2.9 REPLICATING INNOVATION: SUCCESSES AND CHALLENGES

Dale A. Morris*, Mark A. Shafer, and Derek S. Arndt
Oklahoma Climatological Survey
University of Oklahoma
Norman, Oklahoma

1. INTRODUCTION

In 1996, the Oklahoma Climate Survey (OCS) launched an outreach and support program known as OK-FIRST (Morris et al. 2001, 2002) built upon the foundation of the Oklahoma Mesonet (Brock et al. 1995). OK-FIRST was designed to provide current environmental information through an accompanying decision-support system to public safety personnel across Oklahoma. The OK-FIRST program had three basic components: (a) the decision-support system, (b) a mandatory training regimen and accompanying certification process, and (c) ongoing customer support. More than 150 emergency management, fire service, and law enforcement agencies have completed the training program and utilize weather information and associated decision-support tools in their daily operations. OK-FIRST was created, in part, to help improve communication between the weather enterprise and local officials as recommended by a series of Service Assessments published by NOAA's National Weather Service (e.g., NOAA 1998a,b). Through OK-FIRST, OCS could act as a "bridge" between federal activities and scores of municipal and county public safety agencies.

OK-FIRST has been widely recognized for its public benefit and innovation. This recognition includes a Special Award from the American Meteorological Society (AMS), international recognition in the information technology field via the Stockholm Challenge, and one of five coveted Innovations in American Government Awards from Harvard University's John F. Kennedy School of Government in 2001. To narrow the 1000 to 1500 potential programs to five annual winners, Harvard's Innovations Program uses multiple panels including a National Selection Committee chaired by the esteemed David Gergen, advisor to three Presidents, editor of *U.S. News and World Report*, and Professor of Public Service at the Kennedy School, to judge whether contestant programs satisfy a rigorous definition of innovation and the degree to which the programs possess novelty, effectiveness, significance, and replicability (Morris et al. 2000). According to Altshuler, Osborne, and others associated or affiliated with the Kennedy School's research of innovative government programs, innovation consists of "novel" changes that have a "significant impact on performance, and programs that promote the empowerment of frontline employees to make decisions (Altshuler and Behn 1997, Osborne and Gaebler, 1992).

Harvard's Innovations Award provides funds to assist in replication efforts. Since receiving the award, the OK-FIRST program has worked in numerous ways to publicize its successes. Despite these efforts wholesale replication of OK-FIRST has not occurred outside Oklahoma. This paper documents many of these diffusion activities and examines some factors that may have prevented or delayed this replication.

2. WEATHER HAZARDS: A PROBLEM OF SIGNIFICANCE

A self-evident requirement for innovation documented by the brief survey of government innovation of Abramson and Littman (2002) is that true innovations must solve compelling problems; innovations are not merely creative solutions looking for problems. In the case of OK-FIRST, the problem is achieving improved responses to and the mitigation of negative societal impacts of natural hazards and manmade situations that are weather-impacted. For example, every county in Oklahoma has been declared a disaster area by the Federal Emergency Management Agency (FEMA) for weather events at least once between 1999 and 2003 (Fig. 1). In addition, weather had significant impacts upon response and recovery operations following manmade events such as the 19 April 1995 bombing of the Oklahoma City Federal Building (Oklahoma Department of Civil Emergency Management 1995) and the 26 May 2002 collapse of the Interstate 40 bridge across the Arkansas River near Webbers Falls, OK (Morris and Kloesel 2002). The diversity of these disasters underscores the need for multi-purpose (or multidisciplinary) weather-based decision-support systems for public safety officials.

From a natural hazards perspective, Oklahoma is a microcosm of the entire U.S. From 2000 through 2004, FEMA supported 242 major disaster declarations (Fig. 2) in 48 states (including the District of Columbia; Fig. 3). Of these disasters, 235 (97%) were weather related, and 45 states suffered disasters from multiple weather hazards. In this analysis, weather hazards included severe thunderstorms, floods, tornadoes, hurricanes and tropical storms, winter storms, and major wildfires.

