7.1 WHY DON'T COMMUNITY WATER SYSTEM MANAGERS USE WEATHER AND CLIMATE FORECASTS?

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1. INTRODUCTION

Most experts agree that weather and climate forecasts should have an important role in the management of many natural resources (Stern and Easterling, 1999). Thus far, most natural resource managers make minimal use of these forecasts for managing risk and reducing the vulnerability of their systems to adverse weather and climate. In the research presented here, we studied the perceptions of Community Water System (CWS) managers to explore why they do or do not use weather and climate forecasts.

Because weather and climate can be significant hazards to CWS and are fundamental to their operations, it appears that CWS managers could incorporate weather and climate information in their planning to minimize disruptions and compliance violations, schedule day-to-day and season-to-season activities, and consequently insure steady, safe water supplies to the public. We do not know, however, to what extent these managers perceive vulnerabilities associated with weather and climate or recognize the potential benefits of using weather and climate forecasts in their operations and planning. Based on these and other unknowns, this research addressed two questions: (1) What are the barriers that prevent managers from incorporating weather and climate forecasts into their planning? (2) What forms of presentation are most effective for communicating this information to CWS managers?

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The research compared the perceptions of CWS managers in the Pennsylvania portion of the Susquehanna River Basin (SRB) with those of CWS managers in South Carolina. The comparison sought to determine whether perceptions varied because of different physical or institutional contexts. This paper summarizes and synthesizes results presented in several published and unpublished works cited later.

2. METHODS

To answer the first question posed in the introduction, we elicited information from CWS managers in the Pennsylvania SRB and South Carolina. We first conducted focus groups with managers to develop a knowledge base for formal mail surveys. We then constructed two mail survey instruments, one for the Pennsylvania SRB and one for South Carolina. There were small differences between the Pennsylvania SRB and South Carolina versions of the survey to account for regional contexts (e.g., cover graphics), but nothing that compromised the comparability of the results. The surveys had four sections. The first attempted to find out how CWS managers view forecasts in general and if they use weather and climate forecasts in their planning and operations. The second section aimed at determining system sensitivity and vulnerability to weather and climate. The third tried to establish the ability of the managers to understand and use climate forecasts. The fourth section gathered basic information on characteristics of the managers and their systems. We used a modified Dillman (1999) method to conduct the surveys. In all, we mailed

surveys to 784 CWS in the Pennsylvania SRB and to 527 CWS in South Carolina. We concluded the process with 405 valid surveys (a 52 percent response rate) in the Pennsylvania SRB and 269 valid surveys (a 51 percent response rate) in South Carolina.

The survey resulted in a rich source of data. For all data, we reviewed the simple frequencies and then employed standard data-reduction methods (e.g., factor analysis) to produce composite measures of key variables (e.g., trust in forecasts). Following this preliminary work, we generated multivariate models designed to explore the statistical determinants of forecast use.

We also engaged in three other research activities following the mail survey to corroborate, fill holes in, and add depth to the survey results. One explored how the decision frameworks of CWS managers mediate risks associated with extreme weather and climate (Pike, 2004). This work addressed issues of expert knowledge and uncertainty and at the same time assessed vulnerability by developing Bayesian inference models for several CWS in the Pennsylvania SRB. Another post-survey activity involved interviews with managers of 10 of the 15 largest CWS in the Pennsylvania SRB, all receiving their supplies from surface-water sources (Heasley, 2004). Of the nearly 800 CWS in the Pennsylvania SRB, the 15 largest CWS serve 51% of the region's customers. The emphases of this work were to confirm survey findings and to gain deeper understanding of the operational and management contexts of these crucial CWS than the mail survey could elicit. The third activity consisted of interviews with a cross-section of 15 CWS managers in each of four locations: Centre County, Pennsylvania; Worcester County, Massachusetts; Finney County, Kansas; and Cochise and Santa Cruz Counties, Arizona (Jacobs, 2005). These 60 interviews focused on perceived vulnerability to weather and climate and served as geographic and sectoral crosschecks on the mail survey findings. They also provided greater information on the geographical implications of this research than the comparison of CWS in the Pennsylvania SRB and South Carolina provided.

