UNIVERSITY OF OKLAHOMA
SCHOOL OF METEOROLOGY

DROUGHT MANAGEMENT IN OKLAHOMA AND MISSOURI

A REPORT
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By

HEATHER CAMPBELL SESSING
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INTRODUCTION

Drought and water management are complex issues, and complete solutions currently do not exist. Between 1950 and 2000, the world's population more than doubled, and the world's water demands nearly tripled (Vickers, 2005). It depends on which sector you choose to look at for a specific description of drought. Farmers monitor precipitation and weather conditions such as temperature and humidity to understand drought severity. Drought from a city water manager's perspective includes availability and sustainability of water supplies. Hydrologists analyze deficit of snowpack in another state leading to decreased stream flow for drought signals.

In 1980 only three states (New York, South Dakota, and Colorado) had an official drought plan (National Drought Mitigation Center, http://www.ndmc.unl.edu/plan/plan.htm). Since then, several states have experienced at least one severe drought, and many officials across the United States have been organizing a drought plan for their states. Drought events have caused problem, such as decreased community water supplies and crop loss, now only nine states are without a drought plan (NDMC, http://www.ndmc.unl.edu/mitigate/status.htm).

Oklahoma and Missouri are two states that have experienced a severe drought during the last 20 years and have created a state drought plan. The purpose of this project includes four research objectives. The first is to document the strengths and weaknesses of each state's drought plan. Second, identify awareness triggers people across Oklahoma and Missouri use in order to understand severity of drought. Next, the project investigates which tools and resources are needed to alert agencies of emerging drought. The last objective is to compare and contrast governmental response to moderate and severe drought in Oklahoma and Missouri.

The first section of this paper will give a literature review, which includes the climate of

each state and previous work done in drought management studies. The second chapter contains a description of the data collected and methods used to collect data. Chapter three contains a description of political theories, which can be used to describe drought policy action. assesses each of the four objectives using results from the data collection. Chapter four discusses a summary with recommendations for the future.

Chapter I

In drought management, many actions have been made to help people with drought management. In 1995, the National Drought Mitigation Center (NDMC) was created in order to help people minimize risk to drought while also helping people cope with drought. This group encourages people to look toward drought mitigation as opposed to crisis management. In 2004, the Western Governors' Association recommended that a National Integrated Drought Information System (NIDIS) be created to help people with earlier drought warning. So, in 2006 NIDIS was signed into law. The NIDIS goal is to develop a drought portal, create coping strategies, and collect and combine forecasts to create earlier drought warnings.

Mark Shafer (2005) investigated drought information within the arenas of policy makers and scientists. He found that policy makers have little trouble accessing information needed to make informed policy decisions. His results also showed that the scientific community makes an effort to get needed information out to the end users of their information. However, both the scientific group and the policy group can be passive and only engage when something is asked of them or they are asked to participate.

Section 1.2

Studying the climate of a region is important in understanding how a state will respond to

droughts. Measuring precipitation in a region is one of the easiest ways to understand how much rain and snow a region needs for sustainability but decision makers also rely on other variables to assess a certain area for drought. Within the states of Oklahoma and Missouri, local precipitation is the main source of water resources. Mountain snowmelt has little influence within the area except in the larger river systems.

Extremes in annual precipitation occur across the state of Oklahoma. The northwest corner of the Panhandle receives on average between 16 and 20 inches of precipitation per year while more than 50 inches falls in the southeastern of the state (Figure 1).

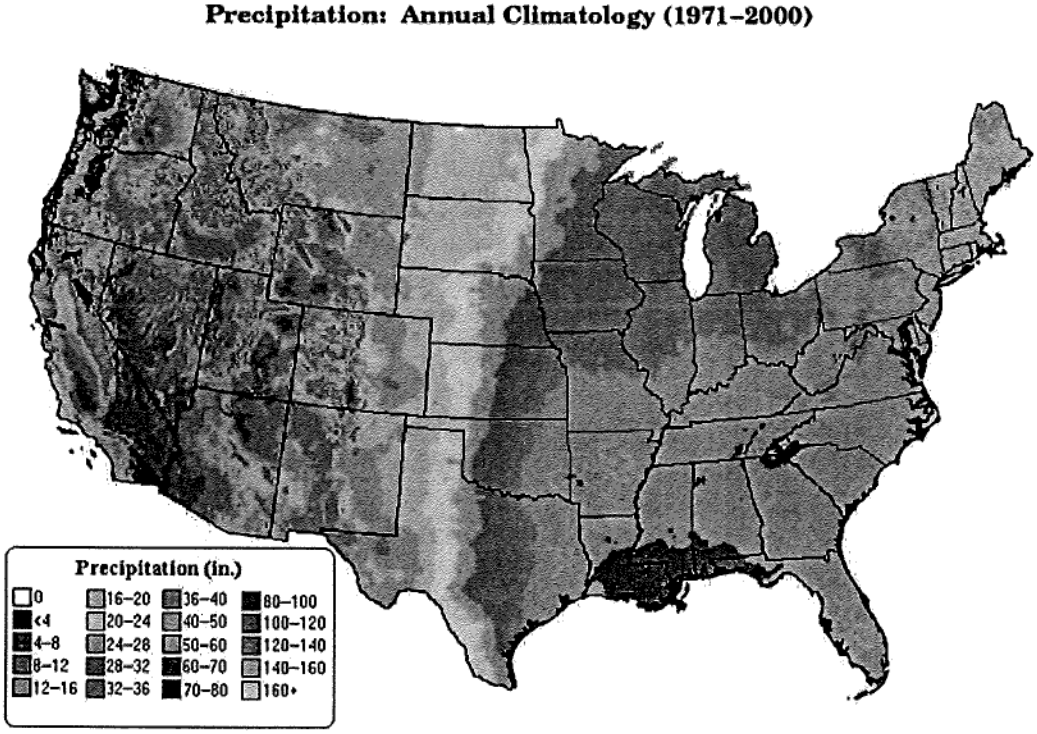

Figure 1. This is a picture of the average annual precipitation values across the country. (Courtesy of the Natural Resources Conservation Service)

The statewide annual average for precipitation is 34 inches with the largest portion of the

precipitation coming during the spring months. Evaporation is an issue to be aware of with surface water especially during the high water usage summer months. Lake evaporation rates are around 48 inches per year in the eastern part of the state, while the southwestern region can see up to 65 inches evaporate in a year (Oklahoma Water Resources Board, http://www.owrb.ok.gov/util/waterfact.php). The geography of Oklahoma varies across the state. The majority of the state shown in figure 2 is rolling plains and hills with three small mountain regions in the southern third and another in the northeastern.

Public water use is the largest reason for water use in the state of Oklahoma, and the majority of the state's surface water is used for public supply (OWRB, http://www.owrb.ok.gov/util/waterfact.php). Oklahoma overlies 23 major aquifers with the majority of water use in the western half of the state coming from groundwater (OWRB, http://www.owrb.ok.gov/util/waterfact.php). The eastern half of the state uses a more balanced contribution of aquifers and surface water for their water supplies.

The Oklahoma Water Resources Board (OWRB) regulates and permits Oklahoma water use. Groundwater is considered privately owned by the person who owns the land on top of the water supply. The privately owned resource is unregulated up to the threshold amount of two acre-feet per year in areas where maximum annual yield studies have not been completed. Areas where water studies have been completed, landowners might be allotted more or less than 2 acre-feet per year depending on how much water can be safely withdrawn (OWRB, http://www.owrb.ok.gov/supply/watuse/gwwateruse.php). If water need exceeds the threshold, a permit must be obtained. Efforts are underway to move to a sustainable yield doctrine for aquifers, which may alter these unpermitted thresholds. For surface water, legislators adopted a western United States. approach when creating policy for water in their streams. It is considered

to be a publicly owned resource, and the law follows prior appropriation rules. Permits are granted based on the order of application, up to the full volume of water carried in the stream. If supply falls below the permitted allotment, water use is curtailed or eliminated among the most junior rights holders while senior rights holders reserve their full allotment. As an example, if city A has had a permit to one river for 75 years and city B has a permit to the same river for 25 years, during times of drought, city A will get the full amount of their allotment. City B would have their amount of permitted water use restricted. The state can restrict "beneficial uses" to assure water is not being wasted. This type of law is known as permissive (Missouri Dept. of Natural Resources, 2006). Unless a particular use is permitted, it is not allowed.

Missouri does not have the extreme in annual precipitation amounts as Oklahoma. The northwest corner receives on average 34 inches of precipitation with amounts increasing to 51 inches around the Bootheel area in the southeastern corner (Figure 3).

