PERCEPTIONS OF DROUGHT IN THE OGALLALA AQUIFER REGION

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ABSTRACT: Farmers of the Ogallala Aquifer region of the Great Plains in the western United States were interviewed concerning their perceptions of drought, weather and climate changes, aquifer conditions, and the adaptive strategies used to cope with these. The results of these surveys parallel and refine the results reported by Saarinen in 1966. Farmers recall classic droughts and the most recent years as drought; intermediate years and droughts are lost from memory. A pattern of perception is suggested by these results wherein experience influences both definition and memory, which in turn affect expectations of the particular environmental event. People's perceptions, expectations, and adaptive responses to recurrent environmental stimuli, such as drought, are related to their direct experiences. When one's experience restricts his or her view of the potential variance in meteorological or other environmental events, however, that restriction may lead to inappropriate or insufficient response to environmental hazards.

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This article reports farmers' perceptions of drought in the Ogallala Aquifer region of the western U.S. Great Plains. The Ogallala Aquifer extends from the southern edge of South Dakota deep into the Panhandle of Texas, and underlies most of the region labeled as the 1930s "Dust Bowl" (see Heathcote, 1980; Worster, 1979). Major droughts have been documented for the region roughly on alternate decades from the 1890s through the 1950s (Warrick, 1975; Warrick and Bowden, 1981), and can be expected to occur again.

The social, biological, and economic impacts of future droughts on regional agriculture will depend in large measure on how farmers of the region prepare for them and how they respond when droughts occur. The farmers' actions, in turn, are influenced by how they recognize and interpret drought. Appropriate adjustments and adaptations can lessen negative impacts whereas inappropriate actions can increase them. Therefore, understanding drought impact requires an understanding of human perception and behavior.

Perception of climate in the Great Plains region has been reported on by Bowden (1976), Kollmorgen and Kollmorgen (1973), and by Lawson (1974). Heathcote (1980) investigated perception of desertification on the Great Plains and perception of drought in Australia (1969, 1974), and Warrick (1975) includes commentary on perceptions in his assessment of drought hazard research in the United States. Most closely aligned to the present study was the work done by Saarinen (1966) on Perceptions of the Drought Hazard on the Great Plains.

In the spring of 1985, questions related to drought, climate, farming practices, and other environmental conditions were asked of 99 farmers in the Ogallala Aquifer areas of Texas, Oklahoma, Kansas, Nebraska, and Colorado. This study follows, by twenty years, the survey work done by Thomas F. Saarinen: It replicates many of his survey questions and shares two of his study counties. Perception of drought was a central concern of both Saarinen's study
and our own, and in this aspect we now have comparative data from 1965 and 1985. The 1985 survey revealed four critical elements of drought perception: drought experience, drought memory, drought definition, and expectation of drought.

PERCEPTION AND BEHAVIOR

In the present study, we are following the practice, common in geography and other social sciences, of using perception to refer to a range of judgments, beliefs, and attitudes. As noted by Golledge (1981, p. 1337), the term "perception" is sometimes used where "cognition" might be more appropriate. The study of environmental perception (and cognition) is one approach to understanding human decisions and choices. These decisions lead to actions that affect the environment as well as to human responses to environmental conditions that affect people (Heathcote, 1980; Whyte, 1985). The study of environmental perception is based on the assumption that behavior is influenced by subjective images of the environment, attitudes, goals, feelings, and beliefs. This assumption, as well as other theoretical and methodological issues relevant to the perceptual approach in geography, has been discussed extensively in the literature (see Bunting and Guelke, 1979; Rushton, 1979; Saarinen, 1979; Downs, 1979; Golledge, 1981; Saarinen et al., 1984).

The relationship between perception and behavior is neither simple nor direct. A person’s behavior in a specific situation depends upon the perceived range of alternative actions, the information available to the person about the alternatives, and the information available about the environmental conditions causing the need to act. Perception of environment thus is one of several factors to be considered in assessing human response to environmental change. But it is a very important factor. A person’s response may be tempered more by conditions he or she perceives than by objectively measurable changes in the external environment.

