

COMMUNITY RESPONSE TO
PROPOSED SNOWPACK AUGMENTATION IN THE SIERRA NEVADA MOUNTAINS*

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BACKGROUND

The Bureau of Reclamation directed its Division of Atmospheric Water Resources Management to develop a research program on orographic cloud seeding in cooperation with the State of California in 1972. The idea for such a program arose in the Bureau's Sacramento Regional Office whose Director was interested in the potential of weather modification technology in solving some of California's water problems.

The immediate rationale for the proposed project was Decision 1379 promulgated by the State Water Resources Control Board in July 1971. This Decision provided that additional fresh water must be passed through the Sacramento-San Joaquin Delta system in order to prevent the intrusion of saltwater. Saltwater intrusion was both an environmental and agricultural problem that had been occurring with increasing frequency in recent years, especially as demands on California's water supplies spiraled upwards.

A federal official explained in an interview with a researcher on March 14, 1974, that Decision 1379 took water away from irrigators and municipalities who had contracts for it -- that the Decision required the release of that water. In terms of future planning, the respondent said, the Bureau would not be able to meet its contract commitments because of the Decision. Further, the State Department of Water Resources experienced the same problem as the Bureau. He explained: "The key thing at the bottom of the proposed research (on cloud seeding) is the water release law in California."

The same rationale was offered by another official at a public meeting

* The research on which this final report is based was supported under Contract No. 6-07-DR-20090, United States Dept. of Interior, Bureau of Reclamation with Human Ecology Research Service for a Social Study of Public Response to Proposed Snowpack Augmentation in the Sierra Mountains of California in connection with the Atmospheric Water Resources Management Program. Support under grants GI-35452 and GI-44087 was given as part of the research on a Comparative Analysis of Public Support of and Resistance to Weather Modification Projects, Sponsored by the Weather Modification Program, RANN, National Science Foundation. The statements found in this report do not necessarily reflect the views of either agency.

in Stockton, California, on June 25, 1974, when he remarked to the audience: "The proposal for a project was triggered by Decision 1379."

A researcher was told that as of June 25, 1974, the Bureau of Reclamation was marketing surface water in the area. This apparent discrepancy between the stated rationale for the research project of the inability to meet the Decision 1379 requirements and the marketing of water was interpreted by water experts in June, 1974, in interviews with the researcher. They said that Bureau projects allowed for the provision of several million acre-feet of water more than was at that time committed under contract. If a Bureau project provides 10 million acre-feet of water, for example, then they need to have that amount under contract, according to these respondents.

One respondent said in an interview on June 26, 1974, that subsequent to the announcement of Decision 1379, the Bureau of Reclamation declared itself as not subject to the state's water rights laws. Attorneys involved in disputes regarding Decisions 1379, 1400 and 1422 decided that the United States should sue the California Water Resources Control Board. The suit, Civil S-3014, was filed on October 15, 1973 in United States District Court Eastern District, at Sacramento. An opinion was rendered on October 9, 1975, and the case, as of January 1977, was on appeal at the Ninth Circuit Court of Appeals; the appeal was made by California.

Several respondents told a researcher in 1974 that historically there had been a good deal of both tension and cooperation between state and federal water management agencies in California. Controlling the water management system in the state is clearly a political situation, the complexities of which are beyond the scope of this article. A legal expert told a researcher that ordinarily the federal government is found by the courts to be exempt from state laws. Thus, the Bureau probably can rely on legal precedent to uphold a stance that it should not have to obey Decision 1379 to release waters for the Sacramento-San Joaquin Delta.

In early 1977, Bureau officials pointed out to researchers that the proposed project is not a water-producing project, but is rather a pilot or demonstration project. The term "pilot" implies that the project will lead in to an operational project, but it is still considered research. Its primary purpose is "to advance the understanding of the science and technology of weather modification," with no requirement to succeed or fail by producing any amount of water.

Skepticism that the Bureau was motivated to conduct a program through environmental considerations, or in response to a desire to conform to Decision 1379, has been expressed. Some respondents have indicated that a cloud seeding program to augment water supplies is in reality an attempt on the Bureau's part to continue to satisfy its agricultural constituency by providing water at artificially low prices in comparison to its actual value.

The Bureau embarked on joint planning with the State's Department of Water Resources, and the two agencies cooperated in conducting a series of 21 public information meetings concerning the proposed Sierra project in communities in the lee, valley and mountain regions in and around the proposed project areas. These meetings were conducted between June and September

1974 in county seats throughout the potentially affected and adjacent areas.*

At these meetings, the proposed project justification presented was the disjunction between water supply and demand in California, and the state's condition of being out of phase seasonally and geographically with regard to water supply and demand.

Although the purposes of these meetings were both to inform the public and to involve those interested in project planning, we found that neither purpose was actually achieved. For one thing, those attending meetings in some areas had professional reasons for being there; e.g., they were involved with on-going operational projects and wanted to know how they might be affected. While it is important, and perhaps decisive to get project information to such individuals and organizations, key opinion leaders and potential opponents have said they avoid such meetings on the grounds that they constitute more "propaganda" from a federal agency interested in furthering its own pursuits. The degree of citizen alienation and mistrust of federal bureaucracies, especially during this period in the nation's history, is well known, and Californians may be expressing a national sentiment in this regard.

For another, the citizenry at large is not likely to be inflamed about a weather modification project until it has actually begun to operate, unless they are aware of prior operations whose effects were defined as sufficiently damaging that they still recall them. Without this kind of motivation, and our study shows that most citizens were not aware of the existing projects in the area, attendance at public meetings is unlikely. Since the average attendance at the public meetings was nine citizens, we can see that only the "attentive public" was represented.

Thus while the need for additional water may be viewed as a problem of some significance in California, cloud seeding is not directly associated in the general public's mind with that need, or as a viable solution to the problem of potential or actual water shortages.

Subsequent to the completion of the series of public meetings, the State of California* decided to discontinue their part of the cooperative project. One story was that an environmentalist had influenced the Director of the Department of Water Resources and persuaded him to give it up. Another story was that the Department would set higher priority on more proven methods of water development than cloud seeding. Neither of these stories was ever completely validated by researchers, but some evidence was gathered.

With regard to the attitude of high state officials toward the project, one such respondent said in an interview on July 18, 1974, with regard to cloud seeding:

* Meetings were held in Jackson, Auburn, Placerville, Sonora, Quincy, Susanville, Nevada City, Tahoe City, Downieville, San Andreas, Bridgeport, Modesto, Stockton, Marysville, Woodland, Sacramento, Oroville, all in California, and Yerington, Minden, Fallon and Reno in Nevada

* The California Department of Water Resources

"I don't think it's a dependable supply of water.
I don't think we should put much store in it.
It's a remote possibility and should not interfere
with the construction of new reservoirs."

On August 1, 1975, the Director of California Department of Water Resources wrote to the Bureau:

"Our Department has been reviewing its priorities over the last two months. As a result, we have reached the conclusion that we cannot put manpower and funds into the Northern Sierra Nevada Weather Modification Project. For the present, we will be directing all of our resources toward re-evaluating the allocation of existing water supplies throughout the state. . ."(Robie, 1975a).

In a further clarification of the Department's position, the Director wrote on September 8, 1975:

"The Department's major emphasis during this and the following fiscal year will be on revision of the water management element of the California Water Plan. . .My review of the funding necessary to do this important task led me to the conclusion that we could not participate in a cooperative weather modification program with your agency at least during the next two years." (Robie, 1975b).

Both the Feather River Basin (the watershed draining into the Oroville Dam, controlled by California) and the American River Basin (the watershed for Folsom Dam, controlled by the Bureau of Reclamation) had been contemplated as primary project areas for the demonstration project. After California made its decision to discontinue participation in the Sierra Project, the American River Basin was selected as the project area and the Feather River was excluded from further consideration. Bureau officials explained that climatological records were more complete for the American River Basin than for the Feather, and that withdrawal of state support made the basic climatological research needed in the Feather impracticable. The project became one to be funded solely from the Bureau sources, although Bureau officials said the state was to continue to provide liaison functions with California residents. The State Department of Water Resources, however, has done little more than send a representative to a few of the meetings the Bureau has arranged in the area.

THE SOCIETAL STUDY

In August 1975, a citizen survey of mountain residents in El Dorado, Placer, Nevada, Plumas and Sierra Counties was conducted. Results from this survey of public response to proposed cloud seeding have been reported in Farhar and Rinkle (1976), Farhar (1975), and Farhar (1976a). In July, 1976 a study of community-level (or systemic) factors with regard to the

proposed project was undertaken. Data from this study are presented in this article. The primary focus of the data collection effort was organizations.

