6.2   THE ROLE OF CLIMATE IN MODERN WATER PLANNING AND RELATED DECISIONS:
NEBRASKA CASE STUDY

Donna L. Woudenberg *, Kenneth G. Hubbard, and Robert D. Kuzelka
University of Nebraska-Lincoln, Lincoln, Nebraska
and
Steven J. Meyer
University of Wisconsin, Green Bay, Wisconsin

1. INTRODUCTION

Climate and weather play an integral role in planning and decision-making processes for people and agencies involved in agricultural and natural resource fields. Access to accurate and timely weather and climate data, and improved use of weather and climate data, will provide economic and environmental benefits – initially to users, but ultimately to all citizens (Changnon, Lamb, and Hubbard, 1990).

The High Plains Regional Climate Center (HPRCC), headquartered at the University of Nebraska-Lincoln campus, is part of a three-tier national climate services support program. [The partners include the National Climatic Data Center (NCDC), six Regional Climate Centers (of which HPRCC is one), and the 47 existing offices of State Climatologists.] Climate data from the Center have been used by a diverse group of individuals and agencies (Hubbard, 1983; Meyer, 1986; and Stooksbury and Curtis, 1995), including (but not limited to) Federal, State, and local governmental agencies, researchers, construction companies, utilities, irrigation districts, law enforcement, and the media.

A concern at the High Plains Regional Climate Center is that climate information is not being used to the extent that it could be, or is perhaps being used inefficiently. This project was proposed to address this concern. A survey was conducted to find out what questions people and agencies have about climate data and its uses, and what needs people and agencies have pertaining to climate data. If a lack of knowledge of data sources and a lack of understanding of its uses is preventing many from fully integrating climate and weather

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* *Corresponding author address:*
Donna L. Woudenberg, University of Nebraska-Lincoln, 246 LW Chase Hall, P.O. Box 830728, Lincoln, NE 68583-0728; e-mail: dwoudenberg2@unl.edu

data into planning and decision making processes, perhaps a product can be developed to aid in use or accessibility.

1.1 *Objectives*

The objectives of this project are:
1. To survey planners and decision-makers who work with natural resources within the State of Nebraska, particularly water resources, to see if and how they use climate and/or weather data in their work;
2. To interview selected survey respondents to gather more detailed information; and
3. To develop an end product that may help the respondents use climate and/or weather data more effectively and efficiently in their area of work.

2. MATERIALS AND METHODS

2.1 *Preliminary Activity*

As part of a preliminary information gathering process, several people with expertise in climate and weather data use and/or water related natural resource issues were interviewed prior to survey development. An interview with the State Climatologist and the High Plains Regional Climate Center's Climate Data Specialist yielded a list of agencies and organizations that request climate and weather data, as well as the types of requests that come into the office. This information was valuable in compiling a mailing list for the survey and for question development.

Interviews with two members of the University of Nebraska faculty yielded several suggestions for the project. Suggestions include: a differentiation should be made between weather and climate in any final products; surveys should be sent to more 'working people' than to those involved in the academic community; final

products should be distributed in various forms (printed materials, websites, etc.); and climate should be viewed as a 'hazard,' as well as a 'resource,' when the planning and decision-making process is used. It was also suggested that the case study be limited to the State of Nebraska, in light of potential differences in budget, policy, etc. in the surrounding region.

2.2 *Survey*

The survey was designed to provide anonymity, in the hope that respondents would be more willing to answer candidly. The survey has three sections. Questions in the first section provide background information on the respondent, including the classification of job type, job title, zip code, and educational background (including climate, weather, and hydrology courses taken or training received in the same).

The second section provides information on whether or not a respondent uses climate and/or weather data on their job. If so, a series of subsequent questions supply information on the time frame, types, and sources of data used, how and/or why the data are used, and when or how often the data are used. An open-ended question was included to give respondents the opportunity to describe products that would be particularly helpful in their job. Questions were also included to indicate the use of short and long-term predictions, anticipated future uses of climate or weather data, and preferences for delivery of educational programs. The final section provides the respondents with contact information for any questions about the survey or questions about the availability of climate data. An addressed and stamped envelope was provided to allow the respondents to return the survey to the office.

A postcard was designed to go out in the same mailing as the survey. The postcard gave respondents the opportunity to request the results of the project. It also asked for a respondent's willingness to participate in an interview to discuss the questions presented in the survey. The postcard was also addressed and stamped and was to be mailed separately, in order to preserve the anonymity of the survey.

3. RESULTS AND DISCUSSION

Approximately 300 surveys were mailed in November of 2001. 140 surveys (47%) were returned. 105 postcards were returned, 55 of which (52%) indicated a willingness to participate in an interview.