DATA COLLECTION

During late February through early April 1985, 99 farmers in the High Plains region were interviewed. These farmers were identified through the aid of County Agricultural Extension Agents in six counties overlying the Ogallala Aquifer: two in northeastern Colorado, and one each from southwestern Nebraska and Kansas, and the Panhandles of Oklahoma and Texas. An important objective of this study was to compare perceptions of farmers operating in areas experiencing greatly differing levels of aquifer depletion. The Ogallala Aquifer region was chosen for this purpose. In the northernmost county, Frontier County, Nebraska, farmers had experienced little aquifer depletion at the time of the study while in the southern counties, especially in Swisher County, Texas, and Finney County, Kansas, aquifer depletion was seriously affecting farming operations (Guten-tag et al., 1984).

Farmers were interviewed in their homes about their farming operations, their irrigation practices, as well as aquifer conditions and problems in their home areas. Participants were asked to describe their local climate and any long-term climate changes occurring in their region. They were also questioned about their opinions regarding irrigation versus dryland farming, different economic approaches to farming, and relationships of humans to nature. Pertinent to this article, farmers were questioned in detail about drought. First they were asked for their definition: "What do you think of as a drought?" Farmers were then asked to recall droughts that they had experienced, and to discuss the effects of past droughts. Then they were asked
about their expectations for future droughts, including whether another drought such as the "Dirty Thirties" could come again, and what the effects of such a drought would be now; whether drought years follow on one another; whether droughts are becoming more or less frequent; what frequency of drought they anticipate in their areas; and whether they had found effective ways of overcoming drought losses.

Results of this survey, as well as meteorological data for the substate regions where the surveying was conducted, are the foundation for the discussion that follows.

RESULTS

Experience, memory, definition, and expectation were critical elements in farmers' perception of drought in the 1985 study. Each is defined below and the results of the study are organized according to these elements.

Experience

The aspects of experience considered in this study were the meteorological events that occurred during the farmers' careers. Droughts experienced indirectly, such as through oral, written, or pictorial accounts, may have had an influence on perception, but they were not measured in this study.

Memory

Drought memory consists of those drought events that were part of the farmers' direct experiences and could be recalled, as well as other periods that may not have been particularly dry but nevertheless were recalled as drought.

Definition

A drought definition is a set of criteria, usually moisture shortage, for classifying a time period as a "drought." Drought definitions might specify, with varying degrees of precision, how long lasting and how severe a moisture shortage must be before it is classified as a drought. Drought could also be defined in terms of social or economic impacts. There is no generally accepted definition of drought—it means different things to different people (Wihite and Glantz, 1985), both to professionals and among the lay public.

Expectation

Farmers' expectations of future droughts included how often they expected droughts to occur and how severe they expected them to be. They also included expectations about the impacts of droughts, such as whether the effects of future droughts could be overcome.

EXPERIENCE OF DROUGHT

Each farmer's drought experience was measured by the Palmer Drought Severity Index (Palmer, 1965) in his or her county over the time he or she was farming there. The Palmer Index, or PDSI, is based on water balance, using historic records of precipitation and temperature, two layers of soil moisture storage, runoff, potential evapotranspiration, and current as well as preceding months' precipitation and temperature. The Palmer Index classifies weather conditions for each month (see Table 1) as departures from "climatically normal conditions for the month and location." The value -4, the threshold of "extreme drought," was calibrated against specific historical drought episodes in Kansas and Iowa, which Palmer regarded as extreme.
Although the PDSI has been criticized (Alley, 1984; Karl, 1985), it remains in widespread use. The PDSI was used in this study as a measure of meteorological drought for comparison with farmers' recollections of drought. Its use here allows direct comparison of the results with those obtained by Saarinen (1966).

