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OK-SAFE: USING WIRELESS TOOLS TO DISSEMINATE CRITICAL WEATHER INFORMATION TO EMERGENCY MANAGERS

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1.0 INTRODUCTION

The OK-FIRST program outlined in the previous paper (Morris et al 2002) serves as a blueprint for replication amongst many customer groups needing real-time access to perishable weather information. The United States has the highest incidence of hazardous weather across the world1. During the past twenty-five years, natural hazards and disasters killed 24,000 and injured 100,000 (Williams, 1992). Since 1989, the average cost of natural disasters to the U.S. economy is $1 billion per week (NHC, 2001). Oklahoma has been especially hard hit, ranking seventh in major disaster declarations since 1976. Recent weather-related disasters across Oklahoma included ice storms (65 counties in December 2000), drought and accompanying wildfires (August-September 2000), floods (11 counties in October 2000), and severe weather (19 counties during the 3 May 1999 tornado outbreak).

The diversity of weather hazards impacts nearly all facets of human life. In particular, as the American society becomes increasingly mobile, the process to keep citizens safe becomes more and more challenging. A mobile society demands that public safety officials make critical and correct decisions regarding the protection of life and property while they are "on-the-go" themselves. For example, responses to hazardous material incidents are more complex when hazardous weather threatens or rainfall occurs. In addition, public safety officials responding to weather disasters often are in harm's way. During the 3 May 1999 tornado disaster in Oklahoma City, rescue crews responding from outlying areas were targets of additional tornadic storms.

Likewise, during times of hazardous weather, reliable utility service is often compromised. To restore services, electric utilities are forced to face these hazards in real time, at remote locations, in an environment where conventional access to critical weather information is not possible. For example, electrical utility crews repairing downed lines can be electrocuted by a lightning strike miles away.

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General aviation (GA), characterized by recreational, business, and charter flights from small municipal and regional airports, also is impacted by hazardous weather. According to the FAA, over 194,000 GA aircraft across the U.S. were registered in 19983. Weather-related accidents in GA are more likely to be fatal than are accidents from any other cause. In 1999, 77 percent of weather-related accidents in single-engine airplanes were fatal. Fatal accidents in multi-engine aircraft were weather-related 89 percent of the time (AOPA, 2001).

2.0 PAST PERFORMANCE IN WEATHER-IMPACTED SITUATIONS

Following major weather disasters, the National Weather Service (NWS) critically evaluates its performance. Their recent evaluations have recommended that:

- The NWS should "work with emergency management officials to seek alternative and more efficient methods to confirm receipt of warnings" (NOAA, 1997).
- The NWS should "continue to work with emergency management to seek ways to improve the timely transmission of weather warnings" (NOAA, 1997).
- "Local and state agencies should explore alternative methods of communicating critical weather products to emergency management officials" (NOAA, 1991).
- The NWS should "work with local emergency management personnel to develop new or enhanced mass communication systems" (NOAA, 1998).

Simultaneously, the National Transportation Safety Board (NTSB) determined that most weather-related accidents in GA were the direct result of faulty decision making and inadequate weather data. In Oklahoma, only a select few terminals in urban settings have detailed weather information readily available to GA pilots. One Oklahoma GA pilot recently described the state of weather information in regional airports as "abysmal". The lack of weather information to support GA is not limited to Oklahoma; it is common across the nation. This problem will be exacerbated as more GA-type traffic is diverted from airports in larger cities and as rural communities welcome additional GA traffic due to the positive implications for economic development.

