Impacts of the Midwestern Drought Forecasts of 2000

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ABSTRACT

In March of 2000 (and again in April and May) NOAA issued long-range forecasts indicating that an existing Midwestern drought would continue and intensify through the upcoming summer. These forecasts received extensive media coverage and wide public attention. If the drought persisted and intensified during the summer of 2000, significant agricultural and water supply problems would occur. However, in late May, June, and July heavy rains fell throughout most of the Midwest, ending the drought in most areas and revealing that the forecast was incorrect for most of the Midwest. Significant media coverage was devoted to the “failed” forecast, with considerable speculation that major economic hardship had resulted from the forecast. This study assesses the effects of the failed drought forecast on agricultural and water agency actions in the Midwest. Assessment of the agricultural and water management sectors revealed notable commonalities. Most people surveyed were aware of the drought forecasts, and the information sources were diverse. One-third of those surveyed indicated they did nothing as a result of the forecasts. The decisions and actions taken by others as a result of the forecasts provided mixed impacts. The water resource actions such as conserving water, seeking new sources, and convening state drought groups resulted in little cost and were considered to be beneficial. However, in the three areas of agricultural impacts (crop production shifts, crop insurance purchases, and grain market choices), mainly negative outcomes occurred. The 13 March issuance of the forecast was too late for producers to make sizable changes in production practices or to alter insurance coverage greatly, and most forecast-based actions taken in these two areas were considered to be negative but financially minor losses. However, 48% of the 1017 producers sampled altered their normal crop marketing practices, which in 84% of the cases led to sizable losses in revenue. This loss can be extrapolated as $1.1 billion for the entire Midwest if the sample statistics are representative of the region. A common result of the failed drought forecast among its users was a loss of credibility in climate predictions and a reluctance to use them in the future. Credibility is a fragile commodity that is difficult to obtain and is easy to lose.

1. Introduction

A drought began developing during mid-1999 in the Midwest as late summer and autumn precipitation remained below normal, and these drought conditions persisted through the winter of 1999/2000 in a six-state area. By March of 2000, large portions of Illinois, Indiana, Iowa, Minnesota, Missouri, and Nebraska were all experiencing drought that was affecting streamflows, groundwater levels, and water supplies in some communities. Three states (Illinois, Missouri, and Nebraska) had convened their drought task forces in 1999 to begin addressing the emerging problems. Up to mid-March, most agricultural interests had not been affected, but the 2000 planting time and growing season were soon to begin.

On 13 March 2000, the leaders of three federal agencies held a major news conference in Washington, District of Columbia, and jointly issued the first-ever drought forecast covering parts of the United States, including much of the Midwest (NOAA 2000a). Figure 1 presents portions of the National Oceanic and Atmospheric Administration (NOAA) News text pertaining to the Midwest, which was available on the Internet to everyone but was aimed at the media. The text indicates with total certainty that the drought would continue, and the map contained with the release (Fig. 2) shows that intensification of the Midwestern drought was “possible” during the April–June period. This first-ever government-issued drought forecast was widely reported in the Midwestern print media.

NOAA issued further drought forecasts in mid-April and again in mid-May. The NOAA (2000b) news release issued on 16 May states, “Severe drought conditions will also persist in Missouri, Iowa, Nebraska, Indiana, and Illinois. The summer forecast favors below normal precipitation and warmer than normal temperatures—a combination that will lead to a worsening drought.”
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DROUGHT GRIPS NEARLY HALF OF U.S.

March 13, 2000 — According to NOAA’s National Weather Service, the United States is in the midst of a worsening drought, following the warmest winter on record. This threat to individuals, agriculture, and industry throughout the country brought together representatives of the U.S. Departments of Commerce, Agriculture, and Interior, as the federal government issued its first spring drought forecast.

"The La Niña pattern which has dominated the United States for the past two years has created a serious moisture deficit in many areas. This could seriously impact farmers, water resource managers, navigation interests and the tourism industry. Forewarned is forearmed," said NOAA Administrator D. James Baker.

The spring drought forecast says the drought is going to persist and, in some areas, intensify. Hardest hit will be southern Arizona, Texas, Louisiana, Mississippi, Arkansas, Alabama, Tennessee, Florida and Georgia in the south, and Nebraska, Iowa, Illinois and Indiana in the north central U.S.