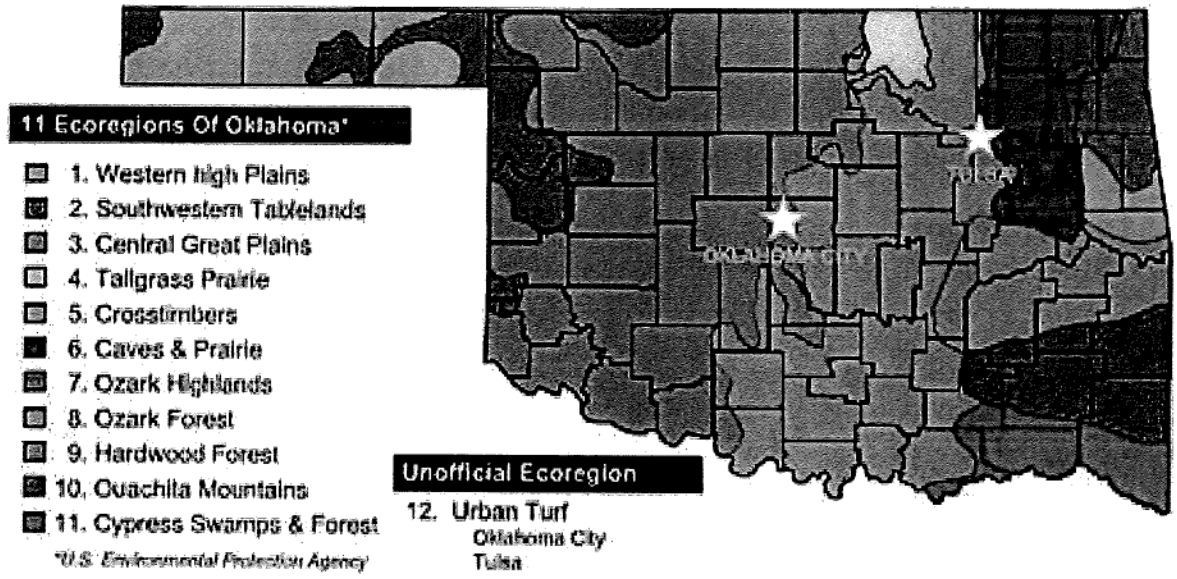

Figure 2. This map indicates where the differing ecoregions exist in Oklahoma. (Oklahoma Office of the Secretary of Environment, http://www.environment.ok.gov/land/ecoregions.html)

Even in dry years, most parts of Missouri have more rain than many locations in Oklahoma. However, lake evaporation is still an issue to work around in Missouri. The northeast corner of the state averages about 36 inches of evaporation per year, and the southwestern corner loses more than 44 inches of water each year (Missouri Drought Plan, 2002). The geography of Missouri shown in Figure 3 is the northern portion state is consists of plains, and the Ozark highlands dominate the southern topography.

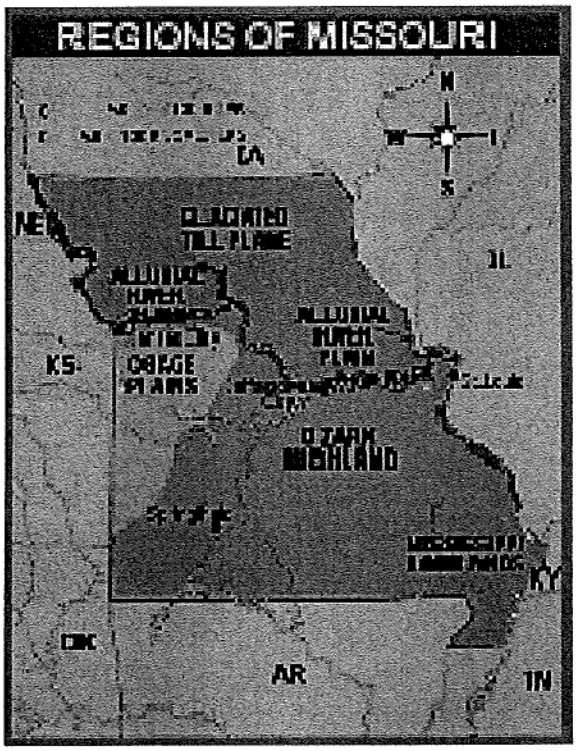

Figure 3. This map is a description of the topographic regions of Missouri. (St. Louis Mercantile Library at the University of Missouri - St. Louis)

Officials are most concerned about population growth with the potential to put a strain on water resources (Missouri Drought Plan, 2002). Northern and West-Central Missouri overlay areas where high levels of impurities in groundwater limit its usefulness as a source. These areas rely mostly on streams, which can become at risk very quickly during a drought. Water allotment is

that landowners do not own the water, but landowners have the right to a "reasonable use" of the water on, adjacent to, or under their land. The courts decide what is reasonable use (MDNR, 2006). During a drought this can be an interesting issue. For example, City A and City B use the same stream. If City A thinks B is using too much water because the stream is decreasing in flow, the courts must settle disputes. Riparian law is commonly referred to as restrictive. A person is allowed to use the water in any legal way he wishes until the courts restrict the use (MDNR, 2006).

Chapter II

This project uses two sets of data. The first data set comes from 10 interviews taken during winter 2009 and 2010. In Oklahoma seven in-person interviews were conducted.

Table 1. The table displays those in Oklahoma who were interviewed, where they were employed, and their role in drought management.

Oklahoma		
Name	Employment	Role in Drought Management
Derek Arndt	Oklahoma Climatological Survey	Assistant State Climatologist
Albert Ashwood	Oklahoma Department of Emergency Management	Director
Danny Hillard	University of Oklahoma Vice President for Government Relations	Former Speaker Pro Tempore of the Oklahoma House of Representatives
Cal Hobson	University of Oklahoma College of Continuing Education Executive Director of Outreach	Former President Pro Tempore of the Oklahoma State Senate
Howard Johnson	Oklahoma Climatological Survey	Former Assistant State Climatologist
Terry Peach	Oklahoma Department of Agriculture	Director
Brian Vance	Oklahoma Water Resources Board	Co-author of State Drought Plan

All Oklahoma interviews were conducted in person at the interviewees' place of work. The purpose for this was to give the person a face to the research being conducted. Everyone in

Oklahoma worked within a reasonable driving distance, so it was decided to conduct interviews face-to-face.

Table 2. The table displays those in Missouri who were interviewed, where they were employed, and their role in drought management.

Missouri		
Name	Employment	Role in Drought Management
Steve McIntosh	Missouri Department of Natural Resources, Water Resources Center	Co-author of the Missouri State Drought Plan
Pat Guinan	Missouri Climate Center	State Climatologist
Judy Grundler	Missouri Department of Agriculture	Department of Agriculture representative on the Missouri Drought Assessment Committee

In Missouri three interviews were conducted by telephone. These interviews took place over the phone because although there is value in face-to-face interviews, the cost of driving to Missouri outweighs the benefits of having in-person interviews. All interviews were audio taped with permission from each individual to ensure no interviewee was misrepresented. Names of officials have also been left off of quotations until permission has been granted for printing their name with their quotes.

The purpose of the interviews was to learn where the state agency gets its drought information, what they do with drought information, and how they get information out to the public. Sample questions include:

- "Is anyone at your agency in charge of monitoring drought status?"
- "Where does your agency get its drought information?"
- "Does your agency disperse information? If yes, how so?"

The full set of questions used in the interview guide are included in Appendix A.

The next set of data used came from surveys. Three hundred questionnaires were emailed out in Oklahoma and Missouri and targeted towards those at a regional or local decision making position in drought management. The breakdown of respondents by agencies in Oklahoma is listed in Table 3, and the classification of Missouri survey respondents divided by agency is listed in Table 4. Specific groups were selected to send out surveys to because they were listed in the state drought plan as playing a role in drought response management.

Table 3. The table lists which groups in Oklahoma responded to the survey, the percentage of respondents compared to the total number of respondents in each state, and the median years of service.

Oklahoma		
Occupation	Percentage of Respondents	Median Years of Service
Oklahoma Agriculture Extension Network	32%	10
Local Government	24%	6
Oklahoma Conservation Commission	15%	15
State Government	9%	24
Academics	3%	16
Agricultural Producer	3%	37
Consultant	3%	1
Emergency Management	3%	33
Federal Government	3%	34
Natural Resources Conservation Service	3%	22
Water Management	3%	21

These groups include agriculture extension agents, water management, local government, emergency management, and local offices of federal agencies such as the National Resource Conservation Service, National Forest Service, and the Farm Service Agency.

Table 4. The table lists which groups in Missouri responded to the survey, the percentage of respondents compared to the total number of respondents in each state, and the median years of service.

Missouri		
Occupation	Percentage of Respondents	Median Years of Service
Missouri Agriculture Extension Network	50%	16
Agriculture Experiment Center	20%	21.5
Water Management	10%	23
Local Government	10%	7.5
Retired Agriculture Teacher	10%	30

There were 44 survey responses, which is approximately a 15% response rate. Thirty-four responses came from Oklahoma, and 10 responses were from Missouri.

The full set of survey questions is included in Appendix A. The University of Oklahoma Institutional Review Board approved both the interview guide and survey questions.

Chapter 3

Section 3.1 - THEORY USED IN DROUGHT POLICY

Using the examples of drought policy from Oklahoma and Missouri, a variety of different policy process models were used to explain the timing of creation or updates to state drought plans and what must happen in order for change to occur.