The organizational study's purposes were to provide a descriptive analysis of institutional response to the proposed orographic snowpack augmentation project, and to produce a set of recommendations relative to public response and communications with the public for officials involved in the project. The procedures to be employed in the study were: (a) to identify organizations and socioeconomic groups (such as cattlemen and environmentalists, or organizations representing these groups) that could have an interest or concern regarding the proposed Sierra Project; (b) to conduct interviews with key individuals representing these groups (the sample was to be drawn on a purposive basis); and (c) to focus interviews on such topics as organizational position toward the proposed project, perception of the local effects of cloud seeding, means of disseminating information about the project, and perceived concerns relevant to the project.

In this article, the organizational sample and method of study are described, and findings on a number of relevant societal characteristics (systemic variables) are presented. These include: perception of water needs in the area; knowledge of prior and proposed projects; belief in the effectiveness of snowpack augmentation on the part of organizational incumbents; a brief description of the area, identifying its principal economic activities and their weather needs; the history of public response to weather modification in the area; the reputability and credibility of weather modification personnel; the existence of trade-offs in connection with weather modification projects; the position taken by local news media toward weather modification and the proposed project; knowledge among organizational respondents concerning the proposed project; information sources for weather modification; and evaluation of past, currently existing, and proposed projects. Preferred decision procedures are also discussed.

In considering the findings discussed here, the reader should be aware that interpretations are offered as to the meaning of the findings for the proposed project and the people and organizations it might affect. Interpretations are offered on the basis of completed and on-going research on the societal aspects of weather modification. The presentation is organized around factors hypothesized to be important in utilizing cloud seeding technology in a socially beneficial manner. Which factors are more important than others is not currently known; therefore an element of judgement is present in the interpretation of findings, and in the conclusions.

A number of cloud seeding projects have occurred in the general area of this societal study. Whatever experience individuals and organizations have had with weather modification up to the time a new project is initiated represents the "trialability" of the innovation (Rogers and Shoemaker, 1971; Farhar, forthcoming). If these prior effects were perceived as relatively efficacious and advantageous, and if the innovation appeared to be compatible with existing social norms and community opinion, and if it were well enough understood, then its adoption (and thus its social desirability) would be established. Throughout this article, findings on respondent knowledge and assessment of prior projects and the social response to them will be presented.

All of the factors discussed are hypothesized to have an impact on the community's willingness to experience a cloud seeding project or their ability to tolerate such a project if they are not enthusiastic supporters of it (Farhar, forthcoming). The findings are primarily descriptive rather than analytical.

Methods

The sample selection. Prior research on the social aspects of weather modification has clarified a number of different kinds of organizations and groups concerned about the impact of cloud seeding in their areas. These groups vary according to what type of weather modification is being proposed for their areas; in this case, the kinds of groups to be located were those with concerns potentially relevant to a snowpack augmentation project. Concerned organizations and groups, which can also be termed "attentive publics", share in common, regardless of the technology being proposed, a perception that their interests, usually economic or "domain" interests, will be affected by the proposed project (Haas and Drabek, 1973). They are thus motivated to learn more about the project, and depending upon what they learn, to take action with regard to it if they feel their interests or responsibilities are notably affected.

From widespread observation of public and organizational response to weather modification projects in the United States, we have developed a classification of organizations and groups that are potentially attentive or concerned about snowpack augmentation. In order to protect respondent anonymity, the names of actual organizations and groups included in the purposive sample are not presented. Instead, the kind of organization represented in the sample is here identified.

The organizations and groups were either located in, or had interests in, the study area -- Placer and El Dorado Counties, California. The basic framework for selecting the sample on a purposive basis is provided in Table 1. For general socio-political levels of administration or concern -- federal or national, state or regional, county and community -- are compared with the variety of functional interests (kinds of organizations or groups) known to have relevance to mountain snowpack augmentation projects. These included forest management, highway management, political entities, on-going weather modification projects in the area, land and water use administrations, environmental organizations, media, and principal economic interests in the area. The latter were defined by local respondents as recreation, lumbering and agriculture, probably in that order of economic importance. (Several respondents viewed area agriculture as declining in economic importance over the past several years as increasing numbers of Sacramento commuters have migrated into the foothills formerly populated by orchards, and farmland is sold for housing developments).

Explanation of Schedules Used. Not all respondents in the organizational sample (N = 48) were given the same interview schedule; four different

TABLE 1
DISTRIBUTION OF PURPOSIVE SAMPLE BY LEVEL OF CONCERN

	Forest	Highway	Political	Land/Water Use Administration	Environmental Organizations	Economic Interests*	Media	Other	Total
Federal	Federal Agency N = 4	Federal Agency N = 1		Federal Agency N = 1	National Organ- izational Re- presentatives N = 2				N = 8
State/ Regional		State Agency N = 2	State Re- present- ative N = 1	State and Re- gional Agencies N = 3	Regional Representative N = 1	Regional Economic Interests N = 5	News- papers N = 2		N = 14
County		County Agency N = 3	County Bo- ard of Sup- ervisors N = 2	County Agencies N = 3	Local Re- presentative N = 1	County/Com- munity Econ- omic Inter- ests N = 9			N = 18
Community			Mayors N = 2				News- papers N = 2	Opin- ion Le- aders N = 4	N = 8
	N = 4	N = 6	N = 5	N = 7	N = 4	N = 14	N = 4	N = 4	N = 48

* Lumbering, recreation, agriculture, utilities.

schedules were constructed in order to elicit relevant data from different functional representatives. These four types of schedules were termed (a) economic interest group representative, (b) political official, (c) media representative, and (d) opinion leader. The opinion leader schedule was further modified for specific types of respondents (such as county agent) to gather specialized information.

Of the 30 economic interest group schedules completed, four were for foresters, six for highway officials, six for land and water use officials, four for environmental organizations, and 10 for lumbering, utilities, recreation and agriculture. The six political official schedules were completed for political representatives at the community, county and regional levels. The four media schedules were completed for newspaper editors in the area. The eight opinion leader schedules were given to community leaders, bankers, and agricultural officials.

Thus, in studying the tables summarizing the organizational data, it should be kept in mind that the largest category of respondents, economic interest group representatives, included a wide array of interests, both public and private.

Perception of Water Needs

It has been hypothesized that the more economically dependent the community is on the weather, the more salient (central, important) the issue of weather modification. The more salient the issue of weather modification, the more tendency there is for adoption to occur. Because an early-stressed rationale for the proposed Sierra Project was the need for more water in northern California to prevent saltwater intrusion in the Sacramento River Delta, we were particularly interested to discover our respondents' perception of local and area water needs. We questioned respondents concerning the long term adequacy of precipitation (a) in their county, and (b) in the Sacramento River Delta.

Very dry conditions prevailed in northern California during the winter and spring of 1976, resulting in severe water shortages in some areas near our study area. Most respondents mentioned the drought -- one said precipitation had been about 25% of normal -- but virtually all viewed the then-current situation as anomalous. The reason the 1976 drought took on dramatic proportions was the realization that dry conditions coupled with increasing population pressures and the concomitant increased demand for domestic power, agricultural and recreational uses could create a future situation with near-tragic consequences.

For example, one respondent told us:

"We are in the midst of a bad drought. If we get another dry winter, we are going to be on the edge of a disaster. In Marin County, they are hauling water for domestic consumption. They can't flush toilets. The last severe drought we had in the early 1930's showed a pattern of low precipitation for

several years in a row. The population then was two to three million. Now it's eleven million, with heavier water requirements; the Sacramento Valley and the San Joaquin Valley are totally developed. In a normal year there is enough to go around with conservation, but the dams aren't full. The meaningfulness of winter precipitation is coming home to urban areas. Water rationing is coming; there is a fire threat to urban and suburban areas, so the effects are not confined to agriculture. If we have another dry winter, I think next year at this time it will be catastrophic, and there will be an exodus out of California."

Most respondents did not share such a grim scenario for the region's future. The responses given to the questions, "Would you say that over the long term you get as much precipitation (rainfall and snowfall) as you need in this county?" resulted in 60% indicating that precipitation is always (or almost always) adequate for their needs. The 40% were less sanguine.

