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THE ROLE OF INTERMEDIARY ORGANIZATIONS AND KNOWLEDGE COMMUNITIES IN BRIDGING BARRIERS

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1. ABSTRACT

Does a cultural divide separate scientists from the broader community in which they live? This concept, proposed by C.P. Snow in 1959, has driven studies and reform movements within the scientific community for more than two decades. Calls to make science more relevant and to bridge barriers have been made. The study described here addresses this cultural divide in the context of drought policy. Its goal is to examine whether such a cultural divide exists and if so, what mechanisms facilitate interaction across this divide.

This study was conducted between the summer of 2004 and spring of 2005. More than fifty individuals, representing both the scientific and state-level policy communities, were interviewed. Questions focused upon how scientists conducted and communicated their research, and information sources upon which policy-makers draw for advice on creating state drought plans. The study used a communications model, consisting of a producer (scientists), a message, and a receptor (policy-makers). The two cultures barrier did not seem to be a significant factor in this process. While little direct communication between scientists and top policy-makers was found, routine communication at lower levels of state organizations assured the effective flow of information into the policy planning process. Drought and climate information was communicated effectively to the policy community and utilized appropriately in creating or updating state-level drought plans.

An additional component, intermediary organizations that help to integrate and reformat information, is included. Findings suggest that these intermediary organizations are a key component in facilitating interaction between the two communities. Scientists, intermediary organizations, and technical staff from state agencies operate together in knowledge communities, in which information is shared for development of state policy.

2. TWO CULTURES

People engaged in scientific research are, in general, distinctly different than those involved in other endeavors (Snow 1964; Kuhn 1962). Thomas Kuhn describes the mode of scientific research as 'puzzle-solving'. Scientific research is designed largely to prove what already is known. Many of the big problems on which scientists work involve designing methods or tools for the purpose of testing theories. They operate within a paradigm – a set of theories that represent a shared belief among the community and an associated set of methods for testing those theories. Paradigms may operate on different scales, ranging from grand theories of Newton or Einstein to paradigms that define what is known among sub-disciplines like biogenetics.

In contrast to the mode of scientific research, the policy process is more chaotic. It does not have the luxury of time or attention to make such exhaustive data collection and analysis. Decisions often must be made with whatever information is at hand, sometimes with only a cursory analysis of any supporting data. The policy process involves key decision points and timetables that are set by human needs.

In the policy-making process, perceptions and values carry equal weight to objective data. Conclusions are drawn from personal observations and interpretation of events rather than from objective data. Problems arise from circumstances, such as perceived needs, rather than sequentially following from a broad theory. Perceptions affect how a problems is defined, which in turn affects alternatives that may be under consideration (Rochefort and Cobb 1994).

Because problems in the political arena are not amenable to scientific paradigms and require value judgments, scientists have preferred to stop at the water's edge, leaving application of their findings to others, whether that be in policy or in commercial enterprises. This is what Freudenburg (1996, p. 44) means when he states: "scientists have made remarkable progress in dealing with technical challenges, but not in dealing with society."

Part of the reason for the separation of scientists from policy is what Snow (1964) called the two cultures syndrome. Snow, a physicist by education, noted a distinct difference between scientists and what he termed the traditional culture. He documented differences in perceptions, approaches to problems, outlooks on life, and even language between the two dominant cultures. The differences were so vast that it resulted in "two groups, comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who had almost ceased to communicate at all." (p. 2). While the difference may not be so vast as Snow identified, others have noted a predisposition among scientists to stay away from political involvement (e.g., Morin 1993; Shapely and Roy 1985).

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The lack of understanding leads to mutual incomprehension. Snow argues that without a common culture, the result is misinterpretation of the past, misjudgment of the present, and a denial of hope for the future. The middle ground is a meeting point where "creative chances" occur, but because the two cultures cannot communicate with each other, opportunity is squandered.

For most of the past five decades, relative separation between science and policy suited scientific research well. During the immediate post-World War II years, many of the problems to which scientists were asked to contribute were of a technical nature, such as building more effective military capabilities or putting a man on the moon. Scientific input was more a question of 'how' rather than 'what'. The 'postwar consensus' was based upon a fundamental assumption that research was separate from, but a necessary precondition, for development (Shapely and Roy 1985).

That line has become increasingly blurred over the last several decades. There are now fewer technical issues, which previously science could address in some degree of isolation. More problems are multi-disciplinary, reflecting a combination of natural sciences, economics, demographics, and human behavior. For example, Mileti (1999) cites a host of individual factors affecting preparedness and response to natural hazards that are beyond the scope of scientific knowledge. Socioeconomic status, age, race, gender, social relationships, and recent experiences with disasters are some of the factors that temper objective risk.

3. STUDY DESIGN

To test the two cultures theory, a study was designed using the area of state drought policy. Over the past several decades, the scientific community has developed a better understanding of the processes that contribute to drought, an ability to use computer models to estimate groundwater movement, and a variety of indices that give early indications of potential drought conditions. Thus, there is a great deal of information available to policy-makers engaged in drought planning activities.