Institutional Rational Choice

Following Ostrom (2007), this study takes points from the Institutional Analysis and Development (IAD) framework to describe the process governing the creation and structure of drought policy. People involved with drought monitoring and management come together bringing information from their perspective, and collectively the group builds or updates a state drought plan. For the purposes of this paper, the assumption is made that the entire state of

Missouri or Oklahoma is the action arena because it contains the actors, an action situation (drought), how actors interact, the subtractability of a common-pool resource (water), and explicit and implicit sets of rules that people might follow at each phase of drought. Below is a scenario of state drought planning using the IAD framework.

Action situation: The standing drought

-Who are the groups affected and how many people are affected?

-What are the allowable actions called by water laws and drought plan?

-What are the potential outcomes if nothing is done and the drought persists?

Actors in this scenario are the governor, agency leaders, and the people who serve on the various state drought committees. One important question the actors must ask themselves is what are the costs and benefits of declaring a drought? If done prematurely, the group could lose credibility should a drought fail to develop. Waiting to take action until a drought has worsened may make it easier to generate public support for actions and allow more flexibility in state and federal response, but required actions may be more severe than if conservation begins earlier. Actors are assumed to have bounded rationality especially when dealing with common-pool resources like water (Ostrom, 2007). There is no way that decision makers are able to look at every different variable for drought identification because information is incomplete. For example, there is not a stream flow gauge or a precipitation sensor every 10 feet. Decision makers have only the information they have access to and have a limited amount of time to make the determination about the drought severity. But as more droughts occur, decision makers can use the collective-choice approach and change their policy according to what has worked and what has not worked in the past situations.

According to Ostrom (2007), rules are shared understandings about what steps are

required, allowed, and not allowed. The rules as to how each group is supposed to respond to increasing drought severity are explicitly stated in each of the states' drought plans. . In Missouri's plan, rules are also explicitly stated as to what measures to take during each phase of a drought leaving no question for the public or the decision makers about what measures to enforce. In Oklahoma, specific response actions are left to the discretion of the actors. An implicit rule would be water law in the state. This constrains actions that may be described explicitly in the plan, but without reference as to why certain actions would be taken. A limited number of interviews precluded a thorough examination of implicit rules. Other factors such as how the climate of a region changes from season to season and the needs of different groups during the seasons would be important in drought preparation planning.

After analyzing the plans, it appears that two groups of rules are at work. Operational rules affect the day-to-day activities (Ostrom, 2007). An example of operational rules could be meeting with a group each month to discuss the current drought situation or following the rules explained in the drought plan. Collective-choice rules would come into play if elements of the drought plan did not perform as expected and needed to be changed. Oklahoma will use collective-choice rules in order to update and enhance the execution of their drought plan.

Because water is necessary for everyone's well being, it would be costly to exclude anyone from using the public water systems. In Oklahoma, decisions on curtailment or exclusion may be more constrained because it is a landowner's right to use groundwater whereas the coupled riparian doctrine in Missouri could make curtailment decisions more flexible. Water can also be considered in variables affected by the subtractability of flow. If City A uses water, there will less water for City B unless the supply is replenished.

Incremental and Punctuated-equilibrium

According to True et al (2007), the conservative nature of American politics is to keep the status quo, so it takes a major conflict or an immense effort to change policy. From a perspective of a decision maker, punctuations in policy occur because of a change in preference or a change in attentiveness (True et al., 2007). Because coalescence of factors sufficient to cause significant policy changes is rare, policy changes often take a form of incrementalism, small changes that occur gradually over time.

The monitoring process in both Oklahoma and Missouri follows an incremental structure. Oklahoma continues monitoring through the dry and wet seasons using the Oklahoma Mesonet and many drought models (McPherson et al. 2007). The Oklahoma Water Resources Board (OWRB) and the Oklahoma Climatological Survey (OCS) also produce seasonal and monthly summaries respectively to keep people informed and keep drought/climate issues on the minds of decision makers (Sandbo et al. 2008). In addition to the seasonal summary, the OWRB has been working with communities to update their water systems. Since this program has started, the OWRB has issued over one billion dollars in low interest loans to communities. One interview respondent in Oklahoma stated that when a drought occurs, the communities with upgraded systems are more able to lessen the effects of a drought to their water systems. In Missouri, the Climate and Weather Committee meets every month to discuss current monitoring and climate events. Meeting so frequently also allows members to keep up to date with who is in the group and what exactly their job is. In Oklahoma, the comparable committee does not meet routinely but regular communication is achieved through the OWRB's monthly publication, *Water Resources Bulletin.*

For policy change, the pattern in both states is punctuated-equilibrium. Drought policy

according to True et al. (2007) would occur when the political problem has expanded past the borders of the expert-driven subsystem and into other policymaking arenas. There are two reasons for the punctuated-equilibrium nature of drought policy.

Most all people, including decision makers and the public, follow the "Hydro-Illogical Cycle (Figure 4).

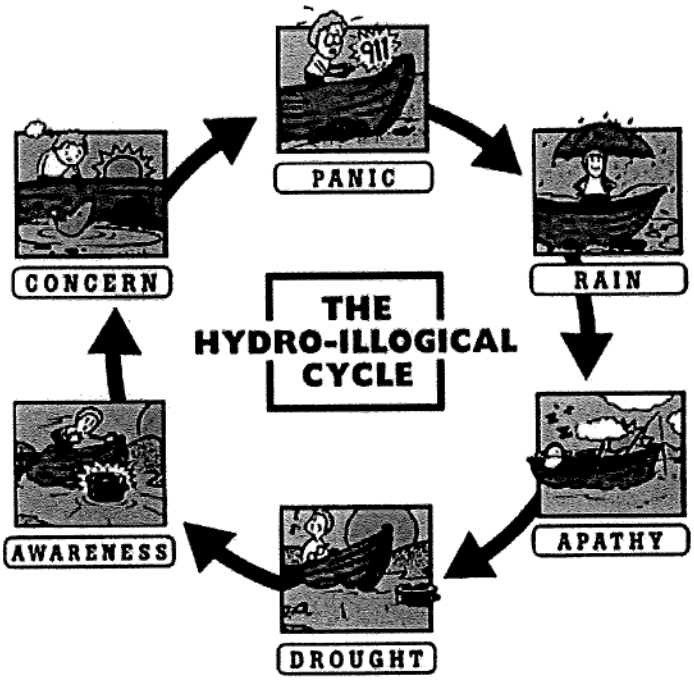

Figure 4. This is an image of the process that people go through before, during, and after a drought. (National Drought Mitigation Center)

When times are good and water supplies are plentiful, people do not worry about improving drought policy, but when precipitation becomes scarce and water systems fail, policy makers are quick to call for updates and improved policy. While water is plentiful, policy makers have the potential to be consumed with many other serious issues: for example a downturn in the economy, high crime rates, rising costs of medical care and insurance, deteriorating roads and bridges. Because of the time needed to produce improved policy for

other needs, drought is put on the backburner. Another reason for punctuated-equilibrium could be that many times, it takes a drought to realize the weaknesses and strengths of a drought. This was demonstrated during Oklahoma's last drought in the spring of 2005 through the winter of 2006-2007. The Oklahoma Drought Plan was updated in 1997, but it took the next drought (2005-2006) to realize the plan was not sufficient (Sandbo et al. 2008).

Multiple Streams Theory

This framework contains the three streams of policy, problems and politics (Kingdon, 1984). The policy stream would be the drought plan in each state. The problem would be a lack of water supplies for crops, livestock and /or people. The politics will be the Governor, the legislature, and state officials responsible for drafting new plans. The politics can be an issue about how often drought would be put on the agenda because some are more involved with the weather community than others. When these three streams converge, a policy window opens, leading to a window of time in which a drought plan could be revisited and updated. Linkages between the streams may be aided by a policy entrepreneur (Zahariadis 2007; Kingdon 1984). The policy entrepreneur could be the Drought Coordinator in Oklahoma or selected individuals in Missouri assigned to advise the Governor. One Oklahoma official explained during an interview his experience as to when drought policy will be looked at.

> "We're probably going to have to have another drought, and that would be the time or shortly thereafter to suggest improving or revisiting our drought plan and drought response. As far as the water community goes, that's when we've had more success in water related initiatives. Unfortunately, that's when you have their [the legislature] ear. Those droughts are when you can go over there and get some support or get some work done. "

So far in Oklahoma and Missouri, drought plan creation and updates have all occurred in response to a drought.

Dispersion models

This framework explains how others will communicate with each other. Dispersion is sometimes called borrowing or diffusion. Models can be used to predict which states will communicate during the drought plan creation or update process because they are learning from each other (Berry and Berry, 2007). The National Drought Mitigation Center (NDMC), acts as a resource for those developing plans, bringing people together with conferences and helping draft their plans.

Results from the interviews indicated that both Oklahoma and Missouri followed advice from the NDMC with drought planning. Regional models can help explain groups that border each other and interact on other issues as sources of information. Missouri got help from Kentucky, Oklahoma from Colorado.