The second item asked respondents "Would you say that over the long term, the Sacramento River Delta gets about as much precipitation as it needs?" Here, the figures are reversed, with about 40% indicating it did, and 60% less sure of the adequacy of the Delta's precipitation.

Most respondents, however, were quick to point out that the adequacy of precipitation itself was not the way Californians conceptualize the need for water. In a state where the water system is the most highly developed in the nation, adequacy of water supplies is equated with adequacies of man-made systems, not with natural precipitation. Water is managed in California; almost all activities dependent on water are dependent on a supply from organizational sources. Thus, questions involving "precipitation," "adequacy" and "needs" evoked a rather different conceptual picture in the minds of Californians than they would say, in an agricultural state in the High Plains.

The real question, the Californians told us, is water needs. Thus, precipitation itself might be viewed as "adequate", while man-made systems might be viewed as actually or potentially inadequate to meet the demands of the social system.

Those who saw no immediate pressing need for more water gave some of the following explanations for their views. "We get 52 inches of precipitation per year in our area." An agriculturally-oriented respondent said, "We do not need any moisture in March and April; it causes blight in the pears if it rains during that period". Another agriculturist said that for dry land farmers, the danger is excessive water; but, he observed, this type of farming was "on the way out". A federal official commented that the agriculturally-productive land in the area receives about 30 to 35 inches of average annual precipitation and such an amount should be adequate. The question, in his mind, was not whether it is needed, but what the state wants to do with the water. A county official felt strongly that what the county needed was what it got in the way of water -- that activities in the county should adjust to the supply of water available.

Environmentally-oriented respondents were also cautious in saying that the area needed more water. One such respondent observed:

"Population growth is occurring at a steady pace. We are not a totally no-growth group, but we want to keep growth controlled. Water could be a limiting factor."

Another (non-agricultural) respondent said:

"Why do you want to increase the water? Mostly for agriculture, but is agriculture number one? It is questionable that we need more water for agriculture. The social fight is fought over who turns the spigot on and off. In the American River the recreation, fish and wildlife values of water are greater than the value to agriculture."

Another environmentalist expressed concern about the "water establishment's" priorities. The water establishment was defined as a set of institutions: public works departments, state water department, the Corps of Engineers, the Bureau of Reclamation, local irrigation districts and local municipalities.

"Our organizational concern about water needs is that too much emphasis is placed on surface storage and not enough on conservation and making more efficient use of what we have. The water establishment puts too much emphasis on capturing and storing more water."

Yet another category of respondents who felt the area had enough water based their argument on the fact that northern California's water is being diverted to Southern California. If such diversion were to be decreased, Northern California would have more than adequate supplies, according to this line of reasoning. One mountain respondent said, "Los Angeles gets most of our water. Our population expansion is restricted by what L.A. does." A local official remarked, "Our water goes to the south -- we may need water rationing." Another observed, "The real question on the Delta is whether they should divert more water -- the Bureau wants to divert more water than they are currently diverting to the south for agriculture." A regional economic interest respondent said: "Water from the northern part of the state is used in Southern California -- using that perspective, we always have a water shortage."

Still, the established fact of northern to southern transfer of water, though not viewed with pleasure, seems almost to have become an accepted part of the scheme of things in California. Respondents from a variety of local economic and administrative interests (including lumbering, skiing, recreation, public works, political officials, and federal agencies) indicated that while current systems are by and large adequate for current needs, projected future needs show that current systems will be outstripped within just a few years.

For example, a local water expert said,

"The supplies as presently developed will handle us through about the 1980-1985 time frame as we project them. We have to conserve water. Beyond 1985, with the projected population growth and the development of agriculture, we're going to have to have additional water or eliminate growth and have stagnation. Stagnation is an unacceptable alternative (we've been through it), so we need water conservation, dams and hydroelectric development."

Another official said:

"We have 21 additional reservoir sites picked out in our county. The Board of Supervisors think water is our greatest asset. The need for additional water will continue because of increasing population in our county."

Thus, there was widespread agreement that population pressures in California are beginning to strain the state's water resources system. As one water expert put it: "California is a desert climate, with the greatest water demand occurring during the annual six-month summer drought." Disagreement occurred on the topic of how water supplies can best be kept consonant with water demands, and also on how existing supplies can best be distributed among a variety of competing interests. Some felt that the agricultural constituencies of water institutions were not paying their fair share for the value of the water they were receiving -- that they were, in effect, being favored with water subsidized at taxpayer expense. Others argued that recreational uses of water, its value for fish and wildlife, its necessity for economic growth and development, and its value in holding back saltwater intrusion outweighed its value for irrigation uses.

Among this plethora of competing water interests in California, the institutions responsible for making decisions -- for "turning the spigot on and off" -- must thread their way. This study was not an attempt to assess the political aspects of water management in California, but rather to assess the citizen and organizational response to a proposed cloud seeding experiment. We found it difficult to draw the line, however, between "science" and "politics". The Bureau's stated rationale for initiating the proposed Project has been greeted with varying degrees of acceptance at face value and of skepticism among organizational respondents. It is clear, however, that additional run-off in the American River Basin flows into Folsom Dam, and thereby increases the Bureau's "domain" of interest. Those organizations defining increased water supplies as in their interest tend to be favorable to the development of water supplies, and if precipitation management is one way to do that, they favor it. Those organizations who define current water management practices as inimical or potentially inimical to their interests tend to be opposed to increased development of water supplies, and thus to the proposed project (Haas and Drabek, 1973).

In a study of this kind, it is not possible to determine which set of organizations has ultimate political power over the question of the development and use of California's water supplies, whether a balance of power exists, or what the actual outcomes will be. From our observations, it does appear that population pressures in California will continue to exert increasing pressure on existing water management systems, that the existing water control

entities and their largely agricultural constituencies will continue to hold control over the ultimate uses of water in the state for some time to come, that the pressures will have effects in other states (including Upper Basin states like Colorado), and that any major change in this system will be the result of political pressure with the direct purpose of re-allocating western water resources. Such pressure will arise in proportion to the organizational domains having large stakes in water resources, and almost all of it will be the result of population growth in the arid and semi-arid lands of the West.

Knowledge of Existing Projects

Over 75% of the organizational sample knew that cloud seeding for snowpack augmentation had occurred for some time in the northern Sierra Nevada mountains. Clearly, organizational incumbents were much more informed than the citizenry at large about the existence of projects, but this is not surprising in view of the fact that organizations were selected for study on the basis of their functional relevance to the proposed project. In fact, it is interesting to examine what kinds of respondents were unaware of cloud seeding in the area. These were most of the community opinion leaders (selected for their role in the two-step flow of information in communities, and who were thus not representative of particular organizations), three local political officials, a newspaper representative, an environmentalist, a highway expert and a skiing entrepreneur. These findings suggest not only a pattern of greater knowledge among functionally relevant organizations, but that snowpack augmentation has not been an important local issue, receiving widespread publicity and public attention. The data also inform us that community opinion leaders are relatively "open" on the issue of snowpack augmentation.

Belief in the Technology's Effectiveness

In surveys on public response to weather modification, belief that cloud seeding is effective in producing desired weather changes has emerged as a key predictor of favorable program evaluation. It is particularly interesting, then, that with regard to this variable, about 75% of the organizational respondents thought that cloud seeding actually works to increase snowfall, and 25% were unsure. None of the respondents thought seeding to be ineffective.

Of 55 responses naming prior cloud seeding projects, respondents were unsure in over half of the cases whether the cloud seeding actually worked (to increase snowfall or decrease hail), while in 48% of the cases they thought that it had. Thus, responses were nearly equally divided between those unsure about the cases, and those more sanguine about the effectiveness of prior cloud seeding.

In orographic settings, belief in efficacy may not emerge as such an important predictor of favorability toward cloud seeding programs as it is

in the agricultural areas where surveys have been formerly conducted. This is because the effects of enhanced snowfall themselves (assuming an effective technology) may be a source of concern for some respondents. Nevertheless, it is notable that the majority of respondents in the organizational sample seemed persuaded that cloud seeding could achieve increases in snowfall.

Those in the organizational sample were somewhat more likely (73%) than those in the citizen survey (53%) to believe that cloud seeding is effective. This difference may be due to organizational respondents' greater knowledge about cloud seeding operations and research, possibly through more direct contact with those involved in them and with the literature.

