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Drought Experience and Perception of Climatic Change among Great Plains Farmers

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DROUGHT EXPERIENCE AND PERCEPTION OF CLIMATIC CHANGE AMONG GREAT PLAINS FARMERS

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Abstract. *How humans perceive, respond, and adapt to long-term climatic change are questions of fundamental interest to nature and society researchers. This paper analyzes the effect of drought experience on Great Plains farmers' perceptions of long-term climate change. Approximately three-quarters of all farmers surveyed believed that the climate is, or is possibly, changing. Drought experience, while perhaps not initiating concern for climate change, can solidify peoples' perceptions of the certainty and nature of the change. The potential cognitive heuristics used in the formation of climate change perceptions are discussed.*

A consensus has emerged in recent years in the scientific community that major anthropogenically-induced climate changes could have cumulative and fundamental effects on the earth's natural systems over the next several decades. Perceptions of climate might affect how people will respond and adapt to global warming. This paper examines possible causal relationships between perceptions of long-term climatic change and drought experience of farmers in western North Dakota and northeastern Colorado.

Background

Climate Change and the Great Plains

The Great Plains could be vulnerable to climatic shifts in a warmer global climate caused by the so-called "greenhouse effect." Most studies point to a warmer and drier climate (at least in regards to total evapotranspiration rates) in the Great Plains (e.g., Rosenzweig 1985, 1987; Ciborowski and Abrahamson 1986; Smith and Tirpak 1988; and Williams et al. 1988). In the northern Plains, Stewart (1987) estimated that atmospheric doubling of CO_2 would result in an increase in Saskatchewan's average

temperature, a 15% increase in annual precipitation, and prolongation of the growing season by 48 days. Higher evapotranspiration rates however, would mean that production of spring wheat would still decrease by 6-14%. Perhaps of even greater importance, the frequency of drought months would be increased by 10 times and droughts would be more severe and longer (Stewart 1987, 414).

Climatic warming would affect the northern Plains' dominant crop of spring wheat, and would have other wide ranging agricultural and economic consequences for the region's inhabitants (Williams et al. 1988). For example, one of the major adaptations predicted for the northern Plains will be a gradual shift from spring wheat to winter wheat (Rosenberg 1982; Rosenzweig 1987). Milder winters would be more conducive to the survival of winter wheat, and the quick growth start during spring and subsequent earlier harvest would to some degree offset the effect of hotter, more drought-prone summers.

While the exact spatial and temporal aspects of climate change are uncertain, it is possible that the Great Plains will experience significant climatic changes during the next 100 years. This change could require substantial shifts in crop types and farming practices. Because of the uncertain nature and timing of the climate change farmers may have to depend upon their own heuristic devices for perceiving and evaluating the farm-level impacts of global warming.

Perception, Uncertainty, and Drought

To comprehend potential or even probable responses by agriculturalists to global warming requires understanding how farmers form their perceptions of climate change from the influences of actual climatic shifts, scientific information, and socio-cultural factors. The fundamental question of this paper is how farmers might come to view climate change.

Perceptions of the environment appear to be affected by the magnitude, frequency, and temporal aspects of environmental change (e.g. Burton et al. 1978; Kates 1962). These perceptions may mediate human interaction with the environment (Burton et al. 1978; Saarinen et al. 1984). Perceptions of the environment and apparent climate modification influenced early settlement patterns and public policy in the Great Plains (Kollmorgen 1969; Kollmorgen and Kollmorgen 1973; Blouet and Lawson 1975). Farmers' experience, perception, and behavior have been interlinked during twentieth century drought and have been described elsewhere (Saarinen 1966; Taylor et al. 1988). Drought onset is slower and its impacts are more protracted than such hazards as tornadoes, hail, and floods. Drought might, therefore, be more difficult to perceive, but because it plays a crucial role in economic survival, most farmers probably have

strong opinions on its magnitude, frequency, and timing (e.g. Saarinen 1966; Kirkby 1974; Taylor et al. 1988).