Figure 1 is an illustrative comparison of both the years of drought recalled by farmers (solid line) and the meteorological pattern of drought that has occurred in the Ogallala Aquifer region (dashed line) since 1930. As indicated by the dashed line in Figure 1, the Ogallala region experienced severe drought lasting almost a decade during the "Dust Bowl" of the 1930s. The 1950s drought generally lasted 5 years in this area, a 2-to-3-year drought occurred in the period 1963-1965, and drought periods since then have been fairly mild and brief.

Meteorological conditions during the period of the farmers' experience are expected to have a profound effect on their beliefs about what moisture levels are normal and what conditions they consider abnormally dry or wet in their areas. Figure 1 shows that people who had begun farming in the Ogallala Aquifer region after 1964 would
have a very limited experience in relation to the potential severity of drought there.

Another way of illustrating how experience of normal dryness and of the range of wetness-to-dryness depends on when a person began farming is shown in Figure 2. The three lines indicate, for southwestern Kansas, the most extreme wetness (top line), the median wetness to dryness (center solid line), and the most extreme dryness (bottom line) experienced by a farmer during the months April through August, depending on when he or she started farming there. For example, one of our respondents who had begun farming in Finney County, Kansas, in 1965 would have experienced, between 1965 and 1985, a median PDSI value almost exactly equal to the 30-year average; drought to a PDSI value of -3, the threshold of severe drought; and extreme wetness up to 5.67. He or she would lack experience of the severe or extreme droughts that occurred prior to 1964. The “step function” shifts in PDSI experience, illustrated in Figure 2, show that a person could farm for quite a few years in an area (20 years in the example above) and still have very limited direct experience of the region’s drought potential. Similar patterns of experience were found for the other four study areas.

DROUGHT MEMORY

The solid line in Figure 1 represents the number of farmers recalling each year as a drought year. In general, farmers tended to recall (a) the prolonged, extreme drought events that have occurred in the region in the 1930s and 1950s, and/or (b) recent years, the 1980s. As droughts become more remote in time, they are less specifically recalled, people remember most recent droughts by year, the more distant severe droughts by decade. Although the drought episodes of the 1930s and 1950s were recalled by large proportions of farmers, memory was vague as to when these droughts began and ended.

Figure 2  Breadth of “Wetness-to-Dryness” Experience in Southwest Kansas, Depending upon First Year of Farming

Analysis of farmers’ drought memories indicates that memories of all but the most prolonged and severe drought events fade rapidly. The percentage of farmers, actively farming at the time, who identified any year as a drought year is negatively correlated with how long ago it occurred. The Pearson product-moment correlation coefficient between number of farmers recalling drought and number of years past was -0.65 for the period 1960-1984. In Figure 1, from about 1960 to the present there appears to be little meaningful relationship between recorded drought and
years recalled as personal drought experience. Note that the solid line in Figure 1, the number of droughts recalled per year, trails off from right to left between 1955 and 1960; the farther the year in the past, the fewer identified it as a drought year.

The relatively mild drought years of the period 1963-1964, which were recalled by over 50% of Saarinen's sample, were almost entirely forgotten by our respondents in 1985. None recalled the peak drought year, 1964. The relatively mild years, in terms of drought, in the early 1980s were frequently recalled as drought years. No months of PDSI drought worse than "moderate" were recorded anywhere in the survey region during this time. Nevertheless, 42 of the 99 farmers interviewed identified one or more years in the 1980s as being drought years.

This pattern of recalling the most severe and the most recent droughts can be explained by analogy. It is similar to standing on the plains, looking up toward nearby mountains. One can see the closest foothills in detail, the tallest mountain peaks somewhat vaguely. The intermediate ranges are hidden from view. This description of memory pattern seems intuitively logical; it fits with our own experience.

It also fits with the results reported by Kirkby (1974) of farmers' perceptions of rainfall in the Oaxaca Valley of Mexico. These farmers remembered the most recent wet year, then progressively wetter years beyond. In addition, the previous year's moisture was recalled regardless of the relative wetness. Kirkby felt that the latest, wettest year blocked memory of earlier years. This was supported by her findings that farmers interivewved immediately after a particularly wet year were unable to recall any wet years prior to that one year.