One reason for this might be because states with adjoining borders typically have similar climatology and topography. Another reason could be that officials in Oklahoma and Missouri were already familiar with the other state's leaders and could glean useful information from the bordering state's plan. Figure 5 shows the status of state drought plan with the most recent graph from 2006.

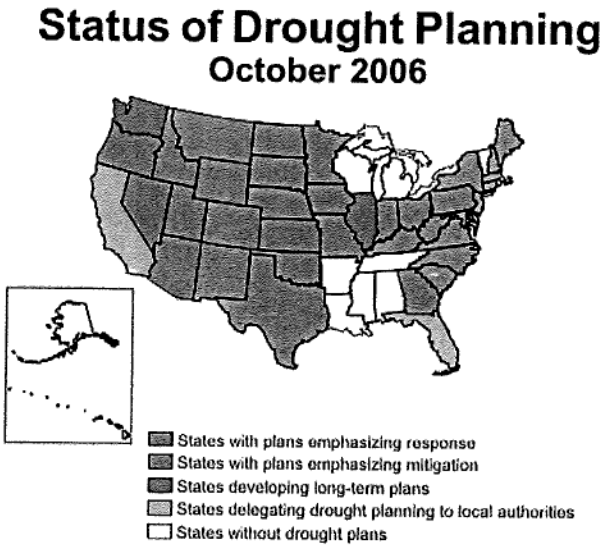

Figure 5. This is a map showing the number of states with and without a state drought plan as of October 2006. (National Drought Mitigation Center)

Section 3.2 - The Drought Plans

The National Drought Mitigation Center (NDMC) has two designations regarding a state's drought policy. A state's plan is geared either toward mitigation or response. Both the Oklahoma and the Missouri plans are aimed to respond to droughts. The plans are organized in a similar fashion, partially due to the fact that both states asked for help from the NDMC with the creation of their plan.

Rural water supply systems are the biggest concern for Missouri officials. Because drought can be daunting to tackle even from a decision maker point of view, the drought plan has created groups that are assigned different tasks (Figure 6).

The bottom tier groups are called the Climate and Weather Committee (CWC) and Impact Teams. The CWC is a standing committee chaired by the Missouri Department of Natural Resources, Water Resources Center and has the task of monitoring precipitation and

water supply from across the state (MDNR, 2002). The Impact Teams are comprised of members who are considered technical experts in fields of health, agriculture, and other groups that would be affected amidst a drought situation. During times of drought, the CWC and the Impact Teams are responsible for reporting water information to the next tier of decision makers, the Drought Assessment Committee (DAC).

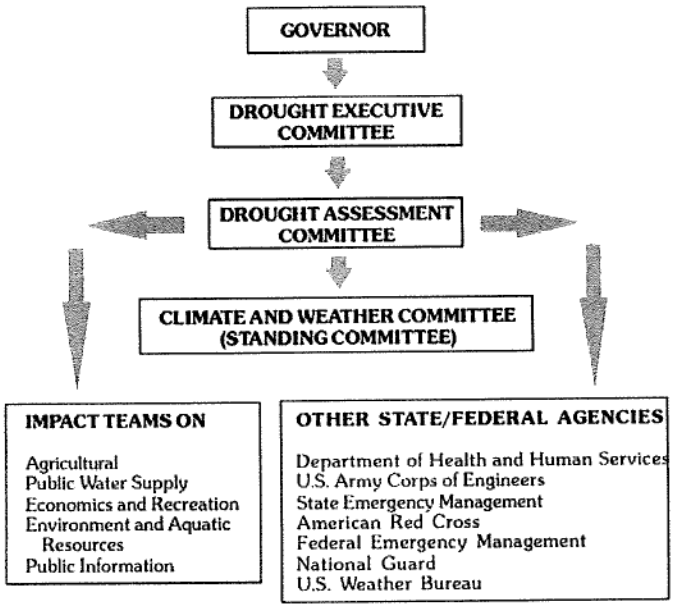

Figure 6. This is the organizational chart of Missouri drought assessment groups. (MDNR)

The bottom tier groups are called the Climate and Weather Committee (CWC) and Impact Teams. The CWC is a standing committee chaired by the Missouri Department of Natural Resources, Water Resources Center and has the task of monitoring precipitation and water supply from across the state (MDNR, 2002). The Impact Teams are comprised of members who are considered technical experts in fields of health, agriculture, and other groups that would be affected amidst a drought situation. During times of drought, the CWC and the Impact Teams are responsible for reporting water information to the next tier of decision makers,

the Drought Assessment Committee (DAC). The DAC contains between 15-20 people from both state and federal agencies, and they have several responsibilities. The two most important jobs are to review the recommendations made by the CWC and impact teams and then to make a proposal to the governor about what action to take. The next tier before the governor is the Drought Executive Committee (DEC). The governor activates the DEC in severe cases of drought. This committee consists of four state representatives appointed by the President Pro Tempore of the Missouri Senate and the Speaker of the Missouri House of Representatives and directors of several state agencies or a designated person who has the authority to provide help and resources in addition to making long and short-term recommendations for drought response. The last tier is the governor, who is the ultimate decision maker.

Missouri has a four-phase approach for all drought situations in the state. Phase one is the Advisory Phase. The CWC will begin making recommendations with the assumption that a drought will persist. When the governor declares a Phase 2 Drought Alert, he will assign a drought alert to the affected counties and call for the start of the DAC. Phase 3 is the Conservation Phase and mandatory water conservation measures are enacted. Phase 4 is a Drought Emergency. This allows state officials to reallocate water to cities who do not have adequate water supplies. The DEC also begins operations during this phase. The drought plan organizes a list of water users from most important to least important: Class A (e.g. hospitals and homes), Class B (e.g. restaurants and agriculture irrigation), Class C (e.g. golf courses and car washes). Restrictions begin for Class C in Phase 2, Class B in Phase 3, and both get banned from usage in Phase 4.

The greatest impacts of drought in Oklahoma are felt in the agriculture community (Oklahoma Drought Management Team, 1997). The plan writers were told that a good drought

plan should have three sections: monitoring, assessment of impacts, and response. So, Oklahoma created three groups to form the Oklahoma Drought Management Team (ODMT) (Figure 7). Unlike Missouri, the governor does not make drought phase declarations. The plan calls for the director of Oklahoma's Emergency Management to be the State Drought Coordinator, which heads the ODMT and issues drought declarations.

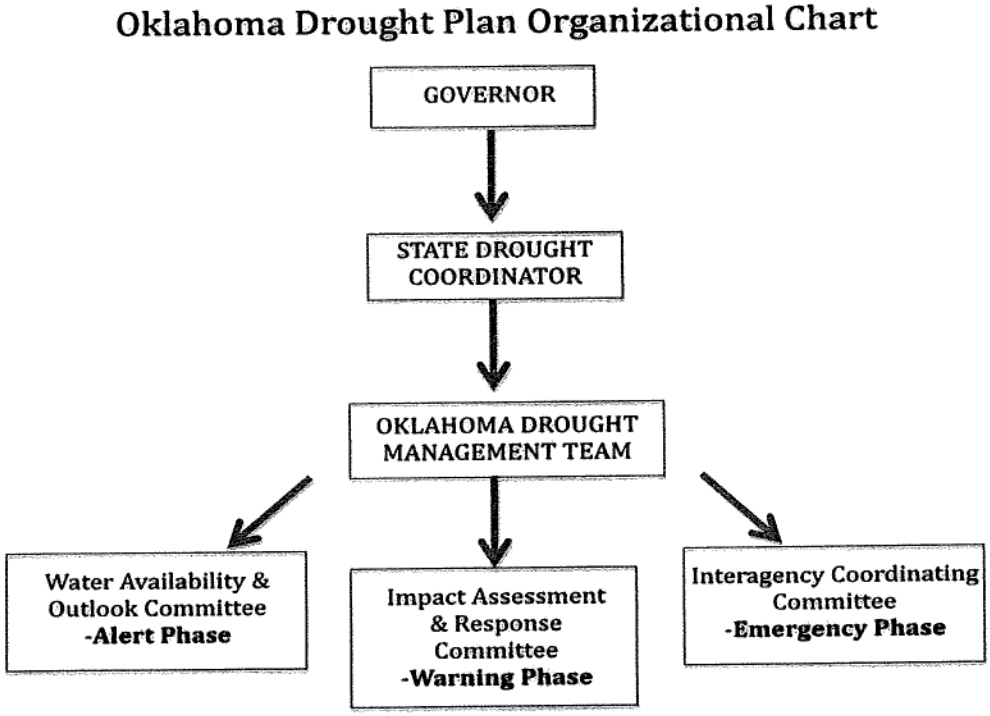

Figure 7. This is the organizational flow of Oklahoma drought assessment groups and leaders.

The first group in the ODMT is the Water Availability and Outlook Committee (WAOC), chaired by the director of the Oklahoma Water Resources Board. This committee is in charge of a monitoring system that assesses many variables indicating the intensity of droughts. This group should informally each month in order to keep up-to-date with everyone's thoughts and opinions of the current conditions. The next group in the ODMT is the Impacts Assessment and Response Committee (IARC), chaired by the director of the state Department of Agriculture.