*Corresponding author address: Dale A. Morris, Oklahoma Climate Survey, 100 E. Boyd, Suite 1210, Norman, OK 73019; e-mail: dmorris@ou.edu

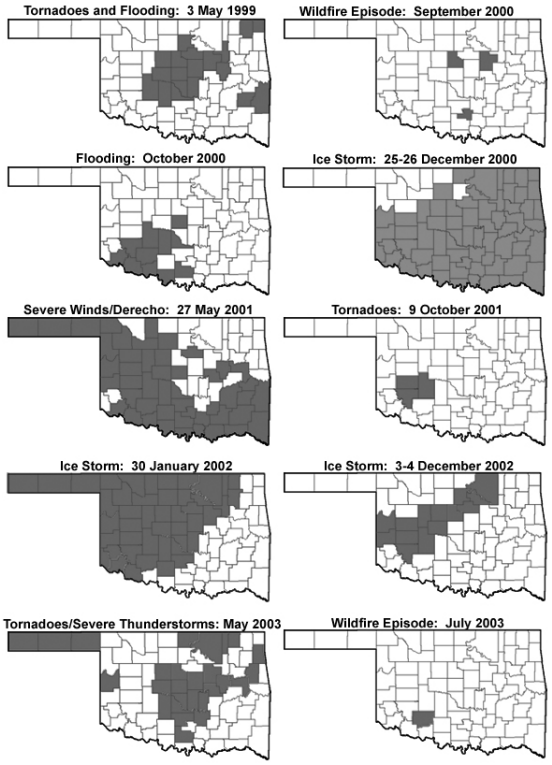


Figure 1. Counties in Oklahoma declared eligible by FEMA for various types of federal assistance during 1999 through 2003 are shaded. The types of assistance were various combinations of individual assistance (for citizens), public assistance (for governments and non-profit utilities to rebuild infrastructure), and fire suppression authorizations.

During this same period, FEMA provided federal funds for fire suppression assistance for 267 wildfires in 26 states (including Southeastern, mid-Atlantic, and Great Plains states in addition to the pervasive wildfire threat across the western United States). Clearly, the problem OK-FIRST addresses exists in all 50 states.

3. DIFFUSION ACTIVITIES

Efforts to publicize and transfer, or "diffuse", knowledge regarding the establishment and operation of OK-FIRST have included a variety of publications, exhibits at conferences, and conducting workshops and institutes. Within the meteorological enterprise, a number of AMS conference papers and two refereed articles were prepared.

3.1 Mesonet 2002

One of the earliest diffusion activities, partially underwritten by Innovations Award funds, was the Mesonet 2002 Insitute. This institute was designed as a "one-stop shop" for information regarding the design, implementation, operations, funding, and outreach of the Oklahoma Mesonet, and was attended by people interested in establishing and/or upgrading automated weather networks. More information about Mesonet 2002 is available at http://www.mesonet.org.

For OK-FIRST, the establishment of the Oklahoma Mesonet was a necessary prerequisite. Prior to the Mesonet, OCS was not engaged in disseminating weather data in near real-time. OCS' primary activities involved climate research and answering questions based upon archived observations from the U.S. surface observing network and the Cooperative Observer network. However, since the Mesonet and OK-FIRST were created, the weather enterprise has greatly expanded the availability of high-quality weather data via the Internet and satellite feeds like NOAAPORT. Consequently, the availability of a basic set of surface data and radar data is nearly ubiquitous; weather organizations in states beyond Oklahoma probably are not required to create a mesonet prior to engaging in outreach and support for the public safety community. Today's problem of weather support for public safety agencies may no longer be the paucity of data, but rather a logical organization of decision-tools and information based upon weather data as well as credible support and training mechanisms.

3.2 Decision-Making in Weather-Impacted Disasters

In 2003, OCS partnered with the United States Telecommunications Training Institute (USTTI; http://www.ustti.org) to begin an annual series of workshops entitled "Decision-Making in Weather-Impacted Disasters". USTTI is a non-profit organization that provides training opportunities in telecommunications infrastructure, operations, and applications for developing countries. In 2002, USTTI desired to create a disaster communications course sequence involving OCS and other organizations to include information about U.S. warning systems, the experiences in Oklahoma involving the Mesonet and OK-FIRST, and communications technologies useful in disasters including broadcast media and amateur radio. The exact course sequence differs annually; OCS has conducted three such workshops for participants from Costa Rica, Nigeria, Philippines, Tanzania, Kenya, Zambia, Nepal, British Virgin Islands, Bahamas, Uganda, Haiti, Malaysia, Indonesia, Thailand, Vietnam, and Laos.