To examine the relationship between farmers' drought memories and meteorological measures of their experience, multiple regression analysis was used to control for the effect of fading memory. For the dependent variable in the regressions, a "drought rating by farmers" (DRF) was computed for each year in each location. The DRF for a location is the proportion of respondents farming there at the time who identified each year as a drought year. For the period 1960-1984, DRF was significantly correlated with the reciprocal of how many years past (1/YP) the identified drought year occurred. In total, 32% of the variance in DRF was explained by fading memory alone.

In order to examine the relation between farmers' drought memories and the PDSI, stepwise regressions were performed using monthly March-August PDSI values as predictors. Because of vagueness in farmers' drought identification in earlier years, the analysis was restricted to 1974 through 1984, the most recent 11 years for which PDSI values were available. For these years, 1/YP still explained 30% of the variance in DRF. The July and June PDSI values emerged as significant predictors, together explaining 20% of the variance in DRF in addition to that explained by 1/YP.3

Another set of stepwise regressions was run using growing season temperatures and precipitation as predictors for this same period, 1974-1984. After 1/YP, July temperature emerged as the only significant predictor (20%) of farmers' recollection of drought. A possible explanation of the emergence of temperature rather than precipitation as a drought-recall predictor is offered by Neal (1986). Irrigation, as an adaptive response to drought, can offset the effects of moisture deficiency, but only slightly offset the effects of excessive heat, which often is a component of drought in the Great Plains.

Memory and Age

Of course, the older farmers have experienced more droughts than have younger farmers and therefore recall more droughts. Farmers over 50 averaged 2 or more droughts recalled, farmers under 50, 1.5. Quite logically,
the proportion of farmers who mentioned the classic droughts of the 1950s and 1930s increases with age (Table 2). The proportion of farmers who mentioned drought years in the 1980s shows a reverse pattern, decreasing with age. Fairly consistently, farmers under 40 recall drought in the 1980s, and farmers over 50 recall the classic droughts of the 1950s and 1930s.

Younger farmers reported less damage from past droughts. Of the farmers under age 40, 33% reported no serious impact on their own farming operations from the last drought of their experience, as compared with 21% of the farmers 40 and older. However, the majority of the latest droughts being reported by these youngest farmers occurred in the early 1980s (see Table 2), which, as noted above, was not a period of very serious drought.

**Drought Definition**

The first mention of the term drought in the 1985 interviews was in asking farmers for their definitions: “What do you think of as a drought?” This immediately followed a series of questions concerning weather and climate, weather extremes, and climate change, so a tendency to answer in meteorological terms was expected.

Drought was defined in terms of deficient rainfall, lack of moisture, or a “dry spell” by 89 of the farmers; 30% of the farmers defined drought to be less than average rainfall; 12 mentioned high temperature or winds in addition to dryness. The remaining farmers defined drought in terms of low crop yields, crop failure, and/or economic impacts.

Opinions differed on how long a dry spell must be to constitute a drought. Of the 66 farmers who mentioned a time span, 68% specified a single season or a period under 8 months, 18% specified one year, and 14% specified that the dry period should last two years to be considered a drought. Of those who defined drought as a dry season, many specified summer or the growing season; a few specified

### TABLE 2

<table>
<thead>
<tr>
<th>Number of Farmers</th>
<th>Age Group</th>
<th>Experience (median)</th>
<th>Years of Farming in 1930s</th>
<th>Years of Farming in 1980-84</th>
<th>Number of Farmers Identifying Drought</th>
<th>Expected Drought Years (median)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Under 40</td>
<td>9.5</td>
<td>50% (4)</td>
<td>83% (13)</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td>13</td>
<td>40-49</td>
<td>24</td>
<td>55% (18)</td>
<td>43% (14)</td>
<td>31</td>
<td>31</td>
</tr>
<tr>
<td>23</td>
<td>50-59</td>
<td>33</td>
<td>70% (28)</td>
<td>35% (8)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>17</td>
<td>60 &amp; over</td>
<td>45</td>
<td>100% (27)</td>
<td>28% (7)</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
<td></td>
<td>63% (43)</td>
<td>42% (42)</td>
<td>15</td>
<td>15</td>
</tr>
</tbody>
</table>

Spring. Many farmers pointed out that seasonal variations in precipitation and temperature are much more important in farming than are annual averages. A wet-winter/dry-summer year, with average annual precipitation, could constitute a functional drought year for summer crops.

