Pilot Stakeholder Assessment Report

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EXECUTIVE SUMMARY

In April 1998, a multidisciplinary team from the University of Arizona was awarded a three-year grant by the National Oceanic and Atmospheric Administration (NOAA) to initiate CLIMAS, the Climate Assessment Project for the Southwest. As one of several NOAA-funded regional assessment activities, CLIMAS is charged to undertake research on the nature, causes, and consequences of seasonal, interannual and decadal climate variability in the Southwestern United States, and to a lesser extent, the implications of longer term climate change for the region. The overall goal of the project is to provide improved information to regional decision-makers and resource managers. The project has two directives: (1) to create and administer a core office responsible for coordinating research activities, communicating research results, and engaging in outreach activities oriented toward linking users' information needs with sources of that information; and (2) to undertake a series of closely integrated natural, physical, and social science research initiatives to assess and enhance knowledge about regional climate variability, vulnerability, impacts, and responses.

The direction of future research and the management of climate information systems should be guided and informed by those whose livelihoods benefit from accurate and up-to-date climate information. In order to initiate this process, CLIMAS researchers conducted a Pilot Stakeholder Assessment. The three goals of the study were as follows:

- to establish a working relationship between stakeholder groups and the CLIMAS research team
- to develop a methodology for assessing the needs and perspectives of project stakeholders
- to inform and guide the activities of the CLIMAS core office and research team

For the purposes of this study, stakeholder is defined as any person, group, or institution that could contribute to the success of CLIMAS or that has the capacity to use climate information.

In selecting stakeholder participants, the research team sought to maximize the diversity of respondents according to city or town size, local economy, and occupation. From February to July 1998, team researchers conducted interviews with 12 stakeholders in the private sector, 10 emergency response managers, 12 land managers, 10 public officials, 2 utilities representatives, 11 water providers, and 15 other stakeholders. In all, seventy-two interviews were conducted in cities and towns across the southeastern portion of Arizona.

The pilot assessment began with open-ended discussions with potential stakeholders. Based on those discussions, a semi-structured interview protocol was created to allow comparison among responses while still permitting the flexibility necessary to capture the diversity of relations between stakeholders and climate information systems[1]. The Pilot Stakeholder Assessment Report analyzes the data collected in these interviews. The report provides a framework for understanding the variability of climate information use, identifies several information gaps where more or improved climate information is needed, outlines constraints that prevent or discourage the use of climate information systems, and provides recommendations for future social science research in this area.

[1] A copy of the final questionnaire is included as Appendix 2.

Use of Climate Information

In the pilot, climate is defined as information extending beyond the temporal extent of a month. Based on this definition, approximately half of the stakeholders interviewed consult climate information in their decision-making. Nearly all of the stakeholders interviewed, however, incorporate weather information into their daily decision-making.

A stakeholder's use of climate information can be organized by two variables: complexity and frequency. Radio, television and newspaper forecasts are examples of *basic information* systems. *Complex information* is that which originates from sources beyond the conventional climate information systems. The Local Climatological Data from the NOAA National Climate Data Center is one example of a complex climate information system. A *frequent user* consults climate information regularly, typically on a daily or weekly basis. An *infrequent user* seldom consults climate information or does so intermittently (i.e. less than weekly).

It was found that complexity and frequency do not necessarily correspond, but rather that numerous possible combinations exist. The following table classifies stakeholders who participated in the pilot assessment in various occupational categories based on their climate information use.

	User of Basic Information	**User of Complex Information**
Frequent User	Emergency Management (Small town) Utilities Farmers	Emergency Management (Large City) Water Provider (Surface Water) Farmers
Infrequent User	Water provider (Groundwater) Public officials Land Manager (State park mangers, developers)	Land Manager (Range Land Management)

Approximately half of the total stakeholders interviewed consult climate data, but no exact correlation exists between climate vulnerability and climate information use. Some of the most vulnerable stakeholders may only use basic information or may not have the capacity to integrate climate information into their decision-making.

The research team discovered that, in most cases, patterns of climate and weather information use correspond directly with occupation. Because their jobs are largely based on preparedness for severe climate events, *emergency response managers* are inclined to use short-term weather forecasting rather than long-term climate information. The exception is emergency response managers in large cities. They often have the capacity to finance large-scale infrastructural projects that require long-term planning, and therefore frequently make use of complex climate information.

The occupational category *land managers* includes range land managers, state park managers, and developers. Of this group, *range land managers* make the most of extensive use of climate related information and are cognizant of the direct relation between climate and the long-term sustainability of ranching. Other types of land managers reported little to no consideration of climate information in the responsibilities of their occupations. Similarly, the *public officials* in the pilot assessment did not perceive a direct connection between climate and their occupational responsibilities. They did, however, comment on the impact of weather on cities and towns.

Water providers often emphasized the precedence of political, organizational, and demographic factors over climate in their decisions concerning water supply and demand. Climate information does play some role in their infrastructure planning, however, and water providers who rely on surface water often perceive themselves as being more vulnerable to climate variability.

Finally, the managers of large *utility* companies (gas and electricity) interviewed in the pilot demonstrated multifaceted use of climate information. Accurate and up-to-date data would allow them to anticipate seasonal supply and demand patterns and to improve long-term planning by anticipating change in state, federal and global environmental policy. Representatives of this sector in smaller towns, however, are not concerned with climate issues.

Information Gaps

The pilot assessment also sought to discern where "gaps" occur in climate information systems and to ascertain the relative ease of access to these systems. Information gaps may represent information not available to stakeholder communities in the Southwest. In addition, information gaps can represent the perceived unavailability of climate information – usually in situations where access to the relevant climate information system is difficult. The most prominent gap identified in the interviews was a lack of climate data at appropriate temporal and spatial scale. Respondents also reported a lack of pertinent historical climate information. These data are perceived as of particular use to farmers, land managers, and water providers who wish to identify patterns for the climate in their region.

Because climate and weather are highly localized in the Southwest, many stakeholders requested more accurate microclimatic data for their particular region. Data on weather and climate, which often originate in larger urban centers, are generally not appropriate to the small microclimates in the outlying areas. This issue was central to nearly half of the gaps identified by stakeholders.

Areas for More or Improved Climate Information by Occupation

Stakeholder Occupation	Area for More or Improved Climate Information
Private Sector	**Ranchers**: Precipitation patterns and better access to scientific reports **Farmers**: Minimum and maximum temperatures, seasonal forecasts, climate and crop conditions in other parts of the world, historical rainfall and temperatures for their microclimate **Miners**: Anomalous rain
Emergency Response Managers	Real-time streamflow, estimated intensity of rainfall, predictions of the duration of drought, and up-to-the minute reports on fire and storm activity
Land Managers	Air quality data, long-term forecasting which estimates impact on local ecology, consolidated temperature and rainfall data, and improved linkages to University research
Public Officials	A clear and concise discussion about climate, the environment and the economy
Utilities (large providers)	Better access to reports and information on global warming
Water Providers	Varies greatly[2]

[2] See chapter II, page 17, for a an explanation of information gaps identified by water providers.

Constraints to the Use of Climate Information

In addition to classifying climate information users and identifying information gaps, the pilot identified constraints to the use of climate information. The participants of the pilot illustrate that there is not always a direct relationship between types of stakeholder and type of climate information use, but that a great deal of variation exists. Although this variation can be partly attributed the stakeholders' occupational activities, it depends also on factors such as rural and urban context, beliefs about the role of information and decision making, and sense of efficacy.

Perceptions of Climate Information: At times, respondents expressed a fatalistic attitude about climate and doubt concerning the ability of forecasters to make accurate predictions. This attitude often originates or is reinforced in cases where stakeholders spend time and money preparing for predicted conditions that never occur.

Decision-making Capacity: Despite recognition of the impact of climate variability and change, stakeholders often lacked the capacity to respond in meaningful ways. Either relevant decisions are made elsewhere in the occupational institution or there are no other viable alternatives to the stakeholder's existing course of action.

Economic Constraints: Some stakeholders do not consult climate information because they cannot afford the time or materials (i.e. computer, Internet access) required to locate the information. Stakeholders in the private sector and those that work for federal agencies are most likely to face economic constraints. Municipal employees generally encountered other forms of constraints.

Information Overload: Climate may be just one of many competing factors that go into decision-making. For some stakeholders, competing factors overwhelm climate in importance and thus constrain the use of climate information. These factors include politics, demographics, and the market.

Recommendations and Conclusions

As a pilot study, the stakeholder assessment seeks to test the assessment methodology and identify areas that require additional research. The following topics merit further investigation.

Community Approach[3]: The pilot identified participants according to the stakeholder community to which they belonged. In future work, intra-occupational variation in climate sensitivity and climate information use may be investigated by selecting specific and uniform sectors for in-depth study. Furthermore, the scope of the pilot excluded an investigation of the relationship between stakeholders. Future research elucidating these linkages would contribute greatly to our understanding of climate information systems.

Additional Activites: Researchers require information about how stakeholders use information. Using focus groups, small group interviews and a web page survey, researchers can collect users' feedback on climate information products that have been provided in oral, written, and Internet presentations. One method by which to do this is to present respondents with examples of web sites and publications on climate.

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[3] Refer to Chapter I for definitions of *stakeholder community* and *geographic community approaches.*

Vulnerability Research: The pilot stakeholder assessment sought to distinguish between those who use climate information and those that do not. A weakness of the approach is that it is blind to the variability in degree and magnitude of climate impacts on stakeholders. A stakeholder assessment would be strengthened by a vulnerability assessment.

Organizational Analysis: Some of the constraints to the use of climate information are due to factors of limited resources and organizational culture. A series of case studies exploring the use of climate information in various organizations could elucidate many of these issues.

The pilot stakeholder assessment successfully developed a methodology which can be replicated in subsequent surveys. The study helped to identify and describe climate information needs for a wide cross-section of the Southwest's stakeholder communities. It also helped to introduce CLIMAS, its core office functions, and its research initiatives to various stakeholders in the Southwest region. The pilot assessment led to a series of methodological suggestions for improving CLIMAS ability to gather more specific information about particular stakeholder communities.

INTRODUCTION

The mission of the National Oceanic and Atmospheric Administration (NOAA) of the U.S. Department of Commerce is to promote global environmental stewardship by supporting efforts to describe, assess, and predict the Earth's environment. To fulfill its mission, NOAA must make observations, process them into useful products, and efficiently disseminate the products to users. NOAA-sponsored research aims to prepare the agency to improve its performance and meet future requirements.

NOAA recently began several pilot projects to assess climate variability and longer-term climate change in terms of impacts on human and natural systems in the U.S. CLIMAS, the Climate Assessment Project for the Southwest, was established in 1998. The project's mission is to improve the ability of the region to respond sufficiently and appropriately to climatic events and climate changes. Central to the project is its ability to provide useful information to regional decision makers and resource managers.

CLIMAS brings together researchers who study the processes and effects of climate on the Southwest region with individuals and organizations who need climate information to make informed decisions. The project aims to foster participatory, iterative research involving researchers, decision makers, resource users, educators, and others who need more and better information about climate and its impacts. The project has two directives: (1) to create and administer a core office responsible for coordinating research activities, communicating research results, and engaging in outreach activities oriented toward linking users' information needs with sources of that information; and (2) to undertake a series of closely integrated natural and social science research initiatives to assess and enhance knowledge about regional climate variability, vulnerability, impacts, and responses.

This document reports the findings of a pilot stakeholder assessment conducted for CLIMAS. Conceptually, the focus on the stakeholder acknowledges that people who use climate information are ultimately the environmental stewards, and their perspectives are critical to the direction and operation of the CLIMAS project. The purpose of the pilot assessment was to identify and characterize the climate information needs of stakeholders in southeastern Arizona. As a pilot, this study only begins to reveal and explore issues of importance to CLIMAS. Still, the results demonstrate how CLIMAS researchers can improve climate information and predictions for the Southwest and also identifies an effective methodology that can be modified for other study areas in the Southwest.