From the scientific and technical standpoint, an extensive infrastructure has been built to enable policy-makers to access information with regards to drought. Organizations such as the National Drought Mitigation Center (NDMC) act as a clearinghouse for drought planning information. The development of the Drought Monitor, a weekly web-based publication that assesses drought conditions across the country (http://www.drought.unl.edu/dm/monitor.html), provides a tool by which operational decision-makers can closely monitor drought conditions. The Drought Monitor's associated e-mail discussion list provides a forum for the discussion of drought among the scientific community and key stakeholder communities.

The study consisted of three groups: a producer group of research scientists, an intermediary group of operational agencies that help convey information, and a consumer group of state drought policy-makers. Between the summer of 2004 and spring of 2005, telephone interviews were conducted with individuals representing each of these communities. The sample consisted of twenty individuals from the research scientist community (38% response rate), representing 18 institutions; 19 individuals representing the intermediaries (33% response rate) from 9 institutions; and 11 individuals representing 10 states (25% response rate). Fourteen of the research scientists were from academic institutions, with the remaining six from federal research laboratories. Seventeen of the 19 intermediaries were employed at federal agencies or national centers, with the other two from state climate offices.

The ten states included in the study were selected based upon having a new or updated drought management plan since 2000. This was to assure an enhanced likelihood that the solicited individuals had some involvement in the planning process and that the information that was available to them at the time of their state plan's update was reasonably similar. Prior to widespread use of the Internet and development of the Drought Monitor, some information may have been less accessible, and therefore not necessarily comparable to this cohort. States included in the study are shown in Table 1. Oklahoma was the only state included in the study whose plan predated 2000 due to its proximity to where the study was being conducted.

Interview guides were used to conduct each interview. For the producers group, questions focused on: (1) production of scientific reports; (2) personal communication with people in policy-making positions; (3) methods used to share information, both within the scientific community and with a broader audience, (4) research in which they were presently engaged, and (5) their perspectives on the use of scientific information by the policy community. Questions asked of the intermediaries group were identical to those of the producers, except that additional questions were added regarding (1) the sources of information that they used, and (2) processes used to integrate information from multiple sources. Because respondents from the intermediaries group primarily were engaged in operational aspects of drought and climate monitoring, research questions were often not asked unless pertinent. Because of the added questions, time did not often permit asking respondents to rate various forms of communication.

Experience gained from interviews of the scientists shaped questions asked of the policy-makers. Questions focused on the process of selecting information and the involvement of scientists in the drought planning process; they did not explicitly focus on specific policy options. Questions were asked in four areas: (1) the process of developing their state drought

Table 1. State drought plans included as case studies.

State	Year of Plan	Type of Plan	Initiated By	Revision	Reason for Update
Alabama	2004 (new)	Response	Agency	Not Required	Inefficiencies and conflict during drought
California	2000 (new)	Local	Governor	Not Required	Proactive measure sought by stakeholders
Hawaii	2004 (update)	Mitigation	Agency	5-Year	Outgrowth of state drought conference
Idaho	2001 (update)	Response	Agency	As Needed	Information from 1990 plan outdated
Kansas	2003 (new)	Response	Legislature	Annual Review	Media / public attention
Nebraska	2000 (update)	Mitigation	NDMC	Not Required	Include more mitigation measures
New Mexico	2003 (update)	Mitigation	Governor	Annual	Provide emergency assistance and improve planning during extended drought
Oklahoma	1996 (new)	Response	Governor	Not Required	Managing ongoing drought
South Carolina	2001 (update)	Response	Agency	Not Required	Experience from recent drought episodes, technology change, organizational restructuring
Texas	2001 (new)	Mitigation	Legislature	Biennial	Recent severe droughts, organizational structure, inventory of programs, assessment mechanisms and timely information

plan; (2) organizational sources of information; (3) the utility and preferred format of scientific information; and (4) how the individual became involved in drought management (if applicable). Detailed questions regarding communications methods, such as the relative importance of journals, media, or e-mail, were dropped due to time constraints on most interviews.

After interviews were completed with the producers and intermediaries groups, follow-up questions were asked of the respondents via e-mail. These questions were to allow for a direct comparison of perspectives between the two groups, with regard to their involvement with policy-makers. Fourteen of the 20 producers and 10 of the 19 intermediaries responded to the follow-up e-mail questionnaire.

4. THE SCIENCE COMMUNITY

There were many similarities between research scientists and intermediaries, as might be expected from the two cultures theory. Within the group, there are shared backgrounds and experience that develop a similar perspective. Both the research scientists and those working in intermediary organizations were positively pre-disposed toward encouraging utilization of their research beyond the scientific community. Both generally favored similar mechanisms for conveying information, although targets for involvement and degree of interaction varied. Perhaps surprisingly, research scientists were directly engaged, and in many cases at a higher degree of personal interaction, than those in intermediary organizations. However, research scientists' engagement tended to be toward individuals at lower levels of organizations rather than with senior policy-making officials.