It was expected that location and the number of years farming would influence a farmer's definition of drought. There was some tendency for the farmers under age 40 to use a shorter time-span definition; 75% of the farmers under 40 defined drought as lasting 7 months or less, compared to only 50% of the farmers aged 40 and over, but this difference was not statistically significant. The expected duration of a drought was not significantly related to either location or years of experience for these farmers.

Although many farmers did not specify severity in their definition of drought, their concept of severity can be inferred from their identification of the most recent years (1980 through 1984) as drought years. Since these years were relatively mild, in terms of PDSI drought in the study region, classification of any of them as “drought years” indicates a low-severity definition: a dry spell called a drought. By this measure, there was considerable variation in the severity required of a “drought.” In total, 30 farmers described only years in the 1930s and 1950s as drought years, whereas 42 farmers identified at least one year in the relatively drought-free 1980s as a drought year.
In Texas, Oklahoma, and Kansas, where the PDSI indicated some periods of mildly below-normal moisture in the period 1982-1984, 29 of the farmers identified drought in that period. In these three states, we can distinguish between a group of 29 farmers who identified drought in this three-year period, and another group of 31 farmers who did not. Examination of the crops and livestock grown by the two groups revealed no apparent differences. Instead, the two groups differed significantly in their definitions of drought duration and in their years of farming experience. Definition of drought duration explained 19% of the variance; years of farming experience explained an additional 10%. Those who identified drought in the period 1982-1984 were much more likely to use a short-term definition of drought. More experienced farmers were less likely to identify these years of mild moisture deficiency as "drought."

In terms of how long they had been farming, more experienced farmers tended to reserve the word drought for more severe events. A farmer's definition of drought duration was not clearly related to experience, although it was usually consistent with past droughts that he or she identified. Differences in experience related to farming location were not reflected in drought definitions.

Thus the spectrum of conditions that might be called "drought" ranges from short and mildly dry (exemplified by conditions in Kansas, Oklahoma, and Texas in the period 1982-1984) to long and severely dry (exemplified by conditions throughout the region in the mid-1950s). Almost all of those who were farming at the time called the 1950s conditions "drought," while slightly less than half in the affected locations called the 1980s conditions "drought." These differences are critical to understanding differences in farmers' responses to other questions involving the word "drought," such as frequency of drought and identification of drought years.

**EXPECTATIONS OF DROUGHT**

Farmers were asked, in open-ended questions, to describe the climate of their area and to list its advantages and disadvantages for farming. Of them, 64% commented that the climate was semi-arid or too dry, which indicates that they consider dryness to be a usual, expected condition in the region. The farmers were also asked to estimate drought frequency: "If you were to live here 100 years, how many drought-years would you expect to have?" Responses ranged from 1 to 90 years per 100, but 55 of the 99 farmers interviewed responded in the range 10 to 20 years. The median number of expected drought years per 100 was 13 (see Table 2).

The farmers' expectations of future droughts were related to their definitions of drought and to their farming locations. Farmers in the southerly locations expected more frequent droughts than farmers in the more northerly ones. The significant north-south split was between Nebraska and Colorado in the north, whose farmers expected a median of 10 and 11 years of drought, respectively, and Kansas, Oklahoma, and Texas in the south, where median numbers of drought years per 100 were 19, 15, and 18, respectively.³

The farmers who used a shorter duration or less severe definition of drought expected droughts to occur significantly more often. Table 3 shows that farmers using a short-term drought definition (under 8 months) expect a median of 20 drought years in 100, while farmers using all other drought definitions expect a median of only 10 to 12 drought years in 100.³ Note also that those with short-term definitions identified droughts in the 1980s far more often than any of the others. These results indicate consistency in a farmer's use of the word drought, since inclusion of milder dry spells expands the number of events to which the word will be applied.