Some drought perceptions have been shown to have no impact on decision making and are considered "nonoperational" (Kirkby 1974). Other evidence, however, suggests that farmers' awareness and perceptions of living in a semiarid environment affects their management style. Parry (1985) noted that farmers in marginal regions are cognizant of climatic variability. They are concerned more with survival than wealth, and therefore emphasize avoiding risk over maximizing outputs.

Lack of clarity about spatial boundaries, occurrence, and perceivable impacts hamper perception of drought events. Gradual changes in climate and climatic variability, as involved in potential global warming, may then be almost impossible for people to perceive. In the St. Louis metropolitan area, for example, a 30% increase in precipitation over 30 years was not noticed by most people (Farhar-Pilgrim 1985). Whyte (1985, 407) hypothesized that "extreme interannual events and natural hazards are likely to produce the greatest behavioral response . . . whereas longer-term climatic events such as . . . CO_2 warming . . . cannot be directly perceived by individuals."

The resulting impression may be that attempts to measure peoples' perceptions of long-term environmental change are fruitless. Previous studies, however, do not provide any insight into how the perception of distinct identifiable episodes, such as major droughts, are related to more subtle long-term phenomena. Brooks (1986, 339) noted a tendency for "sociotechnical systems to respond preferentially to 'fast variables' in the environment, as compared to 'slow variables,' especially when the latter are less familiar or predictable." But does this response to "fast" change in any way affect or alter the perception or response to "slow" change, such as climate change?

A major event, such as drought, can influence future judgement of the probabilities of the same events (Tversky and Kahneman 1974; Riebsame 1986). A recent event can galvanize people to seek information on protection against that hazard (Kunreuther and Slovic 1986). Changes in flexibility, reliability and resilience of adjustments selected, and perception of the probability of future events should result. But because of the time scale involved, people have no direct experience with climate change *per se*. Thus, judgements of the probabilities of future long-term climate change cannot be determined from past experience. Without real experience of the magnitude and impacts of climate change, could people use more recent short-term climate experiences, such as drought, to aid in the assessment of future climate change?

Cognitive Heuristics and Climate Change

Social psychologists have shown that people are poor estimators of risk and probability (Kahneman et al. 1982). Tversky and Kahneman (1974) found that three common heuristics--representativeness, availability, and anchoring--can result in cognitive biases. These biases can, in turn, result in inaccurate perceptions and poor decision making. This paper focuses on the representativeness and availability heuristics.

The representativeness heuristic is used by people to judge the probability of a little known event or situation by comparison to other similar and better known events. People using this heuristic assess the probability of an uncertain event by the degree to which it is "similar in essential properties to its parent population; and . . . reflects the salient features of the process by which it is generated" (Kahneman and Tversky 1972). Common questions about an event might be the likelihood that event *A* belongs to process *B*, or that *A* originates from *B*, or that *B* will cause *A* to occur. In answering these types of questions people incorporate the representativeness heuristic by evaluating the degree to which A is representative of, or resembles, B (Tversky and Kahneman 1974, 1124).

The closely related availability heuristic is the process by which people will assign higher probabilities to events that can more easily be recalled (Riebsame 1986: 130). Tversky and Kahneman (1973, 207) stated:

> Lifelong experience has taught us that instances of large classes are recalled better and faster than instances of less frequent classes, that likely occurrences are easier to imagine than unlikely ones, and that associative connections are strengthened when two events frequently co-occur.

These associative bonds are often based upon experience and salience of the event. The availability heuristic can be split into two general classes: the construction of instances and associations, and the retrieval of associations and instances. This construction and retrieval process can be biased by highly salient data, by an unrepresentative data base, and by beliefs and values (Taylor 1982, 192). For example, a farmer who had recently experienced one moderate drought would be less likely to believe that drought frequency is increasing, than a farmer who had recently endured two major droughts, because the latter event presented easier recall and higher salience.

These cognitive heuristic processes may influence environmental perception and decision making. Riebsame (1986) showed the vital role of these heuristic devices in the endurance of the "Dust Bowl" image, and the implicit guidelines the image sets forth for agricultural policy and land-use

planning. Whyte (1985) discussed numerous examples where heuristics affect the perception and response to hazards, especially beliefs in patterns. She also demonstrated that these heuristics work in close conjunction with one another.