3.0 CURRENT STATE OF THE SCIENCE

The three groups (mobile public safety officials, utility crews for rural electric cooperatives [RECs], and GA) all suffer from the same malady; namely, a near-complete lack of high-quality, site-specific, and up-to-the-minute weather information. Almost no effort has materialized worldwide to deliver affordable weather information and requisite training to support fixed-based emergency operations, much less to support mobile operations. One notable exception to the nation-wide problem of ineffective warning dissemination to a public-at-risk is OK-FIRST (Morris et al 2001; Morris et al 2002)

Where hazardous weather is concerned, the functions of public safety, electrical utilities, and general aviation are often parallel. In a "modernized" setting, proactive response begins as soon as a disaster is detected or threatens. Critical mission functions involve mobilizing and positioning emergency equipment; moving people out of danger; providing needed food, water, shelter and medical services; and bringing damaged services and systems back on line. General aviation also supports critical activities such as law enforcement, forest fire fighting, air ambulance, and other vital public safety services. Lessons learned through the implementation of OK-FIRST revealed that responses to weather-related disasters are hampered when:

- Information is only available at a fixed-base site.
- Power outages interrupt available data feeds, creating misinformation and delayed response, whereas accurate information expedites response.
- Interagency communication is not possible because responding agencies utilize different radio frequencies and cell-phone circuits become overloaded.

4.0 THE DIGITAL DIVIDE

Although OK-FIRST produced quantifiable improvements over previous operating procedures for emergency managers, key problems remain in disseminating critical weather information. Most rural and tribal emergency management agencies have only a slow-speed modem with which to receive critical data. Nearly every agency is at the mercy of the telecommunications infrastructure and power grids remaining operational, especially during intense cloud-to-ground lightning in the summer, ice storms in the winter, and high winds year round. Moreover, the telecommunications infrastructure across rural areas is so inadequate that benefits of the NWS modernization will continue to be limited.

'Digital Divide' means that rural communities do not have an infrastructure adequate to provide for their own protection during times of hazardous phenomena. Even when data are locally available, it likely is dated, is not relevant, or may lack critical details. Hazardous weather also can adversely impact landline telecommunications and cellular phone bandwidth. Therefore, digital network technologies such as broadband wireless communications will be vital to overcoming this digital divide as it applies to emergency management, GA, and the RECs in Oklahoma.

A state that ranks near the top for enduring frequent weather disasters and that simultaneously dwells in the bottom rankings for having modern telecommunications infrastructure is a combination that only exacerbates the next disaster waiting to happen. Because the major metropolitan areas of Oklahoma City and Tulsa are blanketed with media coverage during life-threatening events, the next environmental tragedy in Oklahoma likely will devastate an unsuspecting rural community.

5.0 A SOLUTION IN OKLAHOMA

In January 2001, AARO Broadband Wireless Communications, Inc. of Oklahoma City (AARO) received funding from the Oklahoma Municipal League (OML) to create a high-speed wireless telecommunications network across rural Oklahoma. Supported by the Oklahoma Aeronautics and Space Commission (OASC), AARO is committed to establishing a broadband fixed-wireless point of presence (POP) in 44 Oklahoma communities with regional airports. From the airport POP, AARO and the OML will assist rural towns in providing high-speed wireless capabilities (at least 1 Mbit/sec) to municipal agencies and citizens throughout the surrounding community. The deployment and promise of a high-speed wireless capability in rural Oklahoma is a compelling opportunity to enhance the capabilities of emergency management, general aviation, and electric cooperatives in these rural areas. This rural broadband network will deliver "last mile" data capabilities and will help move Oklahoma from its Disconnected Dozen status into becoming an "e-state".

OK-SAFE will exploit this infrastructure with a wireless, customizable, 21st century mobile weather/hazard warning, information, and decision-support system designed for public safety officials, general aviation interests, and utility service providers in rural Oklahoma. OK-SAFE will target field technologies, meteorological data types, decision-support strategies, and dissemination methods to meet the requirements of first responders more effectively, rapidly, and inexpensively. Combining the OCS penchant for developing award-winning and innovative weather-related applications with the broadband wireless infrastructure of AARO will elevate Oklahoma to a world leader in integrated data and decision support when the lives of its citizens are threatened. OK-SAFE also will revolutionize the method of communicating hazardous weather information to/from the NWS and local communities.