Several analyses were run on the survey data. One analysis was run on the entire data set. A second analysis was run after the data had been stratified by the respondent's agency/organization. A third analysis was run after the data had been stratified by the respondent's educational background.

3.1 *Results Of Analysis Of Entire Data Set*

Results of the first analysis show that 42.1% of the respondents work for the Federal government, 22.9% for the Natural Resource Districts (NRD's), and 11.4% for the State government. The remaining categories (other local government, education, irrigation districts, and 'other' agency) each represent less than 10% of the respondents. The majority of respondents (71.9%) have college degrees, and 13.7% have some college experience. The educational categories of high school, technical, or 'other' educational background each represent less than 10% of the respondents.

Respondents use recent and/or current data (89.1%) more often then historical data (64.8%) or predictions (33.6%). The most frequently used types of data are precipitation, air temperature, short-term predictions (daily to a week), degree days (heating, cooling, and growing), and evapotranspiration (ET). Respondents use climate and weather data most frequently for decision-making, planning, regulatory action, monitoring water quality and/or quantity, and to calculate ET. The most frequently used sources of climate and weather data are the computer, AM/FM radio, the National Weather Service (NWS), television, and the newspaper.

Climate and weather data are used on a seasonal basis by 37.0% of the respondents, 23.0% use it daily, 15.0% weekly, and 10.0% monthly. Respondents rated NWS 1-3 day forecasts at 78.3% accuracy, 7-10 day forecasts at 60.8%, and long-term forecasts at 42.0%. Short-term predictions (daily to a week) are used by 58.0% of the respondents. The 42.0% who do not use short-term predictions cite 'no need' and 'unsure how to integrate' as the primary reasons. Only 30.7% of the respondents use long-term predictions (monthly or seasonal). The 69.3% who do not use long-term predictions cite 'no need' and 'accuracy' as the primary reasons.

The majority of respondents (65.4%) anticipate future uses of climate and weather data as new tools and products become available. Workshops, videos, courses, web tutorials, and CD's were

listed as the preferred methods to receive educational programs.

3.2 Results Of Analysis Of Data Set Stratified by Agency/Organization

The data set was stratified by the respondent's classification of the type of agency or organization they are associated with for the second analysis. Categories include the Federal government (59 respondents), the State government (16), NRD's (32), other local government (6), education (3), irrigation districts (11), and 'other' organizations (13) – which includes utilities – for a total of 140. The majority of respondents in all categories have college degrees, with the exception of those associated with irrigation districts (54.5% have some college).

The majority of those associated with government, the NRD's, and education use historical climate data and recent/current weather data most frequently. Irrigation districts and 'other' organizations use recent/current data and predictions, which is appropriate considering the nature of irrigation scheduling and decision-making within utilities (demand and consumption). Precipitation is the most often used type of data for all agencies/organizations with the exception of the 'other' category, which cited short-term predictions as the type most used – again, it would be appropriate for utilities. Air temperature, ET, and short-term predictions were the other types of data most frequently used by all agencies/organizations.

Respondents associated with the Federal government most often use climate and weather data for regulatory action (53.4%), planning (20.7%) and decision-making (51.7%), and to implement disaster programs (20.7%), for example the USDA Farm Service Agency programs. Irrigation districts most often use data for irrigation scheduling (100%), planning (77.8%), and decision-making (88.9%). The NRD's cited planning (69.9%), irrigation (69.9%), and monitoring water quality and quantity (65.5%) as the primary reasons for using data. The remaining agencies/organizations most frequently use data for planning and decision-making.

The computer was listed among the most frequently used sources for climate and weather data in every agency/organization. Other frequently used sources include AM/FM radio, television, NWS, and the newspaper. The exceptions in this case are the Federal government and education, which list NCDC and HPRCC along with the computer as their most frequently used sources for data.

An interesting trend was found in this data. A larger agency or organization (larger budget, more personnel) tends to use a greater variety of sources on a higher percentage basis. For example, respondents who work for the Federal government, in education, and for 'other' agencies/organizations use NCDC, the Climate Prediction Center (CPC), HPRCC, and the State Climatologist more often than those in other categories. As an agency/organization gets smaller (budget and/or personnel), there is a tendency to use the more visible sources of data – computers, the radio, television, and the newspaper.

All agencies/organizations most frequently use climate and weather data on a daily, weekly, monthly, or seasonal basis, with the exception of the Federal government. Respondents in this category cite 'other' (drought and support for disaster declarations) as one of the primary reasons for how and when they use data.