To answer the second question posed in the introduction, we worked with CWS managers from South Carolina to develop secondary forecast products based on contemporary primary forecasts (issued by the Climate Prediction Center of the National Oceanic and Atmospheric Administration) and historical hydroclimatic data. The aim of this activity was to convey climate forecast information in ways that managers value and understand—and may be required to follow by state drought emergency-management systems.

3. BARRIERS AND IMPLICATIONS

The results of the mail survey and the subsequent interviews revealed three key barriers that prevent managers from incorporating weather and climate forecasts in their planning. Each barrier has significant implications for communicating climate forecasts to resource managers and other stakeholders. We summarize those findings and implications below. Supporting statistics and analyses are available in the cited publications.

3.1. *Barrier 1*

CWS managers who find forecasts to be reliable are no more likely to use them than are managers who find them to be unreliable (O'Connor et al., in press). Those managers most likely to use weather and climate forecasts are those who have experienced weather and climate problems in the recent past; i.e., their heightened feelings of vulnerability are the result of negative experiences with weather or climate. Thus, the strongest barrier to forecast use is risk perceptions. The implication of this finding is that simply delivering weather and climate forecasts to potential users may be insufficient in many cases. Purveyors of weather and climate forecasts need to convince potential users that, despite the absence of recent adverse events, their water resources have suffered historically from—and therefore are vulnerable to—weather and climate.

3.2. *Barrier 2*

Managers' concerns about weather and climate not only vary with their exposure to adverse events, but also with their physical context (water source, system size, and physical geography), and institutional context (the financial, regulatory, and management milieu) (O'Connor, 1999; Heasley, 2004; Jacobs, 2005;

Dow et al., unpublished manuscript). The implication of this finding is that assessments of weather and climate vulnerability and of information needs must consider the physical and institutional contexts of the resource systems and their managers. Achieving a better understanding of these contexts and of the informational needs of resource managers requires working with them directly.

3.3. *Barrier 3*

If faced with weather- and climate-related problems, managers expect more difficulties with associated financial and water quality issues than with their ability to find water and supply it to their customers (Heasley, 2004; Dow et al., unpublished manuscript). Combined with the second barrier, the implication is that managers view weather and climate forecasts as more salient when put into the context of system operations and management needs. Presenting managers with a climate forecast for the United States showing below-normal precipitation for the coming season may not generate much interest. Presenting those managers with a state-specific Palmer Drought Severity Index that suggests a possible drought watch will grab their attention.

4. CONCLUSIONS

The three barriers and their implications summarize the results of our work and answer the first question posed in the introduction. They show that personal experience has a powerful influence on perceptions of vulnerability. They suggest that both physical context and socioeconomic contexts are important in shaping these perceptions. They demonstrate that these contexts can be highly specific and that perceptions, therefore, can be highly specific. They also show that information providers must present their information in ways that are salient to potential users, which may require customization of information for specific user groups. In sum, to overcome the barriers to effective communication of forecasts, forecasts must be specific to the historical, physical, and institutional contexts of the managers and must relate to their ability to realize performance objectives threatened by weather and climate.

Based on the above, we addressed the second question posed in the introduction by producing secondary climate forecast information specifically tailored to CWS managers in South Carolina (Carbone and Dow, 2005). In one instance, we developed methods to produce area-specific drought forecasts by blending long-lead forecasts with joint probabilities of monthly temperature and precipitation from the historic climate record. By providing the CWS managers with probabilities of drought thresholds that trigger water restrictions, we demonstrated that it is possible to extend and customize long-lead forecasts for specific resource sectors, thereby increasing the likelihood of forecast use.

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