Mostly communication occurred along pre-existing organizational channels. For example, if a state water management agency director were seeking input, he might contact others within his organization, who might then contact an individual at a university-based research center that collaborated closely in the past on other issues below the scope of senior management. Sometimes, however, this communication can occur because of the scientists placing themselves in an external setting. Attending Chamber of Commerce breakfasts and interacting with civic clubs place scientists in a forum where they are likely to meet elected officials or other local policy-makers. Sometimes even chance meetings, such as conducting field work, will present opportunities for scientists and policy-makers to cross paths.

4.1 Preferred Methods of Communication

Five categories of communication emerged from the interviews (in order of importance): one-on-one or small-group encounters, meetings, collaborative activities, written communication, and indirect communication.

All research scientists rated personal contact as either very useful (15 respondents) or somewhat useful (5 respondents). Direct contact includes one-time responses to requests for information, personal conversations (either individually or in small groups), and briefings. Responding to requests for information is one means by which communication channels may be established. Communication may be a one-time or ongoing occurrence, depending upon the circumstances. Relationships cultivated through these interactions may open conduits useful for relaying information at a later date. Contact is generated by the policy-maker about as frequently as it is by the scientist.

Meetings were rated as very useful by 16 of the research scientists. Meetings include scientific conferences and meetings sponsored by a state or federal agency, but also public presentations, tours, and internal seminars. Scientific meetings generally were not seen as a way to reach policy-makers, but most respondents found them very useful with regards to information exchange among scientists. Public presentations were mentioned as a means of reaching a diverse audience, sometimes leading to follow-up direct communication.

None of the structured interview questions focused specifically on collaborative activities, but from responses it was clearly important. Collaborative activities may include internal, programmatic activities or external involvement in organizations, boards, and planning activities. It can be as simple as collaborating with a colleague who is externally-focused or serving on a board of a professional society. More direct interaction with policy-makers comes through involvement in local organizations, participation on government-sponsored panels, boards, or task forces, and partaking in large projects whose goal is to transfer scientific knowledge into operations.

Journals, reports, and books are written methods mentioned by respondents as ways in which they communicate with others. Some of these techniques are aimed at other members of the scientific community, but some methods are designed with non-scientists in mind. In general, journals were not a prominent means of communication among scientists from operational agencies. Most noted they had little time to read journals, much less publish in them. Scientists in the intermediaries group were more likely to write and present conference papers, where they would be in a more interactive environment.

Reports tended to focus on assessments, and rarely offered guidance to policy-makers. Assessments included state-of-the-research in a subject area, analysis of climate and trends, and overviews of the performance of drought indices. Those who engaged in policy-relevant recommendations typically targeted reports toward local decision-makers rather than top-policy makers specifically, although not in every case. Reports included detailed assessments, white papers, and routine status reports (“grab and go documents”). Respondents mentioned difficulties in locating reports, mentioning that many are “obscure and hard to get at.”

Indirect communication was viewed as overall the least effective means of communication. Websites and media were viewed most positively, followed by e-mail and direct mail. Many responses related to websites centered around the difficulties in sorting out the good ones from the bad ones. Just as they can be a good vehicle for disseminating information, they can be an equally good vehicle for disseminating misinformation. Like reports, finding them was difficult, but websites were mentioned as a useful tool for directing people to further information once contact had been initiated through other channels.

Media was viewed similarly to websites, being a conduit for both good and bad information. Respondents mentioned using the media as a “highlighter” for questions that are on the public conscience. Media, if managed effectively, can be a good vehicle for broad dissemination of a message. A single interview may be copied in other publications.

Overall, e-mail was generally viewed as an important means for communication among scientists, although the volume of mail could be overwhelming. Even though e-mail may not reach policy-makers directly, it has proven an effective means for delivering information to state agency officials who can then feed information upward through their organizations or state drought task forces, ultimately reaching the policy-makers. A prime example is the Drought Monitor’s “exploder” list, which includes both scientists and state agency staff charged with monitoring drought conditions in their respective states. Through ongoing discussions of drought status, participants on the list share ideas and discuss new research. In the process, somebody almost invariably will provide a summary of relevant articles or reports, making those publications accessible to a wider audience. The Drought Monitor was described as “both a process and a product, and the process is the discussion that takes place prior to its issuance.”

4.2 Interaction in the Policy Process

Views of the policy process were mixed. Some scientists believed that scientific information was manipulated to support pre-determined decisions, while others thought that information was used appropriately. Most striking, however, was that those who viewed the process negatively were not necessarily disengaged from the process. A positive view of the process did not guarantee engagement either. One might expect that

Table 2. Scientists' modes of involvement with policy-makers according to perceptions of use and level of engagement.