This group is responsible for monitoring and assessing the potential impacts Oklahoma is currently facing and would face with a continued drought. One of the biggest jobs for this team is identify the sectors across the state that have become most vulnerable and hardest hit by drought and then improve the state's ability to meet the needs of its citizens. As drought severity worsens, the third group of the ODMT, Interagency Coordinating Committee (ICC), is called to action by a proclamation from the governor. The State Drought Coordinator chairs this committee. This group's greatest role is to figure out what water availability problems can be solved through water allocation, using resources already in Oklahoma. After a determination has been made, the group is responsible for making a recommendation to the governor. If the governor wants to ask for a presidential drought declaration, this group is also responsible for collecting all of the necessary information and data to support a declaration.

Oklahoma also has four different drought phases. During the Advisory phase, the Drought Coordinator will request information and advice from members of the ODMT who are familiar with climate and water resources. If the Drought Coordinator calls for the next phase, the Alert phase, the WAOC is set in motion. After reviewing information from the WAOC and deciding that the drought conditions have worsened, the next phase is a Drought Warning. At this stage, the IARC is activated to start work on problems Oklahomans are facing during the drought and could face if the drought persists. In an Emergency Phase, the last stage of drought declarations, the ICC is brought together all while the WAOC and IARC are still working to monitor as assess conditions.

The two states' plans target different objectives. Since Oklahoma's biggest drought impacts are usually felt in the agriculture community, the drought plan is built to accommodate the type of drought to which agriculture is most sensitive. The Oklahoma Plan is built to respond

to quick, short-term droughts. Missouri's hardest hit areas are water systems, so their plan is built to respond to long-term droughts.

Another difference is the scope of information covered in each of the plans. Missouri's discusses several important topics such as outlining the vulnerabilities of each region, water availability in each region, and important climate variables in each region. In addition, the plan provides several maps showing the information in an easy to read and understandable format. Oklahoma's Plan does not include an in-depth look at vulnerabilities by region, although it does cover overall state weaknesses.

Both states address specific roles for state agencies during a drought. Oklahoma's Plan takes a look at 41 different local, state, and federal groups. Many of these agencies were added to Oklahoma's plan based on subsequent experience during drought (Mark Shafer, personal communication). Missouri's plan only addresses 17 groups and agencies.

An official in Missouri said that their plan during the last drought worked effectively and efficiently, but that fire mitigation needs to be investigated. In Oklahoma, experience has shown officials that errors exist within the plan. According to Sandbo et al. (2008), officials in Oklahoma did not follow the drought plan when dealing with the drought in 2005-2006. One official says that because it has not been updated since 1997, the plan does not take into account several products that have been subsequently developed. For instance, the National Drought Mitigation Center's Drought Monitor was not created until 1999. This fact is important because this plan calls for many different groups to communicate and complete extra work, which is now taken care of in the Drought Monitor and its weekly creation. Also, one Oklahoma official thinks that the plan is just not feasible and that the drought was handled better because officials did not follow the plan. Oklahoma's plan was created to help respond better to short-term

drought. Another Oklahoma official expressed concerns regarding the adequacy of the plan when a long-term drought occurs across many portions of the state. Oklahoma's plan also does not lay out ideas for conservation outside of drought, nor does it address conflict management of water users, however, these topics are addressed as part of the Oklahoma Comprehensive Water Plan with a targeted completion date of 2011 (Oklahoma Water Resources Research Institute, 2009).

Section 3.3 - Drought Triggers

Action at the policy level is event driven. Thomas Birkland (1997) states that a focusing event is a sudden, unexpected event. These are important because, according to Birkland, group leaders use focusing events to support change. Depending on the sector a person is working within, drought can either be slow progressing or suddenly arriving. One survey question asked respondents, "How do you know when you are entering a drought?" One person in the agriculture sector answered for the short term of two to three weeks, while another person with the conservation group has a perspective of the longer term of two to three months. Triggers much like the timing of drought change from sector to sector.

The survey and interviews also included the question "What specific triggers do you use to spur action?" As one would expect, the answers varied among respondents. Certainly not every sector monitors drought in the same manner, but each kept an eye on the information most likely to impact their job responsibility. For example, those in the agriculture groups answered that weather and crop conditions, soil moisture, and surface water reservoirs are used in determining whether action needs to be taken in response to drought. Water managers, on the other hand, look at lake, reservoir, and river levels and daily water use. One water manager said that his drought trigger is when water usage exceeds four million gallons per day in his

community of 5,000 to 30,000 people. However, only 16 of the 44 respondents answered the question, and of the 16, four people said they did not have any specific triggers.

Many of the people interviewed do not have in-house drought monitoring. Even without staff responsible for directly monitoring, agencies know whom to contact if they start hearing talk from those in their sector about drought. Agencies also typically have triggers, which are set according to national agency rules and states rules written in the drought plans. For example, the Oklahoma Water Resources Board always sends out a monthly newsletter, but when state officials raise the drought severity level, the OWRB increases the frequency of newsletter production. Another example comes from the Oklahoma Department of Agriculture. They cannot start applying for national aid until crop loss or precipitation deficits reach 30%.

Triggers are different for each group of people, and both state agencies and locals have information they look to for an indication of drought severity. Even when people have identified the triggers they use to make drought decisions, barriers such as local perception and information exchange appear when gathering drought information.

Section 3.4 - Gap Analysis

The third research goal for this project was to learn from the surveys what tools and resources people around Oklahoma and Missouri use to alert them of evolving drought events. In addition, a gap analysis was used to decide where each state's weakness existed.

Overall, those surveyed said they have little trouble finding the drought information they need. Sixty percent of Missouri respondents said that either they or another person in their organization was in charge of assessing severity of drought. In Oklahoma, 11 out of 30 who answered said they or someone they worked with was tasked with determining drought severity. However, perception and information dispersion are two gaps found in the survey results that

state agencies might consider closing.

State agencies in both states work to create drought information that will be effective for the end user. The survey had people click the box next to sources they use for drought information. A follow up question was posed "Are there characteristics of other sources of drought information that make them difficult to use?" The intent in asking this question was to find out why people were not using all information to which they had access. Only eight people responded with an answer where they explained what made information hard to use, and three answered that information was not localized enough. Specifically, one person felt that the localization problem was especially true for precipitation maps.

Another interesting perception found in the survey results was that of drought authorities. The survey had a question asking if people considered specific individuals as drought authorities in their state. The reason for asking this question was to figure out how well people were connected to those they from whom receive information drought information from. In Missouri, eight people responded that they thought there were drought authorities, and six people were able to name a specific person. In Oklahoma, 42% of respondents either said there were no specific individual drought authorities in the state or they were not sure. Of the 18 who answered that there was a drought authority, 12 could list an agency as a drought authority but either did not know of such an individual or did not list them in the answer. Two people in Oklahoma specifically said that drought information is best looked at from the local perspective, so they did not see any state group as an authority. One Oklahoma Emergency Manager answered, "How can someone else not experiencing my situation be an expert on how I handle a drought?" Whether people agree with his statement or not, his answer represents a perception in Oklahoma that the state agencies are not able to help him manage and monitor drought.

Another gap in drought management is information dispersion. When data begins to indicate drought conditions are appearing in a particular area, state agencies not only rely on scientific data but also rely on word from the field about conditions locally. If local reports do not come, making drought severity declarations becomes difficult. The survey included the question, "If you suspected there were some emerging drought issues in a particular county or region, whom would you contact to investigate?" All but one response in Missouri either identified an organization or a specific person within their state to whom they would pass along information about unfolding drought conditions. In Oklahoma five out of 29 (17%) said either they did not know whom to contact or said they would not pass information along to anyone. Twenty-four of the 29 people answering were able to identify an agency or an individual they would contact in the event of materializing drought.

This reduced amount of sharing information can also be seen with responses to the open-ended question, "Do you provide any comments to authors or other officials involved in the process [Drought Monitor discussions]?" Figure 8 shows 16 people answered in Oklahoma with 10 (63%) stating they did not contribute information, two (13%) said rarely, two (13%) said yes (13%), one person (6%) said occasionally and one other person (6%) said they shared information if asked. Seven people answered in Missouri, and five people (71%) do provide comments to Drought Monitor authors (see figure 9) while only two (29%) said they did not. Interestingly, both Missouri and Oklahoma have a state mesonet, but when people were asked on the survey where they get their information, two people referenced the Missouri Mesonet, and 18 people in Oklahoma referenced the Oklahoma Mesonet. It appears that Oklahoma's gaps exist with passing information about drought conditions and with agency drought authority perception.