Secretary Dan Glickman of the U.S. Department of Agriculture noted, "We saw last summer just what a drought can do to farmers. Looking to the future, we need to be ahead of the curve, prepared for dry weather when it comes and equipped with the mechanisms that will protect farmers and prevent widespread losses."

Last year’s NWS climate forecast anticipated drier conditions in the southern U.S. According to Jack Kelly, Director of the National Weather Service, "This year, for the first time, we are issuing a drought forecast. We are able to do this because of the advances made by the climate research community."

Fig. 1. The text of NOAA News, as issued on 13 Mar 2000, pertaining to the drought forecast and the Midwest conditions.

media continued to give wide coverage to these spring-issued predictions, which were presented by NOAA without any probability of not occurring. They were statements of total certainty calling for future drought continuation and later for intensification.

The predictions sent ominous signals to two major groups that could potentially be affected by the developing drought: 1) farmers and allied agribusinesses and 2) managers of water supply systems. These groups reacted in various ways to prepare for the predicted continuing and intensifying drought. Figure 3 shows the dimensions of the sizable drought in the Midwest in late March of 2000.

Dry conditions persisted in the Midwest during April and May, but by late May/early June most of the Midwest began to experience heavy rains. These persisted for several weeks. Rains occurred frequently in July. The June rainfall across the Midwest ranked as the sixth highest in 102 yr, and the July rainfall ranked as the 27th highest ever recorded. By mid-June the potential for an agricultural drought had ended, and the corn and soybean crops had adequate soil moisture. By the end of July, most surface water supply reservoirs that had been low were recharged, and the local droughts had ended. Some community systems dependent on groundwater sources continued to have supply problems into autumn of 2000. Although most of the June–July rains missed most of Nebraska, by mid-August very little drought remained in the Midwest (Fig. 3). Much of Nebraska continued to experience drought during the summer and autumn of 2000. However, the series of spring forecasts calling for continuation and intensification of the drought through the summer of 2000 had failed for most of the Midwest.

A variety of individuals, firms, and news media in the Midwest began questioning the failed prediction and
were reporting losses stemming from actions based on the drought predictions (Chicago Tribune 2000). Weather specialists received many telephone calls from mid-June through the summer about the incorrect prediction. The media reported that many people claimed the prediction-related actions taken had cost them financially (Cook 2000).

A study was conducted to determine 1) who learned of the drought predictions, and how; 2) how individuals and institutions reacted to the drought predictions, and why; 3) what actions were taken, if any; 4) whether the outcome of the actions taken was good or bad; and 5) how the users of the prediction felt about climate predictions after this experience (Sonka et al. 2001). The design of the collection of data was based on past assessments of the use of climate information (Changnon et al. 1988; Changnon 1997; Sonka et al. 1992).

Agricultural experts working on the project initially postulated the kinds of actions that farmers and agribusinesses could have taken, given that the prediction first appeared in mid-March. Then, three small groups of farmers from three areas met with project leaders to discuss in detail the situation and its effects on them. The results of these focus-group meetings, plus interviews with representatives of agribusinesses, were used to develop a questionnaire sent to 1448 Midwestern farmers who have cooperated in past sampling studies and resided in the drought states and Ohio. Responses were obtained from 1017 farmers. Various other agricultural data such as market reports, crop insurance sales, and planting records were examined to help to discern effects. Information on what happened to water supply conditions in each state was collected using interviews conducted with water officials in each state and with managers of water supply systems of communities that were experiencing water shortages in the spring of 2000.

2. Data collection and analysis

a. Agricultural data

Data were collected from a variety of sources to assess the effects of the drought forecasts on the agricultural sector. Data collection began in January of 2001 with extensive interviews with 10 members of the agribusiness industry to ascertain their responses to the forecasts. The sectors represented include crop insurance, market advisors, grain marketing, seed, agronomy, farm management, and chemical firms.