Topics covered during these workshops include a survey of selected U.S. disasters; the establishment and capabilities of the Oklahoma Mesonet and OK-FIRST; the collection and dissemination of modern weather data like surface observations, radar data and satellite imagery in real-time; warning systems and communications technology in the U.S.

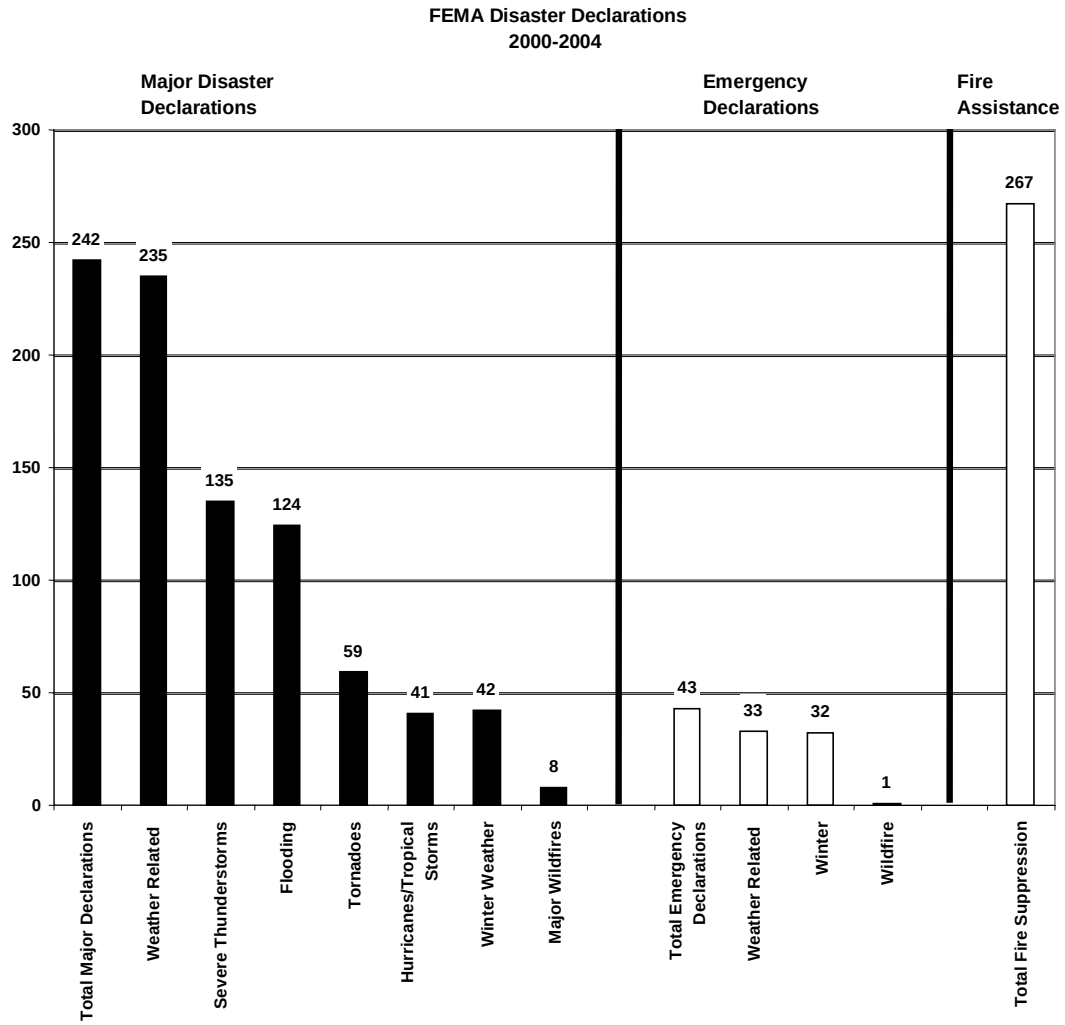


Figure 2. Total FEMA-declared disasters classified by weather hazard during 2000 through 2004. Events with major disaster declarations typically are more severe than emergency declarations.

