoma City. As chronicled by Morris et al. (2002), with additional anecdotes from this event, first responders were in grave danger. The use of OK-FIRST prevented even greater tragedies from occurring.

3.2 The September 2000 Wildfire Episode

After an unseasonably wet late spring in Oklahoma, a significant two-month dry spell occurred in August and September of 2000. The state averaged about 19% of normal rainfall through this period. A fire management product known as the Oklahoma Fire Danger Model (Carlson and Engle, 1998) was available to local officials through OK-FIRST. Daily values of the Keetch-Byram Drought Index (KBDI) were calculated for each Mesonet

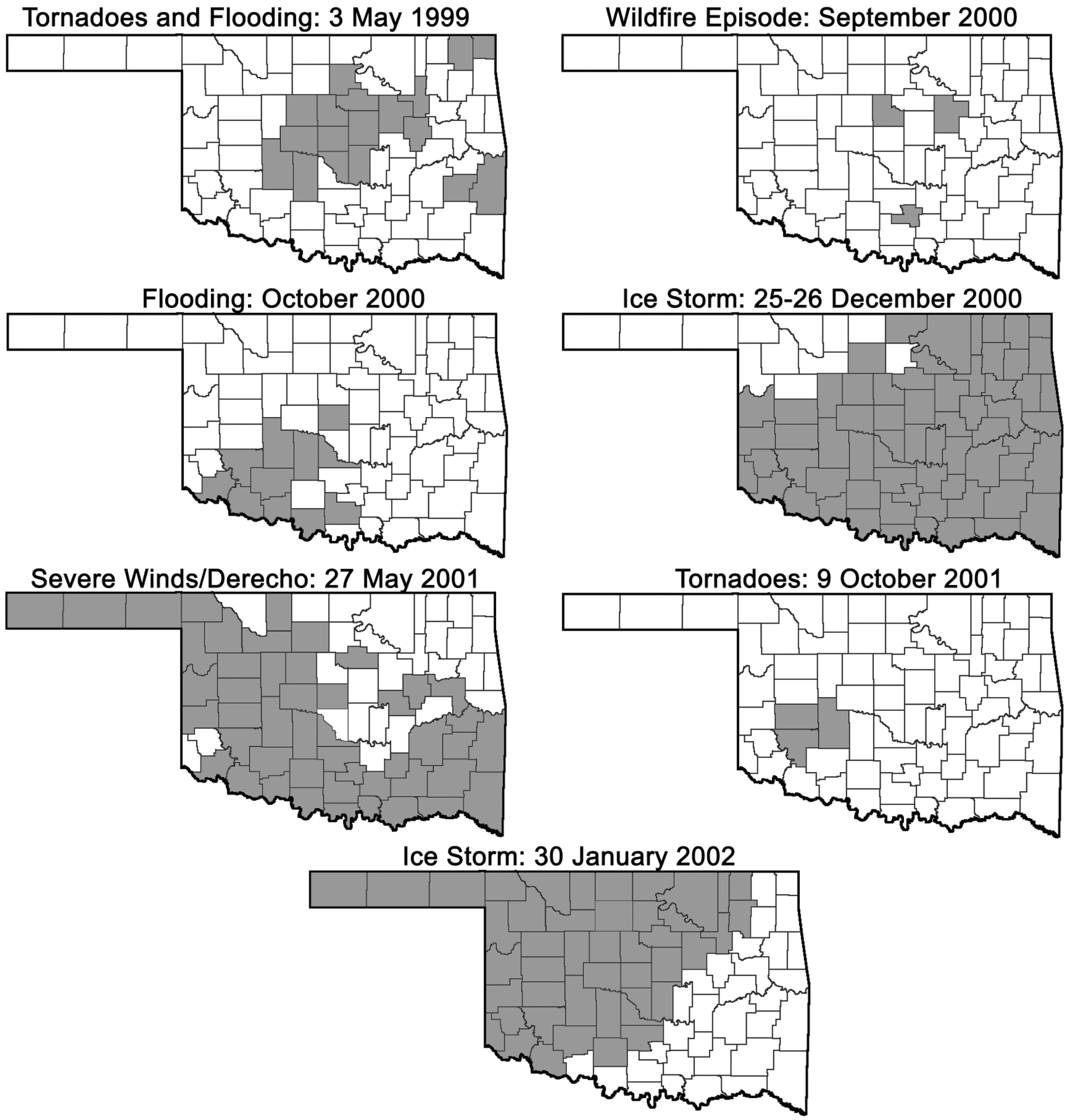

Figure 2. Counties in Oklahoma declared eligible by FEMA for various types of federal assistance during 1999 through 2002 are shaded. The types of assistance were various combinations of individual assistance (for citizens), public assistance (for governments and non-profit utilities to rebuild infrastructure), and fire suppression authorizations.

site and provided routinely through this dry spell. The KBDI models the moisture deficit in an 8-inch column of soil. KBDI values near 0 indicate saturated soil, and values of 800 mean that the 8-inch soil column is completely dry. By mid-September, the KBDI values statewide were 600-800. As the KBDI values increase, the dry soil adds fuel and energy to wildfires, so that the fires become extremely difficult to contain. The entire state was under a burning ban for this period.