A second source of data came from meetings of three focus groups conducted during February of 2001. Each consisted of a 2-h meeting involving seven or eight invited farmers and two project investigators who led the discussion using a list of questions about the fore-
casts and possible actions taken. These discussions allowed identification of many issues and helped to establish the questions to be included in a questionnaire for a large mail survey. Focus groups were convened in three areas: one with no drought (Ohio), one with drought and a failed forecast (Illinois), and one where drought existed and the forecast was correct (Nebraska).

The major source of agricultural data came from a four-page questionnaire based on the findings of the industry interviews and focus groups, coupled with the project’s goals (Sonka et al. 2001). This survey was mailed in March of 2001 to 1448 producers in Illinois, Indiana, Iowa, Nebraska, and Ohio, and the resulting responses allowed a quantitative assessment of farmers’ responses to the drought forecasts in four drought states and in one without drought (Ohio). Ohio was included so that the behavior of producers not directly affected by the forecasts could be measured and compared with that of those experiencing drought. The Nebraska findings allowed comparison of responses where drought continued through the growing season (and the forecast was correct) with those in Illinois, Indiana, and Iowa, where the drought ended suddenly and the forecast failed. However, given the global nature of commodity markets, reaction to a drought forecast is not limited to the drought area. All participants in commodity markets are affected by predictions such as the Midwestern drought forecast. Completed questionnaires were received from 1017 producers, a 70% response rate. The assessment included respondents’ farm demographics (acreage, plantings, livestock, etc.), and analysis revealed that the sample was representative of Midwestern farms (Sonka et al. 2001).

Data on prices for corn and soybean futures contracts, as sold on the Chicago Board of Trade (CBOT), were also collected to assess price trends during 2000. The CBOT prices are considered to be the benchmark for crops bought and sold around the world. In addition, a study was made of newsletters from two major Midwestern market advisory services to assess the information being presented to agricultural producers about drought concerns, market behavior, and marketing advice. Data from the Federal Crop Insurance Corporation on crop insurance for the 1997–2000 period were also collected and studied. Data included the number of insured acres and the number of policies purchased in each county in the Midwestern states. The crop insurance sales deadline was 15 March 2000, just two days after the first official drought forecast was issued. The two days of notice permitted producers very limited time to consider crop insurance choices, and this likely limited actions taken.

b. Water supply data

The assessment of the effects of the drought forecast on managers of state and local government organizations responsible for water management and supplies was based on structured interviews conducted either by telephone or in person. A questionnaire was developed and was used with each respondent to obtain the effects data (Sonka et al. 2001). An initial questionnaire was tested on three state water officials during December of 2000. A revised questionnaire was used in the sampling done during January–March of 2001.

People interviewed included those in state agencies that address water issues (human health, water resources, agriculture, environment, and emergency services) and that were involved directly with actual responses to the drought. Also included were leaders of state drought groups, labeled either as committees or as task forces. Interviews were also conducted with community and rural system water managers who had faced shortages during March of 2000. States assessed included those that were experiencing drought when the forecasts were issued, including Nebraska, Iowa, Missouri, Illinois, Minnesota, and Indiana. Agency staff members in two other states without drought conditions, Wisconsin and Ohio, were also interviewed to compare their reactions to the forecast with those by agency leaders in the drought states.

Those interviewed were asked 14 questions about where and how they received the forecast information, actions they and/or their agency had taken as a result of the forecasts, and the effects of these actions. Those sampled were asked about their views on the utility of long-range forecasts and to identify factors affecting their use. They were also asked about the reasons they did or did not use the forecast and about attitudes toward use of long-term forecasts (past and future). Responses were obtained from 45 state officials, including 6 in Ohio and Wisconsin, and from 31 local water managers in the six-state drought area. Nine of the local managers had not heard of the drought predictions.

The number of state officials sampled in each drought state ranged from 5 to 9, and the 31 local officials came from four states (Illinois, Iowa, Missouri, and Nebraska). Sampling was done in Minnesota, which had drought in its southwestern sections in the spring of 2000, although the drought forecasts did not include Minnesota. Again, note that the forecast of summer drought was correct for much of Nebraska and southwestern Iowa but was not correct for the drought areas in three states (Illinois, Indiana, and Michigan).