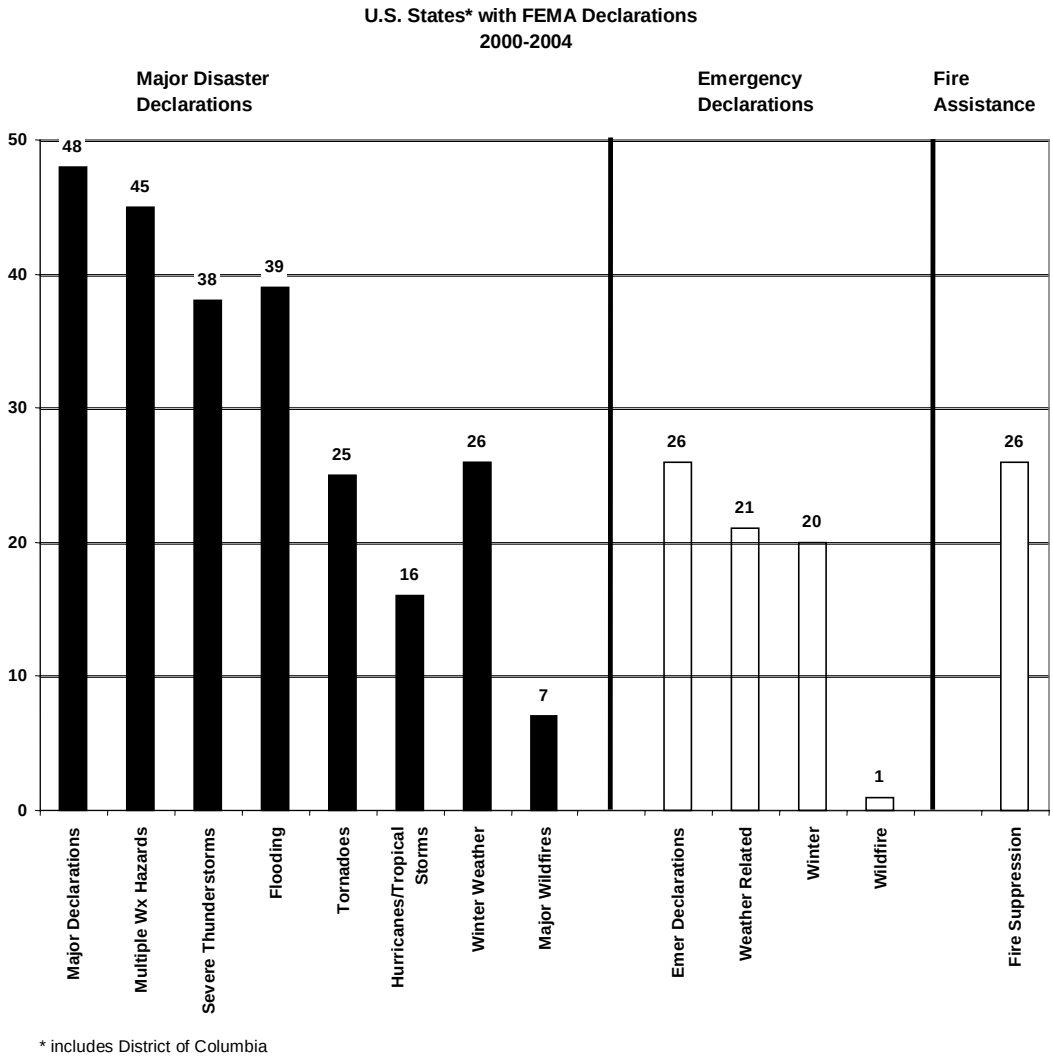
including internet-based systems, broadcast technology including NOAA Weather Radio and the Emergency Alert System, and community-based systems like outdoor sirens. The workshop also includes basic meteorological and climatological topics related to disasters plus tours of operational facilities including an NWS weather forecast office (WFO), a television station, and emergency operations centers.

3.3 Innovations in Managing Weather-Impacted Situations

Both Mesonet 2002 and the USTTI-sponsored workshops presented information relative to replicating OK-FIRST; however, this replication was not the primary focus of either initiative. Based upon experiences from these previous initiatives, OCS hosted a third workshop targeted at state emergency management officials. This "Innovations in Managing Weather-Impacted Situations" workshop was underwritten entirely by Innovations Awards funds, and was attended by thirteen representatives from eleven states.