The research in social psychology has mainly addressed the impact of heuristic biases on probability assessments. But what about the influence of these biases on the qualitative aspects of environmental perceptions? Will people use representativeness and availability heuristics to form qualitative judgments on climate change? I hypothesize that farmers do, and that drought experience can play a meaningful role in this process. The availability heuristic is the mechanism by which farmers retrieve examples of memorable, salient climate events and then construct a scenario of the future climate. But this retrieval and construction process may not be enough to convince a farmer that the climate is changing. Representativeness should provide the link from extreme event to long-term change. Does a farmer's perception of climate change *A* resemble the future climate scenario *B* (which, according to media reports and many experts, may be warmer and drier)? If *A* is roughly similar to *B* then representativeness is at work. The farmer then should be more likely to believe that the climate is changing, see the change as anthropogenic, and view recent events as being caused (in part) by anthropogenic forces.

Perception of Climatic Change: A Case Study

In order to examine the role of availability and representativeness heuristic biases in the development of perceptions of long-term climatic change, a survey was conducted of dryland wheat farmers in the northern Great Plains. Numerous studies discussed the role of extreme events in heightening environmental awareness and response to hazards (e.g., White 1974). The media and others linked the 1988 drought and the greenhouse effect, so drought seemed a logical focus for study.

A Survey of Great Plains Farmers

A mail survey was conducted during the summer of 1989. The survey design designated western North Dakota as a case study area that had experienced frequent droughts (defined by precipitation and drought impact) during the 1980s, especially 1988. A smaller control group of farmers was selected from northeastern Colorado, an area in the Plains that had been relatively spared from major droughts during the 1980s, including 1988.

Dry conditions or drought characterized the 1980s in North Dakota, with only 1982 and 1985 being "wet" years. The 1988 drought was one of the driest in North Dakota history (Aakre et al. 1988). Northeastern Colorado, however, experienced relatively wet conditions in the 1980s. From 1982 to 1988 this portion of the state received consistently above average annual precipitation. Northeastern Colorado escaped the 1988 drought that devastated other parts of the country. However, like North Dakota, Colorado did experience moderate to severe drought conditions during 1989. The two case study areas, therefore, broadly satisfy the criteria for frequent and infrequent drought regions during the 1980s.

A systematic design chose 500 Colorado and 1000 North Dakota farmers from a purchased mailing list that included most of the agricultural operators and landowners in 11 northeastern Colorado and 23 western North Dakota counties. Survey recipients were farm-operators with 100 acres or more of wheat, but 50 acres or less of irrigated land. The sample was deemed representative of dryland wheat farmers. The overall response rate was 37%; allowing for nondeliverable surveys and those who no longer farmed; 44% of the Colorado farmers and 34% of the North Dakota farmers responded.

TABLE 1

SELECTED RESPONDENT CHARACTERISTICS

	All Farmers	ND	CO
Numbers	432	274	158
Mean years farming	29.6	28.0	32.4
Mean farm size (acres)	2045	1826	2424
Median farm size (acres)	1580	1500	1850
Type of farm			
predominantly wheat & small grains	51.4%	47.1%	59.2%
equal mix of small grains & livestock	41.2	45.6	33.8
mostly livestock	5.3	6.2	3.8
other	2.1	1.1	3.2
total	100.0	100.0	100.0

The final sample of 432 agriculturalists represented a group of experienced farmers operating relatively large farms and ranches (Table 1). The Colorado and North Dakota samples differed considerably. The average farm in Colorado was nearly 600 acres larger than in North Dakota, perhaps in part attributable to a corresponding greater average number of years farming for Colorado farmers. North Dakota farms were on average more diversified, having an approximately equal mix of small grains and livestock.