3. Findings: Agriculture

a. Use of crop insurance

Analysis of crop insurance records for 1997–2000 revealed that the number of corn and soybean acres insured, as well as number of policies, had increased since 1997. Figure 4 shows the annual values for insured corn acreage and the temporal increases in all five drought states. Thus, the insurance statistics alone did
not suggest a significant change in sales and insured acreage in 2000.

b. Agribusiness views

All industry leaders that were interviewed were aware of the dry conditions existing in the spring of 2000, and 9 of the 10 were aware of the drought forecasts. Their primary source of forecast information was the Internet. Their reactions to the drought forecast ranged from taking it seriously and incorporating it into certain decisions to not believing the forecast and making no adjustments based on it. Those interviewed whose responsibilities focused on crop production recommended that producers not make changes to protect against the predicted drought. Further, the time between the forecast issuance and the start of the 2000 growing season was too short to make sizable production adjustments because most production plans and expenditures occurred months earlier. Those involved with marketing and the business of production agriculture reported that the drought forecast affected their outlook for the grain markets and the risks producers would face. All of those interviewed had observed a strong marketing response by farmers during the spring, which involved postponement of sales of their old crops and not forward-pricing their new crops. This had resulted in a negative effect on gross farm income from crop sales. The business experts sampled also believed that more farmers had purchased crop insurance as a result of the forecasts. They also felt that the media’s strong emphasis on the drought forecast had been a factor that strongly influenced producers’ reactions. They further reported that they would use future climate forecasts with greater caution than before.

c. Focus group findings

All 23 producers in the three focus groups were aware of the drought forecasts, and some recalled the national news conference at which the forecast was issued on 13 March. In general, most learned of the forecast through general media sources, farm publications, and/or market advisors. Their reactions to the drought forecast were influenced greatly by local conditions and their past drought experience. Assessment of the responses from the three focus groups led to the four major findings presented in Table 1. Several reported that the forecast came too late for making production adjustments. The economic impacts of the marketing and insurance responses were negative. The producers who held onto their old crop and forward-priced their new crop to a
lesser degree than normal realized sizably lower incomes.

d. Producer survey results

A questionnaire was developed to measure drought forecast awareness and responses to the drought forecasts based on the results of the focus groups and agribusiness interviews. Responses were obtained from 1017 producers across the five-state drought area. Almost 97% of the producers were aware of the drought forecasts issued in the spring of 2000. The principal source was the general media (television, radio, and newspapers). Farm publications were the second largest source, followed by the Internet and market advisory services.

Respondents were asked to specify their level of agreement with the drought forecast message in one of seven classes ranging from strong disagreement to strong agreement, and the resulting distribution is shown in Fig. 5. The average score indicated neutral to slight agreement, but the distribution is skewed toward agreement. The responses showed that 42% had some form of agreement, whereas only 17% had some form of disagreement. As expected, agreement was highest in Nebraska and lowest in Ohio.

The producers were asked about farm management decisions they made as a result of the drought forecast, and their responses appear in Table 2. In the five-state area, 39% of the 1017 respondents indicated that they had adjusted production practices, and 40% had made crop insurance changes. Nearly 50% reported making different marketing decisions as a result of the drought forecast. The Nebraska producers had the highest level of response among the five states for all three action areas, whereas Ohio respondents had the lowest responses in crop insurance and production decisions, reflecting their lack of concern because there was no existing drought and none predicted for their area.

The most frequent production adjustments were in planting, tillage, and seed selection, representing 81% of all production actions taken. The most frequent market changes were decreases in sales of the new (2000) and old (1999) crops. These joint market actions represented 84% of all market actions taken by the 448 producers who made changes. The largest crop insurance action was an increase in coverage, representing 79% of all insurance actions taken. Other responses were reported, including pricing fuel ahead of time, decreasing variable costs, delaying capital purchases, planning for more livestock feed, and adjusting livestock inventory.

Producers were asked how the adjustments they made as a result of the forecasts had affected their farm business. The effect of their production decisions was a tendency for losses. Forty-one percent of the respondents felt that there was no gain or loss, 46% of those assessed had either a large or slight degree of loss, and only 13% reported a financial gain. Responses showed

![Fig. 5. Level of agreement with drought forecast reported by 1017 agricultural producers.](image)

TABLE 2. Actions resulting from the drought forecasts expressed as a percent of total sample in each state and the entire region.