Organizational respondents more skeptical or unsure of the efficacy of cloud seeding tended to respond in a knowledgeable way, citing ambiguous or mixed research results from cloud seeding projects or the possible inadequacy of certain statistical analyses. Yet none of the organizational respondents were willing to say that cloud seeding definitely would not increase snowfall. Questions were raised as to the as-yet-unknown or little-understood effects of snowpack augmentation, but several respondents seemed impressed by the fact that utilities in the area had been conducting operational programs for years, and, as one respondent put it, "they swear by them".

Weather Affected Activities of the Study Region

Principal economic activities. The principal economic activity of Placer and El Dorado Counties is recreation. Three major northern California recreation areas are located in Placer County: Squaw Valley Ski Area, Donner Summit Ski Area, and Folsom Lake near Auburn (Auburn Chamber of Commerce, 1975). Placer and El Dorado Counties share the west shore of Lake Tahoe and the headwaters of the American River. The latter is attractive for trout fishing and river touring.

Lumbering and agriculture are also key economic interests. The salaries and wages within the American River watershed, including both El Dorado and Placer Counties, are largely dependent on three lumbering firms (U.S. Bureau of Reclamation, 1972 and 1976a). One of the largest of these firms is the Michigan-California Lumbering Company with a 75,000 acre privately owned "tree farm" (Michigan-California Lumbering Company, n.d.). In Placer County, 38,020 acres are devoted to irrigated agriculture. Of that, 21,860 acres or 57% is used for pasture and 7,930 acres are in orchards (mainly pears) (California Department of Water Resources, 1970). In recent years, agriculture in Placer County has been changing "from fruit growing to livestock and poultry-raising according to the gross agricultural income reported in the county agricultural commission report" (California Department of Water Resources, p. 17). Therefore, "irrigated acreage in El Dorado County consists almost entirely of orchards and pastures" (California Department of Water Resources, p. 3.).

Heterogeneity of weather needs in the target area. A complete assessment of the impact of snowpack augmentation on the range of human activities in the northern Sierra Nevada mountains was beyond the scope of our study. It has been hypothesized that the more heterogeneous the weather needs are in an area, the more likelihood there is that an organized opposition to a weather modification project would develop. An assessment of the proposed project's impacts on important activities within the target area would contribute data needed to evaluate its social desirability.

We asked agricultural respondents what the principal agricultural activities were and what weather requirements they had. Although we did not get complete agreement, the answers were close enough to provide the following description:

<u>Principal Crop</u>	<u>Precipitation Needs and Timing</u>
Livestock (beef)	Pasture: October to May rains
Turkeys	Not applicable
Rice	Dependent on irrigation; in mid-May and in October, dry periods are needed
Fruit	February 15 to April 30; no hard rains or hail; dependent on irrigation; no hail throughout growing season.

In addition to agricultural activities, of course, are other principal economic activities. Weather needs for all of these activities and their value to the local economy should be studied to determine what period would be most suitable for snowpack augmentation activities from a societal point of view.

Assessment of benefit or harm. Political officials (N = 6) and those responding to the economic interest group schedule (N = 30) were asked, "If a cloud seeding program were able to increase snowfall in below normal years, would you say it would probably be of economic benefit, harmful, or make no difference to members of your (organization) (constituency)? Why do you feel that way?" Organizational respondents (particularly economic interests in the area) predominantly viewed the possibility of snowpack augmentation as representing an economic benefit (73%); a minority of 12% assessed the probable economic impact as harmful.

When asked for the reasons for their assessment, respondents citing benefits listed a catalogue of water uses in the area. Clearly, water availability was seen as highly desirable and advantageous, with control of the supply of snow and of run-off as a desirable goal. The advantages of additional water were viewed as far outweighing the disadvantages, judging from the responses to this item. In all, 13 benefits from water were cited 55 times, compared to four disbenefit cited seven times. The benefits of additional water were virtually viewed as self-evident, and at times, expectations seemed to soar over the possibilities. Most often mentioned was increased water for recreation and tourism, (both summer and winter)

agriculture, hydropower and increased forest production. Additionally, the prevention of forest fires (an especially sensitive concern during a drought in lumbering country), better conditions for logging,* water for domestic and industrial use, and environmental benefits including prevention of salt-water intrusion and better conditions (forage and water) for fish and wildlife were cited.

The potentially harmful effect mentioned most often was increased highway maintenance costs. Also mentioned were the possibility of delays in highway construction, sewage disposal problems due to oversaturation and a resulting decline in land values.

Some of the enthusiasm for precipitation control is expressed in the following quotes from respondents.

"Snow is our bread and butter here. We usually have a good cover at the top but poor cover on the lower runs. If cloud seeding could even it out -- Bravo!"

"It would be a benefit to the water users and residents -- the whole population. There would be more surface and underground water and it will reduce fire danger, and help agriculture."

"If we could control the rate of our snowfall, we'd be in pretty good shape. Fairly often we get high storms that don't snow. If seeding could trigger the snowfall from those storms, it really would be beneficial."

"It would increase hydropower production, would create some runoff; it would also increase vegetation, and benefit the users of the streams."

"For a year like right now, recreation would be helped. The rafters are out of business. Also high range and timber production would be increased. Many ranchers turned out this year to ask for refunds (from the Bureau of Land Management) for land grazing rights. The range dried up early and there is fire danger."

Not all, however, were overwhelmed with enthusiasm at the thought of additional snow:

"The counties are subsidized by the state (for highway snow removal); they were paid on a three-year average. If it's expended in a big year, you're on your own. Our county doesn't

* During a drought, loggers face a sudden cut-off of operations at any time during the season that Forest Service officials declare it necessary because of fire danger. A two-week delay in the start of operations due to snowpack would be less disruptive and economically damaging than a work stoppage in mid-season.

have any tax to pay for snow removal. We just absorbed our cost of labor and overtime and fuel. We went through 42 days without a day off -- it was all-time record of clearing roads."

"It would be beneficial if you can control it. Assume there was a dry year and they had seeding in January and February. Then in February and March you could have a huge snowstorm. You can't control it, nature does. You have no liability."

On balance, the view among organizational respondents was that the economic value of additional water through increased snowfall seemed to far outweigh any negative economic consequences. In fact, expectations concerning the potential economic benefit to the community-at-large from snowpack augmentation may be far higher than those that could realistically be expected from current technology. An unrealistically high level of expectations for future cloud seeding, springing spontaneously from respondents' perception of the value of water, could result in disappointment and, eventually, rejection of the project if expectations for its effects are not met. Project officials have never promised increases in run-off as a result of the project to the knowledge of researchers; this enthusiasm for a potential water-producing technology apparently arose from respondent perception of the then-current situation.

Political assessment of potential harm. Respondents in the organizational sample representing the political component of the community, and presumably knowledgeable about its structure and interests, were asked to assess potential harm from the proposed project. Specifically, the initial question in the sequence concerning this issue was phrased: "Are there any groups or economic interests in your county who could be harmed by an increase of snowfall during the winter in below-normal years?"

Of the six political officials responding to this item, four (or two-thirds) said there were no groups or interests who could be harmed by such an increase. The other third, two respondents, indicated that there were potential disbeneficiaries. These were identified as highway crews who have the problem of highway maintenance and snow removal, travelers suffering the inconvenience of storms and blocked highways, and residents at higher elevations who experience mobility and transportation problems. People in general were also cited as disbeneficiaries through heightened exposure to avalanches and snowslides, and increased strain to roofs and structures.

When asked whether any action had been taken by the respondent, other political officials, or anyone else concerning these groups, one of the two indicated that no action had been taken; the other said that the Board of Supervisors had passed a resolution requesting that cloud seeding be stopped.

It seems significant that one-third of the political officials had identified potential disbeneficiaries of snowpack augmentation in their local areas, and two area Boards of Supervisors felt strongly enough about the matter to pass resolutions against wintertime seeding operations in the county. The latter action is discussed in more detail later in this article.

Economic Well Being of the Area

It has been observed that organized opposition to weather modification projects tends to occur when a project has experienced some economic difficulty in the presence of cloud seeding (Farhar, forthcoming; Weisbecker, 1974). Thus, it seemed to be important in assessing the societal implications of the Sierra Project to get some assessment of the economic well being of the area. We relied on information from bank officers, opinion leaders, political officials and media representatives for this assessment.

For one thing, we asked these respondents for their assessment of the economic well-being of the general area over the past five years. All of the eleven respondents answering this question felt that most of the people in the area were about average or above average in prosperity.