Associations between farm size, years farming, and type of farm operation, and climate perception variables, such as attribution of drought and climate change causality, were weak or nonexistent. However, respondents who had farmed fewer years were somewhat more likely to believe that droughts were becoming more frequent and that future droughts would be worse. The importance of age (or farming experience) in the formation of environmental perceptions is well documented (Saarinen 1966; Taylor et al. 1988). This paper does not seek to replicate these studies *per se*, but rather to explore the cognitive processes that may be used to form perceptions of long-term climate change. Thus, the topic of age in affecting perception is only briefly discussed.

Drought Experience

Drought impact can be assessed by what farmers say, in addition to climate and crop yield data. Colorado and North Dakota farmers differed substantially (Table 2). Farmers in both samples believed that they were

TABLE 2

COMBINED RESPONSES FROM FIVE-POINT LIKERT STATEMENTS*

Statement	Strongly agree or agree		Strongly disagree or disagree	
	CO	ND	CO	ND
Farm income reduced by 1988 drought**	62.1	79.6	29.4	12.6
My farm was damaged by 1988 drought**	29.8	44.4	53.2	41.9
1989 drought will decrease yields	79.9	80.2	8.4	11.9
1989 drought will decrease income	75.0	78.8	13.8	11.1

*Percentage of farmers from each state. **Differences between states are significant at chi-square 0.05 level.

affected by the 1988 drought. A greater proportion of North Dakota farmers than Colorado farmers, however, saw themselves as adversely affected. Perceived income and yield losses due to drought in 1989 were essentially the same in the two states.

The impact of the 1988 drought on farmers' management strategies also differed between the two states (Table 3). When asked if the 1988 drought had led them to change their farm management strategies for three or more years into the future, 49% of North Dakota farmers said "yes" or "maybe", compared to only 31% of Colorado farmers. Drought experience can apparently affect farmers' future drought responses. Over 48% of North Dakota farmers said they would or might respond differently to future droughts, compared to 40% of Colorado farmers. In a separate question 66% of Colorado farmers indicated that they planned to continue current farm management practices in the coming years, compared to 54% of North Dakota farmers.

Drought experience clearly affected certain climate perceptions in the two states (Table 4). North Dakota farmers perceived more droughts during the 1980s than did Colorado farmers. Five years in the 1980s were remembered as drought years by 15% or more of the North Dakota farmers, but only two years were remembered as drought years by 15% or more of Colorado farmers. This variation is consistent with different

TABLE 3

DROUGHT IMPACT AND RESPONSE TO FUTURE DROUGHTS*

Question	Yes		No		Maybe	
	CO	ND	CO	ND	CO	ND
Did the 1988 U.S. drought lead you to change your farm management strategies 3 or more years into the future?	18.1	36.9	68.5	51.0	13.4	12.2
In the future will you respond differently to drought than you did during past droughts?	8.4	16.5	60.0	51.7	31.6	31.8

*Percentage of farmers from each state. Differences between states are significant at chi-square 0.05 level.

TABLE 4

RECOLLECTION OF PAST DROUGHTS IN RESPONDENT'S STATE*

Year	ND (n=274)	CO (n=158)
1989	26.6	24.0
1988	70.1	20.9
1987	16.1	3.8
1986	3.3	3.2
1985	6.6	2.5
1984	3.3	1.9
1983	4.0	2.5
1982	3.3	1.9
1981	18.2	.6
1980	25.9	3.8
1961	33.2	2.5
1956	1.8	7.0
1955	1.8	20.9
1954	.7	14.6
1936	7.7	1.9
1935	3.3	10.8

*Percentage of farmers in each state mentioning selected years.

perceptions of drought frequency. More North Dakota farmers believed that droughts are occurring more frequently than did their counterparts in Colorado (Table 5).

Experience significantly affected recall and expectations of drought(s). It was easier for farmers to recall more recent (1988 and 1989) and/or extreme events (1980) than older or moderate ones (cf. Saarinen 1966; Taylor et al. 1988), and using the availability heuristic they were able to extend this recall ability to an assessment of how drought frequency is changing.