CHAPTER I

APPROACH AND METHODOLOGY

In early 1998, CLIMAS embarked on a multifaceted research agenda to "...undertake research on the nature, causes, and consequences of climate change and variability in the Southwestern United States with the goal of providing improved information to regional decision-makers and resource managers" (Bales et. al 1998). As part of the research, the CLIMAS social science team undertook a pilot stakeholder assessment. The pilot ran from February to July 1998. In keeping with the initial focus on regional assessment activities in southern Arizona, the pilot was designed to identify and characterize the climate information needs of different stakeholder groups in that area. The intent was to develop initial information needed by CLIMAS researchers that would improve their understanding of existing patterns of climate information utilization and needs. What follows is an explanation of the approach and methods used by the stakeholder assessment.

Theory and Approach

The central tenet of the stakeholder assessment is that both the management of climate information systems and the direction of future research should be guided and informed by those whose livelihoods depend on accurate and up-to-date climate information. Information needed from stakeholders in the Southwest includes (1) a general understanding of the topical, spatial, and temporal parameters of climate information both used and desired by respondents, (2) how climate impacts their livelihoods or operations, and (3) how well-connected they are to current climate information systems. The stakeholder assessment was also set up to begin the process of identifying potential CLIMAS users, those who should be targeted for CLIMAS outreach activities, and those who do not need or use climate information. The pilot therefore required a methodology for systematically incorporating stakeholder concerns into the formation and growth of CLIMAS.

Enhanced communication between CLIMAS and stakeholders is a prerequisite for success in attaining the goals identified for the project. This emphasis on communication is significant in two senses: on the one hand, it acknowledges that, under this type of project, stakeholders' vulnerabilities and needs should be the principal reasons for developing better climate information and information systems. On the other hand, it addresses the desire of NOAA to create genuine partnerships between information centers and the consumers of this information.

Stakeholder Theory

The term **stakeholder** has been the subject of much discussion and debate across disciplines in recent years. Fields such as environmental management, international development, and business management have developed unique definitions and theories surrounding this topic (Mitchell 1997, Peelle 1995, Phillips 1997). Most of these definitions roughly encompass the same space: the term stakeholder refers to persons or groups of persons that can affect the outcome of a project or policy or that are affected by a project or policy. In the scope of a typical project, stakeholders usually represent groups, organizations, or institutions comprised of persons with some shared ideology or concern.

Stakeholder: Any person, group, or organization that could contribute to the success of CLIMAS or that has a need or capacity to use climate information.

Part of the core office mission is to incorporate climate information into private and public decision making in the Southwest. To fulfill this mission, the CLIMAS will both serve and depend on the stakeholders interviewed in the course of this study. For the purposes of this study, then, a *stakeholder* will represent any person, group, or organization that might contribute to or benefit from CLIMAS research initiatives and the CLIMAS climate information system.

Community Approach

The pilot study also incorporated the concept of community. The term **geographic community** represents a physical, spatially-located city, town or community. Examining geographic communities provided valuable information on how stakeholders react to climate variability, contextualized in a particular town's climate, location, and dominant economy. For the pilot, the research team chose to focus on these geographic communities in order to easily identify key individuals who should be interviewed and to maximize use of time and funds. Through this process, the research team was able to outline some of the **stakeholder communities** present in the study area. The stakeholder community was defined as a group of individuals who share the same livelihood, interact in a common social network, and possess some common interest. An example of a stakeholder community would be ranchers who practice holistic ranching methods. Geographically, these ranchers may be scattered across the Southwest, but they participate in the same economic sector, share a common ideology, and may even communicate periodically. Understanding these communities ultimately provides a more accurate and complete picture of how stakeholders uniquely perceive and respond to climate variability and change.

stakeholder community: A group of individuals who share the same livelihood, interact in a common social network, and possess some common interest.

Methods

The scope of the pilot stakeholder assessment was refined as our knowledge of each community and its concerns grew. In the first stages of the pilot, interviewers took a broad sample of potential core office users to get an idea of the stakeholders' climate information needs and interests. These early respondents were selected from a group of individuals who had completed a survey at the Southwest Regional Climate Change Symposium and Workshop, held at the University of Arizona September 3-5, 1997. The criterion used for selection was representativeness within a wide variety of occupations (e.g., researchers, farmers, land managers, and pubic officials). This first round of interviews, which was open-ended in structure, provided a base of knowledge from which to build an informed and more structured interviewing strategy.

Matrix

We next created a matrix for identifying potential respondents. Critical variables were identified with the assistance of the CLIMAS team (the critical variables are described below). Each identified variable was used to construct categories, thereby creating a mechanism for identifying a similar group of contacts in towns of different demographic and economic character. (A sample matrix is provided in Appendix 1).

Critical Variables

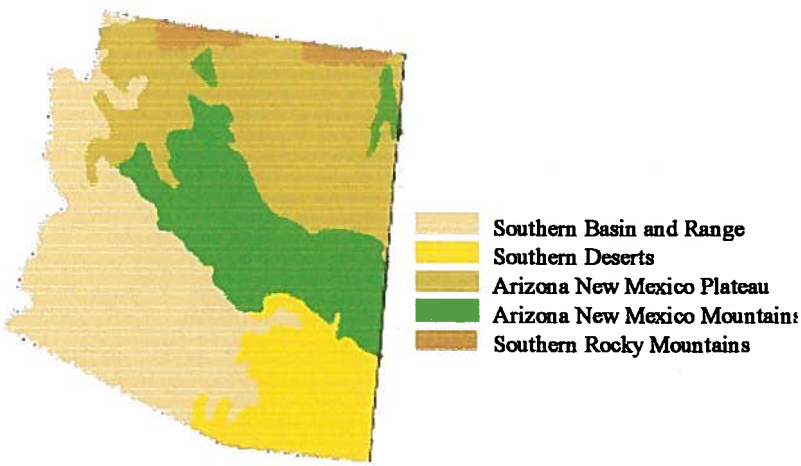
- **Ecozone:** The CLIMAS team identified ecological zones as one of the primary critical variables by which the stakeholders should be divided. To reduce the scope of the study, the pilot study team focused their efforts on the Southern Deserts ecozone (Figure 1.1).

- **Land Ownership/Town Size:** This matrix category compounded two critical variables, land ownership and demographic stature. Participating communities were divided into one of five categories: *large urban city* (any city with a population above 100,000), *medium urban city* (10,000 - 100,000), *rural public town* (less than 10,000 and dominated by public lands), *rural private town* (less than 10,000 and dominated by private lands), and *Native American*. Although this last classification of land is extremely significant in the Southwest, time was not sufficient to establish the necessary relationships with the various Southwestern tribal administrations. The CLIMAS research team has identified Native American issues as a topic for research in year two.

- **Dominant Economy:** The CLIMAS team devised a typology of towns in the Southwest using four economic bases, including agriculture, manufacturing, service/tourism, and mining/other. With the help of the Arizona Department of Commerce's web page at http://www.commerce.state.az.us/, the pilot study team categorized all towns with according to one of the four dominant economies. Although not all towns conform to once economic type, researchers determined, based on number employees and gross earnings, which sector comprises the driving component of the economy. With this matrix category in place, towns were selected to fit the matrix cells. Note that all cells were not filled (for example, Tucson is the only large urban city in the southern deserts ecozone).

- **Occupation:** The final matrix category consisted of six occupational types determined to broadly represent potential stakeholders; public officials, water providers, land managers, utility managers, emergency response managers, and miscellaneous stakeholders. Pilot team members sought a representative of each occupational type in each selected city or town.

Figure 1.1 Ecozones in Arizona



Sampling, Contacts and Scheduling

Selection of participants was directed by the matrix categories described above. In terms of sampling, the category Land Ownership/Management created the first stratification in the selection of towns. Assigning each city or town to a category of dominant economy created yet another stratification and usually reduced the number of possible towns to three or less. Towns were then selected based on their representativeness or convenience.

Once researchers had selected a city or town, a member of the team began to locate potential respondents using a variety of methods. We often began searching by contacting individuals within the CLIMAS research group who are familiar with a particular city or town. When possible, we checked the local web page which often gave the names and phone numbers of city officials. Snow-ball sampling was also a critical component of the process. Researchers contacted the town clerk or another knowledgeable individual at the town's city hall or chamber of commerce to gain information about residents and potential respondents. Also, while conducting interviews, researchers asked respondents to identify other people to interview. This snowball sampling method increased our knowledge of the localized administrative networks as well as the initial outlines of the stakeholder communities in the Southwest.

Certain matrix occupations, like emergency response personnel or water providers, were easily identified because generally only one individual in a community filled that role. Other matrix occupations such as land managers or miscellaneous stakeholders, however, provided a wide array of possible respondents from which to choose. Informed contacts were invaluable for identifying potential respondents in these categories.

Identifying individuals in occupations that would best represent local land ownership and the economy proved particularly difficult in some areas. It should also be mentioned that, in the case of large cities, the team often interviewed more than one representative for each occupational category in order to better capture the administrative and infrastructural complexity of the urban context. For the other cities and towns in the sample, the pilot study team identified a single respondent for each matrix cell.

Nearly everyone we contacted agreed to be interviewed, provided they had time available. If an interview could not be arranged because of schedule conflicts, our contacts often identified other members of the community we might approach. Each set of interviews was concentrated to one day in order to maximize researchers' time and project funding (see Figure 1.2 for the location of the cities and towns covered in the pilot survey).

Over the course of five months, a total of 71 interviews were conducted. Of these, 58 filled matrix categories. Tables 1.1, 1.2, 1.3, and 1.4 report the number of stakeholders interviewed within the four matrix variables.[4]

Table 1.1 Number of interviews completed in each ecozone

Ecozone	Interviews
Southern Basin and Range[5]	3
Southern Deserts	55
TOTAL	58

[4] Tables 1.2, 1.3, 1.4 do not include the thirteen "non-matrix" interviews, but include interviews from the Southern Basin and Range ecozone.

[5] The focus of the pilot stakeholder survey was the ecozone Southern Deserts. However, three interviews were conducted in the Southern Basin and Range ecozone in the initial stage of the project.

Table 1.2 **Number of interviews completed in each category of "land ownership and management"**

Land ownership/management	Interviews
Large urban	9
Medium urban	20
Rural private	19
Rural public	8
Indian land	2
TOTAL	58

Table 1.3 **Number of interviews completed in each category of "dominant economy"**

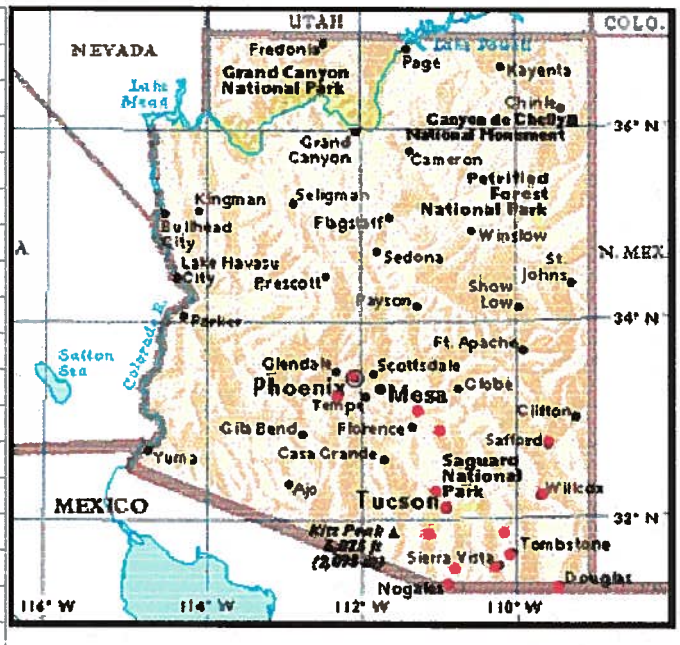
Dominant economy	Interviews
Agriculture	20
Manufacturing	6
Mining/other	9
Service/tourism	23
TOTAL	58

Table 1.4 **Number of interviews completed in each category of "occupation"**

Occupation	Interviews
Miscellaneous Stakeholders	12
Emergency response	10
Land management	12
Public Officials	10
Utilities	2
Water providers	11
Other	1
TOTAL	58

Figure 1.2 Cities (marked in red) in which interviews were conducted

Douglas
Goodyear
Green Valley
Hayden
Huachuca
Kearny
Marana
Nogales
Oro Valley
Patagonia
Phoenix
Sacaton
Safford
Sells
Sierra Vista
Sunizona
Tombstone
Tucson
Willcox



After: 1996 National Geographic Society Cartographic Division, http://www.nationalgeographic.com/maps/atlas/usstates/sarizom.html

Interview Procedure

The pre-matrix round of open-ended interviews provided a baseline of information from which to create a semi-structured interview procedure. Although we subsequently moved to a more structured interview format for the matrix-determined interviews, we continued to keep a conversational style to the interview. The semi-structured nature of the questionnaire ensured that certain compatible data were gathered from study participants. At the same time, the questionnaire allowed interviewers the flexibility to tailor the interview to markedly different respondents. The interview consists of seven sections, each capturing a unique dimension of climate information use (see Appendix 2 for the full interview protocol).