Prosperity was attributed to the following conditions. The popularity of recreation and tourism in the area aids the local economy. (One respondent said, "Eight million Californians are within one tank of gas from here.") Population in-migration was also seen as aiding the local economy, as was the construction business in second homes. New, clean industries have been locating in the area, we were told, and the assessed property valuation has been increasing. Those who indicated prosperity was "about average" were concerned about what they termed a "serious unemployment" problem in the area (cited by one respondent as 11%).

Political officials, since they would be most knowledgeable about this question, were asked whether the county (or area) had been designated a Federal Disaster Area at any time in the last five years. One respondent said that El Dorado County had been so designated two years ago for a large timber fire, and that the disaster designation had been applied for in 1976 in connection with a timber fire earlier in the year. This was the only disaster designation brought to our attention by organizational respondents.

Economic interest group representatives were asked whether members of their organizations had experienced economic difficulty at any time during the past five years. Six respondents said members of their organizations had. Fruit growers were described as having experienced severe economic difficulty for the past four to five years, due to "fluctuating market conditions for fruit. Consumers want food for nothing. All we want is a reasonable price for our fruit." Also blamed for fruit grower problems was hail.

"A hailstone of any size -- a crystal that's hardly visible -- will scar the fruit and throw it out of grade; then you can't sell it."

Other agriculturists were also seen as having very severe economic difficulty. The cattlemen had been adversely affected by low prices. Small cereal grains were damaged by excessive moisture in 1973 and 1974. "In 1973, there was three times the normal rainfall by December. It drowns crops."

Lumberers have also experienced severe difficulties in 1974 and 1975,

because "the lumber market is volatile; there is supply-demand fluctuation and construction is down."

Tourism has been somewhat adversely affected by drought conditions:

"This year we have closed the forests against campfires and cut back on tourism. This may not be too harmful to the economy because of campers (vehicles) and propane stoves. People don't use wood fires as much as they used to."

A general comment about the Tahoe area economy was that it had experienced difficulty:

"There has been a petroleum shortage, less tourism, less skiing, inability to provide facilities at Tahoe, and a moratorium on the construction of second homes while sewer line installation goes on."

We also inquired as to the proportion of county residents receiving some kind of welfare or unemployment benefits, and received estimates ranging from 6% to 15%. In comparison, the national unemployment rate for July, 1976 (when these estimates were made) was 7.4% (U.S. Department of Labor, 1976).

Respondents indicated to us that recreation, agriculture and lumbering were the three principal economic activities in the area. Since all three are weather-dependent to some extent, and all had experienced some economic difficulty in the past five years, a cautionary note is introduced with regard to the social acceptability of the project. Should these activities experience severe economic hardship during the Project's existence, especially because of weather-related phenomena, the potential for organized opposition would probably be enhanced. As conditions stood in July 1976, the economic situation appeared healthy enough, except for dryland farmers and possible fruit growers, to sustain the Project without serious societal problems.

History of Social Response to Cloud Seeding in the Area

Presence of organized support for cloud seeding. About a third of those asked whether there had been any supporters or sponsors of cloud seeding in the area said there had been. Five respondents identified SMUD, PG & E and other utilities, and public water and irrigation districts. Ski resorts, the Corps of Engineers, the State's Department of Water Resources, and area fruit growers were identified as interested groups or sponsors. Most of these supporters were thought to favor cloud seeding either because they believed that it worked, or they hoped that it worked and were willing to try it in order to change the weather for their benefit. Support (or at least interest in cloud seeding), was known to have existed in the area for several years, and one respondent said that interest dated back at least 15 or 20 years.

The fruit growers had sponsored a hail suppression project for several years in the fifties, but by the late fifties one sponsoring group terminated their support of the program. According to one respondent, "It cost more than they figured they were saving, so they quit." Another group continued sponsorship until 1963. The contractor for these projects had been Dr. Irving Krick of Water Resources Development Corporation.

Supporters sometimes assert that cloud seeding projects are for the benefit of the community at large, or at least for a majority of the public. SMUD was cited by one respondent as arguing that their program would result in lower utility rates. "This year SMUD raised the rates because they had trouble with their nuclear power plant, and they had to buy extra power." Such arguments in support of having cloud seeding attempt to appear to "moral persuasion"; e.g., the project is for community welfare, or will result in the greatest good for the greatest number. In justifying projects organizations might wish to implement, appeals to moral principle are sometimes employed in addition to economic justifications, and these appeals seem to have occurred to a limited extent in the Sierras.

Organizational respondents did not find these types of arguments persuasive.

One said:

"They've been persuasive from the standpoint of continuity (in operations), but I don't think it works. They're not really increasing the snowpack. A little cloud seeding won't mean much -- it's really Mother Nature."

Presence of opposition. Just over 40% of the organizational respondents asked about the presence of opposition in the area knew of some opposed persons between 1972 and 1976. Some individual fruit growers have expressed opposition because they fear that cloud seeding might cause hail, or otherwise cause damage to the sensitive fruit crop. They have argued that cloud seeding does not work, and that man should not interfere with God's or Nature's plans. One respondent said that some agricultural people in Apple Hill were concerned about the direction of flow of storms that could endanger their orchards and vineyards.

Another respondent told us that mountainous residents had expressed concern about the structural strain of snow loads and ice, and that as people become more aware of local cloud seeding this is being mentioned more often.

Heterogeneity of weather needs was the basis for one comment:

"Some local people are jealous over the notion of robbing Peter to pay Paul. The construction industry likes dry weather, the utilities like wet weather, and the farmers want either wet or dry weather depending on the season."

Environmentalists and conservationists were mentioned as potential opponents, who might fear such outcomes as robbing one group of its rainfall for the benefit of another group, but such arguments were not seen as persuasive by organizational respondents.

Though most respondents did not feel opponent arguments were sufficiently persuasive to affect their own positions toward weather modification, one political official said that opponent arguments were persuasive "in the sense that I am concerned about their fears. They have not provided facts, they can only speculate."

Thus, when constituents express concern to political officials, the very expression is a matter receiving some attention from them. Yet, according to these findings, no grassroots organized opposition to cloud seeding has yet arisen in El Dorado and Placer Counties. Opponents remain unorganized, and express their opinions to reasonably responsive county governments who have taken action; the immediate need for opponents to organize is probably decreased by the action of their political representatives.

Perception of controversy about weather modification. The presence of a prior organized opposition in an area may contribute to social rejection of any proposed cloud seeding. This tends to occur because prior opponents recall the previous controversy and often move to forestall the possibility of future projects, or to halt them if they are begun.

No organized opposition or extended controversy concerning cloud seeding was known by researchers to have occurred in the northern Sierra Nevada mountains, even after some 25 years of seeding operations in the area. What opposing sentiment existed appears, until most recently, to have been confined to individual expressions of concern. The withdrawal of support from the prior hail suppression project was apparently not marked by controversy, but was rather a judgement on the part of the voluntary association of farmers paying for it that it brought them insufficient relative advantages.

Where public opposition to cloud seeding has arisen in other parts of the country, researchers have sometimes observed a tendency on the part of those running a project to adopt an adversary stance toward opponents. In some of those cases, project officials have denied that cloud seeding could have caused the harm alleged by those expressing concern. The implication sometimes has developed that project officials knew what they were talking about and no one else did. The most serious weather modification controversies have been marked by this kind of adversary stance between opponents and proponents. It may be possible in these cases that those expressing concern became opponents by virtue of the response of project officials. Some opponents have told us this was the case.

Another finding from weather modification controversies elsewhere is that any occurrence of damaging weather while cloud seeding is in operation may be attributed to those operations. While a court of law

may not uphold a causal link between seeding and alleged harm, the court of public opinion sometimes has. No matter on which side the burden of proof lies (seeders or opponents), neither can probably prove conclusively that the activity did or did not cause the damage.

In uncertain situations like these, the credibility and reputability of the organizations involved in a cloud seeding project are important in determining the public response to it. Credibility appears to be heightened by responsiveness of project officials to expressed concerns.

Reputability and Credibility

The behavior of those affiliated with cloud seeding projects has been hypothesized to be a factor affecting whether a project will enjoy social acceptance or be terminated or prevented because of social rejection (Farhar, forthcoming). A description of change agent and broker behavior conducive to adoption of innovations may be found in Rogers and Shoemaker (1971). If project meteorologists, sponsoring organization representatives, and other personnel are viewed favorably by local residents, the project is more likely to be accepted. These personnel may be termed "change agents" and "brokers" with regard to weather modification.