If farmers do use the availability heuristic to form assessments of future droughts, differences in the perception of drought frequency should arise from differences in amount of individual experience. In the study, those who had been farming longer were less likely to believe that droughts were becoming more frequent (Table 6). Although most farmers will be influenced by recent events, older farmers have a greater sample

TABLE 5

PERCEPTION OF DROUGHT FREQUENCY*

Response	CO (n=156)	ND (n=265)
Becoming more frequent	20.5	55.8
Occurring at same frequency	64.1	35.5
Becoming less frequent	7.7	1.5
Don't know	6.4	7.2

*Percentage of farmers from each state. Differences between states are significant at chi-square 0.001 level.

TABLE 6

YEARS FARMING BY PERCEPTION OF DROUGHT FREQUENCY*

Years Farming	More Frequent	Same Frequency	Less Frequent	Don't Know
3-19	48.6	38.4	.7	10.9
20-39	48.3	44.1	2.1	5.5
40-70	31.3	55.2	9.0	4.5

*Percentage of respondents from each years farming category that chose a specific drought frequency response. Differences are significant at chi-square .001 level.

size (of droughts) to draw upon and would be less likely to see an illusory correlation between a few drought years in a row and a long-term trend (cf. Tversky and Kahneman 1974). Similar associations were found regarding experience and assessment of the impact of future droughts. Respondents who had been farming for shorter periods of time were more likely to believe that future droughts would be worse. On a 5-point Likert scale, 36% of those farming for 3-19 years, 32% for 20-39 years, and 25% for 40-70 years strongly agreed or agreed with the statement, "In my lifetime, I expect future droughts to be worse than past ones" (chi-square significance level .01).

From Drought Perception to Climate Perception

Farmers may use one or more heuristic devices to assess future climate change. The assessment may be by linkage, using the representativeness heuristic. This suggests that a comparison is being made between farmers' own perceptions of climate and someone else's (experts or media). In contrast, the assessment may be by extension (availability heuristic) suggesting that farmers continue the currently perceived climate trend into the future. Farmers may be predisposed to the idea that climate is changing, regardless of experience. More than 78% of Colorado and 73% of North Dakota farmers believed that the climate is or possibly is changing, but only 29% of Colorado respondents answered with certainty, compared to 41% of North Dakota farmers (Table 7). Drought experience may play an especially crucial role in reinforcing and polarizing farmers' perceptions of climate change.

Farmers also appeared to draw on recent experience in ascribing the types of climate changes that might be occurring. Respondents who believed the climate is or might be changing generally described the change as toward drier, warmer, and windier conditions (Table 8). North Dakota farmers were more likely than their Colorado counterparts to describe the climate change as warmer and drier. Colorado respondents were slightly more likely to describe the climate change as wetter and with less wind.

The literature on heuristics indicates that, in addition to experience, "enduring cognitive structures, such as beliefs and values . . . foster preconceptions that heighten the availability of certain evidence, thus biasing the judgment process" (Taylor 1982, 192). In the case of climate

TABLE 7

IS THE CLIMATE (IN RESPONDENT'S STATE) CHANGING?*

Response	CO (n=156)	ND (n=268)
Yes	29.5	41.4
Possibly	48.7	31.7
No	21.8	26.9

*Percentage of farmers from each state. Differences are significant at chi-square 0.01 level

TABLE 8

TYPE OF CLIMATE CHANGE PERCEIVED BY FARMERS WHO BELIEVE THAT THE CLIMATE IS OR POSSIBLY IS CHANGING*

In what way(s) is climate changing?	ND (n=196)	CO (n=122)
Warmer	70.4	52.5
Colder	10.7	13.9
Drier	72.4	54.1
Wetter	0.0	9.8
More wind	55.1	54.9
Less wind	.5	4.1
Longer growing season	10.7	10.7
Shorter growing season	23.0	13.9

*Percentage of farmers choosing a specific type of change by state. Differences between states are significant at chi-square 0.01 level.

and greenhouse-effect warming, we might expect that the agricultural significance farmers attach to the climate change issue would bias their judgments on climate change. For example, we should find that the higher the level of importance farmers affix to the climate change issue the greater the likelihood that they will see the climate as changing. Furthermore, we would expect that this would be most notable in North Dakota because of the recent droughts.