<table>
<thead>
<tr>
<th>Location</th>
<th>Production decisions (%)</th>
<th>Marketing decisions (%)</th>
<th>Crop insurance decisions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>IL</td>
<td>36</td>
<td>56</td>
<td>43</td>
</tr>
<tr>
<td>IN</td>
<td>33</td>
<td>33</td>
<td>31</td>
</tr>
<tr>
<td>IA</td>
<td>40</td>
<td>44</td>
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<td>58</td>
<td>55</td>
</tr>
<tr>
<td>OH</td>
<td>29</td>
<td>52</td>
<td>26</td>
</tr>
<tr>
<td>Five-state area</td>
<td>39</td>
<td>48</td>
<td>40</td>
</tr>
</tbody>
</table>
little regional variability. Several respondents also indicated ways in which their production decisions had generated long-term negative implications. For example, they altered conservation tillage and herbicide selections, which increased the presence of weeds in their fields in 2000 and succeeding years.

The most significant outcome reported by the 48% of respondents who made changes in their marketing plans (Table 2) was a loss of crop sales revenue (Fig. 6). Lower sales revenues resulted from acting (selling) in summer instead of in the spring, and then lower-than-expected grain prices occurred in summer as the drought ended. Only 14% reported a gain in revenue as a result of their marketing decisions. They sold in April–May.

Prices at the CBOT for soybeans and corn both rose in late March of 2000 and reached a high during mid-April to late May. For example, prices per bushel of corn, based on the CBOT corn futures for December contract, were $2.45 on 15 March, $2.60 on 15 April, $2.70 on 15 May, $2.25 on 15 June, and down to $1.90 on 15 July. If drought is expected, a farmer typically develops an expectation for a price increase in response to an expected lower supply of grain; such wide expectations led to the noted price increase in the spring of 2000.

The producers sampled were not asked to provide specific information about their financial losses or gains from their market actions resulting from the drought forecasts. However, an analysis of potential financial effects from the marketing decisions reported by those sampled was performed based on conditions for an average-sized Midwestern grain farm (500 acres) and the typical decisions made about marketing the old and new crops, as reported in the questionnaire. This response was based on a typical marketing pattern, with 25% of the 1999 corn and soybean crops sold during the latter half of April and, in addition, one-fourth of the 2000 crops forward-contracted using November 2000 contracts, as priced during the latter part of April of 2000. By using this approach, the estimated price received by a typical producer would have been $105,954, given the actual market prices in April of 2000 that were high because of the drought and the forecasted drought continuation (Sonka et al. 2001).

The analysis was also performed allowing the farmer not to do the marketing in April, with a plan to wait until July when, as a result of the drought forecasts, it could be assumed the market prices for both crops, old and forward-contracted, would be higher than in April. This was the scenario representing effects from the use of the drought forecast. Analysis of this delayed decision to sell, in light of the market’s rapid fall after the rains began in June and a lower July price, leads to a net farm income of $92,974. This is a loss of approximately $13,000 attributed to the use of the failed drought forecast.

Sampling of the 1017 farmers in the five-state region revealed that 488 (48%) made marketing decisions based on the drought forecasts (Table 2), and 84% of those 488 reported losses. If these percentages are applied to the five-state area, which has 220 296 grain farmers, one would estimate that approximately 105 000 Midwestern farmers made marketing decisions based on the drought forecasts. Then, 84% of them, or 88 000, had losses. If the loss, as estimated for the average farm ($13,000), is applied, the estimated regional total loss from market decisions is $1.144 billion. Of course, a few farmers, 14%, reported gains from their market actions, so the net regional effect would be somewhat less.

The typical financial result relating to crop insurance was higher crop insurance expenditures, as reported by
66% of the respondents, whereas 25% reported payoffs that offset their added expenditures, and 9% reported other outcomes. Increased expenditures were greatest in Illinois, Iowa, and Ohio, where 75% reported additional purchases, and less than 18% reported that payoffs offset their added costs. However, nearly 60% of the Nebraska producers who had a summer drought reported that payoffs had offset their added costs. The net dollar losses from added insurance purchases, as measured across the entire Midwest and attributable to the forecast, were deemed small and were difficult to quantify.