In the California study, we found that about half of the organizational respondents had had face-to-face contact with personnel representing various cloud seeding projects in the area. The majority of these contacts took place in public or professional meetings, and some occurred in relatively "private" meetings between officials in their roles as agency representatives. Contact at professional meetings may be either formal or informal, and a few of the respondents knew weather modification personnel personally.

Of those who had contact with such personnel (N = 21), about half indicated that they were favorably impressed by the person(s) with whom they had contact. They mentioned that the individuals had "vision", that they were "dedicated, well-educated and interested professional people," and that they were responsive in initiating contacts and attempting to explain their work in understandable fashion. Some of those unimpressed by their contacts described change agents and brokers as supplying unsubstantiated claims concerning the technology's effectiveness. Others complained of personnel not knowing enough about their topic, of being impolitic by saying that the public are ignorant and should not be told anything more than absolutely necessary, and by the perceived non-responsiveness of these personnel to questions and concerns put before them thus incurring resentment. A few respondents indicated that their contacts with weather modification personnel were too brief for them to make an assessment.

Although the majority of those indicating they had contact with change agents or brokers said they were favorably impressed, the present "image" of the weather modification change agent in the area is not highly favorable. Respondent judgements were based largely on contacts with personnel

other than those affiliated with the proposed project, but some unfavorable opinion and, perhaps, credibility problems will probably carry forward and it may take some time before weather modification personnel are viewed with greater favorability and respect by a larger proportion of organizational incumbents.

Trade-Offs

No adequate formal mechanisms to compensate potential or actual losers from weather modification projects has yet been developed in the United States. Yet, some writers have felt that the development of adequate compensatory arrangements will ultimately be necessary for the socially beneficial application of weather modification technology (Changnon, et al., 1977; Haas, 1973).

Although no formal means of compensation has yet been developed, some informal accommodations have been suggested and implemented in connection with weather modification projects elsewhere. For example, in one mountain project area where timber interests were concerned about difficulty in moving heavy equipment in muddy conditions, a project sponsor suggested building a bridge for them.

Successful "trade-off" arrangements between a project and those potentially concerned about its effects are hypothesized to be associated with its social acceptability (Farhar, forthcoming).

We did not discover any existing arrangements in the northern Sierra Nevada area between on-going projects and others.

The Bureau of Reclamation, in connection with the proposed project, has developed agreements with two potentially opposed organizations in the area. These agreements may be viewed as mutually beneficial to the organizations involved, since each provides desired information to the other, and a cooperative arrangement allows the potential for wider social benefit through the acquisition of knowledge that might not otherwise be possible.

The first of these agreements was a memorandum of understanding between the Bureau of Reclamation and the Forest Service for Region 5 (which includes the entire state with 17 National Forests). This agreement provides for a "mutual understanding" in planning all field activities and for adequate liaison between the two agencies. The Bureau will provide hydrometeorological data to the Forest Service, and the Forest Service will submit proposals for related studies to the Bureau. Special use permits for the conduct of weather modification projects over Forest Service lands are issued by Forest Supervisors. The Forest Service defines itself as supportive of the proposed research project.

Another agency involved in research related to the project is California's Department of Transportation (CALTRANS). They have reviewed existing information on the probable consequences of increased snowfall on highway conditions, and may continue to monitor this relationship under Bureau sponsorship.

This kind of cooperation among agencies, continued and expanded, heightens the probability of organizational support for the project and contributes to its overall social acceptability.

Media Position

In some areas of the country, it has been observed that editors of local or regional newspapers and magazines have sometimes taken an editorial position with regard to weather modification and to specific projects. Whether such positions help to shape public opinion or are a reflection of it is not known, but editorial positions are sometimes found to be associated with the occurrence of support or opposition to a project. We therefore wanted to assess the area's media positions as of July 1976.

We talked with representatives of media having a total circulation of 233,000 in the general area of the proposed project and its periphery concerning their views on snowpack augmentation and the activities of their papers toward it.

The findings show that the media have taken no strong editorial positions one way or the other on weather modification or on specific projects. All expressed an interest in the general topic and felt it probable that they would editorialize in the future. The situation in July, 1976, could be characterized as "open" with regard to editorial policy and was certainly not opposed to weather modification or to the proposed project.

Knowledge and Information Sources

About half of the organizational respondents (54%) were aware that a research program to augment snowfall in the Northern Sierra Nevada Mountains had been proposed. Respondents were thus more aware of previously existing projects than about the proposed project. Proportionally, they were more knowledgeable about the proposal than the population-at-large, a finding hardly surprising since, for many respondents, their organizational interests were potentially involved.

Organizational respondents considered themselves to be more well-informed about the proposed project than citizens did, although about 54% of the organizational sample had either heard nothing about the project or knew very little about it.

Although the organizational sample was not randomly drawn and thus is not representative of organizations in the area, it was selected on the basis of the organization's functional relevance to snowpack augmentation. If anything, we would expect these organizational incumbents to be more well informed about the Sierra Project than organizations as a whole. Thus it appears fair to conclude that information efforts up to July 1976 had not reached a good many salient groups. About a third of the sample considered themselves "fairly well-informed" or "very well informed."

Virtually the entire knowledgeable portion of the organizational sample had learned of the project through interpersonal contact. One respondent learned of it through a news release, and he was a newspaperman. One first heard of the Sierra Project in August, 1975 as a respondent in the citizen survey. Four respondents heard of it through public or special meetings initiated by the Bureau of Reclamation. The remainder got their information from a variety of informal contacts in the community or professionally. As one respondent put it: "I am active in the community, I know about these things."*

Recommended information sources. The best source of information on the proposed Sierra Project was defined by respondents as brochures and newsletters mailed to the organization, mentioned by half of the sample. Also mentioned as suitable information sources were special meetings (12%) and newspapers and magazines (11%).

In summary, the findings suggest that a wide variety of information sources should be employed to keep organizations (and the public) informed about the Sierra Cooperative Project. Recommended mechanisms for public information included: mailed newsletters, news releases and meetings initiated by project personnel. In addition, a good deal of information is exchanged through the interpersonal networks of each community in the area; project personnel could make an effort to become widely acquainted with area residents in order to aid information exchange.

Evaluation of Projects

Assessment of prior and current cloud seeding projects. Thirty-one organizational respondents identified projects that had been or were being conducted in the area. Two of the respondents indicated opposition to the identified projects, most were uninformed about them and were thus neutral, and a few were favorable. Respondents were asked to give the reasons for their organization's position toward these projects.

(1) Those opposed (N = 2)* had taken the position because of highway snow removal problems and for a complex of reasons cited by one respondent as follows:

"First, the possible irreversibility of climate effects over the long term. Cloud seeding could be uncontrollable -- it could cause snowpack that doesn't melt, resulting in more cool air, and would act as a moisture releaser with such climate change effects as a new series of storm patterns. Second, in nature, if you disrupt something here you will affect something there. You can fool around with

* An interesting sidelight to this line of thought is that all 48 organizational respondents are now aware of the proposed Sierra Project by virtue of having participated in the societal study.

* It should be kept in mind that organizational respondents are often speaking for a broader number of area residents than their actual number would suggest.

Mother Nature only so much, and then you are asking for trouble. Third, we have no control over those running the project. Everybody does things around here without our being informed about it."

It appeared that these respondents had taken an opposition stance toward existing projects in part by virtue of public relations problems with organizations involved in them. The resentment created by this prior problem has some effect on their position toward the proposed project. For Sierra Project officials, this would be an inherited problem.

(2) Those favorable (N = 6) included two respondents who felt that the prior Krick hail suppression program had helped to protect the area's fruit crop. One respondent had been a contributor to the project on the basis of his tonnage; he recalled in the late fifties having experienced a ten-second hailstorm that cost him \$80,000. Three respondents defined the northern Sierra Nevada mountains as a climatologically favorable area for productive cloud seeding, and, given the lack of known adverse environmental impact and increasing population demands for water, food and energy, they favored snowpack augmentation projects. As one respondent described it:

"The two most important needs today are for food and energy. Cloud seeding answers both these needs. With artificial storage areas being exhausted, we need to turn to natural storage areas and that is where the bigger and more dense snowpack helps us. Most of the deep rooted old growth trees are gone due to extensive lumbering in this area; now we have dense growth of shallow-rooted younger trees that require much more consistent moisture. . . Cloud seeding is the best way to take care of this requirement.