Those involved in education have the most confidence in NWS forecast accuracy, rating 1-3 day forecasts at 84.9% accuracy, 7-10 day forecasts at 80.0%, and long-term predictions at 70.0%. Ratings for other agencies/organizations for 1-3 day forecasts range from 68.2% to 81.2% accuracy, ratings for 7-10 day forecasts range from 47.3% to 65.5%, and ratings for long-term forecasts range from 30.0% to 44.6%.

Most agencies/organizations use short-term predictions in their work, with the exception of the Federal government and education, the majority of which do not (67.8% and 66.7%, respectively). Of those who do not use short-term predictions at all, the majority cited 'no need' as the reason. The remainder of those who do not use short-term predictions cite accuracy or 'unsure how to integrate' as the reasons. The majority of respondents in all categories do not use long-term predictions, with the exception of those involved in education. NRD respondents who do not use long-term predictions cite 'unsure how to integrate' as the primary reason for not using them, indicating a desire for more information. The remaining respondents in all agencies/organizations who do not use long-term predictions cite accuracy and 'no need' as the reasons.

The majority of respondents in all agencies/organizations anticipate the future use of climate and weather data as new tools and products become available. Workshops, courses,

and videos were most often rated as the preferred methods to receive educational programs.

3.3 Results Of Analysis Of Data Set Stratified By Educational Background

The data set was stratified by educational background for the third analysis. Categories include high school degree only (11 respondents), some college (19), college degree (100), technical degree (6), and 'other' educational background (3), for a total of 139. (One survey respondent did not complete the educational background section, hence the discrepancy.)

Respondents with only high school degrees are scattered among all of the agencies/organizations, with the exception of the 'education' category (all of whom have college degrees). Slightly over half of the respondents who have had some college (52.6%) work for the Federal government, and approximately a third (31.6%) work for irrigation districts. Just under half of the respondents who have a college degree (44.0%) work for the Federal government, and approximately one-fourth (26.0%) work for the NRD's. Half of those with technical degrees work for the Federal government, the remaining work for NRD's and irrigation districts. One respondent in the 'other' educational background category works for the Federal government, one for other local government, and one for an irrigation district.

Recent/current weather data are most frequently used in all educational background categories. Historical data follows as the second most used time frame of data, with the exception of those with technical degrees, who use predictions more often. Precipitation is, again, the most used type of data, followed by air temperature, degree days, ET, and short-term predictions.

Those who have a high school degree most often use climate and weather data for planning (70.0%), decision-making (70.0%), and monitoring water quality/quantity (40%). Those with some college most often use data for decision-making (66.7%), planning (40%), and irrigation (40%). Those with a college degree use data mainly for decision-making (58.9%), planning (44.2%), and regulatory action (37.9%). It is interesting to note that climate and weather data are used more often, and for a greater variety of reasons (including design, educational programs, research, monitoring water quality/quantity, hydrology applications, irrigation, communication, and policy), by those with a college degree than by those in any other category. Those with a technical degree use data for decision-making (66.7%), planning (50%), and communication (50%), and also use data for a greater variety of reasons, but not to as great of an extent as those with a college degree (percentages are lower). Respondents in the 'other' educational background category most often use data for planning (66.7%).

The most frequently used sources for climate and weather data are the television and AM/FM radio, which appear in the top five listing of sources for all five educational background categories. Computers and newspapers are frequently used as sources for data in four of the five categories. The NWS and HPRCC are frequently used as sources of data in three of the five categories. It is interesting to note in this case that as the degree of education increases, the variety of sources used tends to increase, and the more likely a person is to use a less visible source. For example, NCDC is frequently used as a source of data by 60.0% of those with a college degree, 26.3% of those with some college, and 18.2 % of those with high school degrees. The same pattern exists for CPC, HPRCC, and the State Climatologist.

As in the previous two analyses, climate and weather data are most often used on a daily, weekly, monthly, or seasonal basis. Those with some college or a college degree use data at other times as well, expanding the range of uses to annually, during drought or flood, or some combination of the above.

Respondents with a technical degree had the most confidence in the accuracy of all NWS forecasts in this analysis, rating 1-3 day forecasts at 84.8% accuracy, 7-10 day forecasts at 74.7% accuracy, and long-term forecasts at 58.8% accuracy. Ratings for accuracy for all other categories ranged from 74.0% to 78.2% for 1-3 day forecasts, from 55.0% to 65.5% for 7-10 day forecasts, and from 40.0% to 45.0% for long-term forecasts.