To determine states to invite to the workshop, a methodology was developed to relate several factors addressing risk of weather-related hazards and a state's ability to implement a weather hazards management program. These risk measures included the following:

- *Federal Disaster Declarations.* An analysis similar to the one presented in Figures 2 and 3 was performed. Federal disaster declarations were tallied for each state for the years 2000-2004 (http://www.fema.gov). Events were counted both for overall designation and for sub-categories of storms, floods, tropical storms, winter weather, earthquakes, and fires. In addition, counts of total federal assistance (disaster declarations plus fire management assistance and emergency declarations for winter weather) were counted. Values for federal



* includes District of Columbia

Figure 3. Number of states with FEMA-declared disasters for each type of weather hazard between 2000-2004.

disaster declarations during the study period ranged from 11 for FL and OH to zero declarations for CT, RI, and UT. CA led in total federal assistance with 53 requests, while ID and RI had only one request each.

- *Population*. Three measures for population were used, based upon the 2000 census. The overall population was used to identify states with the greatest numbers of people at risk. CA had the greatest population (33,871,648), and WY had the fewest residents (493,782).

- *Population Growth*. As population centers grow, city and suburban boundaries push outward, creating new urban-wildland interfaces which may pose risks, especially for wildfires. Furthermore, rapid population growth may stretch the abilities of local responders. NV posted a 66.3% population growth from 1990-2000 and the District of Columbia posted a 5.7% population decline. ND posted the least population growth (0.5%) for any state.

- *Population Density*. Heavily urbanized areas expose a large number of people to risks associated with relatively small-scale events. For example, a tornado in a large metropolitan area would likely result in more fatalities than one is a less populated area. NJ had the greatest population density (9,378 people per mi^2), while AK had only 1 person per mi^2.

In addition to measures related to the risk presented by natural hazards, the ability of a state to marshal resources was estimated by the following measures:

- *Per Capita Income*. An assumption was made that wealthier states would have access to more flexible resources to apply to innovation (e.g., Walker 1969). For this study, NJ reported the highest per capita income ($58,588) while WV reported the lowest ($31,008).

- *Government Performance Project (GPP) Rating.* In 2003, the GPP (http://www.gpponline.org) rated states on five measures plus an overall grade: financial, human resources, information technology, capital, and managing for results. More recent reports have collapsed rankings into four categories (money, people, infrastructure, and information). Each state was assigned a letter grade for each category, and then an overall grade. Because this study focuses on implementation of a weather-based decision-support system, information technology was expected to be a key factor. UT and WA received grades of A while the District of Columbia scored the lowest with a D. Several states were given grades of C+. Overall grades ranged from A- (MI, UT, and WA) to C+ (AZ, CA, CO, MA, MS, MT, NM, NY, OR, SD, and the District of Columbia).

- *Resources.* Each state's total financial resources were determined from a survey by the National Association of State Budget Officers (2004). The data were normalized to a per capita resource measure such that CA with $79 billion in total resources could be compared to the $792 million in total resources of WY. Per capita measures were used because larger total state budgets do not necessarily provide more flexible resources. Per capita resources ranged from a $3,981 in AK to $896 in MI. This study excluded the District of Columbia which had $9,988.

Each of the above measures of risk and ability to cope were ranked approximately into quintiles. Natural break points were used where possible. States with the greatest number of declarations, total federal assistance, population, population growth, population density, per capita income, per capita resources, and overall GPP grades were assigned a value of 1 while states at the other end of the scales were assigned a value of 5.

The risk rankings were averaged to determine an overall risk score. Similarly the ability rankings were averaged to determine an overall ability score. The results are presented in Table 1. Risk and Ability were then independently rank-ordered. States ranking high in both measures were selected as candidates for the workshop, except where clustering occurred. States ranking high in one measure but geographically separated from others already selected were added as candidates. One state, MT, was added to represent a geographical region otherwise not included.

Fifteen states were initially targeted for invitations: CA, CO, FL, IL, KS, KY, MN, MS, MT, NJ, NY, NC, OH, TX, and WA. From this original pool of states, representatives attended the workshop from CA, IL, MN, MS, NJ, NY, NC, TX, and WA. Representatives from FL and OH expressed interest, but declined the invitation due to ongoing disaster operations. Invitations were subsequently extended to AR, GA, NE, PA, and VA, based upon available workshop space and geographic diversity. GA and PA sent representatives. Attempts to obtain a representative from FEMA were unsuccessful.