In summary, the financial effects of the producers’ actions from the forecast were multifaceted. Those that decreased their plant populations realized lower yields and lower incomes. Producers who delayed crop sales lost considerable income they would have received if they had not altered their normal marketing strategy. The implications of the lower income included reduced repayment capacity for debt; delayed replacement of capital items, such as tractors; and increased need for outside income from off-farm jobs. Insurance-related losses were likely minor.

Producers’ future use of climate forecasts was also assessed. Producers were asked if their expectations for the 2001 growing season (recall that this survey was done in March of 2001) were influenced by climate predictions, and 32% said their opinions were affected by the predictions. Those in Nebraska expressed the greatest influence (59%), whereas those elsewhere had much lower usage (<20%), an outcome reflecting where the 2000 forecasts were in error. Most producers reported that the forecasts served only to provide a general sense of the possible future, and only 15 of the 1017 respondents indicated that long-term predictions highly influenced their decisions. Many reported that the failed forecast was a prime reason for not using the 2001 predictions. When asked why they did not use predictions, 66% said the lack of accuracy was the main reason, and many others felt the predictions did not focus adequately on their local conditions.

4. Findings: Water supplies

In March of 2000 drought conditions were detrimentally affecting community water supplies in parts of Illinois, Iowa, Missouri, and Nebraska. Each state had water-short communities in the drought areas, and the number ranged from a low of 13 in Iowa to 33 in Missouri. Many state water experts indicated that most of the community shortages resulted from generally inadequate sources existing prior to the drought’s onset. In Minnesota and Indiana there were concerns about the below-normal soil moisture levels and the low flows in rivers, but no community problems had yet developed.

All six states experiencing drought in March of 2000 either established a drought group (committee or task force), with members drawn mainly from state water-related agencies, or convened an existing drought group task force during March or April of 2000, although drought groups in Illinois, Nebraska, and Missouri had begun meetings in 1999. The forecast in the other four states was considered a major factor in the convening of the drought groups.

Similarities among the survey responses were identified, and these in turn were used to develop categories. The 14 questions asked of each respondent fell into three general classes: 1) access to drought forecast information, 2) use/nonuse of the forecasts, and 3) results of usage of the forecast. The following results are based on the responses obtained from the 70 people sampled in the six states with drought (Illinois, Indiana, Iowa, Minnesota, Missouri, and Nebraska).

a. Information about the forecast

All 39 state officials and 22 of the 31 local water managers interviewed were familiar with the drought forecasts shortly after they were issued on 13 March 2000. Most were also aware of the ensuing drought forecasts issued by NOAA in April and May of 2000. Drought forecasts obtained by state officials came from five sources, with the media and state climatologists being the primary ones. Eighteen of the 22 community/rural water managers learned of the forecast from calls from state water agency managers.

b. Use/nonuse of the forecasts

Eighteen of the 39 respondents in state agencies believed the drought forecast was accurate, and most (20) local water managers also believed the forecast. Some believed its certainty represented a new scientific discovery, and many others thought it to be a reasonable projection, given drought’s well-known persistence in this area, once initiated. Most of those in state agencies who believed the forecast were either hydrologists or engineers. Furthermore, most believers reported that they realized that long-range climate forecasts are uncertain and that they had “calibrated” uncertainty into the NOAA drought forecast.

Most of the atmospheric scientists who were sampled reported scientific amazement and/or disbelief in the forecasts. Actions of atmospheric scientists fell into three classes: 1) critical of the scientific basis for the forecast and, in turn, openly critical of it to state managers and others; 2) privately critical of the forecast but distributed it statewide without expressing any judgement about it; and 3) accepted the forecast as reality and distributed it.

The attitudes toward the forecast, as reported by one-half of the state officials sampled, were influenced by others. In many states, this influence was due to the comments of the state climatologist or comments by other atmospheric scientists in the state. All 22 local water managers reported that the views of state officials
about the importance of the prediction had influenced their thinking and plans.