- **General Questions:** This section is the same for each stakeholder. These questions are designed to elicit information about how climate impacts livelihood, use of climate information systems, ability to locate particular information in those systems, and the satisfaction with the current state of known climate information.

- **Sector-Specific Impacts:** This section deals with questions unique to the different occupational categories of the matrix. Sectors for which these questions are most relevant include farming, land management, emergency response, public officials, water providers, and ranching.

- **Annual Calendar:** This section asks questions about how information use differs throughout the year. Although this information was asked of all stakeholders, it was most effective with farmers and ranchers because their operations are largely based on seasonal patterns dictated by different kinds of crops or by cattle.

- **Time Line:** This section investigates the demand and use of climate information in relation to historical weather events. Respondents were asked to recall major weather events in their local area. Events such as the flood of 1993 were mentioned by the interviewers to prompt the respondent. Using these events as a mnemonic device, interviewers inquired about the respondent's event preparedness, information sources preceding the event, and how information use might have changed in the wake of the event.

- **Information List:** This section focuses on a laundry list of information sources. We incorporated this section in the survey to obtain a comprehensive understanding of the climate information systems used by the stakeholders. The data gathered will also allow us to gauge which information systems are more and less trusted by the stakeholders.

- **The Core Office:** This section collects information about what kind of climate information services stakeholders desire. Respondents were asked to evaluate the potential utility of a core office such as CLIMAS and to suggest ways they might interact with it. Respondents also suggested ways that the core office might present climate information, as well as the kinds of workshops they would like to attend.

- **General Observations:** This section gathers background information about the respondent, contextual information about the city or town, region, and industry/agency in which the respondent works, and/or other information of potential use to the research project.

Interviews generally lasted about one hour and were conducted by two interviewers, one conducting the interview, the other taking notes. Over the course of an interview, however, both interviewers often took an active role in guiding the discussion. With the permission of the respondents, interviews were tape recorded. At the conclusion of each interview, the interviewers gave their business cards to the respondents and encouraged them to call if they had any questions.

Databases

The responses and notes from each interview were brought back to the office and entered into a set of databases. The interview data were entered into a word processing program and then later introduced into a qualitative data analysis program called Non-numerical Unstructured Data Indexing Search and Theorizing (or NUD*IST). NUD*IST requires the interview text be structured and formatted in a particular manner to facilitate later content analysis. The interview texts averaged 1.5 to 2 pages in length in standard word processing format. Interview notes were written and labeled in NUD*IST in such a way that particular sections or themes from interviews can be isolated and selected. For example, the NUD*IST database would allow a researcher to abstract all the responses to question 2 given by respondents categorized as land managers.

Microsoft Access was also used to keep track of study participants. In a table entitled "Participants", the name of each person interviewed was entered along with basic information about his or her occupation, address, telephone number, and position within our study matrix. Each respondent was assigned a number that became the primary vehicle for identifying each person in later analysis of the data to ensure confidentiality. Those respondents who wished to be added to the CLIMAS mailing list were also noted in the database.

The Access database contains another table, "Information", that records data assessing both current use of climate information systems and useful climate information not available. The table records information respondents need, information in which they have interest, and information

produced or collected by the respondent that might be useful to the rest of the stakeholder community or to the CLIMAS research team. As in the first table, the assigned stakeholder number was used to ensure consistency and confidentiality across databases.

Analysis

Various approaches were used to analyze the different databases. The NUD*IST database allowed us to call up specific questions and analyze relevant content from the interviews. This database also allowed us to derive themes from the data and to compare and contrast common sections of the interviews. The Access database centralized the information generated by respondents and, in conjunction with the themes derived from the NUD*IST qualitative data, allowed us to piece together a picture of the major gaps in climate information systems serving the stakeholders. Similarly, we were able to gauge the factors that both facilitate and block stakeholder access to existing climate information systems. The stakeholder team met often to discuss findings and to draw upon our collective experience in order to extract the stories behind the data.

CHAPTER II

RESULTS OF THE INTERVIEW

This chapter summarizes the responses to the stakeholder survey. Much of our discussion will be in terms of the matrix, described in Chapter One, which guided our search for respondents who reflect the multiple facets of Southern Arizona's stakeholder communities and helped to conceptualize the complex set of variables incorporated into the survey. The matrix was created by the intersection of the following critical variables: 1) ecozone, 2) land ownership and management, 3) dominant economy, and 4) occupation. Over the course of five months, a total of 71 interviews were conducted. Of these, 58 filled matrix categories. The remaining 13 pre-matrix interviews were conducted during the preliminary phases of the assessment to obtain the basic information needed to create a more structured survey.

Rather than report responses to individual questions, we have consolidated responses into four categories: *Climate and Job Responsibility*, *Gaps in Climate Information*, *Climate Data Collected by Stakeholders*, and *The Core Office*. For each of these topical areas, the most convenient variable by which to categorize and describe stakeholders is occupation. Within this framework, further variation is often explained by the size or dominant economy of the respondent's city or town.

IMPORTANT DEFINITIONS

Several definitions are integral to fully understanding the following discussion such as the distinction between **weather and climate**. For the purposes of this study, weather is defined to include events occurring from the present moment to a maximum of 30 days, and climate as patterns of events that extend beyond 30 days. Respondents that use historic data to identify events extreme (e.g. torrential rain, severe drought, destructive wind, etc.) are identified as weather information users, while those stakeholders that are interested in identifying trends or establishing a "norm" from the historic record are identified as climate information users.

We have also defined several categories of climate information users based on the **complexity and frequency** of information they use. For the purposes of this study, we have defined complex information as that which originates from sources beyond the conventional climate information systems (such as TV, radio, and the newspapers). Conversely, information acquired through conventional information systems will be referred to as basic information. The Local Climatological Data from the NOAA National Climate Data Center is one example of a complex climate information system, while radio and television forecasts are examples of basic information systems. A frequent user is defined as one who consults climate information regularly, typically on a daily or weekly basis, while an infrequent user seldom consults climate information or does so intermittently (i.e. less than weekly).

It was found that complexity and frequency do not necessarily correspond, but rather that numerous possible combinations exist (see Chapter Three for a more detailed description of these categories).

Climate and Job Responsibility

As we expected, there was wide variation between and among individuals representing occupational categories on the question of how climate effects job responsibilities. Many users, particularly those in smaller towns, do not have the infrastructural and financial support to focus their energy on the long range implications of climate in relation to their job. Instead, they report reacting as best they can to extreme climate events. What follows is an evaluation of the importance respondents in various job categories ascribe to climate in their daily routines, as well as an assessment of the reported integration of climate information into their decision-making.

Emergency Response Management (10 interviews)

A majority of the ten emergency managers we interviewed make extensive use of forecasting. However, because their jobs are largely based on preparedness for severe punctuated climate events, they are inclined to use short-term forecasting (what we would call *weather information*) rather than long-term climate information *per se*. However, this varies with the size and sophistication of the agency in question. For example, Tucson's emergency management unit has the personnel and infrastructure to make extensive use of both weather and climate information systems. By contrast, small towns depend almost exclusively on weather information, often provided by the county government or larger cities.

This arrangement in smaller towns leads to a dilemma for the emergency managers. The information provided by organizations in large cities is often too general to represent the idiosyncrasies of any particular microclimate. An emergency manager from a rural private town, for example, reported that he does not monitor weather or climate on a regular basis because he does not have access to town-specific climate information. As is the case in other small towns, the respondent's use of climate information was hindered by a range of obstacles: poor radio reception, insufficient resolution of data, and lack of equipment and personnel. For such town officials, emergency response is almost exclusively reactive rather than proactive.

Emergency managers report widely different impacts of climate on their jobs. The emergency manager of a medium urban city, for example, pointed out that climate directly affects the scope of his job – increased humidity exacerbates allergy attacks, and high summer heat causes heat strokes. In contrast, one medium urban city's fire chief saw no connection between the responsibilities of his job and climate. He attributed this to the fact that he only deals with emergencies inside the city and most emergencies in this jurisdiction are human-caused. Yet another emergency response manager in a rural private town expends his efforts almost exclusively to flood preparedness.

Land Managers (12 interviews)

The twelve interviews contained in this single occupational category contain a diverse set of actual occupations, and led, in turn, to a highly variable set of responses.

We interviewed three range land managers, all of whom made extensive use of climate information. Range land management responsibilities center on monitoring the changes in range land conditions and, based on this information, advising ranchers. Changes in range conditions are, in part, climate driven. As a result, land managers are interested in historic, current, and predictive climate information. They actively seek up-to-date climate information to integrate into their range-management strategies. For example, current range management techniques are largely based on the grassland dominant range conditions of decades ago. Although scrub brush is becoming more common, land managers continue to promote a grassland management strategy. Several respondents

in this category stated that they would consider changing their management strategy if research indicated that climate was driving a permanent shift from grass lands to scrub brush.

The nine state park managers, developers, and city managers we interviewed reported much less interest in climate information in spite of the fact that weather events and prolonged climactic change demonstrably affect parks, urban development, and city operations. Weather patterns, and perceptions of weather, may affect tourism, just as prolonged droughts, heat or other less-desirable climate changes may compromise a land developer's customer base. Stakeholders in these occupations expressed only intellectual curiosity with regard to climate information. One park manager, for example, expressed an interest in historic and future trends in rainfall, although he has no capacity to integrate this information into his decision-making.

Public Officials (10 interviews)

Of the ten public officials we interviewed, nine did not perceive direct connection between climate and their occupation even though they often spoke of how weather impacts their towns, thereby affecting policy decisions. A politician in a rural private town, for example, mentioned that their economic development plan was formulated largely in reaction to the 1993 floods, which severely damaged the town's infrastructure. A public official in a medium urban city made policy decisions based on climate information from their sister city across the border. Overall, however, policy makers did not see climate information as a major factor in their decision-making processes.

The one exception to this trend was a community development director in a medium urban city. Groundwater withdrawals in this community are believed by some to be causing diminished flow in the nearby river, which is internationally recognized as an important riparian area. Because of the relevance of climate to this critical issue for the community, the director recognizes the importance of climate information to his job and considers climate data in numerous aspects of his planning including wastewater management and the design of storm-water detention basins.

Utilities (2 interviews)

The pilot stakeholder assessment sample included only two individuals in the utility sector, both from Tucson. Both respondents indicated that their organizations had a strong interest in the development of improved climate information systems. After a few additional phone conversations with other individuals in the utilities sector, we determined that utilities representatives in cities and towns smaller than Tucson tended to be people who, as subsidiaries of larger power and gas companies, dealt exclusively with the business side of the utilities operation and were not concerned with its associated climate issues. We did not interview the representatives of the utility sector we contacted in smaller towns and categorically eliminated interviews in this sector for the remainder of the project.

The two Tucson utility representatives acknowledged the importance of climate for their job responsibilities and for their company. The gas company must order gas from El Paso, Texas four days in advance. To order the proper quantity to meet peak winter-weather demand, the company must project consumption patterns based on weather predications. A miscalculation results in either a surplus of gas at a financial loss for the company or, if underestimated, a gas shortage for customers. For the representative of the electric company, climate figures into his job responsibility indirectly through policies such as the clean air act, imposed to prevent the effects of global climate change. This stakeholder continuously stays aloof of the most recent research concerning climate change so that he can make changes in his company in anticipation of new policy. Climate information, however, does not factor directly in his day-to-day decision-making, despite the apparent relationship between heat waves and the demand for electricity related to air conditioning systems.