The results here, however, are unclear. The distinction between independent and dependent variable is difficult to ascertain. If farmers believe the climate is changing, do they then assign greater significance to the climate change issue? Or do farmers' beliefs about the importance of the climate change issue bias their perceptions of climate change? Nearly 90% of Colorado and more than 80% of North Dakota farmers either strongly agreed or agreed with the statement, "The possibility of climate change is something every (respondent's state) farmer should be concerned about." The strength of these attitudes in both North Dakota and Colorado suggest that experience may not affect the salience of the climate change issue as hypothesized. Farmers may be predisposed to believing that climate change is an important issue, regardless of recent experience.

Belief in climate change, however, is associated with salience of the issue. Respondents in both states who thought the issue to be important

were more likely to believe that the climate was changing. For example, 92% of the farmers who believed the climate was changing strongly agreed or agreed with the statement, "The possibility of climate change is something every (respondent's state) farmer should be concerned about." Only 70% of those who did not believe the climate was changing strongly agreed or agreed with the statement (the difference was significant at the 0.001 level).

Experience apparently did not directly affect farmers' beliefs about the climate change issue. The importance farmers assign to the issue may originally influence their perceptions of climate change. But, as discussed earlier, that experience will then play a reinforcing role in their perceptions of climate change.

Causality

This study hypothesized that farmers use the availability heuristic to retrieve instances of how climate might be changing. They then use the representativeness heuristic to make the actual link by asking whether perceived change fits with or resembles the large scale long-term event. If the fit is good then they would tend to believe that the climate is changing. Are Great Plains farmers in fact using this process to make judgments of the greenhouse effect and subsequent global warming?

One way to illuminate the question is to examine respondents' beliefs about the causes of drought and climate change. If farmers are using the representativeness heuristic to make the link from drought to climate change, we would expect that they have in mind some notion of how the climate is "supposed" to be changing, according to such sources as the media or scientific predictions. In the case of global warming, they should be ascribing the cause of the recent droughts and/or climate change to the greenhouse effect, ozone depletion, air pollution, or some other human induced factors. Furthermore, there should be some difference between North Dakota and Colorado. Since North Dakota farmers have experienced more drought in the 1980s than the Colorado respondents, they should have been more likely to find a better fit between their own preconceptions of a generally warmer and drier climate and predictions of global warming presented in the media. Thus, they would have been more likely to attribute the cause of the 1988 drought and climate change to anthropogenic factors.

The survey data indicated that the majority of farmers were not using the representativeness heuristic to make judgments about climate change. Differences between North Dakota and Colorado farmers' attribution of drought and climate change causality appeared negligible (Table 9). Both groups tended to credit the cause of the 1988 drought and climate change

TABLE 9

PERCEPTIONS OF DROUGHT AND CLIMATE CHANGE CAUSALITY*

Question and responses	CO	ND
Weather cause(s) of 1988 US drought?		
drought cycle	55.7	57.7
shifting jet stream***	38.6	48.9
natural variability	28.5	24.8
el Niño	17.7	18.6
greenhouse effect	16.5	15.0
ozone depletion	12.7	14.6
sunspot activity	10.8	9.9
If you think climate is, or possibly is changing, what is(are) the cause(s)?		
natural cycles**	46.2	37.6
changing weather patterns**	29.1	36.9
air pollution	26.6	18.2
greenhouse effect***	21.5	15.7
ozone depletion	19.0	16.1
sunspot activity	12.0	9.9
el Niño	12.0	13.9

*Percentage of farmers from each state choosing a specific cause. Farmers often chose more than one cause.
**These two responses are over-represented. Many respondents who did not think the climate was changing would choose one of these two.
***Differences between states are significant at chi-square 0.05 level.

to natural variability, shifting jet streams, and other natural causes, and less so to human-induced factors. Farmers in both states showed a strong belief in "drought cycles." Some small differences exist (and in directions opposite to that hypothesized) between Colorado and North Dakota farmers' beliefs of the cause of the 1988 drought and of perceived climate change. For example, Colorado farmers are slightly more likely to attribute the 1988 drought and climate change to human-induced causes such as the greenhouse effect, ozone depletion, and air pollution.