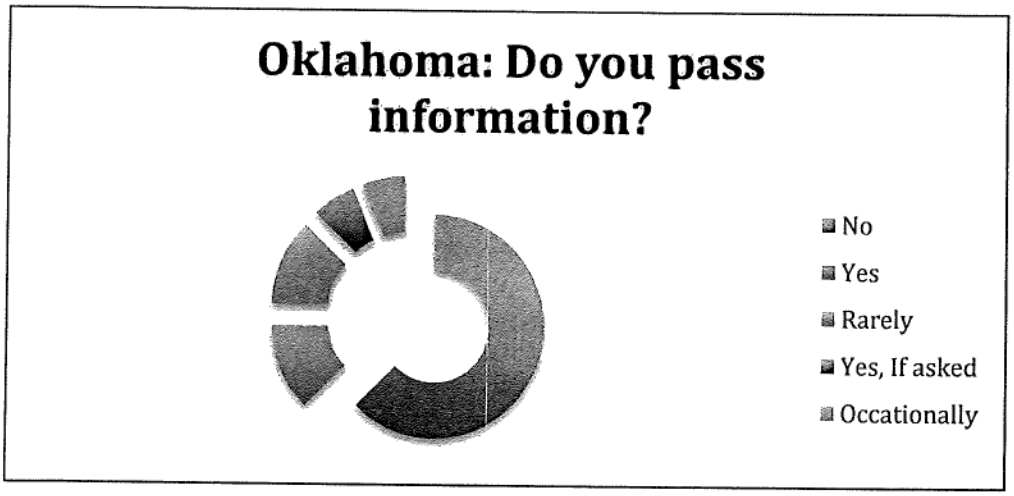

Figure 8. The chart below shows the composition of answers when Oklahoman respondents were asked if they give information to those involved with Drought Monitor discussions.

While Missouri seems to have a better-connected network with drought information, the state's gap is connecting monitoring data and instruments.

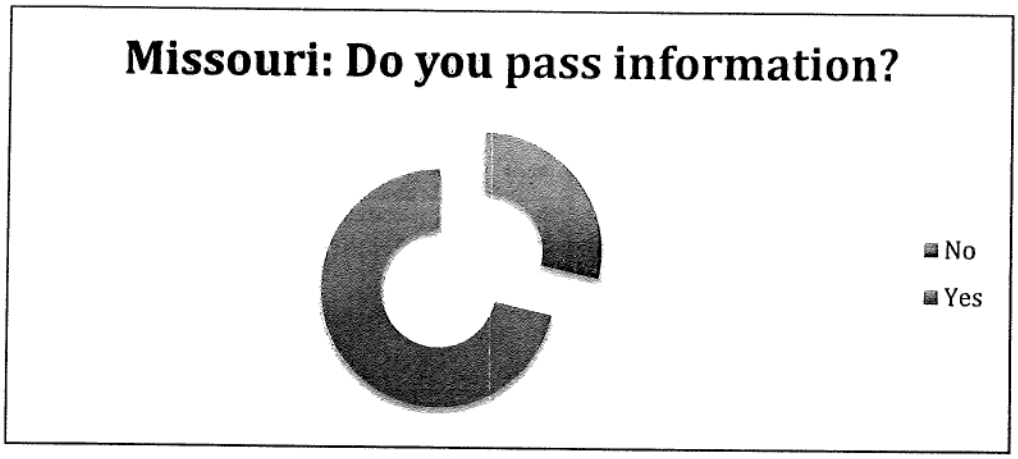

Figure 9. The chart below shows the composition of answers when Missouri respondents were asked if they give information to those involved with Drought Monitor discussions.

Section 3.5 - Government Response

The final research goal is to look at state government response to moderate and severe droughts affecting Oklahoma and Missouri. In the previous section, it was discovered that the

Missouri Mesonet was not directly followed at local levels as a drought monitoring resource as commonly as the Oklahoma Mesonet, but Oklahoma does not have as well connected groups when transferring information up from the local level.

One element of government response is Oklahoma's lack of drought plan implementation discussed in section one. Although Missouri government response followed their state drought plan very well, Oklahoma officials are aware of the fact the drought plan was not used during the last drought, but agencies are well connected enough that government drought response was not hindered. Agencies still communicated effectively and were able to let people, such as agency and legislative leaders, know how the drought situation was evolving and changing in severity.

One way Oklahoma state government improves response is through updating public water systems before a drought occurs. According to one person interviewed, the state, through the Oklahoma Water Resources Board, gives loans and grants earmarked to improve water systems. Investing in infrastructure helps replace wasteful or inefficient system, so during a drought event, a city's access to water might last longer than it would have before the system upgrade.

Another component to state government response is tied to federal funding. One agency director stated the state agriculture departments cannot apply for federal financial aid until the state sees a 30% crop loss or reduction in rainfall. The state is unable to provide financial assistance until the threshold is reached delaying assistance during early stages of drought.

While state government is important, local government is also valuable. Many times local government is in charge of water supply systems and storm water management. Twenty percent of those responding to the survey considered themselves to be "local government." An interesting find from the survey responses was that eight of the nine local government responses

had not received any training with weather, climate, or fire in the last three years. Sixty-seven percent of the local government group worked in a city of at least 5,000 people and one of those came from a city with a population of 30,000.

It is interesting that so many responses came from local government, because that is not a group that was targeted for this research. Surveys were given to people in charge of statewide list serves for conservation, agriculture, water resources, and emergency management. When the local government groups were asked if they considered any individuals to be a drought authority, only two of the nine listed an agency, but interestingly all three state government responses were able to list at least one state group they considered to be a drought authority. The survey asked people where they would go to get more information if they wanted it, and out of local government responses four mentioned the internet or state agency information, one person said he would prefer a seminar or class training (this was one of the untrained in climate, weather, and fire). One response said that drought is a natural phenomenon in the hands of God Almighty, and no amount of research or education would change that. Lastly, five of the nine responders were responsible for maintaining their local water supply, but only 33% of them were familiar with the Drought Monitor.

Overall, people were pleased with state government response. Each state does what it thinks is best to help individuals through drought times. One area government response might be added to would be within the local government sector. Many people in this sector are in charge of city water supply systems, but very few have weather and climate training and may not be aware of contacts for information or resources like the Drought Monitor.

Chapter 4 - Recommendations and Summary

The first recommendation would be for the State of Oklahoma to improve the state's

drought plan. Now, this is obviously easier said than done for mainly two reasons. During distressed state economic times, employees leave and no one is hired to fill their positions, leaving more work for those remaining behind. Finding people who have the time and knowledge of networks and protocol is difficult when state agencies are under staffed. In addition to lack of personnel, the perceived need to update is low. While the state has low stress drought situations, the need is low. During severe drought (i.e. 2005-2006), the state managed drought without a plan, so there is no urgency to update the existing plan. But, as states look towards developing climate adaptation plans, updating drought plans might be a good manual on strategy and organization. Also, the Oklahoma Water Resources Board is in the process of updating its comprehensive water plan for the entire state. After this is complete in 2011, information outlining regional water supplies and secondary water supplies could be a useful addition in an updated drought plan. While the state has a strong focus on assessing water resources, now might be an opportune time to address its drought plan. If it is completed before a severe drought evolves, legislators and state agency leaders could be more willing to approve the use of a new state drought plan.

The next recommendation is for state officials to reach out more to city government. The survey results indicated that several local government officials have important roles like managing a city's water supply, but only one had any training in weather, climate or fire within the last three years. The Oklahoma Climatological Survey (OCS) has a program called OK-First, which allows it to train public safety officials about weather and climate (Oklahoma Climatological Survey). Perhaps either OCS or a combination of groups could create a program called OK-Local in order to help reach two goals. First, local governments have the opportunity to be more involved with the drought impact reporting if they know whom to contact so that state

agencies can better represent local counties in their assessments. Secondly, local governments might become more educated in understanding drought triggers and recognizing long-term weather patterns potentially affecting local water availability. The low training rate of those in Oklahoma who consider themselves to be involved with local government could be positively influenced through increasing contact connections between agencies and local government while also increasing weather and climate training opportunities.

Drought is in the eye of the beholder. An agronomist thinks drought means lack of rainfall for a short period of time. The conservationist looks for precipitation and temperature ranges over a two-month period, and the water manager uses lake and reservoir levels to understand drought. This study attempts to analyze Missouri and Oklahoma drought management.

Drought theories attempt to help people understand processes occurring with drought policy and planning. First, rational choice helps one understand the drought plan process. Rational actors with limited information and time help create a plan for a collective group and a collective goal – water – without elimination of choices. Incrementalism explains the frequency of drought operations. As the drought worsens, people begin to monitor more frequently, but as the drought decreases in intensity, people do not monitor as much, like a bell-shaped curve. Punctuated equilibrium expounds why policy is sometimes not developed in an incrementalism-like fashion, such as drought plan policy. Drought policy is passed with a frequency matching a step function. State officials create policy after a drought using lessons learned during the previous drought. Then, nothing changes in a state's plan until the next drought event. Once flaws are found after a new event takes place, policy is updated. In other words, updates are not added to a drought plan in small increments each year, but instead updates are event-driven.

Finally, the multiple streams theory helps us understand that all three streams of why state drought plans are updated. The theory contains three streams: a problem stream or a standing drought, a policy stream or solutions to help management the drought, and a politics stream, which consists of political will. Multiple streams theory explains that all three streams of problems (a drought event), policy (solutions) and politics (political will) must merge in order for action to occur.

This study has four research goals: compare and contrast the state drought plans, understand drought triggers and barriers to sound decisions, discover gaps in drought management across the states, and finally look at government response in the states.