Water Providers (11 interviews)

Nine of the eleven water providers we interviewed relied on groundwater for their water supplies. While we only spoke with two surface water providers, there did appear to be significant difference in how groundwater providers and surface water providers view climate.

Although groundwater supplies are vulnerable to climate change, the impacts of climate variability on these supplies may not be immediately discernible. Thus, groundwater providers often resembled emergency response interviewees in their sensitivity to climate impacts and need for climate information. For example, short-term events have the potential to damage infrastructure, thereby representing a day-to-day concern. In contrast, the issues surrounding the long-term impacts of climate on groundwater supply are often beyond the temporal scope of their decision-making and planning. Within this context, water providers expressed little concern for climate relative to other organizational and institutional factors.

For example, one major factor in how water providers view climate was their place in the hierarchy of decision making and organization. Those who initiate decisions, such as hydrologists or engineers, typically pay closer attention to climate factors in meeting the responsibilities of their job. Although lower-level decision-makers sometimes reported an awareness of the connection between climate and the responsibilities of their job, they generally did not see climate information as important.

We spoke with one large and one small surface water provider. As mentioned, their perceptions of climate differentiated them from groundwater providers. Unlike groundwater providers, surface water suppliers regularly consult information on snow-pack, reservoir levels, and evaporation rates to assist them in calculating allocations. This figures are used on a daily, weekly and seasonal basis. The large surface water provider, for example, uses water reports on inflow, storage, release and diversion to canals for his daily operations of the reservoir system. He also considers seasonal and yearly forecasts, based primarily on snow-fall, to design the operations plan for the following year. For instance, in advanced warning of a drought, he will begin to supplement surface water supplies with groundwater. He does not, however, consider climate as a factor of long-term sustainability. "Conservation," he explained, "is the responsibility of local authorities." He continued to say that his company is simply following their legal obligation to supply water.

The small surface water provider to whom we spoke demonstrates how other institutional factors influence decision-making. As a water commissioner in a medium urban city, he is constrained by the Global Equity Decree, established in 1935 by the U.S. District Court, which prioritizes the allocation of Gila River water in times of drought and sets "maximum diversion rates" in times of excess. His principle responsibility is to apportion water based on the guidelines of the decree. A water and waste water operator in one of a rural private towns also operates under institutional constraints. He indicated that he acts in response to the town council's desires rather than in response to the climate, although extreme climate events often cause damage to infrastructure such as pumps or the lagoon's levee, for which he is responsible.

Gaps in Current Climate Information Systems

One goal of the pilot stakeholder assessment was to integrate feedback from the responding stakeholders into the process of developing the core office's climate information system. To this end, the assessment identified information "gaps" in which further research or a more effective dissemination of data would prove useful to stakeholders. Gaps in the climate information systems of the Southwest are of two types. First, the gaps can represent information stakeholders perceive as unavailable where access to the relevant climate information system is difficult. Second, the gaps can represent climate information that is actually not available to the stakeholder communities of the Southwest. Both types are discussed below.

Gaps in climate information systems occur for various reasons. Gaps may be the result of a stakeholder's lack of familiarity with the availability of climate information, which either reflects the user's lack of access to resources needed to search for information or the producer's failure to make the information sufficiently available. In many cases the data are available, but the accuracy may be insufficient for the needs of the users or, similarly, the geographic resolution of the data may be incongruous with the scale at which users operate. Finally, a gap in information may be primarily the result of the institutional constraints of a specific agency or organization.

Gaps are described by stakeholders in as many as three dimensions; topic, space, and time. Stakeholders may identify a need for more information in a particular topical area or may note that they lack information pertinent to a specific geographic area. The temporal frequency and range of data are another critical factor mentioned by stakeholders. Stakeholders who have a complex understanding of climate information may articulate their information gaps in terms of all three dimensions, while other stakeholders may only mention one or two dimensions.

What follows is a general discussion of information gaps and a more detailed account of gaps within each occupational category.

General Gaps

In general, climate information users who rely on conventional, tightly packaged sources (such as TV, radio, and newspapers) felt the information they already consult are sufficient; those using more complicated climate information, such as "raw data," often cannot find enough climate information to suit their needs. In other words, those who only consult basic climate information or weather forecasts generally need less information while those who used complex climate data need more climate information.

Many respondents reported a lack of pertinent historical climate information (see Table 2.1). Historic climate data are of particular use to farmers, land managers, and water providers who wish to establish a norm for their particular region. Participating stakeholders often indicated that they were aware that these sorts of data exist but were unable to locate or acquire them. One land manager complained that he is unable to find a complete fire history for his area for the past five years, which hinders his ability to justify his fire prevention budget.

Table 2.1 Information Gaps by Temporal Scale[6]

Temporal Scale	Number of Gaps
Historic and Provisional	95
Real-time	42
Predictive	64

The most prominent gap, however, involved the spatial scale of available data. Climate and weather are highly variable in the Southwest, and localized microclimates dominate many regions. Consequently, data on weather and climate which often originate in larger urban centers are generally not appropriate to the small microclimates in the peripheral areas. This issue was central to nearly half of the of gaps identified by stakeholders and, based on three interviews with BIA officials, appears to be an even greater problem on reservations.

Table 2.2 summarizes the number of "gaps" identified for several topical areas and the number of respondents those gaps represent. Note that an individual often indicated more than one gap (the number per individual ranged from 0 to 4). Data on precipitation and "general climate"

[6] Note that respondents often cited more than one information gap.

overwhelmingly represented the areas of largest need. The gaps identified for precipitation range from one stakeholder's need for site specific, predictive information on precipitation patterns as well as real-time conditions at weekly intervals to another stakeholder's need for general fifty-year precipitation outlooks. "General climate" was added as a category for stakeholders who have a variety of needs that they were unable to specifically articulate. Gaps identified in this area include information on global climate change, general yearly outlooks, and spot weather forecasts. One stakeholder simply responded that he would like "anything" that was specific to his town. The number of needs in this category probably indicates a general lack of familiarity with climate information, as well as a variety of access problems reported by the respondents.

Table 2.2 Information Gaps by Topic

Information type	Numbers of Gaps	Number of Individuals
Air/wind	7	7
Drought	4	4
Evaporation	1	1
Flood	5	5
Flora and fauna	2	2
General climate	25	20
Groundwater	2	2
Hydrology	1	1
Precipitation	26	17
Snow-pack	5	5
Soil	1	1
Streamflow	5	5
Temperature	2	2

Miscellaneous Stakeholders (12 interviews)

Miscellaneous stakeholders are one category in the matrix variable *occupation* (see Chapter One). The category was added to insure that a representative of a town or city's dominant economy would be included in the interview schedule. Miscellaneous stakeholders, therefore, are a diverse group that includes farmers, ranchers, factory operators, and natural park managers. Generalizations about this group are difficult to make given the range of their concerns and needs. However, the gaps identified by this category of respondent are important to recognize. This is especially true for the four farmers we interviewed in this category.

The pilot survey revealed that farmers, like other stakeholders who rely heavily on factors other than climate to make decisions, demand a high accuracy of predictive information. While farmers noted the primacy of the market in their decision making process, they also suggested a variety of hypothetical climate and weather information products that would be useful. Despite significant differences in the technological sophistication of the respondents, the participating farmers also displayed a general unfamiliarity with available climate information. Participating extension agents, a primary information source for farmers, also demonstrated a lack of familiarity with climate information systems in the Southwest. This situation suggests insufficient networks between extension agents and agencies such as the Bureau of Land Management or the United States Geological Survey. Ironically, extension agents also identified the University of Arizona as an institution with which they seek improved access. Clearly, expanding interactions between the Cooperative Extension (USDA) and the University-based research community will improve the flow of information to the stakeholder communities of the Southwest.

Finally, farmers often expressed a specific need for better or additional information on minimum and maximum temperatures, seasonal forecasts, climate and crop conditions in other regions of the world (particularly salient for export-oriented farmers), historical rainfall and temperatures for their microclimate, and more timely warnings of major climate events. Word-of-mouth was often cited as an important mechanism for disseminating information in these areas, but farmers would like to see a more formal, quality-assured method for obtaining these data.

Of the two interviews conducted with ranchers, information on precipitation patterns appeared to be most significant to their operations. All decisions are made on the anticipated amount of fodder which is almost completely contingent upon precipitation patterns. Fall and spring are critical times for this information when ranchers must regulate the number of calves and cows in the herd. One rancher also suggested that scientific reports should be made more widely available and that their content should better reflect the concerns of ranchers in Southern Arizona.

We also conducted one interview with a representative of the mining industry under the category miscellaneous stakeholder. This respondent is responsible for the construction of new facilities, infrastructure planning, and all water management issues, responsibilities which require careful long-term planning and a consideration of climate variables. On a weekly basis, this individual must calculate figures for average rainfall, and based on these figures, decides how much water to remove from the mining pits through evaporation or pumping. The problem he has encountered with this method, however, is that the data available do not include figures for anomalous rain, which compromises the accuracy of his calculations.

Emergency Response Management (10 interviews)

As emergency response managers are reliant on real-time and predictive climate information, most of the gaps they identified were of a similar character. Furthermore, individuals in this group must rely on quick decisions and rarely have time to interpret data. A great majority of the ten respondents in this category noted a need for concise summaries of weather conditions and estimated impact on their particular region. Like most stakeholders, emergency response managers report difficulty finding up-to-date weather information for their microclimate. Many of the emergency management respondents asked if CLIMAS could provide a call-in line for them. In terms of real-time data, the velocity and volume of streamflow, and the intensity of precipitation constitute the sort of information most commonly requested by emergency response managers.

Emergency managers tend to be very cynical of predictions as reflected in one respondent's commenting that, "Mother Nature does what she wants and we cannot try to control her." This stems from previous experiences where the teams have prepared for predicted events that never occurred, such as the predicted impact of Hurricane Nora on Southern Arizona in 1997. One emergency manager recalled how, on account of a prediction for sixteen inches of rain from Nora, he was forced to expend time and energy on an elaborate disaster preparedness plan despite his suspicions that the storm would not cause a drop of rain. Similarly, El Niño has created much cynicism in the Southwest among this group. The media hype created expectations that never materialized in some regions, resulting in seemingly wasted preparations. However, since emergency response managers have no other choice but to consult weather predictions, they hope for more accurate long-range forecasting information systems that will enable them to better prepare for events. Furthermore, since most emergency response managers are also fire or police chiefs, extended forecasts allow them to coordinate employee training for particular climatic events or conditions. One such stakeholder said that if he knew it was going to be a dry year, he would train his men for the health emergencies typical of dry weather, as well as allocate resources for a greater number of fires than usual.

Major topical areas identified as information gaps by emergency response managers included real-time streamflow (more gauges are needed), estimated intensity of rainfall, predictions of the duration of drought, and up-to-the-minute reports on fire and storm activity. Also, historical data on fires and floods are often difficult to find for the microclimates of the Southwest. Such information will help emergency response managers justify their budgets.

Land Managers (12 interviews)

As mentioned, the twelve land managers we interviewed consisted of both users of basic and complex climate information. This division is articulated by the split between range land or fire managers (who generally qualify as complex information users), and urban land or state park managers (who consult little to no climate information in their decision-making). Land managers, who often hold positions in government agencies as well, reported a lack of sufficient civil resources to pursue climate information. Land managers are often unsure where to find the information they seek or simply cannot afford to spend the time to acquire the information. With limited resources, they are particularly critical of the slow and cumbersome process of obtaining data from organizations such as the Western Regional Climate Center located at the Desert Research Institute in Nevada and the United States Geological Survey. Three of the respondents in this category also mentioned The University of Arizona as a difficult source of information. Improving linkages between the this particular stakeholder community and the University would directly improve ability of land managers to make informed decisions about long-term management strategies.

Participating land managers mentioned difficulty obtaining several particular types of information. Archival and historic climate data were frequently mentioned as useful but elusive information to locate and obtain. Land managers also mentioned air quality data, long-term forecasting which considers impact on local ecology, any site-specific information, consolidated temperature and rainfall data, and any local reports as areas in which they would like to see more or improved information.