There appears to be a weak negative relationship between a farmer's estimate of drought frequency and the number of
The farmers interviewed were also asked whether another drought as severe as the “Dirty Thirties” would occur again, and, if it did, would the effects be the same. Of the farmers, 71% felt that a recurrence of such a drought was at least possible, a majority (55%) believed that such a drought would probably recur, and a fourth felt it definitely would recur. In total, 80% of the farmers interviewed, including all but one of the farmers under 40, felt that the effects of another “Dust Bowl” drought would not be as severe as it was in the 1930s. This was attributed primarily to changes in agricultural technology that have occurred since 1940, particularly irrigation.

Combining these responses with the tendency of more experienced farmers to use a more severe definition of drought, we conclude that the oldest group of farmers, the only ones who were farming in both the 1930s and the 1950s, tended to see drought as something more severe and more difficult to overcome than the dry spells experienced in recent years.

### DISCUSSION

**Comparisons Between 1965 and 1985**

Saarinen identified a distinctive pattern of drought recollection among Great Plains farmers. Farmers remembered the most recent drought, the most severe droughts, and to some extent the “drought of primacy” (i.e., the first drought they experienced as farmers). Saarinen noted that even the most recent “incipient drought” was recalled, in Adams County, Nebraska, by over 50% of the farmers interviewed. This memory was inversely correlated to farming experience—old-timers did not mention the incipient drought of the years 1963-1964, newcomers did. Results of the 1985 survey substantiate and expand upon Saarinen’s description.

### TABLE 3
Definitions of Drought Compared with Recalled and Expected Droughts

<table>
<thead>
<tr>
<th>Number of Farmers</th>
<th>Expected Drought Duration (median)</th>
<th>Number of Farmers</th>
<th>Expected Drought (median)</th>
<th>Years of Farming Experience (median)</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>28 (29%)</td>
<td>25</td>
<td>3 (27%)</td>
<td>24</td>
</tr>
<tr>
<td>17</td>
<td>10</td>
<td>15</td>
<td>12 (25%)</td>
<td>24</td>
</tr>
<tr>
<td>9</td>
<td>11.5</td>
<td>6</td>
<td>16 (38%)</td>
<td>44</td>
</tr>
<tr>
<td>15</td>
<td>13.5</td>
<td>12</td>
<td>10</td>
<td>28,5 ± 2</td>
</tr>
</tbody>
</table>

years he or she has been farming. The correlation between these two variables is $r = -0.20$, just at the borderline of statistical significance. Since the farmer’s definition of drought severity was shown above to be significantly related to his or her years of experience, this is not surprising.

When asked whether they thought droughts were becoming more or less frequent, 54 farmers felt the frequency of drought was not changing. However, 31 felt that droughts had become less frequent in recent years as opposed to 11 who felt drought frequency to be increasing. Whether farmers felt drought had become more or less frequent is significantly related to farming experience at a 95% confidence level. Farmers who had experienced the 1950s, and/or the 1930s, were more likely to feel that drought had become less frequent in recent years.

The expected impact of drought was probed with the question, “Have you found effective ways to overcome drought losses?” The responses were significantly related to both age and experience, at a 95% confidence level. Most (84%) of the farmers under age 60 felt they had found ways to overcome drought losses, while only 52% of those 60 and over felt that way. Responses to this question were not significantly related to either farming location or drought definition.
of how drought is recalled. Saarinen surveyed in Nebraska, Kansas, Colorado, and Oklahoma, so the survey areas are reasonably analogous. Finney County, Kansas, and Frontier County, Nebraska, were included in both surveys. It is important to note that Saarinen's survey immediately followed a two-year period of rather severe drought (1963 through 1964). Using the aggregated PDSI drought scale shown in Figure 1, drought severity/duration for the Ogallala region included in the 1985 survey totaled 254 for the period 1963-1964. The total drought severity/duration for the same region for the period 1983-1984, the two years preceding the 1985 survey, was 14. Saarinen noted, from his reconnaissance survey, that "Great Plains wheat farmers speak frequently, animatedly, and, in dry spells, almost exclusively about drought." During the fieldwork for the present survey (February and April 1985) it was difficult to find any group of farmers who were discussing drought; instead it was virtually impossible to find three or more farmers together who were not discussing farming economics. The period preceding the 1985 survey did not show drought of any significance. However, the 1985 survey coincided with a period of serious concern, both among farmers and in the national media, with farm economics. A rally of farmers, protesting farm foreclosures and loss of needed federal farm programs, was held in Ames, Iowa, during our first week of surveying.