Data was collected in two sets. First, ten interviews were taken in person and over the phone from people who worked at state agencies impacted by drought. In addition, 300 surveys were sent out to those with occupations directly affected by drought such as conservation groups, agriculture, water management, and emergency management. Forty-four survey responses were collected in Oklahoma and Missouri. These surveys were used to assess how those in the local areas were receiving drought information and how information was dispersed.

First, this study analyzed state drought plans. Both the Missouri and the Oklahoma state drought plans follow the same patterns of response. Each state gleaned information from the National Drought Mitigation Center giving them similar organization, but the plans still have differences. Each plan has committees informing the governor, and each has a four-phased approach to increasing severity of drought. However, in 2006, during the last severe drought, Missouri followed the steps in their drought plan, while Oklahoma did not (Sandbo et al. 2008). Oklahoma's plan was not utilized largely due to the fact that many of the communication measures were arduous and completed in other ways not listed in the plan.

Secondly, as a result of the survey responses, drought triggers appear to be different throughout each sector of drought management. Those with water management tend to look at lake and reservoir levels, and a farmer finds a trigger in a shorter term.

Another goal was to analyze what people use to understand drought severity and the gap currently existing with products. It was found that some survey respondents feel unrepresented in national maps. Another gap was whether or not people feel there are drought authorities within the state. Only 11% percent in Missouri who answered the question felt they did not feel drought authorities existed, but 42% of survey respondents in Oklahoma either said there were no drought authorities or they were not sure if there were drought authorities. Through the results of the surveys, it appears Missouri does a better job of linking drought officials

The last goal of the research was to analyze government response. Ultimately, states are doing what they think is best. Even though Oklahoma did not use their drought plan, agencies were able to work better and more effectively without it. But the biggest focus should be on those within local government. Out of those who responded to the survey, five of the nine were responsible for a public water supply, but only one has had training in the last three years regarding weather, climate, or fire. Only 33% of those considering themselves in local government were familiar with the U.S. Drought Monitor. Training in this sector has the potential to open more lines of communication giving state officials more information from the local level and giving locals information about additional resources.

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Appendix A

The interview guide used during the telephone and in-person interviews and the online survey sent to about 300 Oklahoma and Missouri local officials are attached in the section.

Survey of Local Drought Management in Oklahoma and Missouri

PART 1: EMPLOYMENT AND EXPERTISE

I'd like to begin with some background on your role in drought monitoring or management in (Oklahoma / Missouri).

Q1: Please specify if you work for one of the following organizations:

_____ Conservation District

_____ Oklahoma Cooperative Extension Service

_____ Farm Service Agency

_____ Agricultural Producer (Farmer, Rancher, etc)

_____ Water Management

_____ Emergency Management / Public Safety

_____ Local Government (City, County)

_____ Tribal Government

_____ State Government

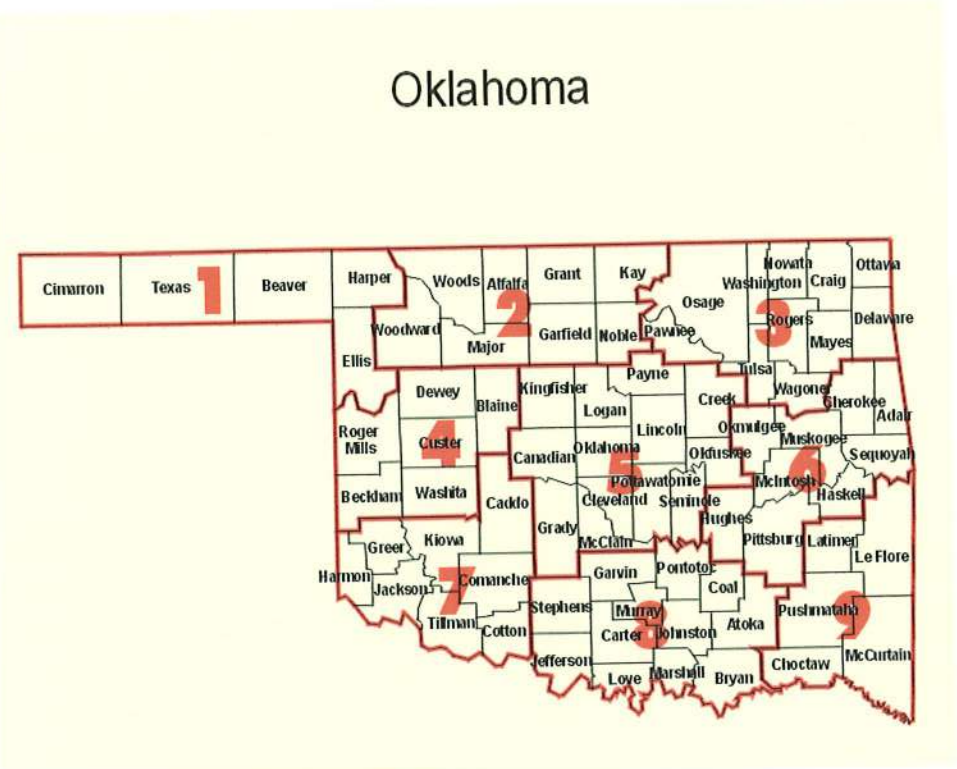
_____ Other: Please Specify _____

Q2: How many years experience do you have with your current job?

Q3: In which state do you work? (Oklahoma / Missouri)

If "Oklahoma", proceed to Q4; if "Missouri" proceed to Q5

Q4: In which region do you work? (then proceed to Q6)



Q5: In which region do you work?

Q6: What is the population of your town? If you live in the country, what is the population of the town closest to you?
-less than 1000
-1,000-4,999
-5,000-29,999
-30,000-99,999
-100,000 or greater

Q7: Have you received any training dealing with weather, climate, or fire within the last 3 years? Examples are classes (either online or in person) about climate change, fire prevention, and severe weather training? (yes/no)

Q8: If yes, what type of training did you receive?

Q9: Do you have any formal role in drought management (such as determining water rationing or monitoring indices)? (yes/no)

Q10: If yes, please elaborate on your responsibilities:

PART 2: YOUR PERCEPTIONS OF DROUGHT

The next few questions relate to how you think drought affects your community.

Q11: When you hear the word "drought", what comes to your mind?

Q12: How do you know when you are entering a drought?

Q13: How is your community affected by drought?

Q14: Are there any particular groups, businesses, or geographical areas that are especially susceptible to drought?

Q15: What is the worst drought you can recall? What were some associated impacts on your community?

Q16: If you wanted to learn more about drought, how would you go about doing that?

PART 3: MONITORING AND COMMUNICATION

The next series of questions ask how you and your community monitor and relay information about drought.

Q17: Do you or others in your organization conduct your own assessments of drought severity or drought indicators? (yes/no/not sure) (If No or Not Sure skip to Q29)

Q18: DURING DROUGHT, how frequently do you monitor the following indicators?

	Nearly Daily	About Once A Week	Once Every 2-3 Weeks	About Monthly	Seasonally	Not At All
Palmer Drought Index						
Standardized Precipitation Index						
Keetch-Byram Drought Index						
U.S. Drought Monitor						
Drought or Seasonal Outlooks						
Precipitation Departures						
Reservoir / Lake Levels						
Stream Flow						
Snowpack						
Soil Moisture						
Groundwater / Wells						
Crop Conditions						
Water Use / Consumption						
Burn Ban Status						

Q19: For the indicators that you use most frequently were most important to you for drought monitoring, what characteristics make these sources important to you?

Q20: Are there characteristics of other sources of drought information that make them difficult to use? Please explain.

Q21: Can information on drought be located easily or is it hard to find?

Q22: Is information on drought user-friendly? (i.e. Are figures and text presented in a clear and understandable manner?) If no, what information would you like improved?

Q23: If all were easily available, how important would they be?

	Very Important	Somewhat Important	Not At All Important	Not Relevant
Palmer Drought Index				
Standardized Precipitation Index				
Keetch-Byram Drought Index				
U.S. Drought Monitor				
Drought or Seasonal Outlooks				
Precipitation Departures				
Reservoir / Lake Levels				
Stream Flow				
Snowpack				
Soil Moisture				
Groundwater / Wells				
Crop Conditions				

Water Use / Consumption
Burn Ban Status

Q24: What specific triggers do you use to spur action? Please describe all triggers you use (such as daily water use exceeding 15 million gallons).

Q25: DURING NORMAL to WET times, how frequently do you monitor the following indicators?

	Nearly Daily	About Once A Week	Once Every 2-3 Weeks	About Monthly	Seasonally	Not At All
Palmer Drought Index						
Standardized Precipitation Index						
Keetch-Byram Drought Index						
U.S. Drought Monitor						
Drought or Seasonal Outlooks						
Precipitation Departures						
Reservoir / Lake Levels						
Stream Flow						
Snowpack						
Soil Moisture						
Groundwater / Wells						
Crop Conditions						
Water Use / Consumption						
Burn Ban Status						

Q26: Which of the following websites or organizations do you consult to get your information? Choose all that apply.