Responses about the use or nonuse of the forecasts fell into three categories (Table 3). Nine state water managers used the forecast to alter their personal duties. However, most state actions (18 of 39) involved the respondent’s institution or agency, or several agencies acting in concert, including the drought groups of the six states. Twelve state officials reported making no decisions and taking no actions related to the forecast. Most community water managers used the forecast to make a community-wide decision about actions to take regarding the drought.

The uses of the forecast information fell into six categories (Table 4). The primary application reported by state managers was to inform others of the forecast, and 12 of the 39 reported that the forecasts and ongoing drought had led to changes in staff assignments. Note that, in many of these applications, the respondents reported that it was difficult to separate the use of the forecasts from the influence of other pressures related to the ongoing drought. The two clearest signals of the drought forecasts being a key factor are 1) decisions to convene state drought groups and 2) calls to inform local water managers. In 12 of the 18 locations in which action was taken, local managers put water conservation rules in effect, and in 9 of the 18 locations they acted to enhance local water supplies.

Seven state officials reported making small expenditures, less than $5000, as a result of forecast-based actions, and most involved staff time devoted to special drought-related duties. Ten of the 22 local water managers reported some expenditure of funds, typically less than $20,000, related to endeavors to develop new water supplies.

### Table 3. Was a decision made and/or action taken based on the drought forecast? Results are based on the six states with drought and those aware of the forecast.

<table>
<thead>
<tr>
<th>Level</th>
<th>No</th>
<th>Yes—self*</th>
<th>Yes—institution**</th>
</tr>
</thead>
<tbody>
<tr>
<td>State</td>
<td>12</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Local</td>
<td>3</td>
<td>1</td>
<td>18</td>
</tr>
</tbody>
</table>

* Used in personal duties only.
** Used in the home institution’s activities or in multi-institutional actions.

c. Results of forecast usage

The respondents were asked about problems and benefits, if any, caused by the their uses of the forecasts. The problem responses fell into three categories, the predominant one being “no problem.” Confusion over the forecast and its local/agency applications was a problem reported by a few respondents in both the state and local groups. Seven climatologists reported problems mainly in the form of calls and complaints from agricultural interests about the incorrect summer forecast.

The majority of the respondents in state agencies and local water institutions reported that their use, or the state’s use, of the forecasts had been beneficial (Table 5). The benefits were often tied to getting actions accomplished that were seen as needed, such as helping a local community decide to enact water conservation rules. In general, the preponderance of beneficial outcomes represents an interesting case of an incorrect forecast providing benefits.

Another area of impact from the drought forecasts pertained to effects on future usage of long-term forecasts. Respondents were first asked about their prior usage of climate predictions, and 19 of the 39 state agency respondents reported occasional past use when extreme weather conditions such as droughts or floods existed. Nine frequent users were atmospheric scientists, but 29 of the 31 local water managers had not been users of climate predictions. When asked about how the drought forecast had affected their attitudes toward future use of climate predictions, three kinds of answers were obtained (Table 6). Nearly one-half of the state officials (17 of 39) reported that the incorrect forecast would lessen their interest in and use of climate predictions. Some reported that the error had no effect on their future usage, and 10 officials indicated that they would continue to use future predictions but also that the drought forecast had influenced how they would interpret future forecasts and their uses.
d. Views from nondrought states

Three state officials in Ohio and three in Wisconsin, both nondrought states, were interviewed about the March 2000 drought forecast. Four of the six did not recall seeing or hearing of the drought forecast. The two that did remember the forecast reported being surprised at the certainty of it. No one reported any applications of the forecast, although one climatologist reported that the forecast had caused concern among area farmers. None felt that the forecast would affect their future usage of climate predictions.

5. Summary

This study sought to assess the effects of the failed Midwestern drought forecast for the summer of 2000 issued in the spring of 2000, on ensuing agricultural decisions and water agency actions in the Midwest. Major segments of Illinois, Indiana, Iowa, Missouri, and Nebraska were experiencing winter 1999/2000 drought conditions and were included in the drought forecast.

Information on agricultural effects was collected through interviews, focus groups with 23 producers, studies of insurance and market data, and responses to a mail survey from 1017 agricultural producers. Effects on water supplies were defined using interviews with 76 officials responsible for state and local water supplies.