Public Officials (10 interviews)

Although public officials are almost invariably basic climate information users (see discussion at beginning of the chapter) , four stakeholders in this category did express an interest in studies that have been done in their local area. One politician commented that he has noticed a cycle in the climate of the region around Safford and would like to see a study done on this matter. Another public official expressed interest in reading reports on the water supply of the Colorado and the potential impacts of severe drought on southern Arizona.

Many public officials are currently unsure about the potential impacts of climate variability expressed a willingness to learn more about the subject. They simultaneously expressed their desire for a clear and concise discussion about climate, the environment and the economy. Public officials generally expressed that they do not have the time or impetus to pursue this material themselves, but nearly all claimed they would glance at it if they found something of this sort in their mailbox.

Utilities (2 interviews)

Of the two respondents in the utility sector, a representative of an electric power company noted that federal regulations stemming from climate-related policy could directly affect his position. These regulations might lead to a shift away from coal-based energy to more sustainable energy sources. This respondent emphasized that better access to reports and information on global warming would be of great use to other stakeholders in similar occupations.

Water Providers (11 interviews)

Although water providers' climate information needs vary significantly, one prominent trend did emerge from the interviews. Much like the farmers interviewed for this study, water providers rely heavily on factors other than climate to make decisions, and consequently, water providers generally require more accurate or precise climate outlooks to supersede these factors.

From our sample of eleven water providers, it is difficult to assess which water providers have greater needs based on the variables that were determined for this study. Surface versus groundwater, urban versus rural: neither distinction clearly separates those with greater information needs from those who do not consider climate an important factor. While it may appear that agricultural water providers are more likely to value climate information than urban suppliers, anecdotal information gathered during the pilot study suggests that this may not be true. Rather, as one water provide from a small town concisely stated, "Agriculture doesn't have a future here, but urbanization does. Real long-term information on water supply will be needed to accommodate the needs of an urban lifestyle..."

The size of the water provider, however, does appear to determine the company's capacity to use climate information. Large water providers generally value climate related data and have the resources to collect and integrate this information into their decision-making. Consequently, large water providers identified more gaps, on average, than smaller water providers. This correlation should not, however, be interpreted to mean that large water providers have a greater need for more climate information than smaller ones. The situation may actually be quite the opposite.

Climate Data Collected by Stakeholders

In the interview, we asked stakeholders if they collected any of their own climate-related data, and if such data might be made available to the public. Of the 58 matrix interviews we conducted, sixteen of the respondents do collect climate-related data of some kind. The types of information most commonly collected are precipitation and temperature data. In addition, stakeholders often collect data particular to their occupations; the depth-to-groundwater data collected by water providers is a good example of this. For the most part, these data-collection efforts are informal – they lack the verifiability and consistency to be useful to scientists or the public. One notable exception is the data collected by National Weather Service stations to which some stakeholders contribute. These data are currently made public through the NWS. These collection efforts reflect a significant interest in climate and weather in the stakeholder communities of the Southwest. The particular collection efforts of each occupational category are detailed below.

Miscellaneous Stakeholders (12 interviews)

Six of the eight miscellaneous stakeholders we interviewed collected various types of climate data, according to the informational demands of their occupation. Overall, temperature and precipitation data were most frequently collected. Examples of such data collectors and the intended use of the data included: a mining engineer for ASARCO uses data for water models and report preparation; a University of Arizona Extension Agent helps ranchers understand range trends; a golf course superintendent seeks to understand water consumption on his greens and fairways; and the manager of a nature preserve seeks to understand the relationship of climate to stream flow in Sonoita Creek. The most advanced generator we interviewed is a consultant at Fort Huachuca who collects extensive data on the ecological condition of lands on the base (including monitoring plots, belt transects, a complete botanical inventory, etc.). The remaining four respondents collect no data at all.

Emergency Management (10 interviews)

Only two of the ten emergency response managers interviewed collect their own data. These fire chiefs and town marshals are mostly basic climate information consumers rather than generators of information. The exceptions were a fire department that hosts a weather station for the National Weather Service and another that uses portable equipment to record weather information during emergency events. The latter also generates fuel loading maps order to predict the geography of brush fires for upcoming fire seasons. They create general maps based on visual observation of range conditions within their district.

Land Managers (12 interviews)

In general, federal, state, local, and private land managers focused on the informal collection of temperature and precipitation data only. A notable exception to this was a hydrologist with the Bureau of Land Management who is responsible for maintaining a network of temperature and precipitation gauges at locations throughout southeastern Arizona since 1978. Several of these sites include hygrothermographs and anemometers. He also maintains a number of stream gauge stations used in conjunction with the weather stations. He has entered most of these data into a computer database which is available to the public.

Public Officials (10 interviews)

Public officials report the collection of little or no climate information. Both of the respondents we interviewed who are responsible for sewage treatment plants do monitor and record temperature and precipitation to understand treatment processes. The data collection methods are, however, informal and not amenable to public dissemination.

Utilities (2 interviews)

Of the two respondents in this category, only the representative of the electric company collects climate data. His company is considering wind-powered generators as an alternative to coal burning and they are developing a research institute to collect wind data that will assist them in this project. This respondent said that he would gladly share the information they gather with the core office.

Water Providers (11 interviews)

Based on our sample, most water providers do not collect climate data. While nine of those interviewed acquire water through groundwater pumping, only three record the depth-to-water measurements with any frequency. Most of these stakeholders only gather data on water production rates. Among smaller water provider, the absence of data collection corresponds with the relatively low importance that this group attributes to climate. As mentioned previously, groundwater providers make most of their water management decisions based on political and demographic factors.

We did find, however, that among larger providers, like Tucson Metro Water, data collection is common. Tucson Metro records depth-to-water data as well as production and groundwater recharge rates. As a large surface water user, the Gila Water Irrigation in Safford also records monthly diversion flows.

The disparity in the capacity to collect and analyze climate-related data between large and small providers has, of course, implications for climate vulnerability. The capacity to collect and analyze data accurate in the immediate area may significantly improve large water providers' ability to adapt to climate variability.

The Core Office

Every respondent was told that the pilot stakeholder survey was linked to a core office, located at the University of Arizona. They were informed that the core office would focus on climate variability and change and would primarily serve as a clearinghouse and reference center[7].

Each respondent was asked 1) how he or she would prefer to access the core office, 2) what content would be most useful in a newsletter, and 3) what topic would be best for a workshop. The questions were not structured which resulted in a wide variety of responses. Some respondents did not answer every question in this section.

Information System

When asked about access to the core office, 83% of the respondents said they would prefer to be linked to an information system through either a web site, toll-free telephone number, and/or newsletter (see Table 2.3). Approximately half of the respondents who mentioned the Internet as a method for communicating with the core office expect to get the information or data they are looking for at the core office's site and the other half only requested links to other sites. Approximately ten stakeholders expressed needs for services that are beyond the planned scope of the core office's activities. For example, emergency response managers commonly requested a facility they could call for an up-to-the-minute report on weather conditions anywhere in the state. Most other stakeholders who requested a phone service, however, simply wanted a referral to the proper organization, a small portion of data, or the answer to a question within two weeks. Two out of the three farmers interviewed suggested fax as a medium of communication with the core office, implying that fax may be important for linking this group to an information system.

Table 2.3 Preferred Method for Accessing the Core Office

Mode of Access	Number of Respondents
Internet	13
Phone	13
Newsletter	7
Fax	3
E-mail	3
Radio	1

Newsletter

A great majority of the individuals interviewed strongly supported the circulation of a newsletter and offered their suggestions for its periodicity, content, and format. Of those that commented on the periodicity of the newsletter, 60% suggested a weekly or monthly circulation. Several stakeholder also suggested a bi-yearly or seasonal newsletter. Generally, those supporting the idea of a newsletter said that they would spend ten to fifteen minutes reviewing the information in each issue. Clearly, the format of the newsletter should be concise.

[7] The core office also engages in basic and applied research, has a major role in coordinating CLIMAS research activities, and develops networks with entities in government and academia as well as in the private sector.

In terms of content, suggestions were widely varied. One respondent suggested that the newsletter serve to educate participants on the effects of climate change, one respondent wanted a summary and subsequent updates of available data sources, and one respondent wanted regular updates on current and predicted droughts. Three respondents wanted updates on precipitation forecasts for their local area. The desire for local coverage was a clear theme as 60% of those who mentioned spatial resolution asked that the information contained in the newsletter be at a city level. 50% of respondents requested that the data cover a greater time period than a month (for the purposes of this report, any information extending beyond a month is considered climate). Two respondents also expressed interest in weekly reports of the historic average precipitation and temperature for their region.

Although the feedback gained from stakeholders regarding the newsletter has been extremely informative, the core office should continue to solicit ideas and suggestions for the newsletter in order to make it as useful as possible to a wide variety of stakeholders.

Workshops

Approximately one-fourth of the respondents said they would attend a workshop if they found the topic relevant to their positions and if the workshop was held in a timely fashion.

Of those who suggested a topic for a workshop, nearly 40% want assistance finding climate information from a variety of different sources, interpreting this information, and applying it to their occupations (see table 2.4). Another 17% of respondents are curious about the accuracy of current forecasts. As a related topic, two respondents want information on how forecasts from urban centers can be effectively applied to the small towns in which they work.

As the CLIMAS research team has proposed, an evaluation of forecast accuracy would be a great benefit to many these stakeholders. An evaluation of this sort could answer numerous questions posed by stakeholders concerning what type of forecasts are most accurate, when forecasts are most accurate, and what sources are the most reliable.

Table 2.4 Suggested Workshop Topics

Topic	Number of Suggestions
Finding and Using Climate Information	9
Accuracy and Limitations of Forecasts	4
Applying Forecasts Locally	2
Seasonal Weather	2
Other	6

CHAPTER III

THEMES

This chapter synthesizes the findings of the study into general themes. These themes pull together stakeholder responses to provide a overview of the salient issues that emerged from the interviews.

Complexity and Frequency of Information Use

As we expected, the complexity and frequency of climate information use varied between and within stakeholder communities. This variation can be characterized to describe several categories of climate information users.

For the purposes of this study, we have defined **complex information** as that which originates from sources beyond the conventional climate information systems (such as TV, radio, and the newspapers). Conversely, we are referring to information acquired through conventional information systems as **basic information**. The Local Climatological Data from the NOAA National Climate Data Center is one example of a complex climate information system, while radio and television forecasts are examples of basic information systems.

The frequency of information use is also an important distinction between stakeholders. A **frequent user** is defined as one who consults climate information regularly, typically on a daily or weekly basis, while an **infrequent user** consults climate information irregularly or less often than weekly.

It was found that complexity and frequency do not necessarily correspond, but rather that numerous possible combinations exist (see Table 3.1) For example, both users of complex and basic climate information may consult climate information systems infrequently. The distinction between complexity and frequency of use generally corresponds to respondent occupation. As shown below range land managers, who consult historic averages for rainfall, temperatures and soil moisture, use complex information systems such as USGS and NOAA, but do so infrequently (maybe on a monthly or seasonal basis). Discrepancies in this pattern are often explained by the size of the town or city in which the respondents work; smaller towns reported limited access to climate information. This is true in the case of emergency response managers. In smaller towns these individuals did not have the capacity to consult complex information systems regularly and so rely daily on the radio and TV for their weather and climate information needs.

Information Use and Vulnerability

Complexity and frequency of climate information help delineate the core office's potential clientele and the best way to serve them. Frequent users of complex information clearly have greater needs than infrequent users of basic information. This is not meant to suggest, however, that the core office ought to ignore current non-users; indeed, they may be highly vulnerable to climate variation and climate change. The degree of stakeholder vulnerability, even for current non-users, should be factored into to the core office's client-targeting decision.

Water providers represent the group which may be most vulnerable despite their basic and infrequent use of information. We assumed water providers to be one of the categories in need of better climate information, yet this category was found to be comprised of both users of basic and

complex information, perhaps because some water providers do not see a clear connection between climate and their operations. For these users, climate falls low on their list of priority concerns, especially in cases where they see themselves as having been insulated -- rightly or wrongly -- by construction of the CAP and the enactment of the Groundwater Management Act which regulates groundwater pumping in areas of high demand.