Expectations	Style of Engagement	
	Active	**Passive**
Information Used / Interpreted Correctly	Collaborators	Consultants
Information misused / misinterpreted	Educators	Critics

scientists holding a more preferential view of policy-makers may be more likely to be engaged in the process than those who view policy-makers' motives with skepticism, but this was not always the case. Some who view policy-makers in a negative way are nonetheless engaged in the process, trying to improve it despite its problems. Others who view policy-makers positively choose not to be engaged, often letting results "speak for themselves." These dimensions lead to four different roles of scientists: collaborators, consultants, educators, and critics (Table 2).

Collaborators are those who have positive expectations and are actively engaged. They are most likely to be involved in state drought task forces, work directly with state or federal officials, or participate in other hands-on types of activities where they routinely interact with policy-makers or those who have access to policy-makers on a routine basis. Collaborators usually take a long-term perspective of the process and will remain engaged and available over an extended period of time. Collaborators recognize the need to shape information so that it is useable by different communities. Respondents from this group mentioned terms like context, ambiguity, filter, and translate. They recognized the demands on the time of policy-makers and the necessity to condense information.

Those who have positive expectations but are not actively engaged with the process can be considered consultants. These scientists see their role as limited to the production of knowledge and responding to others when called upon. Reasons for detachment include philosophical concepts of the role of science, time or resource constraints, or a preference to leave applications to others. Scientists in this group may interact indirectly through colleagues, most likely within their organizations, who are actively engaged with policy-makers. An example is a university faculty member who discusses her research and views regularly with another faculty member who is the state climatologist.

Those who have negative expectations of the policy process but are actively engaged fall into the category of educators. Rather than eschew the process, educators seek to improve the process, either through direct interaction or through affecting the general environment in which the discussion takes place. Scientists from this group may use methods such as the media or the Internet to call attention to misuse or misinterpretation of scientific information. Educators believe that, while many policy-makers may misuse scientific information, there are some who are willing to invest the time to learn about scientific issues and apply the information properly. Outreach programs are a primary method used to interact outside of the science community, providing both an opportunity for training and a vehicle for transmitting information. Like collaborators, educators also take a long-term view of the process, and attempt to foster relationships over an extended period of time.

Critics tend to concentrate their time and efforts on communication within the scientific community. Whether it is because they are busy or because they do not believe information will be used properly by policy-makers, they find more rewards in professional publications, interacting at scientific conferences, and conducting research. The extent of their involvement is primarily through professional societies.

All four roles were evident in each of the two groups of interviews. Research scientists from the producers group seemed to exhibit more characteristics associated with consultants, namely a generally positive disposition toward policy-makers but a preference for providing information and not interpretation. Intermediaries generally exhibited more skepticism of policy-makers, but were more likely to be engaged in the process, suggesting a preference toward the educator role.

4.3 Barriers to Involvement

What is particularly stunning is that all of this effort to communicate with policy-makers occurs not just without organizational support, but in many cases in spite of organizational barriers. Scientists working in federal facilities are, in many cases, actively discouraged from publishing information for use by policy-makers. Scientists in universities often face a system that rewards professional publications, but places little value on interaction beyond the peer-review system. Some professional societies hold policy forums, but reports from these usually offer a state-of-the-science overview with some recommendations for further research. Although individual scientists find means of reaching policy-makers, the lack of institutional support limits the ability for science as a body to engage policy-makers: "the institutional issues are important; they determine the shape of the possible solutions."

5. THE POLICY COMMUNITY

The backgrounds of the policy respondents varied considerably. Most had some technical backgrounds, and those who didn't learned through years of experience. Backgrounds represented included meteorology, climatology, geography, business, journalism, hydrology, and forestry. One described having come into the drought management position "not knowing a whole lot about drought," but through participation in NDMC-hosted meetings and reading reports, the individual quickly became sufficiently familiar with the subject.

Overall, the policy-makers cohort in this study exhibited few problems with accessing, understanding, or applying scientific information. Some described a learning-curve when they became involved in drought planning, but even those with less technical backgrounds were able to utilize the scientific information that was available to them. Most were quite trusting of the advice they received from the scientific community. Information from sources such as the National Drought Mitigation Center and other state drought plans were frequently mentioned as useful.

Respondents were mixed on preferences for summarized information versus detailed reports. Some officials preferred having details to examine substantiating information and justification for recommended actions. Others "would definitely take the scientific word" if time did not permit a more thorough evaluation of information. All mentioned wanting access to a detailed report, even if they did not have time to read it. One respondent said that in the early stages of becoming a drought manager, detailed information was more important, but as comfort levels increased, summarized information was easier to use.

5.1 Drought Roles

Involvement in drought policy could be characterized as drought advisors, drought managers, or agency leaders. Drought advisors are scientists who have formal roles in the policy-making process, but lack authority to implement the policy. These are often individuals from university-based centers or federal agencies. Most often, these members serve on monitoring groups and synthesize information on drought status for the state drought committee. While they may lack authority in directly creating policy, they serve in an influential role in which they could certainly advise those who are drafting the policies.