Agenda topics for the workshop focused more on OK-FIRST than did the Mesonet 2002 symposium, which had a greater Mesonet focus. However, some attendees expressed interest in establishing a mesonet or augmenting existing weather data sources with additional automated stations. Particular topics were aligned with the three components of OK-FIRST: the decision-support system, training, and support. A representative panel of existing OK-FIRST participants shared thoughts and ideas about the potential benefits of having OK-FIRST-like services across the nation.

Because the workshop participants were from state emergency management offices, considerable discussion about training occurred. Traditional emergency management has a four-fold structure of preparedness, response, recovery, and mitigation. Emergency managers require training in these four areas in addition to instruction in many other disciplines including human and physical resource management, incident command, terrorism and biological hazards. With these existing requirements, state emergency management offices typically do not have in-house expertise to conduct effective training on weather hazards and the access and interpretation of available weather data, although many do conduct training on other aspects of emergency management for municipal and county-level emergency management personnel. Consequently, various avenues were explored including forming partnerships with academic institutions and corresponding NWS weather forecast offices (WFOs). Each WFO has a Warning Coordination Meteorologist (WCM) whose duties include outreach to the emergency management and broadcast media communities. Another prominent idea was for OCS to utilize its existing training regimen via new distance learning techniques to assist train-the-trainer programs in each state.

As of August 2005, four of the states have made substantial progress toward implementing or improving their own public safety decision-support systems. The Illinois Emergency Management Agency recently upgraded to a NOAAPORT data feed to support some operations. Representatives from Pennsylvania have returned to further evaluate OK-FIRST's training regimen and discussions with representatives in New Jersey and North Carolina are ongoing. North Carolina is especially interested in the training resources of OK-FIRST.

	Risk Categories					Ability Categories				
	DD	Tot. Fed.	Pop,	PG	PD	PCI	GPP	PCR	RISK Score	ABILITY Score
AL	1	2	3	3	3	5	5	5	2.4	5.0
AK	2	2	5	2	5	1	5	1	3.2	2.3
AZ	4	2	2	1	4	4	4	5	2.6	4.3
AR	2	3	4	2	4	5	5	5	3.0	5.0
CA	3	1	1	2	2	2	4	1	1.8	2.3
CO	4	1	3	1	4	1	4	4	2.6	3.0
CT	5	5	3	5	1	1	5	1	3.8	2.3
DE	4	5	5	2	1	1	1	1	3.4	1.0
DC	3	4	5	5	1	3	5	1	3.6	3.0
FL	1	1	1	1	1	4	3	4	1.0	3.7
GA	3	4	1	1	2	3	3	2	2.2	2.7
HI	5	5	4	3	2	1	5	1	3.8	2.3
ID	5	5	4	1	5	4	3	4	4.0	3.7
IL	3	4	1	4	2	2	2	2	2.8	2.0
IN	2	3	2	3	2	3	3	3	2.4	3.0
IA	4	5	4	5	4	4	1	3	4.4	2.7
KS	2	4	4	4	5	3	2	3	3.8	2.7
KY	1	1	3	3	3	5	1	2	2.2	2.7
LA	2	3	3	5	3	5	3	4	3.2	4.0
ME	3	3	4	5	4	4	3	2	3.8	3.0
MD	4	5	2	3	1	1	1	2	3.0	1.3
MA	4	5	2	5	1	1	4	1	3.4	2.0
MI	4	5	1	4	2	2	1	5	3.2	2.7
MN	3	4	2	2	4	2	2	1	3.0	1.7
MS	1	2	4	3	4	5	4	5	2.8	4.7
MO	3	4	2	3	3	4	1	5	3.0	3.3
MT	3	1	5	2	5	5	4	4	3.2	4.3
NE	3	5	4	4	5	3	3	3	4.2	3.0
NV	5	1	4	1	5	2	5	5	3.2	4.0
NH	5	5	4	3	2	1	5	5	3.8	3.7
NJ	4	4	1	4	1	1	3	1	2.8	1.7
NM	5	1	4	1	5	5	4	1	3.2	3.3
NY	2	2	1	5	1	2	4	2	2.2	2.7
NC	2	4	1	1	2	4	2	3	2.0	3.0
ND	2	3	5	5	5	5	3	4	4.0	4.0
OH	1	2	1	5	1	3	2	2	2.0	2.3
OK	2	2	3	3	4	5	5	4	2.8	4.7

Table 1. Risk and Ability rankings for the 50 states. Shaded states attended the Innovation in Managing Weather-Impacted Situations Workshop.