Despite the very different conditions preceding the two surveys, there is a great deal of similarity in the results. The 1985 Ogallala region survey found that farmers tended to recall moderately dry recent years as drought years, to recall only extreme drought events beyond that immediate time horizon, and nearly a third mentioned a drought that occurred within 1 to 2 years of their beginning farming (their "drought of primacy"). However, three-fourths of these latter also fall within the 1930s and 1950s, classic-severe drought periods for the region. The 1985 results differ in magnitude from the 1965 results, especially in memory of most recent years as drought years. Saarinen reported those drought episodes recalled by "at least half of the farmers who were there at the time," which include the periods 1962-1964 or 1963-1964, plus the classic drought episodes of the 1950s and the 1930s "Dust Bowl." None of the most recent droughts of the 1985 Ogallala survey was recalled by more than 50% of the farmers present at the time. But the classic drought episodes, as with Saarinen's results, were recalled by more of the farmers surveyed than were actually farming there during the 1930s or 1950s.

A difference from the pattern of drought memory described by Saarinen is suggested by the 1985 results. It appears that the most recent years may be identified by some as drought years simply because they are the most recent years, if moisture levels are even slightly below normal. But the most recent years are not recalled as drought by everyone. The modification to Saarinen's pattern of drought memory, demonstrated here, is that inexperienced farmers remember the most recent dry periods or seasons as droughts; experienced farmers remember their most severe droughts—the "classics."

ELEMENTS OF PERCEPTION

Figure 3 is a schematic depiction of the relations among these four elements of drought perception derived from this study. The figure indicates that memory of drought stems primarily from drought experience. In addition, the way one defines drought is largely a reflection of droughts experienced. Memory and definition interact in that what one recalls as drought depends on how one defines drought, and that definition of drought is influenced by the droughts one remembers. The expectations one holds about future drought will be dependent, in turn, upon how drought is defined and the way in which past experiences are remembered. These combined elements of perception should
influence one's behavior regarding anticipation of and preparation for drought.

Figure 3 is not intended as a complete or rigorous statement of a theory of drought perception. It is simply presented as a heuristic guide to thinking about the elements of perception uncovered in this study.

Definition and experience were both important factors in farmers' memories and expectations of drought. The farmers differed in their use of the word drought, some applying it only to prolonged periods of severe moisture deficiency, others using it to refer to short, mild spells of moisture shortage. Those who included short or mild drought often referred to particular periods in the growing season that are crucial to plant growth.

Under meteorological definitions such as the PDSI, the term drought-prone has little meaning since each location is compared only to its own normal conditions. But farmers in the hotter, southerly areas of the Ogallala region expected more droughts than those in the cooler areas, indicating that they see their location as more drought-prone.

Experience pervades the model of drought perception offered here. The most consistent means of differentiating among farmers' memories, definitions, and expectations of drought is to separate the sample by location and years of farming, that is, by experience. Referring again to Figure 2, we can view the space between the upper and lower dashed lines as the width of a farmer's wetness-to-dryness horizon. More limited experience will yield a more limited perspective on weather variability. In addition, it has been 30 years since the last drought in the region of really classic severity.

Therefore, younger farmers cannot have gained experiential knowledge of the true potential for drought in the western Great Plains. We have discovered a number of drought perception characteristics that separate our sample into those with an extended drought horizon and those with a limited drought horizon.