Drought managers are more directly immersed in the process, and often work within the agency tasked with the responsibilities for responding to drought. They usually, but not always, have technical backgrounds. These individuals are the ones who are usually tasked with reporting on drought conditions, coordinating responses among agencies, and keeping the plan up to date.

Agency leaders are senior officials in agencies directly affected by drought, including water resources, agriculture, and emergency management. Their primary role is one of critical review, delegating most authority for planning to lower levels of their organizations. These individuals do take an active interest in the process and during drought episodes will become a primary conduit for the flow of information to their state's executive and legislative leaders.

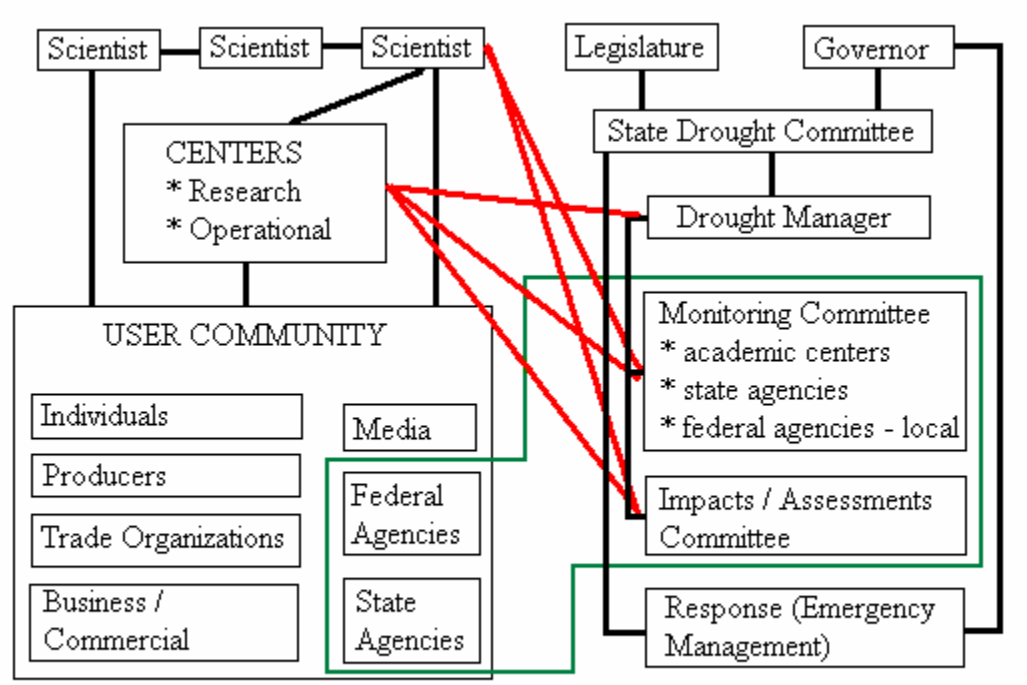
5.2 Structure of Information Flow

The process by which drought planning generally occurs is that the need for planning is passed down from state officials, through agency leaders, to a drought manager or task committee. One or more individuals on the task committee then recruit scientists, mostly from within the state or federal agencies with local offices, to the committees. The committees and/or drought managers review a variety of scientific information to develop a plan appropriate for the state. The plan is then presented to the main task force / coordinating committee, which is then typically forwarded to the Governor or state legislature for approval. Thus, while the people charged with policy-making may not actively evaluate scientific information, trusted staff members within their agencies do so on their behalf. Generally recommendations are accepted, and a scientific basis for recommendations appears to be an asset.

Respondents commented that scientists made "every effort" to provide officials with useable information. Sources such as task committees were able to evaluate scientific information and develop relevant recommendations for inclusion into state drought policies. In some cases, officials either established an ongoing dialogue with scientists or were able to use existing communication channels to retrieve information. Local sources of expertise were mentioned as quite useful in the planning process: "whatever we needed they would do their best, and I mean in some cases with limited funding."

A conceptual diagram of the information flow between the science community and the drought policy community is shown in Figure 1. The scientific community is represented on the left side of the diagram. The black lines indicate channels of communication within the science community. Individual scientists share information among themselves through established communication channels, including journal articles and scientific conferences. Some, but not all, of the scientists have direct links to user groups or science-based centers, such as the NDMC or NOAA organizations. Contact between scientists and user groups are typically either initiated by the scientist through venues such as outreach programs or general services which are mostly responses to information requests originating from members of the user community.

Figure 1. Linkages between the scientific and drought policy communities. The scientific community is depicted on the left side and the state drought policy community on the right. Communication channels are shown by the solid lines and overlapping groups shown within the green box.