Assessment across both the agricultural and water management sectors revealed notable commonalities. Most people surveyed were aware of the drought forecasts, and the sources through which they became aware were diverse. Significant media coverage had been devoted to the drought forecast. Actions taken by those in both groups in reaction to the forecast were often dependent on the source of the forecast and the credibility assigned to the forecast by that source. Many respondents noted that the forecasts were reported as if they were “certain” that the drought conditions were going to occur and to intensify.

The uses of the forecasts were numerous and varied. One-third of the forecast recipients did nothing as a result of the forecasts. Cases in which actions were taken typically involved adjustments to ongoing activities. In some cases, the resulting actions enabled better management against future drought conditions, as well as the expected 2000 drought. The myriad types of uses of the drought forecast led to a range of outcomes. Some were seen later as beneficial, some led to a waste of funds, and some involved a loss of financial resources. Another common result of the failed drought forecast in the five-state area was a loss of credibility in climate predictions and their future use. Credibility is a fragile commodity that is difficult to obtain and is easy to lose.

The agricultural assessment explored producer and industry participant reactions to the forecast, the decisions they made based on the forecast, the implications of those decisions, and the effects on future use of long-term climate predictions. The majority of the agricultural producers and industry participants either had a neutral attitude or possessed some level of agreement with the forecast when it was issued. The largest source of information about the drought forecast was the general media, followed by the agricultural press. Agricultural production responses to the forecast were limited to minor alterations, such as changes in planting, seed variety, and tillage. Therefore, financial losses and gains from production responses were small. Producers increased their federal crop insurance coverage in 2000, but it is unclear whether the decision was due to the existing dry conditions or to the drought forecast. If they did increase coverage, slightly higher expenditures with less payoff was the common financial result.

The most significant response by agricultural producers to the drought forecast was revision of marketing strategies, primarily delaying sales of the 1999 crop and engaging in less-than-normal forward-pricing of the 2000 crop. Depending on the extent to which these strategies were employed in the Midwest, substantial financial losses on the order of $1 billion likely resulted. Producers also reported that an overall, but not financial, effect of the failed forecasts and their associated publicity was an increase in skepticism regarding long-term climate forecasts and government institutions.

Among state water officials and local water managers, awareness of the drought forecast was high, and their sources for becoming aware of the forecast were diverse. The nonatmospheric state scientists or engineers generally believed the drought forecast. Most of the atmospheric scientists questioned it either openly or privately, but their responses varied from ignoring the forecast to presenting it to a drought agency group.

At the state agency level, the response to the drought forecast ranged from no response, to convening state drought task forces, to issuing statewide messages about the drought. The state water officials did not harbor negative feelings about the incorrect forecast. A common, but small, problem was responding to numerous complaints about the failed prediction. Benefits were accrued from state-level actions, such as solving current water shortage problems, establishing drought task forces, assisting with drought preparedness, and increasing awareness of current weather problems at the top state government level.

At the community level, almost all of those aware of the prediction responded to the drought forecast by enforcing local conservation and/or developing additional water supplies. Most decision makers that took action resulting from the forecast felt that their actions were beneficial. Most of the local water engineers are not routine users of climate predictions. In summary, the drought forecasts prompted state water officials to take certain actions, many of which they felt were needed.
anyway. No major costs were involved, and no one felt that the forecast failure hurt them or their state. In general, the results reveal a case of ‘no predictive skill, but benefit.’

For both the agricultural producers and water officials, the reaction to and actions resulting from the 2000 drought forecast depended on the level of knowledge or understanding of climate predictions and the manner in which climate predictions are used in the agency’s or the individual’s work. Within the agricultural sector, the short-term effect of the drought-forecast response was negative but likely small relative to the total forces affecting agricultural economics. In the water management sector, the short-term effect was considered to be positive by most. The long-term effect for agriculture includes increased mistrust of media, government, and institutions and a skepticism of long-term predictions that may detract from effective economic decision making. The long-term implications of the failed 2000 drought forecast for state water officials and for their likelihood of future use of forecasts also were generally negative. Long-term forecasts of drought issued as certain, or interpretable as certain, should not be issued. Levels of uncertainty need to be included.

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REFERENCES