Farmers with an extended perspective tend to be older. They have experienced more droughts and thus recall more droughts. Their experience has included extreme drought. Although some of the older farmers use a mild, short-duration definition of drought, they are more likely than younger farmers to define drought as harsh and long. With greater severity and duration in their definitions, they tend to expect fewer such droughts to occur, but droughts that will certainly be felt. They also notice a reprieve; they feel that drought frequency has decreased in the past few years.

Although these more seasoned farmers feel that changes in farming technology will greatly change the nature of future drought impacts, they don't feel that drought has been overcome. They've experienced the deprivation that has resulted from extreme, prolonged drought.

By contrast, younger farmers with more limited experience have not seen as many droughts and so, of course, do not recall so many. Because of the pattern of drought history in the region, this experience has not included drought of truly classic proportions. They have only rather limited drought episodes to recall, and thus they tend to define drought as less severe and shorter. They do expect to see more of these milder droughts. More of the farmers in this group feel that they have found effective ways to overcome drought losses.

**PATTERNS OF PERCEPTION**

We offer Figures 2 and 3 as guides to thinking about patterns of perception of meteorological or other environmental events. The relationship among elements presented
in Figure 3 may be applicable to perception in general. Such a contention requires further investigation, for example, construction of a perception-of-environment research project so that statistical techniques, such as path analysis (for example, see Pedagorz, 1982: Ch. 15), could be applied to the sequence of interrelationships suggested.

The type of analysis represented in Figure 2, which relates environmental events to the careers of people involved in environmentally sensitive activities, could be used in studies of other environmental variables. For example, in the analysis of hazard experience, the "experience horizon" might be defined as severity of storms, level of flooding, or earthquake severity. A graphic picture of "breadth of experience" as a function of age or length of career might be helpful in explaining intergenerational differences in behavior as well as in predicting future changes in response to environmental events.

In assessing people's perceptions, expectations, and adaptive responses to recurrent environmental stimuli such as drought, it is critical to assess the frequency of the event in relation to a human lifespan. How often does the phenomenon occur? How long ago was the last one?—since so many recurring environmental meteorological events occur without predictable regularity. How severe have the episodes been that fall within the experience of the people living there now?

Without these perspectives, the environment and behavior community—particularly the perception of hazards group within that community—is vulnerable to criticizing people "for behaving quite illogically," when in fact their behavior is quite rational in relation to their experience. After all, droughts used to be a lot worse than they are now, but Grandpa's memory is beginning to fail him. And we've heard too often about how our parents had to walk three miles through snow, chest deep, to get to the school bus. Skepticism is not only natural, it is necessary. To a certain extent one has to rely on his or her own knowledge and experience. When, however, that self-reliance restricts our view of the potential variance of the living environment, it can be to our detriment.

NOTES

1. More details, and results from other lines of questioning, can be found in Taylor et al. (in press).
2. Since the PDSI is computed monthly, creating a summary value for comparison with farmers' recollection of droughts (which were in terms of "drought years") required temporal aggregation. For illustrative purposes, monthly PDSI values of -1.0 or below were added to obtain a rough index of yearly drought severity for each of the five survey areas in this study. The absolute values of the yearly sums provide annual summary values that include both drought severity and duration. The cutoff value of -1.0 was chosen because Palmer used this "mild drought" value as the threshold of actual drought conditions. Values above -1.0 were ignored, so this aggregate term includes drought only and is not counterbalanced by any periods of relative wetness that may have occurred.
3. The results are plotted in Figure 1.
4. Based on a stepwise discriminant analysis.
5. The north-south difference is statistically significant at a 99% confidence level using a Wilcoxon test.
6. This difference in drought expectation is statistically significant at a 95% confidence level based on nonparametric analysis of variance using the Kruskal-Wallis test.
7. This correlation is significant at the 90% confidence level, but not the 95% level.
8. Based on a nonparametric analysis of variance using the Kruskal-Wallis test.
9. The comparison with age used the chi-squared test, that with experience used the Wilcoxon test.

REFERENCES