The majority of those with high school degrees, college degrees, and 'other' educational backgrounds use short-term predictions. Almost half of those with some college (47.4%) and exactly half of those with technical degrees use short-term predictions. Of those who do not use short-term predictions, the majority cited 'no need' as the reason. The remainder of the respondents who do not use short-term predictions fall into two categories – some college and college degrees. These respondents cite 'unsure how to integrate,' accuracy, and 'unsure how to obtain' as reasons, indicating a desire for more information. The

majority of respondents in all categories do not use long-term predictions. Respondents in all categories cite 'no need' as a reason for not using long-term predictions, and respondents from three out of the five categories cite accuracy as a problem. Respondents with some college, college degrees, and technical degrees also cite 'unsure how to integrate' as a reason for not using long-term predictions, and some of those with a college degree list 'unsure how to interpret' as a reason. These responses indicate a desire for more information, as with short-term predictions.

The majority of respondents with a college degree or 'other' educational background anticipate future use of climate and weather data as new tools and products become available. Workshops, videos, and courses again rate high as preferred methods to receive educational programs.

3.4 *Post Survey Interviews*

The postcards of those who were willing to participate in an interview were sorted by agency/organization, for a total of 17 separate agencies/organizations. Respondents from 13 of the 23 Natural Resource Districts and respondents from 17 of the 81 USDA Farm Service Agency County Offices were willing to participate in interviews. An attempt was made to schedule interviews with the 15 remaining agencies/organizations, and limit the number of interviews with NRD and FSA personnel for a more balanced outcome. 31 interviews were conducted, in person, between March and September of 2002, covering all sections of the State.

Post-survey interview questions were designed to gather more detail about the on-the-job uses of climate and weather data. Respondents were asked to describe the goals of their jobs, what time frames of climate and weather data are used in their work, and the reasons for using the data. Information regarding the frequency of use, benefits of making correct assessments and losses due to incorrect assessments, the process used to incorporate data into the activities described, sources of data and types of data used, and how the data are related to the activity (directly, models, etc.) was gathered in further questioning. A final question asked for suggestions for tools or products that may be helpful in their work.

Reasons for using climate and weather data are as varied as the agencies. Utilities and irrigation districts tend to use data to predict demand and/or consumption. The DNR is concerned with administration of water use, adjudication of rights, and administration of Compacts and Decrees. The Department of Environmental Quality (DEQ) focuses on surface water and groundwater quality and quantity, and air quality. The main focus of the NRD's in the eastern part of the State, particularly in the metro areas of Omaha and Lincoln, is flood control and warning, as is also the case for the U.S. Army Corps of Engineers (on the Missouri River). The NRD's in the rest of the State are mainly concerned with groundwater management, a justified concern taking into consideration the trend towards aquifer depletion (and increased nitrate levels) caused by irrigation.

Climate and weather data are also used for watershed and wetland maintenance, for wildlife and fish surveys, to develop educational programs for the public, as support for documentation, in modeling, to determine trends in the chemical composition of rainfall, and to advise irrigators.

A pattern developed during the interviews that supports several trends found during the data analysis. (The larger the agency/organization, the more likely one is to use a wider variety of data sources for a wider variety of reasons, and the higher the educational background, the more likely one is to use a wider variety of sources for a wider variety of reasons.) The utility companies provide a good example. Interviews were conducted with utilities associated with Omaha, Lincoln, and several progressively smaller towns in the central and western part of the state. The larger budgets (and larger number of employees) of the Omaha and Lincoln utilities allowed these companies to have state of the art equipment and access to all necessary data. As the utilities budgets and number of employees decreased, so too did the access to, and use of, even basic data.

Some interesting suggestions for tools and products were received. Several people asked for a listing of sources of climate and weather data. Many asked for historical precipitation and temperature data to use in analyses (most of which is available). Many people asked for additional weather stations across the State for better coverage of weather events, and for more stream gauges (for the same reason). Several expressed a desire for more accuracy in forecasting, and many asked for guidance on how to more effectively integrate climate and weather data into daily operations.

4. CONCLUSIONS

Survey analyses indicate that the larger an agency or organization is (budget and/or personnel) or the higher the educational background of the user, the greater the tendency is to use more varied sources of climate and weather data for a greater variety of reasons. Post-survey interviews support the trends found in the survey analyses.

Interviewees suggested tools and products that would be helpful in their jobs. Some products are already available (historical precipitation and temperature data, for example), but potential users are not aware of how to access the data. This indicates the need for additional educational efforts. Several other interviewees requested a listing of sources of climate and weather data. Both of the above potential user needs could be accommodated by the creation of a 'clearinghouse' for climate and weather data – a complete listing of all current sources of data. The product should be delivered in various forms, such as a website and a mailed hardcopy, with notification of the product given to survey respondents and other potential users.

Interviewees suggested several preferred methods to receive training on the interpretation of climate and weather data and the integration of climate and weather data into planning and decision-making processes.   These include workshops, short courses, and web or paper tutorials.   The requests for additional weather stations and stream gauges, and increased accuracy of forecasts point to the need for a multiple agency response to user needs.

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