Nevertheless, a subgroup of farmers might have made the link with the representativeness heuristic to global warming. This subgroup comprised the approximately 35% of the respondents who believed that the climate change could be explained, at least in part, by the greenhouse

effect, ozone depletion, and/or air pollution. In this subgroup we find that farmers' perceptions of drought frequency and climate change were especially influenced by their perceptions of drought and climate change causality.

In the sample overall, farmers who believed that droughts were becoming more frequent or did not know, were more likely to attribute the 1988 drought to human induced causes. Farmers who believed droughts were occurring at constant frequency were more likely to attribute the cause to natural variability, and to a lesser degree drought cycles. Perception of climate change provides similar results. As farmers became more certain about climate change, the likelihood that they attributed the 1988 drought to a shifting jet stream, ozone depletion, and the greenhouse effect increased and the likelihood that they attributed the drought to natural variability decreased (Table 10). This contrast was even more apparent among the previously mentioned subgroup.

TABLE 10

BELIEVED WEATHER CAUSE(S) OF THE 1988 U.S. DROUGHT AND PERCEPTION OF A CHANGING CLIMATE*

Drought cause	Is the climate changing in your state?		
	Yes (n=157)	Possibly (n=161)	No (n=106)
Shifting jet stream	52.2	45.3	32.1
Greenhouse effect	26.1	14.3	2.8
Ozone depletion	22.3	13.0	3.8
el Niño	19.1	23.6	10.4
Natural variability	15.9	26.1	42.5

Selected Responses, CO and ND combined.

*Percentage of farmers from each climate change response category choosing a specific drought cause. Percentages are not additive, only comparative. All percentages come from cross-tabulations that equal or exceed the chi-square 0.05 significance level.

Conclusions

This paper examined how Great Plains farmers perceive long-term climatic change. Approximately three-quarters of all farmers believed that the climate is, or is possibly, changing. The certainty of the belief was much stronger among North Dakota farmers, where drought has been more prevalent in recent years. The majority of farmers did not see the climate change as human induced, despite links made by the media. However, farmers who were more certain that the climate is changing, or that droughts were becoming more frequent, were more likely to attribute the cause to humans.

Drought experience, while perhaps not initiating concern for climate change, can solidify peoples' perceptions of the certainty and nature of the change. Drought appears to provide a partial catalyst for consideration of more long-term climate change, although the perceived changes are not necessarily related to media and expert predictions. Farmers in both Colorado and North Dakota view the climate change issue as an important topic. Climate may be of such fundamental importance to all farmers that drought experience will have minimal impact on salience.

Farmers apparently incorporate the availability heuristic when they make judgments of future climate. That is, they simply extend current climate trends to the future drawing upon recent experience, especially such memorable events as drought. However, a subgroup of farmers (perhaps one-third of respondents) appear to use the representativeness heuristic to make links from perceived climate changes to long-term events such as the greenhouse effect.

The distinction here between the availability and representativeness heuristics could be significant in the potential for response to global climate change. If farmers use the representativeness heuristic to make links between perceived climate trends and the scientific and media predictions of global warming, they might likely reject their own climate perceptions if the perceptions do not fit with global warming predictions. If farmers' climate perceptions do roughly fit with greenhouse predictions, farmers might make the link, and perhaps more quickly and explicitly adapt responses.

Most farmers, however, apparently use the availability heuristic to extend their perceptions of current trends into the future. In the case of drought the availability heuristic may lead to appropriate adjustment practices on the Plains to global warming. On the other hand, what if in the coming years Great Plains farmers experience a series of wet years or decreased temperatures? If farmers are using the availability heuristic to make judgments of future climate they may adapt practices that will

actually hinder long-term adaptation to global warming.

Whether differences in cognitive processes are related to subsequent adjustments to long-term climate change is an important question hinted at in this paper. Further work is needed to ascertain whether these climate perceptions are strong enough to influence long-term planning and adjustment, or whether they are only nonoperational perceptions on which farmers seldom act. Work on these questions could have significance for future educational efforts and policy programs aimed at reducing vulnerability to global warming.

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