Many fire agencies monitored the daily KBDI values to adjust staffing policies and paging procedures during the ensuing wildfire episode. When new fires were reported, dispatchers alerted different sets of neighboring fire departments based on various KBDI thresholds. When the KDBI values were extreme, more departments were paged when a new fire was reported to increase the probability of containment when the fire was small.

By mid-September several wildfire complexes were so large that state resources were exhausted, and FEMA authorized federal fire suppression assistance. A few weeks later, the dry spell “ended” with flooding rains so severe that several municipal water systems failed. Nevertheless, KBDI values between 500-800 indicated that although the meteorological drought may have ended, the state still had problems from a fire management perspective. State officials used this information and continued the burning ban despite the floods.

3.3 Ice Storm of 25-26 December 2000

A devastating ice storm affected southeast Oklahoma during the Christmas holiday period. An OK-FIRST training session was held the week before the ice storm, and the daily weather briefings highlighted the possibility of serious consequences for southern and eastern Oklahoma. One of the workshop participants was the emergency manager for Ardmore in southern Oklahoma, who began to make advance preparations for the ice storm as the workshop ended. As a result, he had generators and supplies ready for his community.

OCS also sponsors a companion outreach and support program for Oklahoma's rural and non-profit electrical cooperatives. During a workshop held in early 2001, several of the participants not only used the available weather products for locations of the most serious icing, but also monitored the melting process of the ice on the power lines. As ice melts and drops from the lines, the lines can snap and cause more outages. By using their decision-support system, they were kept abreast of these conditions.

3.4 Cordell Tornado of 9 October 2001

An F3 tornado caused serious damage or destruction of over 500 buildings in the rural town of Cordell (population 2,867) in west central Oklahoma on 9 October 2001. On this particular day, a total of 19 tornadoes occurred in the area, but the most widespread and significant damage occurred in Cordell.

The county emergency manager on this day was monitoring his OK-FIRST displays as media attention focused on storms located to the north and outside his county. When he saw the development of a southern storm, he alerted the Cordell fire department, which sent spotter crews to monitor the storm, as he had to move on to other duties. The firemen maintained a watch for the storms and sounded the towns warning sirens as the storm approached the city. As a result, only nine minor injuries and no fatalities occurred, although many residents were displaced for months.

3.5 Bridge Collapse of 26 May 2002

On the morning of 26 May 2002, a barge struck a pillar that supported a bridge for interstate highway I-40 over the Arkansas River in eastern Oklahoma near the town of Webbers Falls. The ensuing forces caused the bridge to collapse in the river, plunging traffic associated with the Memorial Day holiday into the water below. Unfortunately, fourteen drowning deaths resulted.

Immediately, a rescue operation commenced followed by recovery period of several days. Strong to severe thunderstorms were located in the area, and OK-FIRST displays were used numerous times by staff at the Oklahoma State EOC in Oklahoma City. In particular, an opening between storms was sought so that Oklahoma Governor Frank Keating could fly to the disaster site along with the state emergency management director. As the recovery operations persisted, zone forecasts, forecast discussions, radar imagery, and other NWS products were relayed from the OK-FIRST system to workers in the field so staffing and other logistical arrangements could be made. For example, a crane removed vehicles from the water, but advance notice of thunderstorms was required to shut down operations due to lightning considerations.

4. SUMMARY

Since 1996, the state of Oklahoma has operated an all-hazards decision-support system for public safety officials. Through this system and requisite training, local, often rural, agencies have access to a comprehensive suite of weather analysis tools and threat products.

Recently, a warning process for severe weather has been described that consists of a three-fold relationship between the National Weather Service, the media, and emergency managers. This manuscript has shown that the appropriate weather focal points in some communities are public safety officials other than emergency managers. Unfortunately, many of these officials have been neglected in the availability of specific and modern weather information.

It has also been shown that a multi-hazard approach to the decision-support system design has been important and beneficial. In addition, information on storms that do not satisfy severe-warning criteria may be critical to the daily operations of public safety agencies.

5. ACKNOWLEDGEMENTS

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