The varying ease of access to pertinent climate information further complicates the ability of stakeholders to use complex information. One respondent, a general manager of a water company of a medium urban city, reported actively pursuing climate information, usually to no avail until he recently stumbled upon the evapotransporation rates he has been seeking on the Internet. The respondent remains receptive to climate information, but he still lacks adequate information and the information-gathering experience to integrate climate factors into his decision-making. In another example, the general manager of another water provider suggested that climate did not figure largely into the decision-making process of the organization, despite the volatile water issues that surround the city's aquifer.

Table 3.1 Climate Information Use Patterns by Occupation

	User of Basic Information	**User of Complex Information**
Frequent User	Emergency Management (Small town) Utilities Farmers	Emergency Management (Large City) Water Provider (Surface Water) Farmers
Infrequent User	Water provider (Groundwater) Public officials Land Manager (State park mangers, developers)	Land Manager (Range Land Management)

Summary

In sum, indicators of the complexity and frequency of climate information use suggest those stakeholder communities most likely to make use of the CLIMAS core office. At the same time, it is important to take into account those individuals who, although lacking access to and/or knowledge of existing climate information systems, may be vulnerable to climate change and variability. These stakeholders might benefit significantly from the core office's services in the future (See Chapter IV for a more detailed discussion).

Temporal Scale of Climate Data — Weather vs. Climate Information

Although nearly all the respondents demonstrated an interest in the interview topic, the type of information they used and needed varied greatly. One component of this variation was the temporal scale of climate data in which the participants expressed interest. Interviewees expressed a need for a range of climate information products, including paleoclimatic records, "real-time" measurements, and both short-term and longer-term forecasting. While all participants expressed curiosity about climate, the interviews revealed a distinction between those who rely on weather information and those who have a need for climate information of a broader temporal scale.

As indicated in Chapter Two, weather and climate have been given specific definitions for the purpose of this study. **Weather** is defined to include events occurring from the present moment to a maximum of 30 days, and **climate** as patterns of events that extend beyond 30 days. Respondents who used historic data to identify extreme events were identified as weather information users, while those stakeholders interested in identifying trends or establishing a "norm" from the historic record were identified as climate information users. Based on this distinction, approximately half of all respondents expressed a need for climate information or predictions.

Reliance Upon Short-Term Forecasts

The bulk of the interview participants rely on the mass-media for climate-related information and weather predictions. They often conceptualize climate trends in terms of "global warming", yet make decisions based on the weekly forecast. All participants expressed at least some level of climate "consciousness," regardless of occupational category or decision-making capacity. There was less reliance on long-term climate forecasts than expected, however, as was the case for both the extent of current climate information use and the expressed need for climate information. Short-term weather forecasts were widely used among those interviewed and appeared to be of greatest utility in day-to-day decision-making. This information need was largely satisfied through existing media outlets (such as the Tucson television stations).

Beyond the ubiquitous use of mass-media forecasts among interviewees, users of complex climate information emphasized a need for improved short-term predictive forecasts. Many interviewees indicated that they go beyond the regular media outlets to consult the National Weather Service or NOAA by weather radio, Internet, or telephone.

Emergency response officials provide an example of a complex need for short-term forecasting. Several respondents expressed an interest in better tracking and prediction of convective storm cells during the summer monsoon season. Many of these officials currently utilize an Internet web page featuring Doppler Radar images of storm cells, which they used to improve their ability to predict locations where emergency response might be needed. These attempts to "fine-tune" local forecasts corresponded with a wide-spread desire to better understand what, when, and how local atmospheric conditions might develop.

Another example of an entity needing accurate short-term forecasting is the local natural gas utility in Tucson. A planner for the local office of this company must decide roughly four days in advance how much gas to purchase through a pipeline from El Paso, Texas. Using company-generated 14-day weather forecasts, this planner attempts to meet peak demands without overbuying and compromising profits. However, like the emergency management agencies mentioned above, even the need for more complex information articulated by this respondent was limited to short-term weather forecasts.

Reliance Upon Climate Data of Broader Scope

The pilot study team identified several occupational groups which expressed a need for climate information with a long temporal horizon. This broader interest correlates in many cases with how sensitive the user is to climate variation. The decision-making capacity of stakeholders in the face of such variability may also be a factor with regard to the temporal scale of the information needed. In general, stakeholders who manage land or whose farms appear to be sensitive to climate variability have the decision-making capacity to incorporate information of a broader temporal scope into their operations. A farmer's cotton crop, for example, is extremely sensitive to temperature changes and precipitation during the planting and harvesting season. Climate information projecting average temperatures 30 days in advance, or climate information using historic averages to identify the likely start date of the summer monsoons, could help a farmer make sound decisions about seed

variety and planting dates, thereby mitigating some of the inherent climate vulnerabilities of farming. Likewise, a rancher or federal land manager who must oversee the long-term health of grazing lands may have a greater interest in information extending into the future or information documenting the past beyond the daily or five-day weather forecast.

Summary

The temporal scale of the climate information used or needed by the respondents varies greatly. Certain sectors, such as farming and land management, demonstrated a need for information of a broader temporal scale, in part due to their climate sensitivity and long-term decision-making capacity. The stakeholders of southern Arizona appear to need more spatial and temporal accuracy in forecasts extending no further than a month. This is best characterized as "weather" rather than "climate" information. Although this pilot assessment did not set out to distinguish between these types of users, it may be useful in the future to do so. This shift in focus might reveal that the limited use of historic or longer-term forecasts was in part due to institutional constraints, short decision-making or planning horizons, a failure on the part of stakeholders to perceive the implications of larger-scale climate variability, or additional factors.

Spatial Resolution of Climate Data

Many of the people interviewed in the pilot study expressed dissatisfaction with the way climate information systems portray rural climate conditions. There is a sense of metropolitan bias in the information they receive and rely upon, particularly for those interviewees located some distance from the metropolitan centers of Tucson or Phoenix. This trend is particularly prominent with users of basic climate information (who typically rely solely on television and radio forecasts from large metropolitan centers). Such dissatisfaction, which ultimately derives from the spatial resolution of short-term forecasting, also applies to users of more complex information, such as emergency response personnel.

Arizona's Summer Monsoons and Where Information Falls Short

Results of the pilot survey indicate that, in southern Arizona, the dissatisfaction with short-term forecasting is often related to the prediction of convective storm cells during the summer-monsoon season. Because these storms are highly localized, they are notoriously difficult to predict. One stakeholder, an emergency management official, noted that his town was particularly vulnerable to flooding. Reports on the location and intensity of storm cells provide vital predictive information for emergency preparation. The town's reception of the signal from Tucson television stations is weak, however, and the forecasts produced by these stations (and by the National Weather Service) do not adequately represent local conditions. This stakeholder, like many others in rural locations, wishes that his town could obtain more specific predictions and of local weather.

This issue of spatial resolution was raised primarily by those stakeholders who rely on short-term forecasting. The relative paucity of users of complex information in this study prevented us from better understanding whether spatial resolution might also be an issue for those relying on longer-term forecasts or historic data.

Summary

While the question of spatial resolution was a common one, especially regarding prediction of monsoon storm cells, the reasons for the dissatisfaction with storm predictions reside very much in the phenomenon of the monsoon itself. Current forecasting fails to accurately predict the behavior of

these systems with much accuracy, as current technology does not allow precise forecasting of the monsoon storm cells. Other issues of spatial resolution and local coverage (like local wind direction and speed) may be less difficult to address theoretically, but they require capital expenditures for remote weather stations. Because of these problems, the need for better microclimate information was frequently expressed by the participating stakeholders. Access to accurate microclimate information is particularly essential to those occupational groups responding to short-term predictions.

Constraints to the Use of Climate Information

As we have stated before, most people we interviewed expressed an interest in climate at some level, perhaps because most stakeholders recognize that climate impacts their jobs and/or livelihoods in some fashion. However, beyond this recognition there is a great deal of variation in the use of climate information to comprehend or mitigate these perceived impacts. This variation can be partly attributed to institutional and personal constraints resulting from the stakeholders' occupational activities.

Climate Sensitivity and Information Use

This study did not seek to understand the climate sensitivities or vulnerabilities of interviewees *per se*; rather, we sought a better understanding of access to and use of climate information systems. Through our questions about how climate and climate information affects job responsibilities, however, we were able to generally gauge the impacts of climate variability on various stakeholders and occupational categories. As may be expected, the climate sensitivity or vulnerability of a stakeholder appears to constrain the degree to which he/she uses climate information. For occupation sectors like farming, the relatively high sensitivity to climate drives individuals to consult varied sources of information.

An emergency management official in a medium urban provides an example of low climate sensitivity and the use of basic information. For this official, the bulk of his workload (emergency medical calls and household fires) is not particularly climate-sensitive. Even those climatic events (such as flooding) that might cause problems are not a particular concern because the location, infrastructure, and design of the city puts it largely out of harm's way. In this case, a lack of vulnerability translates into a perceived lack of need for and use of climate information. Alternatively, one small, family farmer we interviewed appeared highly sensitive to climate, yet he only consulted basic climate information. Two factors explain this. At the time this individual lacked a computer, an essential tool for access to many of the climate information systems. Furthermore, this individual feels skeptical about climate information products which he has associated with the "politically motivated" global warming literature.

Decision-Making Capacity and Information Use

In addition to the sensitivity or vulnerability of stakeholders, the decision-making capacity they possess in the face of climate variability is also a major constraining factor in information use. While most interviewees perceived that climate had an impact on their livelihoods at some level, not everyone had the same capacity to respond in meaningful ways.

Certain stakeholders possess the ability to make decisions and alter their course of action in the face of climate variability. For these people, having appropriate climate information at the appropriate time can facilitate good decision-making and help them avoid adverse climate impacts. For other stakeholders, the best climate information available will not be of use because they do not possess the capacity act upon it. In essence, these people's hands are tied. In many cases, relevant

decisions are made elsewhere; in other cases, there are no viable alternatives to the current course. The ability or inability to make decisions, in particular settings, are referred to as *organizational constraints* because the structure of the organization in which they work often enables or constrains what choices can be made in a variety of climatic circumstances. In one case, a biologist was hired by a military base to direct a long-term ecosystem management project which was canceled soon after his arrival. This individual has continued to build a detailed database of the local ecology, but has no capacity to affect land use in the area.

As might be expected, organizational factors create variation in the type of climate information needed. Those who have decision-making capacity, like farmers and land managers, are more likely to use climate information because it may prove useful in selecting appropriate courses of action. For these stakeholders, greater quantities of climate information improve their position.

Stakeholders in the service and tourism industry, however, are faced with a vastly different scenario. For the owners of resorts and other facilities that depend on tourist revenue, cold or rainy weather in Arizona may translate into a significant decline in business. As the study participants indicated, even their best efforts to recruit clientele through marketing and lowering rates during periods of unpleasant weather rarely succeed in improving the market.

Perception of Climate and Climate Information

Perceptions of climate and climate information play an integral role in determining whether stakeholders incorporate climate information into their decision-making and planning. Many of the respondents expressed a fatalistic attitude about climate and doubt concerning the ability of forecasters to make accurate predictions. Other stakeholders were less skeptical about climate research and forecasts, but still did not perceive a link between such information and their professional occupations.

For some of the interviewees, climate was an easily-recognized factor in their livelihoods; it took little prompting for them to sketch out the connections between climate, climate information, and their job responsibilities. Others lacked interest in the connection between climate and their livelihood (even in situations where we, as interviewers, perceived direct connections). While the degree of stakeholder curiosity is not measurable, we quickly recognized a strong tie between climate curiosity and the use of weather information. Certain stakeholders are not particularly vulnerable, do not have decision-making capacity, but nonetheless frequently consult climate information. Others are aware of climate but made little effort to seek climate information.

The inability of some interviewees to use climate information in these cases appeared to relate to the fatalism and skepticism mentioned above. An emergency management official in Tucson expressed this sentiment in the following statement: "You can make guesses about climate, but Mother Nature will do what she wants." Other interviewees used the example of the recent predictions about Hurricane Nora to express skepticism about climate and weather forecasting. This hurricane was predicted to produce heavy rain and localized flooding in some parts of Arizona, including Tucson. Many emergency response officials prepared for this event only to have no precipitation fall at all. "The sand bags are still in my trunk," commented one fire chief.