The goal of OK-SAFE is to develop three wireless decision-support systems that are designed for public safety, general aviation interests, and utility service providers. The systems will share common elements but will be customized for each user community. Real-time radar data from more than 15 radar units located in and around Oklahoma plus high-density observations from the Oklahoma Mesonet, available to users on-demand are among the data resources that will underpin the decision-support systems. Because mere *access* to information systems is not the total *solution* to meet the needs of user communities, training and support components are essential to ensure the proper use and application of the information.

For the three user groups, OK-SAFE will: (a) develop *skills* in using wireless technology, (b) develop *proficiency* in accessing and navigating the respective decision support systems, (c) increase *ability* to interpret and apply data available from the decision-support systems, (d) increase *use* of weather data to support decision-making, and (e) improve *collaboration* within each user group. The successful accomplishment of this list of short-term/intermediate outcomes will also *contribute* to broader, longer-term outcomes, which are affected by many factors and are not under the complete control of OK-SAFE.

6.0 SIGNIFICANCE

Innovative government programs are expected to empower frontline employees to make accurate and proactive decisions. A program's innovation can be evaluated by the degrees of novelty, effectiveness, and significance that it possesses. OK-SAFE will be novel because *graphical* weather imagery has not been available via *wireless* telecommunications. In addition, OK-SAFE will reliably deliver real-time weather information to moving vehicles (emergency vehicles, utility trucks, and GA aircraft). Hence, firefighters on-scene will know about an approaching wind shift without relying on a radio call from a third party. Mobile utility crews will have radar data to indicate storms that could adversely impact nearby power grid components. OK-SAFE will be effective because the project staff will monitor usage of the system by each component, insist upon user feedback, and maintain collaboration with the evaluation staff to ensure that evaluation results are incorporated into project improvements. The significance of OK-SAFE will be better and proactive decisions that produce improvements in safety and reductions in human casualties from natural hazards.

7.0 REFERENCES

Aircraft Owners and Pilots Association (AOPA), 2001: *The 2000 Nall Report*, General Aviation Accident Trends and Factors for 1999, AOPA Air Safety Foundation Technical Report, Landsburg Publishing, National Transportation Safety Board, Washington, D.C.

Morris, D.A., K.C. Crawford, K.A. Kloesel, and J.M. Wolfinbarger, 2001: OK-FIRST: A Meteorological Information System for Public Safety. *Bull. Amer. Meteor. Soc.,* **82**, 1911-1923

Morris, D.A., K.A. Kloesel, and K.C. Crawford, 2002: OK-FIRST: A 6-Year Retrospective. 18th Intl Conf on IIPS for Met., Ocean. and Hydro. and Interactive Symp. on AWIPS. *Amer. Met. Soc.*, January 13-17, Orlando, FL.

Natural Hazards Center (NHC), 2001: 2000 Catastrophes and Casualties, *Natural Hazards Observer*, Volume XXV, Number 4, University of Colorado, Boulder, CO, March 2001.

National Oceanic and Atmospheric Administration, 1991: *Shadyside, Ohio, Flash Floods, June 14, 1990.* Natural Disaster Survey Report [NTIS PB91-204966INZ]. National Weather Service, Silver Spring, Maryland.

National Oceanic and Atmospheric Administration, 1997: *The Central Texas Tornadoes of May 27, 1997.* Service Assessment. National Weather Service, Silver Spring, Maryland.

National Oceanic and Atmospheric Administration, 1998: *Central Florida Tornado Outbreak of February 22-23, 1998.* Service Assessment. National Weather Service, Silver Spring, Maryland.

National Oceanic and Atmospheric Administration, 1999: *Oklahoma/Southern Kansas Tornado Outbreak of May 3, 1999.* Service Assessment. National Weather Service, Silver Spring, Maryland.

Williams, Jack, 1992: *The USA Today Weather Book*, Chapter 1: The USA's Wild Weather. Random House Publishers, New York, New York.