"We should concentrate the snowpack in the early winter (October and November) -- this is when we need a heavy snowpack. Then the subsequent snowpack will press down, making the moisture a solid field of ice. This makes for a slow and consistent run-off during the summer months without the danger of flooding, providing good irrigation. California is one of the best agricultural areas in the country, and we depend on irrigation to do the job. Also, the more abundant the water supply, the purer the water, and this cuts the costs of preparation of water for consumption considerably.

"Also, falling water is the cheapest form of energy and the most pollution-free. The more hydroelectric power, the better, and a slow melt helps us here also."

Thus, we see that organizational incumbents favorable to already-experienced projects were influenced by their own interests being assisted or benefited by these projects, and where those interests might be more regional in character, a broader regional perspective was employed in defining projects as beneficial and therefore desirable.

(3) Those neutral, uninformed, or not caring (N = 23) represented the largest proportion of respondents aware of prior cloud seeding. Virtually

all of these respondents reported that as far as they were able to determine, prior projects had not affected them in any way, and they were therefore not much concerned about them. One respondent commented that the effects of existing projects were probably "minor and subtle," and another said, "We ignore them." Thus, no potential ground for opposition appears to exist among these organizations or others, as long as they perceive their interests as remaining unthreatened by project effects.

Five respondents felt prior projects had caused some economic harm to them, and three thought they had produced benefits. Those who felt seeding had caused harm did not necessarily take an opposition position toward the projects, but rather discussed conditions under which projects could be made more acceptable to them. Such conditions included improved environmental studies, compensation for highway snow removal, cessation of seeding in early spring when fruit crops are vulnerable, and clarification of the legal ramifications of cloud seeding over Wilderness Areas.

Relationship of prior evaluation and current evaluation. In order to determine what effect opinion about currently existing or prior cloud seeding projects had on opinion about the proposed Sierra project, Table 2. summarizing these data was prepared. Almost two-thirds of the organizational sample were favorable toward the proposed Sierra project; of those, 15% had no knowledge of the currently existing projects. None of the unaware respondents was opposed to the proposed project, and 9% of the informed respondents were opposed to it.

A remarkable pattern of similar response to prior and proposed cloud seeding exists. Of those favorable toward existing projects (22%), all were favorable toward the proposed project. Of those neutral or undecided about existing projects, 62% were favorable to the proposed project, 26% were undecided, and 12% were opposed. Of those opposed to existing seeding (4%, or two respondents), one was favorable and one was opposed.*

Among the respondents neutral or undecided about existing cloud seeding, the favorable position toward the proposed project may be linked to its experimental nature. Uncertainty is linked to lack of knowledge about the effects of these projects, and several respondents voiced the hope that currently unanswered questions about the effects of seeding in the Sierras would be answered by the experiment.

In addition, the favorable stance taken by 40% of the non-knowledgable respondents is typical of citizen survey findings in several states prior to the implementation of a local cloud seeding effort. These results seem to imply that, to these respondents, the seeding experiment sounds like a good idea. However, 60% of the non-knowledgeable respondents were withholding judgement. Among knowledgeable respondents, over a third were not willing to indicate a favorable position toward the proposed project, and those

* The one "deviant" case in this regard explained that his concern about the cost of highway snow removal had been, in the interim, over-ridden by the area's need of water -- an awareness heightened by the drought.

TABLE 2
POSITION TOWARD PROPOSED SIERRA PROJECT BY
POSITION TOWARD PRIOR PROJECTS
(Organizational Sample)

Position Toward Existing Projects	Position Toward Proposed Sierra Project			
	<u>Favorable</u> (40) *	<u>Undecided Neutral</u> (60)	<u>Opposed</u>	<u>Total</u>
No knowledge of existing projects	4 (15)	6 (46)	0	10 (23)
Favorable to existing projects	6 (100) (22)	0	0	6 (14)
Neutral toward existing projects	16 (62) (59)	7 (26) (54)	3 (12) (75)	26 (59)
Opposed to existing projects	1 (50) (4)	0	1 (50) (25)	2 (4)
Totals	27 (61)	13 (30)	4 (9)	44(100)

*Row and column percentages in parenthesis.

flatly opposed amounted to four respondents (9% of the organizational sample). Thus, a sizable minority of respondents were withholding judgment on the project's desirability, presumably until more information about the project reached them, or until they had experienced its effects once in operation.

Organizational action on prior projects. Political officials and economic interest representatives were asked whether they had taken any action in support of or opposition to cloud seeding in the area. Over half had taken no action (56%), about a third had taken action in support of cloud seeding, and about 11% in opposition. One respondent indicated that he had supported the prior hail suppression program some 15 years earlier. One utility reported cooperation with the Fresno State College Project Censare research program in snowpack augmentation, and with another utility in sharing information and adopting randomized seeding procedures. The California Department of Transportation has participated in a study funded by the Bureau of Reclamation to review existing information and assess the probable consequences of increased snowfall on highway conditions (CALTRANS, 1976). An environmental health department supported snowpack augmentation in a letter to its Board two years previously. Agencies interested in water development had also taken minor action. As mentioned earlier, the Bureau and the Forest Service agreed to a mutual understanding with regard to the proposed project, and the Forest Service is supportive of it.

Taking action in opposition to cloud seeding have been the El Dorado County Board of Supervisors, on record as opposed, and the Natural Resources Defense Council who have submitted testimony to the Domestic Council and and presented papers at various public and professional meetings.

In summary, the prior history of weather modification in the northern Sierras has not resulted in a polarized community situation with regard to the issue. Certain problematic areas have become identified through past experience with cloud seeding, but these do not appear to be sufficiently serious, if responded to, to result in social rejection of the Sierra Project on the basis of past experience. The situation could more accurately be characterized as one in which some opposition and a fair amount of skepticism exist as a result of past projects, but enough favorability remains so that future projects could hope to build sound social relations in the area.

Organizational position toward weather modification. We inquired as to whether any of the organizations in the economic interest group and political samples had taken a position in the past with regard to weather modification in general. The data show that over a quarter of the organizations had taken a prior position. Of these nine organizations, five had expressed favorability and four opposition to prior cloud seeding. Organizational position toward prior cloud seeding might be important with regard to the proposed project, especially if organizations had taken a public stand which might be difficult to retract.

Responses to this item indicated, however, that a few organizations had taken a position on snowpack augmentation on the basis of the proposed Sierra Project itself, and others on the basis of prior operations. An important variable in determining organizational position, other than functional

structure, was whether a given project was operational or experimental in nature. Several organizations expressed interest in the results of an experimental project.

Those organizations taking a favorable position toward weather modification generally were in water, power and forest management. They cited the need for additional water, and for the management of natural resources. As one respondent put it, "We've been in favor of management of all kinds -- watershed, water and land management." Such organizations see snowpack augmentation as beneficial to their domain interests.

Organizations opposed to weather modification generally tended to be environmental groups, forest management* and County Boards of Supervisors, organizations who tended to see their interests threatened by snowpack augmentation.

As one forester put it:

"Often times the problem of granting weather modification special use permits are compounded by the fact that the projects overlap Wilderness Areas. . . Our interest, of course, in the wilderness is to protect it from the encroachment of man. When using the target area for cloud seeding, the proponent must provide reasonable evidence that he will not change natural conditions incompatible with the wilderness. The likelihood of our opposing a research project is not high given the amount of uncertainty associated with the environmental effects of cloud seeding. We are dependent on the Bureau's results for that very vital information."

Thus, opposition to the proposed project is unlikely from this quarter, since research results on environmental effects are desired.

Opposition stances by environmentalist organizations were also moderated by interest in research results. One such respondent said:

"We've not said go or stop, but have made recommendations about what should be done. If they do it properly, it's O.K.... We would prefer that they follow Cooper's recommendations** to assess the benefits of a full-scale project. He recommended such techniques as laboratory tests of silver iodide in the soil and checking with wildlife experts on the migration of deer herds, etc. Research can be done in other ways than throwing silver iodide in the air."

Clearly, environmentalist organizations were concerned that research defined as adequate from an ecological point of view be conducted at least in conjunction with, if not prior to, the proposed project.

* Both favorable and opposed views were expressed by forest management.

** The reference here is to Cooper, Cox and Johnson, 1974.

County Boards of Supervisors in El Dorado and Nevada Counties have both gone on record in opposition to cloud seeding on economic grounds.***
On June 13, 1975 the El Dorado Board of Supervisors wrote the Bureau of Reclamation as follows:

"At regular meeting held on Tuesday, June 10, 1975, after consideration of (the Bureau of Reclamation's Award of Contract for the Sierra Cloud Seeding Research Project), the Board of Supervisors of El Dorado County directed that you be advised of its request for the following:

The Nevada County Resolution gives some of the background of the problem from the area's county government point of view (Nevada County Board of Supervisors, 1975).