On the right side of the diagram is the state-level drought policy community. Participants may include the state legislature, the Governor, and state agencies. Typically, the Governor or the legislature establishes a state drought committee to coordinate response to an ongoing drought situation and make recommendations for improving preparedness. The drought committee usually establishes one or more subcommittees. Most plans include a monitoring committee, responsible for assembling assessments of climate and weather conditions and making operational recommendations to the drought committee, and some sort of impacts or assessment committee. The Impacts committee may have both operational duties, in reporting the impacts of ongoing climate anomalies, and longer-term planning, including conducting vulnerability assessments. The response function is usually delegated to the state emergency management agency, which reports directly to the committee and the Governor.

In most cases, the state drought committee appoints a drought manager, as discussed in the previous section. The drought manager serves as the primary conduit of information from the monitoring and impacts committees, although the committee chairs may report directly to the state drought committee or even serve as members of the committee. The subcommittees represent a reservoir of scientific and technical information upon which the state drought committee may pull. Technical staffs within the state agencies are often tasked to serve on these subcommittees. In addition, technical staffs from related federal agencies which have an in-state presence serve on the subcommittees. Local National Weather Service offices, USGS personnel and NRCS soil conservation staff are frequently involved. Academic centers, housed within the state universities, often participate. Examples include the state climatologist or state geological survey. This provides a direct source of scientific expertise into the drought monitoring and planning process.

This expertise is often tasked with more of the day-to-day monitoring and detailed assessments process. In terms of developing overall drought policy, including issues of organizational structure, drought categories and associated actions and mitigation measures, the drought manger and subcommittees draw from a wider source. These are indicated by the red lines connecting the two sides of the diagram. The most frequently-mentioned external links were to other state plans and resources from the National Drought Mitigation Center. In addition, scientists serving on the subcommittees bring their own knowledge and expertise into the process, which is informed through conventional scientific channels, such as reading journal articles and attending scientific conferences. Thus, there is a link from individual scientists into the planning process via subcommittee members. Drought managers may participate in similar communication, but from the interviews it did not appear that this was typically a primary source, although notable exceptions did occur. During the plan development phase, the subcommittees may independently draw from similar sources. Notice especially the overlap (green line) between federal and state agency members of the user community and subcommittee members.

Major barriers appeared not so much in creation of the policy documents, but in implementation of the plan's recommendations. In eight of the ten cases, the planning process was initiated in part because of recent or ongoing drought events. As these events ended, the impetus behind the planning and mitigation activities faded, such that gaining legislative approval and appropriations for implementation became difficult.

5.3 Knowledge Communities

Despite the differing goals of research and policy, information is exchanged between the two. The exchange process may be enhanced through intermediary groups that help translate scientific and technical information into formats more readily accessible to policy-makers, not unlike the way information is discussed in 'knowledge communities' (Stone 1996). These communities share information, problem definitions, and alternatives among themselves and try to influence the adoption of favored policy prescriptions and program implementation. They may take different forms, according to the degree of a common, shared, belief system. Knowledge communities collect information from various sources and process it into a range of alternatives, from which policy-makers may draw.

Knowledge communities are a means by which individuals or groups can share information regarding a particular topic. These may range from individual reports to broader discussions of the policy environment. For example, social experimentation creates 'inventories of information' that may be used at some later date (Feldman 1989). Knowledge communities aggregate information from multiple disciplines in a shared analytic framework (deLeon 1988). In other words, knowledge communities put the pieces together so that decision-makers do not have to invest as much time in deciphering contradictory results from multiple studies.

Because what the scientific community produces may not be what is needed for policy-making, there needs to be an additional component to the communication. Knowledge communities provide such a link. In the case of science-based issues, knowledge communities could be expected to be composed of individuals or groups who understand both the scientific and policy process, and can sift through findings laden with qualifications and confusing terminology to structure information into contextual evidence to be consumed by policy-makers. These communities will amalgamate information coming from the scientific community and provide a single point of contact for policy-makers.

Involvement in knowledge communities also allows producers a chance to help shape how that information is initially presented. Science historically has relied upon findings that "speak for themselves." More and more, however, researchers are realizing that effort is needed to assure analyses and evaluations are used in a substantive fashion within the policy process (Patton 1986). Although producers cannot control the information once it is presented, relating findings to issues within the policy communities increases the utility of those findings to that community.

The science community and drought managers in state agencies were found to resemble knowledge communities, which share information, problem definitions, and alternatives among themselves. As Stone (1996) stipulated, knowledge communities try to influence the adoption of favored policy prescriptions and program implementation. That appears to be the case in this study. Routine scientific interaction, such as the Drought Exploder e-mail list, and public presentations continually shape the state of knowledge about drought processes, impacts, and mitigation measures. This internal communication within the scientific community provides inventories of information that can be accessed through multiple entry points. Drought managers access these inventories during the drought planning process by contacting members of the knowledge community directly as well as indirectly, through other state plans and reports.