-US Drought Portal
-National Drought Mitigation Center
-National Climate Data Center
-Climate Prediction Center
-US Geological Survey
-Corps of Engineers
-Bureau of Reclamation
-National Weather Service
-Private companies
-U.S. Department of Agriculture (USDA)
- State/Local Conservation District
-Media (national and local)
-State Climate Office
-Regional Climate Center
-Automated weather networks (state Mesonets)
-Agricultural Statistics Service
-State water resources bulletin
-Universities
-Other

Q27: DURING DROUGHT, how frequently do you monitor or consult with the following organizations?

	Nearly Daily	About Once A Week	Once Every 2-3 Weeks	About Monthly	Seasonally	Not At All
Governor's Office						

Emergency Management (state or local)
State Water Resources Agency
State Agriculture Department
State Environmental Protection Agency
Conservation Districts (state or local)
National Weather Service
State Climate Office
NIDIS / US Drought Portal
National Drought Mitigation Center
National Climatic Data Center
Regional Climate Center

Q28: DURING NORMAL to WET times, how frequently do you monitor or consult with the following organizations?

	Nearly Daily	About Once A Week	Once Every 2-3 Weeks	About Monthly	Seasonally	Not At All
Governor's Office						
Emergency Management (state or local)						
State Water Resources Agency						
State Agriculture Department						
State Environmental Protection Agency						
Conservation Districts (state or local)						
National Weather Service						
State Climate Office						
NIDIS / US Drought Portal						
National Drought Mitigation Center						
National Climatic Data Center						
Regional Climate Center						

Q29: Do you receive any kind of drought status notification from other individuals or agencies?

Q30: Is there any sort of routine status message provided to you, such as a monthly or weekly notice of drought conditions, including an "all clear"?

Q31: When you become aware of or are alerted to drought, what do you do with that information?

Q32: Do you communicate drought status to other individuals, organizations, or city or county agencies?

Q33: If you wanted to reach the general public in your community, how would you contact them? (check all that apply)

- press release / newspaper
- television
- radio
- message on website
- newsletter
- e-mail
- direct mail
- mailer, such as a utility bill insert
- town hall meeting
- phone calls / personal contact
- other (please specify):

Q34: Do you provide any written materials to the community about water conservation or thresholds for actions?

Q35: Do you hold any community forums on water issues or discuss water issues at association meetings? (yes/no) (if no, skip to Q39)

Q36: If yes, how often do you hold such meetings?

Q37: In what kinds of venues are meetings held?
- town / city hall
- public library
- school, college or other academic institution
- other:

Q38: How many are typically in attendance?

Q39: Are there specific individuals whom you regard as drought authorities in your state?

Q40: If you suspected there were some emerging drought issues in a particular county or region, whom would you contact to investigate?

Q41: Are you familiar with the Drought Monitor? (yes/no) (if no, skip to Q44)

Q42: If yes, do you know state or local people who participate in Drought Monitor discussions?

Q43: Do you provide any comments to authors or other officials involved in the process?

PART 4: DROUGHT PLANS

Thank you for your patience. We are nearly done. First, a few questions about drought planning.

Q44: Does your community have a drought response plan? (Yes / No / Not Sure) (if no or not sure, skip to Q56)

Q45: Are you familiar with your community's drought plan? (Yes / No) (if no, skip to Q56)

Q46: How important do you think the following goals are in your community's drought plan?

	Critically Important	Very Important	Somewhat Important	Not Very Important	Not Applicable
Protecting municipal water supplies					
Maintaining lake levels / river levels for tourism / recreation					
Assuring agri-business has sufficient supplies					
Assuring local businesses / industry have sufficient supplies					
Power generation					
Ecosystem maintenance					

Q47: Do you think there is a disconnect between what the plan prepares for and what the community actually needs? Are there examples of the disconnect?

Q48: Do you think your plan is consistent with your state's drought plan? (yes/no)

Q49: Are you aware of any ideas that may have been discussed during the plan's creation that were not included in the plan? (yes/no) (if no, skip to Q52)

Q50: What were those ideas?

Q51: What constraints may have prevented them from being included in the final plan?

Q52: Has your community experienced a severe drought since the plan was enacted? (yes/no) (if no, skip to Q56)

Q53: Overall, do you think your plan worked well (yes / no / not sure)?

Q54: What aspects worked the best?

Q55: What recommendations do you have for improving the plan?

PART 5: GENERAL COMMENTS

Finally, just an opportunity for you to tell us things we may not have considered when preparing this survey.

Q56: What information about drought would you like to have that isn't presently available?

Q57: Are there any other important factors to you when it comes to monitoring drought that were not included in this survey? Please explain.

Interview Guide for Drought Managers in Oklahoma and Missouri

YOUR ROLE IN DROUGHT MANAGEMENT

I'd like to begin with some background on your role in drought monitoring or management in (Oklahoma / Missouri). How are you involved in the process?

What specific organizations do you use as sources of drought information? Please describe how you use the information from each organization.

Do you, or others in your organization, conduct your own assessments of drought severity or drought indicators? If so, what are your sources?

Do you directly examine the information or do you delegate the responsibility to others?

Are there specific individuals whom you regard as drought authorities in your state?

If you suspected there were some emerging drought issues in a particular county or region, whom would you contact to investigate?

Do you look at the U.S. Drought Monitor on a regular basis? If so, do you use a website to access it or do you receive it via e-mail or newsletter from others? If you access it via a website, what is the source (NDMC, drought.gov, another state agency)?

Do you discuss, notify, or otherwise communicate drought information to others? If so, whom and how?

If a drought develops in your state, are you engaged with the Governor's Office in assessing and managing the event? If so, what is your role?

During the most recent severe drought episodes in (Oklahoma / Missouri), how often were you involved in drought management activities with the Governor's Office (daily basis, weekly, monthly, only once or twice...)?

STATE DROUGHT PLAN

Were you involved in the most recent update to your state's drought plan (OK=1996; MO=2001)? If so, what was your role?

What was it that spurred your state to make a drought plan?

-your state underwent a severe drought
-another state underwent a severe drought (if yes, which state?)
-your state's lawmakers wanted to produce a drought plan
-another state prepared a drought plan and there was pressure to produce one for your state
-your state recognized a need without having to deal with a recent drought
-other reasons:

Was there adequate drought information to develop and implement the drought plan?

Would you characterize your state's drought plans as geared towards drought mitigation or response? Do you think the current emphasis is the best approach for addressing drought in your state? Why?

Some state drought plans are geared toward protecting municipal water while other states focus on tourism or agriculture. What does your state focus on? Do you think there is a disconnect between what the plan prepares for and what the state actually needs? What are some examples of this?

Did you adopt other measures from other states in either your state's drought plan or your monitoring or management guidelines?

Were there ideas for drought plans you were forced to leave on the table? What were the ideas and what were the constraints?

If you have had a severe drought since the plans have been enacted, did the appropriate authorities follow the guidelines of your state's drought plan? (yes / no / haven't had a severe drought) ?

If yes, how well do you think the plan performed? Do you have suggestions for improvements?

If no, do you feel that the drought was managed better or worse than it would have been if the plan had been followed? Why?

Do you think the state's drought plan is adequate? If yes, what characteristics make it work so well?

What recommendations would you make for improving your state's drought plan?

PERSONAL COMMUNICATION (agency staff / committees)

The next few questions address personal communication you may have had with senior decision-makers.

Do you have direct, personal communication with individuals in policy-making capacities, such as senior officials in federal or state government or elected officials? (yes/no – if no, skip to next section)

If yes, whom (not necessarily specific names, but titles like Governor or Secretary)?

How did that contact originate?

What was the nature of the initial communication? (examples: a briefing on drought status, a board / commission meeting, asked for advice)

Do you maintain regular contact with that official or other policy-makers? (yes/no). If yes, how often do you communicate with him/her?

USE OF SCIENITIFIC INFORMATION:

Have you ever been contacted by or worked with anyone from the scientific community?

Are there any specific organizations that you use as sources of drought information? (yes/no). If yes, please describe how you use the information from each organization.

What characteristics make these sources important to you? (look for words like credibility, trust, relationship, understand information)

Are there characteristics of other sources that make them difficult for you to use? (look for phrases like 'don't know how to contact them', 'information doesn't match my needs', 'I can't understand the information')

Do you have direct, personal communication with individuals conducting research on drought? (yes/no)

If yes, how did that contact originate? (Select the answer that best describes the situation.)

☐ I approached the individual or his/her staff

☐ The individual or his/her staff contacted me

☐ The individual and I were at a common meeting

☐ The conversation occurred in the context of a task force / study meeting

☐ Other: _____

Do you think that scientists make adequate efforts to provide you with useable information?

Is information on drought accessible? Understandable?

Does it matter if information has been peer-reviewed by members of the scientific community?

Would you rather have information as bullet points or executive summaries, or would you rather have information elaborated with more detail, including caveats and uncertainties behind the information presented?

Do you find a detailed assessment difficult to understand? To apply?

This concludes the interview. Thank you for your participation in this project.