Some may be skeptical because of inaccurate predictions. Such examples, however, may simply confirm existing attitudes about climate and climate predictions held by those who are skeptical in the first place. Although not all stakeholders share this perspective, this does demonstrate how personal viewpoint appears to be an important factor in constraining how individuals value climate and various climate-information products.

Economic Constraints

Some stakeholders do not consult climate information because they cannot afford the time or materials (i.e. computer, Internet access) required to locate the information. One federal employee responsible for monitoring range conditions complained that he is not in direct connection with the University of Arizona and therefore has trouble locating reports. He added that he simply does not have the resources to send someone to the library and he would be greatly assisted by the Core Office if they could index materials relevant to his position. Two of the farmers we interviewed did not have Internet access. The cost of buying a new computer a exceeds the benefit they perceive they will gain from Internet access. Both farmers, however, felt as though they were obligated to eventually purchase a computer.

In general, we found that stakeholders in the private sector and those that work for federal agencies are most likely to face economic constraints. Municipal employees generally encountered other forms of constraints.

Climate and Other Factors in Decision-Making

For respondents who possess decision-making capacity in their jobs, businesses, and livelihoods, climate information was seen to be useful in selecting courses of action. However, for many of these individuals, climate was just one of many competing factors that go into decision making. For many of the interviewees, competing factors overwhelm climate in importance and thus constrain the use of climate information. The following topics exemplify the sorts of competing factors that exist:

Politics. In the context of local government, political realities often subsume climatic factors in decisions affecting public resources. While the political exigencies behind such decisions are often short-term in nature, climate information inhabits the longer time scale of coming years or past decades. A city council representative who focuses on natural resource planning responded adamantly in discussion of the possible use of tree-ring records for the long-term understanding of climate and the city's water resources: "You may be looking at tree-ring data, but down in City Hall they're not."

Demographics. In the rapidly-growing Southwest, meeting the demands of the expanding population dominates planning. Water providers offer a good example. All urban water providers we interviewed rely upon groundwater sources. While these providers may not be as directly vulnerable to climate variability as surface water suppliers, one might presume that climate information would nonetheless factor into future planning. However, these stakeholders explained that planning is solely predicated upon the demographics of growth in customer base (calculated by extrapolating from past growth). Also notable are constraints posed by Arizona Corporation Commission rules that require private water companies to provide each customer with water of a specified pressure and quality. Citing such constraints, respondents representing private water companies did not perceive a significant role for climate information in future planning. In general, water providers noted that, even if future droughts could be predicted with reasonable accuracy, the demographics of growth provide a more reliable input into planning and decision-making than climate information.

Summary

A range of factors constrains the use of climate information by stakeholders. Some of these include low sensitivity to climate variability, lack of decision-making capacity (and other organizational and institutional constraints), personal bias or worldview, and a host of other competing factors. These constraints exist in a complicated mix particular to each individual or organization. However, certain occupational sectors exhibit patterns in the particular kinds of

constraints that exist on the use of climate information. We have given some examples of these patterns in the paragraphs above.

The explication of these constraints is not meant to imply that there are sectors of Southern Arizona society for which climate information will never be useful or needed. Instead, our focus on constraints assumes that the use of climate information is not solely determined by the quality of the products themselves, but also by the nature of the intended audience. The reasons people are constrained from using climate information are many, varied and complex. However, it is clear that such constraints must be understood both when identifying the actual and potential stakeholders of the CLIMAS research agenda and how to address their problems of climate information access.

Conclusions

The incipient themes from the pilot study give a preliminary view of the composition of stakeholder communities. The complexity of climate information use and the frequency at which users consult climate information systems largely follow occupational lines. The complexity and frequency of information use may not correlate with vulnerability. Rather, the stakeholders that do not consult climate information may be the most vulnerable and could receive substantial benefit from the capacity building and outreach activities of the core office. Several temporal and spatial themes are also of note. On the temporal side, weather, defined as a maximum 30 day outlook, turns out to be as important, if not more, to respondents as climate. Spatially, respondents expressed the frustration at the metropolitan bias of information. This bias neglects the very different climates of regions in Southern Arizona, subsuming them under the forecasts of Tucson or Phoenix. Finally, we found a range of factors that constrain the use of climate information in the Southwest. These include a low sensitivity to climate variability (real or perceived), the greater importance assigned to variables other than climate in decision-making, and the idiosyncrasies of individuals who, based on their own interests and motivations, either utilize or eschew climate information. These themes are all critical to understanding the stakeholder communities in Southern Arizona. We have only scratched the surface of many of these issues, and they merit further study.

CHAPTER IV

RECOMMENDATIONS

The National Oceanic and Atmospheric Administration (NOAA) and the Climate Assessment Project for the Southwest research group perceive the need to improve climate information quality and availability in the Southwest. The pilot stakeholder assessment supports this perception and pinpoints some of the climate information gaps and the salient climate challenges with which stakeholders grapple. The assessment offers a cross-section of different occupations in geographic communities of different size and different dominant economies to inform CLIMAS operations and research. In addition, the assessment has raised public awareness about CLIMAS and its potential as a climate information clearinghouse for the Southwest. The study demonstrates that there are some significant and well-defined climate information needs. The study also reveals that, although climate variability and change may affect a wide range of entities, climate information may not be incorporated into the decision-making process.

This chapter makes suggestions and recommendations for CLIMAS outreach and research activities, and it suggests new directions for further study. The chapter is organized into two sections: the first makes suggestions for the research group as a whole, and the second section makes recommendations for future social science research.

Research Group Recommendations

CLIMAS should respond to the heightened expectations of stakeholders.

One of the primary responsibilities of the CLIMAS core office is to identify and respond to the needs of stakeholders for climate information. We have addressed this by speaking to 71 people in a variety of occupations and geographical areas to find out how they are impacted by, and react to, climate and climate information. Many stakeholders were pleased that they were being included in the formative stages of the project. To paraphrase one rancher, this project is unique because, while many centers created for the community rarely consult the community, this project has made stakeholder feedback an integral part of its design and approach to research. Respondents are enthusiastic about the prospect of beginning a dialogue with climate researchers via the core office that will assist researchers in creating and disseminating the best information and will assist users in obtaining and understanding that information. Yet, CLIMAS must be cautioned that along with heightening interest about the project, expectations have also been raised. By design, the stakeholders have been drawn into the formation of the core office, and, seeing its potential benefits, now have a vested interest in the core office and its progress.

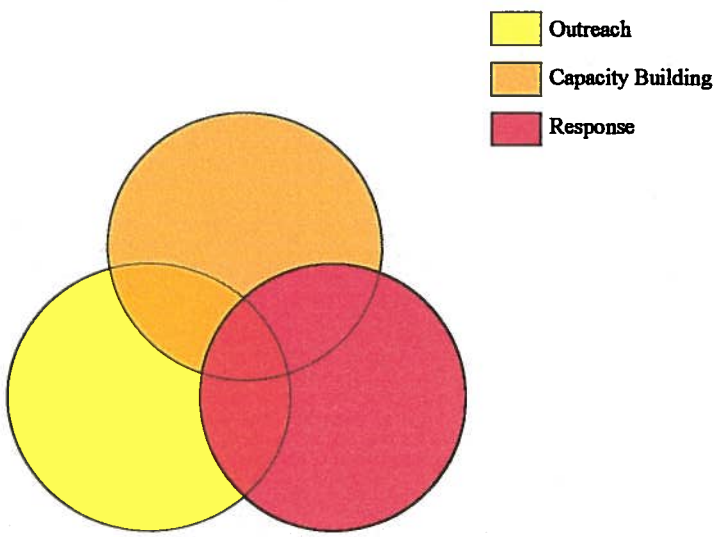
Given the heightened expectations raised by the pilot survey, it will be crucial to maintain contact with these respondents as research activities unfold. Since this study was completed the core office has begun to circulate newsletter updates to stakeholders about the core office's activities as well as about upcoming events and research findings. To ensure that these individuals have an opportunity to remain involved in research activities and in core office outreach efforts, the core office should continue to include stakeholders in all mailing lists of people designated to receive announcements, newsletters, and other communications sent out by the office. The stakeholder assessment team maintains an Access database of the addresses of interview respondents. It will be

essential for the core office to be supplied with an up-to-date copy of this database at all times We also strongly support the ongoing development of the CLIMAS web site, particularly with regard to online provision of executive summaries of research publications and information on upcoming projects.

CLIMAS research team should delineate its role in the climate information system and define the stakeholder communities it seeks to serve.

The CLIMAS research team must make the fundamental decision of whom the core office will serve. In the context of climate information systems, the pilot stakeholder assessment team sees the core office as potentially fulfilling three roles: response, capacity building, and outreach (see Figure 4.1). At a minimum, the core office should be responsive to the stakeholders who already use climate information by making its presence known, and by directing individuals to the climate information that is most appropriate to their needs. The core office also has the potential to extend beyond this role as a information clearinghouse to engage in capacity building. Capacity building requires that the core office take an active role in educating those who, due to certain constraints, are limited in their climate information use (see Chapter Three for a discussion of these constraints). Finally, the core office should seek the means to reach vulnerable stakeholder communities that do not currently express an interest in climate information.

Figure 4.1 The potential roles of the core office



The CLIMAS research team has already committed to two of the core office's potential roles: response and capacity building. These roles have been fulfilled, for example, through the creation of a web site and by gathering information about what kinds of workshops would be most useful to stakeholders. This role could be further expanded by creating a listserv to connect interested individuals to the core office. The listserv would provide a public forum for stakeholders to ask questions and offer suggestions to one another. The benefit to CLIMAS is threefold: (1) the listserv allows CLIMAS researchers an opportunity to monitor stakeholder concerns and, if desired, personally respond to these concerns, (2) it provides an excellent mechanism for disseminating CLIMAS research results and for alerting listserv members about upcoming CLIMAS workshops and events, and (3) it has the potential to serve as a pipeline for information about where listserv members obtain their climate information (e.g., reports and web sites). The pilot's respondents

would be a logical starting point for a listserv. If properly maintained by a monitor, the CLIMAS web page might be a good way to direct site users to the listserv.

The core office also has the possibility to perform outreach to stakeholders that do not recognize their own vulnerability to climate. If the core office decides to assume this educational role, then it must also address theoretical and ethical issues concerning vulnerability, giving preference to some individuals and groups over other, and potentially shifting attention from other concerns, which may indeed be more pressing, to climate. The CLIMAS team has begun a discourse on the topic and must continue it throughout the project.

Further Social Science Investigation Recommendations

Like any study, the pilot stakeholder assessment has uncovered many new avenues for exploration. The pilot assessment began to address the variation in stakeholders' climate information needs, desires, and their ability to access appropriate climate information systems. As a pilot study, however, this report is limited in scope. A comprehensive assessment of the stakeholder communities of the Southwest remains a vital step in the success of the core office. This assessment would address the many questions which remain unexplained or require different approaches.

Some elements of the pilot should be carried over into future stakeholder assessment research. The usefulness of face-to-face interviews was immediately evident and remains a cornerstone of the social science research agenda. Our first interview, pulled from the list of people who filled out the Southwest Regional Climate Change Symposium survey, was with an emergency management person from Pima County. In reviewing his responses to the 1997 SW Climate Symposium survey in preparation for our personal interview with him, it appeared, based on his short and often vague responses, that he might not be in need of climate information. For example, in response to "Do you routinely use climate information in your decision-making? If so, how, and from where do you obtain this information?", he merely answered "Yes-short term- NWS/NOAA". After our interview with him, however, we had a very different picture—he regularly used an immense amount of information and had definite opinions on where and how the information falls short, and shared other perceptions which were not represented by the Symposium. We found that people were more apt to give us their time and thoughts about how climate information is useful to them if we approached them in a personal interview.

The matrix categories identified by the NOAA research group were useful in narrowing down the universe of stakeholders in the Southwest. With the matrix sample, interviewers were able to interview a diverse set of stakeholders over several months. The necessity of narrowing our study, however, limited the depth of investigation. The geographic focus lacked the depth to accurately represent the effects of sector specific variables for some occupational categories. Moreover, the pilot study largely omitted persons located between geographic centers and organizations that are not tied to one town or community.