DD = Disaster Declarations
Tot. Fed. =Total Federal Assistance
Pop. = Overall Population
PG = Population Growth
PD = Population Density
GPP = Government Performance Project Rating
PCI = Per Capita Income
PCR = Per Capita Budget Resources

	Risk Categories					Ability Categories				
	DD	Tot. Fed.	Pop,	PG	PD	PCI	GPP	PCR	RISK Score	ABILITY Score
PA	2	3	1	5	1	3	1	3	2.4	2.3
RI	5	5	5	5	1	2	5	1	4.2	2.7
SC	2	3	3	2	2	4	1	5	2.4	3.3
SD	4	3	5	4	5	4	4	5	4.2	4.3
TN	1	2	2	2	2	4	3	4	1.8	3.7
TX	2	1	1	1	3	4	2	4	1.6	3.3
UT	5	5	4	1	5	2	1	3	4.0	2.0
VT	3	4	5	4	4	3	3	4	4.0	3.3
VA	1	2	2	2	2	1	1	3	1.8	1.7
WA	4	1	2	1	3	2	1	2	2.2	1.7
WV	1	2	4	5	3	5	5	3	3.0	4.3
WI	3	4	2	3	3	2	3	2	3.0	2.3
WY	5	3	5	4	5	3	5	3	4.4	3.7

Table 1, continued.
DD = Disaster Declarations
Pop. = Overall Population
PD = Population Density
PCI = Per Capita Income
Tot. Fed. = Total Federal Assistance
PG = Population Growth
GPP = Government Performance Project Rating
PCR = Per Capita Budget Resources

4. STATE CLIMATE OFFICES: POTENTIAL REPLICATORS?

In the early 1980s, state climate offices (SCO) were established when the NWS terminated state-level climatologist positions in favor of a three-tiered climate services program. These three tiers include the National Climatic Data Center (NCDC), six regional climate centers, and state climate offices to be funded and operated by the individual states. Accordingly, OCS was founded in 1980 with the legislative mandate to "acquire, archive, process, and disseminate in the most cost-effective way possible, all climate and weather information which is or could be of value to policy and decision-makers in the state". With the establishment of the Oklahoma Mesonet, OCS has grown to be the largest SCO in terms of staff and budget; the mandate was expanded in 2003 to "maintain and operate the Oklahoma Mesonetwork, a statewide environmental monitoring network". Prior to the Mesonet, OCS was more typical of other SCOs, with five employees.

To ascertain whether SCOs outside of Oklahoma could be potential replicators of OK-FIRST, a cursory survey of SCO websites (http://lwf.ncdc.noaa.gov/oa/climate/aasc.html), the official websites of state governments, and the websites of all 50 state emergency management agencies was performed. In particular, the following aspects were examined: (a) mandated or mission statements published on the SCO website, (b) whether the state government website links to the SCO website, and (c) whether there were linkages between the SCO and emergency management websites. These factors were chosen as they could reveal how the SCOs view themselves and also provide glimpses of any partnerships that may exist between SCOs and state emergency management agencies.

4.1 Existing Mandates/Mission Statements

Most SCOs are affiliated with academic institutions; only three (IA, MN, and SC) were located within another state agency. Five SCOs (AR, TN, MT, RI, and MA) were either vacant or had no web presence. Most often the SCO is attached an atmospheric science or geography department; a significant number of State Climatologists are part-time with their primary obligations related to research and teaching. Of the 45 SCOs with websites, fourteen did not publish a mandate or mission statement. Of the remainder, 14 SCOs mentioned the acquisition and/or dissemination of climate *and weather* data, while another 15 states mentioned some sort of climate services, but not weather data. Three states included language similar to OCS' mandate, and eight states mentioned automated weather networks. Five SCOs explicitly stated serving the state emergency management and/or public safety communities. Through this analysis, it is evident that some SCOs view themselves as pure climate offices; others view themselves as providing both climate services and weather data.