The planning process has taken the step of integrating scientific and technical information into the social, economic and political frameworks of the states. The result is that there are concrete, defensible recommendations for policy actions should a window of opportunity open (Kingdon 1984). The drought planning process is really one of linking two of the three streams: problems and policies. Scientists actively contribute to linking solutions (policies) to problems faced by individual states through collaboration with members of their state drought committees or drought coordinators. Since most of these state plans were developed or updated during the last major drought episode, we have yet to see how they will respond when the politics stream conjoins with the problems and policies streams. The implementation measures that scientists and policy-makers have developed collaboratively may be given an opportunity once drought again appears on the agenda of senior policy-makers in the state legislatures and Governors offices.

6. KEY FINDINGS

This study revealed a vibrant knowledge community, in which scientific expertise on drought-related information is actively shared with state policy-makers. Contrary to expectations, policy-makers had little difficulty accessing, understanding, or utilizing scientific and technical information during the drought-planning process. Scientists made every effort to make information available to state drought task force members and to provide information in a variety of formats preferred by policy-makers. Policy-makers, even those without a scientific background, did not exhibit any difficulty in being able to use the information coming from the scientific community. Thus, in the case of drought policy, there did not appear evidence supporting the two cultures theory.

Key findings of this study are:

1. ***There is no substantial cultural gap.*** Interactions between scientists and those directly involved in developing state drought policies exhibited little difficulty in utilizing scientific information and advice.

2. ***The organizational structure posed more of a barrier to communication than did the technical nature of the material.*** Restrictions on communication between scientists and those in policy-making positions inhibits what scientists and policy-makers both described as the most effective form of communication: direct contact. Academic rewards systems, such as tenure and promotion, created an additional barrier through emphasizing scientific communication over service and outreach activities.

3. ***Policy-makers have little difficulty accessing, understanding, and utilizing scientific and technical information.*** The first drafts of state drought plans are usually created by individuals at lower levels of state organizations. Most have some scientific or technical background, but even those who did not were able to conquer a learning curve and easily understand scientific information and advice.

4. ***Research scientists are as likely to engage decision-makers as are intermediaries, but at more local levels.*** Most research scientists sought opportunities to apply their knowledge to societal issues. Predominately, this took the form of close collaboration with local decision-makers, not necessarily in a policy-making context. Research scientists often focused their efforts on individual farmers or producers, local water managers, or economic development groups, especially relating to operational decision-making.

5. ***Intermediaries are more likely to be engaged in federal initiatives, and earlier in the process than research scientists.*** Staff at federal organizations or national centers were among the first to be contacted by policy-makers seeking advice. Their participation occurred primarily through working groups, in which they actively collaborated with policy-makers. Resulting documents created a framework for broader participation by other members of the scientific community and a cross-section of policy-makers and stakeholders.

6. ***Both research scientists and intermediaries tend to be passive.*** Involvement by either group likely was initiated by a request coming to the scientist. Time constraints were mentioned by several respondents. Those in operational environments described themselves as being overwhelmed with deadlines, such that they had little time to seek out new opportunities. Research scientists had more ability to initiate contact, but they too often pursued collaboration after contact was initiated by another individual.

7. ***Internet communication is a key feature of a drought knowledge community.*** Communication both within and external to the scientific community is enhanced by Internet-based tools. E-mail discussion lists, especially the 'drought exploder' list used to produce the weekly Drought Monitor publication, and websites were excellent vehicles for scientists to communicate with each other, develop some degree of consensus, and distribute summarized information to external audiences. Regular publications gain attention and identify individuals willing and capable of assisting policy-makers who need scientific or technical expertise. The internal communication process creates shared knowledgeable among the participating scientists, such that policy-makers need not be directed to a single individual who possesses some specialized expertise.

7. RECOMMENDATIONS

The findings of this study suggest that the process of transferring scientific and technical information to the policy community works well. However, there are some barriers that could be removed and facilitators that could be enhanced to improve the process. The most prominent barriers that emerged were issues associated with academic rewards systems, required clearance on public statements, activities that foster communication within issue areas, funding for extension and outreach activities, and policy implementation. The following recommendations are offered to address these barriers.

Recommendation 1: Professional societies should facilitate issue-specific workshops as forums for scientists and policy-makers to directly engage, not only in national arenas but through state and local chapters in which local decision-makers may be involved. Through issue-specific workshops, the state of the science can be addressed, providing policy-makers with guidance on current knowledge, uncertainties, and suggested applications of that knowledge. This is often done at the national level, for example through the American Meteorological Society's Atmospheric Policy Program, but local chapters rarely host such workshops. Findings and recommendations from national workshops may not address problems on the local agendas and may not be applicable to local circumstances. Thus, local chapters should undertake similar workshops to develop summary reports and recommendations for their communities.

Recommendation 2: Scientists should seek employment in legislative or executive staff positions to be a resource for top policy-makers. Skilled staff are a key link in the transfer of scientific and technical information between the scientific community

and senior policy-makers. These people can be found in technically-oriented agencies, but it is not clear if similar individuals exist in state legislatures and Governor's staffs, other state boards or commissions, or their federal counterparts. Fellowship programs address this niche at the national level. Similar efforts should be undertaken at state levels to address policies not on the national agenda.