For the purposes of the pilot stakeholder assessment, the geographic approach afforded us a broad picture of climate impacts and information use in the Southwest. Having delineated the basic structure of the stakeholder communities in the Southwest, the stakeholder assessment should seek to understand why variation exists between users in the same occupation as well as the nature and range of climate vulnerability within these groups. To accomplish this, we see the need for two distinct approaches, an organizational analysis and stakeholder community approach. Both of these must be informed by a vulnerability assessment.

Need for Future Vulnerability Research

The primary concern of our study has been to distinguish between those who use climate information and those do not. However, as we have pointed out, the CLIMAS team must be cautious of categorically omitting those who do not currently profess a need for climate information. This elision might neglect those who currently do not use climate information but are extremely vulnerable to climate and climate events. As mentioned before, the pilot stakeholder assessment was not created to deal with issues of vulnerability, issues which merit further study. The CLIMAS group must continue to work on identifying vulnerable stakeholders and improving their ability to access climate information.

Organizational Analysis

Throughout our study, it became apparent that organizations are some of the major users of climate information. Yet not all organizations with climate-sensitive operations are able to access this information. The reasons for this are not entirely clear, but it appears that some of the constraints to climate information are due to factors of limited resources and organizational culture. Numerous government officials are unable to invest the time required to locate information, and some of the staff of state institutions we spoke to do not have Internet access. A larger obstacle, perhaps, is the "cultural" issue of the organizations which internally prevent the use of climate information.

These issues are of importance to understanding the tenor of the stakeholder community in the Southwest. Because the pilot was not constructed to obtain this level of information, we suggest that the group be broadened to bring in those individuals and disciplines which specialize in institutional and organizational analysis in order to find out why and how climate information is or is not important to different climate sensitive organizations. Branches of the federal government meriting analysis might include the National Park Service, in particular its fire preventive and wildlife watch groups, the United States Forest Service, the Bureau of Indian Affairs, and the Bureau of Land Management. Branches of the state government meriting attention might include the Arizona Department of Water Resources and Arizona Game and Fish.

Stakeholder Community Approach

The process of comprehensively defining stakeholder communities in the Southwest will build upon our experience from this pilot assessment, which used a geographical approach focused on designated communities. A full assessment of the stakeholder communities should seek to uncover intra-occupational variation in sensitivity to climate variability, to take an intensive look at different occupations and address the question of how and why individuals with the same livelihood are differentially affected by climate variability. To do so, the team should focus on those sectors which appear to be climate sensitive, such as farmers, water providers, and some land managers, and then carefully select respondents of these sectors that differ by size, region, and operation. By comparing these individuals, we would expect to gain insight on variations, responses to climate information, and why some individuals in climate sensitive occupations do not view climate as an important factor in their decision-making. As mentioned before, the pilot assessment was not intended to address the issue of stakeholder vulnerability to climate, but the stakeholder community approach should certainly begin to address this issue.

Suggested Methods

Venue

There are multiple ways to approach and collect information from stakeholders. As we have noted, face-to-face interviews generate rich data. Because such interviews are time and resource intensive, however, other approaches are also needed.

Focus groups are one productive method for bringing stakeholders together and collecting information. Focus groups typically consist of 7 to 10 selected participants chosen because of certain common characteristics. The selected group takes part in a planned discussion in an non-threatening environment. Interviewers solicit stakeholder perceptions within a pre-defined area of interest. The CLIMAS focus groups might be selected along occupational or organizational lines with the aim of obtaining feedback about the products and research produced by CLIMAS or other organizations. This method is beneficial in that it facilitates the acquisition of multiple perspectives in one sitting, thereby enhancing the interface between the research group and the stakeholder community.[8]

Other methods could include small group interviews or a web page survey. In contrast to focus groups, small group interviews are less structured and aim to engage a number of people in the interview process at one time. Whereas focus groups are typically composed of people who do not know each other, small groups may include individuals who know and work with one another. The core office has already posted one web page survey as another way to contact many people. A web page survey, available as an option during a browsing session, can enable the CLIMAS core office to gather data about (among other things) those visiting the website, the frequency and duration of their use, and the purpose of their visit.

Methods

Throughout our interviews, we elicited suggestions about what climate information stakeholders would like to receive and how it could best be presented. In order to do this more effectively, it would be useful to bring climate information products to the interview. These products would help move responses from hypothetical climate information needs and wants to ways that existing information might be used or changed. This critical process will ensure that CLIMAS products meet stakeholder needs.

The CLIMAS team envisions two different ways of presenting these products for use. The first option is to assemble climate products into "toolboxes" that interviewers can present to stakeholders. This toolbox would include examples of different types of climate information (such as precipitation forecasts or historical climate trends). Stakeholders can be asked if they understand the information product, how and when they might use such information, and what changes or improvements they would suggest for its content or presentation. The second option is to hold focus group sessions in which a carefully-selected group of individuals view different climate products and, as a group, discuss the effectiveness of those products. This process can make use of hardcopies of CLIMAS products, or can be held in a computer lab. In the latter example, each individual is given a computer terminal loaded with certain climate products. As the stakeholder peruses these electronic products, their choices are monitored. The group is later brought together to discuss how they might interpret and use such information products, what they like and dislike about the information presented, and how the information products might be improved.

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[8] For practical guides to focus group methodology, consult Morgan et. al 1998, Krueger 1994, Stewart 1990, and Morgan 1988.

Conclusions

The pilot stakeholder assessment successfully defined a methodology which can be replicated in subsequent surveys. The study helped to identify and describe climate information needs for a wide cross-section of the Southwest's stakeholder communities. It also helped to spread the news about CLIMAS, its core office functions, and its research initiatives. Finally, our experience in the pilot survey led to a series of methodological suggestions for improving CLIMAS's ability to gather more specific information about particular stakeholder communities.

It is our recommendation that CLIMAS continue and expand contact with the stakeholder communities of the Southwest. This communication is essential to CLIMAS's effort to integrate stakeholder information needs into it's research agenda. The pilot stakeholder assessment has generated vital information that helps us better understand the communities and sectors that CLIMAS was established to serve, but it has only touched upon the many issues surrounding the potential impacts of climate variability and change.

APPENDIX 1

STUDY MATRIX

SOUTHERN DESERTS					
Land Ownership/ Land Management	Occupations	Dominant Economy			
		Agriculture	Manufacturing	Service/tourism	Extractive/other
Large Urban (>100,000)	Politicians				
	Water providers				
	Land Management				
	Utilities				
	Emergency Response				
	Miscellaneous Stakeholders				
Medium Urban (10,001-100,000)	Politicians				
	Water providers				
	Land Management				
	Utilities				
	Emergency Response				
	Miscellaneous Stakeholders				
Rural Public (<10,000)	Politicians				
	Water providers				
	Land Management				
	Utilities				
	Emergency Response				
	Miscellaneous Stakeholders				

Interviews completed

Not applicable to study

SOUTHERN DESERTS					
Land Ownership/ Land Management	Occupations	Dominant Economy			
		Agriculture	Manufacturing	Service/tourism	Extractive/other
Rural Private (<10,000)	Politicians				
	Water providers				
	Land Management				
	Utilities				
	Emergency Response				
	Miscellaneous Stakeholders				

Interviews completed

Not applicable to study

APPENDIX 2

STAKEHOLDER INTERVIEW PROTOCOL

General questions (GQs)

1) a) What are the responsibilities of your job?
b) What factors do you consider in making decisions?
2) a) For which of these responsibilities do you see climate information as important?
b) What type of information do you consult in your decision making? [Prompt historic, current, predictive]
3) Are you able to find the climate information you need?
   If no, what are the reasons? [Prompt lack of access to communication technology? Information not produced? Information produced not reliable?]
4) Are there information gaps or is there information that you have been unable to find?
5) Are there reports or information that you know exists but have had difficulty locating?
6) a) Do you record or collect any of your own climate related data?
b) Could this data be made available to the public?
7) What groups or committees do you belong to? [In what kind of networks is the stakeholder active?]
8) How satisfied are you with the climate information that you have found?

Sector Specific Impacts

Farming (FM)

1) What size farm do you operate?
2) Are the crops sold on a local, national, or global market?
3) What crops are cultivated? For each crop: What are the most significant climatic elements that affect the value and productivity of the crop?
4) What factors or strategies exist/are employed to mitigate the potential for damage caused by climate variability?

Land Management (LM)

1) What kind of land does you manage?
2) Do you issue permits? If yes, based on what climate information do you issue the permit?
3) What factors or strategies exist/are employed to mitigate the potential for damage caused by climate variability?

Emergency Response (ER)

1) To what natural disasters is the city most vulnerable? (floods, fire, etc.) With what factors are you most concerned? (Snow-pack, streamflow)
2) What information do you monitor to anticipate such an event and during such an event?
3) What factors or strategies exist/are employed to mitigate the potential for damage caused by such an event? (i.e. how do you respond?)

Politicians (P)

1) What policies are most closely related to issues of climate variability? What information does you consult in developing each policy?

Water Provider (W)

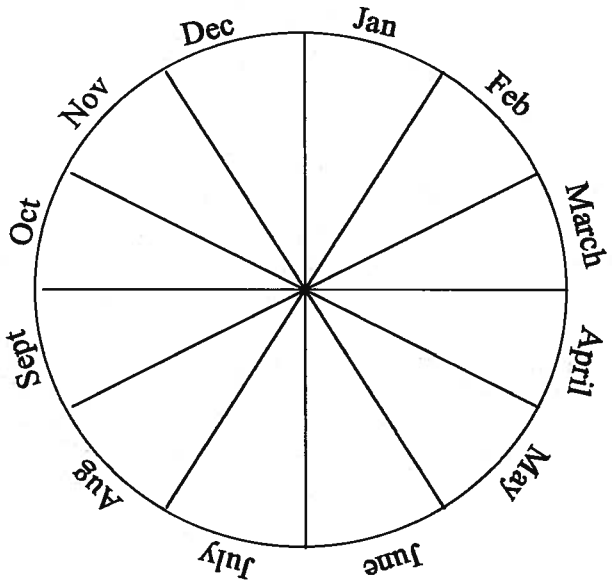
1) Is your primary source surface or groundwater?
2) Are your operations impacted by climate? If yes, how? What factors or strategies exist/are employed to mitigate any impacts caused by climate variability?

Ranching (R)

1) On what kinds of land does you run your cattle? (National Forest, BLM, etc..)
2) What factors or strategies exist/are employed to mitigate the potential for damage caused by climate variability?

For annual calendar (used with every stakeholder) Record periods of information need on the below graphic.

1) Think about your yearly decision making cycle. For what types of things do you plan?
2) For which of these plans do you see climate information as important?



Time-line

1) Think back about the flood of 1993. Were you aware that the flood was coming?
   If so, how? How far in advance did you know? Was there other information, besides knowing the flood was coming, that you gathered? What kind? From where?
   Did the results of this event change how you collected climate information?
2) Can you think of another climate event that impacted your livelihood? [Prompt for fire, drought, wind, flood, freeze, and insect damage.]

Information List

1) What information sources have you used to forecast the weather for your occupation? Please be as specific as possible, including the name of the source

- Radio broadcasts □
  If yes, which one(s)?
  If no, why not?
- TV (local and/or national) □
  If yes, which one(s)?
  If no, why not?
- Newspaper
  If yes, which one(s)?
  If no, why not?
- Internet
  If yes, which site(s)?
  If no, why not?
- Periodicals □
  If yes, which one(s)?
  If no, why not?
- Newsletter
  If yes, who sponsors it?
  If no, why not?
- Technical reports □
  If yes, whose report?
  If no, why not?
- Consulting professionals (i.e., extension agents) □
  If yes, what kind of professional?
  If no, why not?
- Word of mouth (i.e., friends, neighbors)
  If yes, who?
  If no, why not?
- Natural or personal indicators □
  If yes, what are they?
  If no, why not?
- Other

The core office (C)

1) Would you use a climate information core office that indexed climate information and provided links to agencies that produce the information you need? If so, how would you best access it? (Internet, phone, mail, site visit)
2) For your purposes, what might be the best format for climate information? Spatial and temporal frequency and extent of data needed?
3) Would you be interested in attending workshops which help you interpret existing climate data or understanding new data? Suggestions on topics?

General observations(GOs): Basic demographic information is gathered through observation (gender) and questions. Include contextual information about the city, region, and industry/agency in which the respondent works.

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