4.2 Linkages As State Agencies

OCS views itself as a hybrid institution – both as an academic endeavor and as a state agency with obligations to taxpayers. OCS has also invested resources to create linkages to other state agencies (e.g., water resources, environmental quality, public safety, emergency management). It is especially noteworthy that only seven SCOs (ID, IA, MN, OK, SC, VA, and WY) are listed on their state's comprehensive listing of agencies. As stated above, three of the seven are not attached to academic institutions.

4.3 Linkages From Emergency Management

Only seven SCOs were linked from state emergency management websites. Two states linked to the corresponding regional climate center; in both instances, the regional center was located in their state and the corresponding SCO had a very weak web presence with no mandate published. Florida has a State Meteorologist located within their emergency management agency; they did not link to the Florida SCO, presumably because they have in-house expertise. Two other states' emergency management agencies (TX, IN) linked to the parent academic institution of the SCO. While not explicitly tallied in this study, most state emergency management websites did link to the NWS WFOs that serve their state. Hence, emergency managers regard weather data as important to their mission; yet, linkages are not necessarily well established between SCOs and emergency management officials. This is a somewhat surprising result, considering that FEMA has a requirement for states to publish and/or update a state hazard mitigation plan in order to receive mitigation grants following disasters. In Oklahoma, OCS is a major player in the creation of the hazard mitigation plan by providing climatologies of severe weather, floods, droughts, and other weather hazards. With this requirement, it would seem that SCOs and state emergency management agencies would collaborate and establish linkages; if these linkages exist, they are not well publicized via either agency's website.

4.4 Uniqueness of OCS

As previously stated, OCS was similar to other SCOs until establishing the Mesonet. In 1989, Dr. Ken Crawford became the State Climatologist and Director of OCS following a 30+ year career in the NWS. OCS subsequently partnered with Oklahoma State University and the Oklahoma Department of Public Safety (DPS) to design and deploy the Oklahoma Mesonet. When Dr. Crawford came to OCS, he brought both an operational philosophy and linkages he had established at the NWS between DPS and emergency management. These types of linkages probably do not naturally occur in environments dominated by academia; academic institutions also typically do not develop programs that require commitments that may approach 24x7 operations.

Besides Oklahoma, 18 SCOs either have "weather data" in their mission statement/mandate and/or operate automated weather networks. While these networks likely differ from the Oklahoma Mesonet in spatial density and reporting frequency, a significant percentage of SCOs may be similar to OCS in their approach to fulfilling their mandates. These states may be more open to establishing OK-FIRST-like programs than the remaining states.

Because of the Oklahoma Mesonet, OCS will be in a unique position to improve traditional climate services once the network has been operational for 30 years. While considerable debate exists within the climate community about replacing and/or augmenting manual cooperative observing stations with automated stations, no doubt exists that Oklahoma will be able to produce climatologies at improved spatial densities using variables not previously possible (e.g. atmospheric and soil moisture and winds).

5. CONCLUDING THOUGHTS

Walters (2002) noted six motivations behind the establishment and spread of innovative government programs: (1) frustration with the status quo, (2) responding to crisis, (3) focusing on prevention, (4) emphasizing results, (5) adapting technology, and (6) doing the right thing. In this system, he classified OK-FIRST as an innovation that both responded to crisis and was an adapter of technology. The lead author's personal motivations in helping establish OK-FIRST also involved frustration with the status quo and doing the right thing. Additional factors in spreading innovations listed by Abramsom and Littman (2002) that also may apply to OK-FIRST include collaborations with other government agencies, using information technology, and providing rewards for the innovation. For OCS, a significant motivator for establishing OK-FIRST and similar outreach programs was to foster statewide political support at the grassroots level as a foundation for an eventual legislative campaign to achieve permanent funding for the Oklahoma Mesonet (i.e., the reward for the innovation). Among potential replicators, it is not clear if these motivators are completely absent, or if limiting factors (such as hierarchies, regulatory constraints, absence of reward incentives, or hesitancy by stakeholders) act as obstacles to replicate the innovation. For a significant percentage of personnel in both state climate offices and state emergency management offices, a substantial obstacle for replication of OK-FIRST may simply be a lack of professional interest in forming cross-disciplinary partnerships.

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