Recommendation 3: Academic departments should review their hiring, tenure and promotion policies and assure that service activities are given equal weight to research activities. In a report by the National Academy of Sciences (2004) on the state of interdisciplinary research in academia, the committee found that "collaboration is often impeded by administrative, funding, and cultural barriers between departments, by which most research and teaching activities are organized." The academic promotion and reward system and department-based budgeting structures of universities were cited as particular problems which create "drag" on interdisciplinary research. Without structural changes in the metrics by which faculty are judged, changing the tenure system will prove problematic.

Recommendation 4: Universities should assure adequate and consistent funding for outreach activities, including Extension programs. Respondents who collaborated with colleagues in extension programs all noted that outreach and extension activities are the first things to be cut during budget shortfalls. Extension programs have proven remarkably effective in transferring scientific knowledge to non-technical audiences. These programs require a steady input of scientific research from universities. As problems have grown in complexity, the need for inter-disciplinary academicians to supply this research has grown. Both the research and the outreach programs are essential parts of the universities' missions to be good stewards of their communities.

Recommendation 5: Delegate discretionary authority on public and legislative contacts to the unit director levels of federal organizations, supplemented by active internal dialog among unit directors and the organization's public affairs and legislative affairs offices. The goal of oversight is to assure consistent and accurate information is provided to those who request it. It is in the interest of the agency to assure this, because inconsistent statements often lead to political problems for the agency. Thus, some form of oversight is necessary. Transferring this authority downward in the organizational hierarchy to the unit director level allows more staff to have direct contact with the individual requesting the information, or at most have only one intermediary. This is the most effective means of communication and allows opportunities to clarify information or offer interpretation if asked. Regular contact between the unit directors and their staff often helps to develop trusting relationships. This may ease concerns over offering interpretation or opinions, something often wanted by policy-makers or their staffers. In order to protect the parent agency's interests in assuring a consistent message, unit directors should inform the public affairs or legislative affairs office of any contact, including what information was provided. Regular meetings among unit directors can clarify guidelines governing contacts and develop appropriate responses to anticipated questions. Some sensitive issues may be retained at the headquarters level.

Recommendation 6: The scientific community should build grassroots constituencies to encourage implementation of measures written into policy documents. Many state drought plans have specific mitigation actions written into them, but wither for lack of funding. Generating the political will to follow-through on the mitigation efforts can be challenging. Building local constituencies and working with larger politically-active organizations can help to bridge this barrier. These local constituencies can be useful for implementing some measures during the 'wet times' or can be drawn upon when the next drought occurs and political windows of opportunity re-open. Local chapters of professional societies are well-positioned to help build and maintain these constituencies. State agency officials, federal officials, and even university faculty and staff, have restrictions on their involvement in political activities. Non-profit societies face fewer restrictions. Working through local chapters, members could recruit external advocacy groups to encourage state legislatures to address mitigation provisions in the state plans.

Recommendation 7: Promote the development of knowledge communities around policy-issue areas using both formal and informal communication in which issues are discussed and policy-relevant documents generated. Knowledge communities are an important link in synthesizing scientific information into policy-relevant documents. The scientific community should emulate the knowledge community built around drought, expanding to other areas on the national, state, and local agendas. Through communication between members of the knowledge community, both through formal means such as publications and scientific conferences, and through informal means such as the e-mail list and workshops, the latest scientific knowledge is debated and integrated into operational documents and advice to policy-makers. E-mail distribution lists, web-based conferencing (blogs), or similar methods allow for rapid, shared communication. Members of the knowledge community periodically produce a variety of documents for different audiences, including white papers, summaries, bullet points, and regular publications distributed via the Internet. This completes the link of accessibility to the policy community.

8. FINAL THOUGHTS

The fact that so many scientists are willing to engage in applications, despite the barriers, encourages the use of scientific information by policy-makers. Established connections between academic and agency scientists provide a conduit of information into the state drought planning process. Plans that have been developed or updated in recent years reflect the transfer of this knowledge, especially in those stipulating mitigation actions. However, political will and action to implement these measures is lacking. The plans create a basis upon which senior policy-makers may draw, but all officials interviewed who mentioned mitigation measures in their state plans also believed that little would be done until a new crisis emerged. How scientists are involved in the process of implementation would be a fruitful area of follow-on research to this study.

This study revealed a remarkably vibrant and active knowledge community. The ease with which information is exchanged between scientists and policy-makers is remarkable. Credit goes both to the scientists and to the policy-makers who are engaged in this process. Both groups have invested time and resources to understand the other and to tailor information to meet specific needs. As C.P. Snow said, the middle ground is where creative chances occur. These individuals within the drought knowledge community are without doubt creating those creative chances. Even though some of the ideas which have emerged from this collaboration have yet to be implemented, there will certainly be opportunities in the future at which such ideas may be tested and refined.

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