"WHEREAS, the Federal government...has provided grant money for cloud seeding in the Eastern Nevada County area (a reference to the Pyramid Lake Pilot Project) and,

"WHEREAS, the manager of the five-year pilot project has stated that his staff is convinced the snowfall from storms that were seeded has increased the snowfall from 10% to 15%, and,

"WHEREAS, the Truckee-Donner area has an average 500 inch snowfall and a 15% increase would increase the snowfall 65 inches, and

"WHEREAS, the costs of snow removal in the Truckee-Donner area have reached a critical state and it is anticipated that to maintain the same level of snow removal, the County will have to expend \$700,000 which will cost the local taxpayer an increase in taxes of 84¢ per \$100.00, and

"WHEREAS, the Federal government has made a grant for the cloud seeding but has made no provision to take care of the costs to the local taxpayers of removing the additional snow.

"NOW, THEREFORE, BE IT RESOLVED BY THE COUNTY OF NEVADA, ACTING BY AND THROUGH ITS BOARD OF SUPERVISORS, that:

- (1) The Board of Supervisors of the County of Nevada request the immediate termination of all cloud seeding programs in eastern Nevada County.
- (2) No future seeding programs be authorized until the Federal government has filed an Environmental Impact Report.
- (3) If the cloud seeding program is to be continued, the Federal government be required to provide a grant to Nevada County to purchase necessary snow removal equipment to remove excess snow caused by the cloud seeding program. . ."

Nevada County was not included in the organizational study.

Copies of this resolution were sent to both the United States Senators from California, the U. S. Congressman from their district, state legislators, the Sanitary District, and the Boards of Supervisors of neighboring counties. This action alone is enough to qualify the Counties of El Dorado and Nevada as having what we have termed "organized opposition" in our sociological studies of public acceptance of and resistance to weather modification projects in the United States.

What makes these specific resolutions particularly interesting is that they reveal under what conditions those opposed might be willing to tolerate a cloud seeding project in the area: (1) the filing of an Environmental Impact Report, which identifies areas for future needed research* (U.S. Bureau of Reclamation, 1976b) and (2) some compensation to the counties for highway maintenance. Setting aside the thorny problem of liability for weather effects, the Federal government has often, in the past, made grants to local communities and school districts impacted by Federal programs. Thus, the device of paying a grant to a local community has long precedence, and may seem to these Supervisors an eminently reasonable approach to employ in this situation.

Some of the Supervisors, however, might well be opposed to the project for reasons in addition to economic ones. An extremely well-designed research project based on an adequate Environmental Impact Report, buttressed by a compensation system for counties and other actions set forth in the Recommendations section, would undoubtedly assist in gaining the tolerance, if not the enthusiasm, of these opposed Supervisors.

The fact that 9% of the organizational respondents indicated their organizations had taken a stand in opposition to weather modification, usually with some conditional position attached, is sufficient evidence that the potential for controversy in connection with the proposed Project exists.

Hypothetical evaluation of an experimental project. Seventy percent of the organizational sample were favorable to the idea of a "five to eight-year research project to study the effects of cloud seeding for snowpack augmentation in the Sierra Nevada Mountains." Three respondents were opposed to the idea.

Those favorable mentioned, as reasons for their opinion, the benefits of increased knowledge about the effectiveness of cloud seeding technology and about its effects (N = 15) and the area's need for more water (N = 7). However, even those indicating an overall position of favorability to the idea of an experimental project had questions about it. What about legal complications? Who is going to pay for it? Who will benefit from it? What about the possibility of floods? We don't want damage. We don't know the effects. What about increasing the precipitation in one area at

* The Bureau of Reclamation has filed a programmatic Environmental Impact Statement for Project Skywater (U.S. Bureau of Reclamation, 1976b).

the expense of another? As one respondent put it:

"We simply know nothing about it. Where is the target area? How much snow will we get? When in the season will we get it? When will the seeding be done? Will they seed when there is wind? Will it be done at night or during the day? Can they increase individual storms or what? We want windless storms, not windy storms."

Another favorable respondent said:

"We would like to participate in the decision-making process. We want to be in a position to give input. We want to know if this project will cause any problems."

Those opposed gave reasons reflecting their organizational interests; if it affected their interests, they would oppose it. Such interests have been outlined in other sections of this report. Those in a more neutral position simply felt they would need more information about a specific proposed project before deciding their position toward it. They were not, in other words, favorable to the idea of such a project, but would want to decide on a project-by-project basis.

Hypothetical evaluation of an operational project. In contrast to the relatively favorable opinion expressed by the organizational sample toward a snowpack augmentation experiment, opinion concerning an operational project was markedly less favorable. About half of the sample were neutral or undecided toward the idea of a "relatively permanent operational project to increase mountain snowfall in below normal years," 16% were opposed, and about a third were favorable.

In general, the reasons given for favoring an operational program were about the same as those given for favoring an experimental program; not mentioned as a benefit from an operational program was an increase in scientific knowledge. Organizational incumbents were somewhat more likely to mention a direct benefit to their own organizational interests in the case of an operational program. Respondents were more hesitate and conditional in their favorability to operations than experimentation, stating that their actual position would depend on the results of research. For example, a favorable respondent said:

"A lot more study and research should go into it. We need to preclude damage to crops, and keep snowpack at higher elevations. The fruit trees need protection."

Those indicating they were currently opposed to the concept of an operational program were concerned about knowing the full effects of snowpack augmentation before "going operational". Concern was expressed for the fruit crop, over downwind effects ("If we take Nevada's water, they should sue us"), and over significant amounts of snow damaging the area's ecology. As one respondent put it:

"One can imagine that there would be long-term effects from an important project -- this is what concerns me. You can get people hooked on the additional water and long term environmental effects may become irreversible, even from a societal point of view."

Those in the neutral and undecided categories on the operational program concept comprised half the sample. Many of them indicated that they wanted a great deal more information about the impacts of cloud seeding, including the Sierra Project research results or the results of an Environmental Impact Report, before adopting a position. One respondent said: "The burden of proof is on the seeders to convince us that it is worthwhile." Others were concerned about the area's heterogeneity of weather needs:

"There would be economic disbenefits offsetting the economic benefits of water. We'd want to study that."

"The peach orchardist and I may want snow, but the gamblers want few snowstorms so people can drive over to Reno. Experimentation is immune from possible conflict because you are still testing, but for the operational program, it will be trickier to figure out what will be best for all."

One organization was concerned that operational snowpack augmentation might be limited to below normal years (as the item stated). "We are interested in the production of water in well above-normal years." If an operational project thus limited snowpack augmentation, the organization would not be favorable toward it.

Another respondent was concerned about the concept of "below normal" years, calling for better reliability of prediction criteria for the snowpack at any point in the season. Along these lines, one respondent (knowledgeable about weather modification) said:

"I would like to contest the Bureau's 'below normal year' concept. You don't know whether any particular year is going to be below normal until the year is concluded. To say that you can tell what kind of year it is going to be by taking early 'snow course measurements' is a lot of bull. This is not an accurate way of determining season-long snowfall. What they do is take a snow course measurement on January 1, and each month thereafter. They know what the snowpack is supposed to look like on January 1 of each year -- what is normal. But as you can see, a lot can happen between monthly measurements."

Yet another organization feared that water rights in connection with cloud seeding might become an issue if the Federal government ran an operational cloud seeding project.

"Water rights won't be an issue when private industry does the seeding (as in the case with most cloud seeding in California)."

Private industry owns the water, of course. But when a Federal agency does the seeding, there is the possibility that a legal question of who owns the water may arise. The State of California has never sponsored an operational cloud seeding project, so the issue has never come up."

It is interesting that since the "water rights issue" has never arisen in connection with cloud seeding in California, the respondent assumed that was because private industry ran operational projects rather than governmental entities. Water rights may well be a legal question in any event because cloud seeding affects atmospheric processes which may be considered in the public domain, as are oceans, and because the watersheds presumably being affected are often government-owned lands. Thus, our interpretation is that issues of water rights are an inherent socio-political and legal problem in every orographic snowpack augmentation project, whether publicly or privately sponsored.

In sum, the concept of an experimental snowpack augmentation project met with fairly widespread favorability among organizations in the proposed project area, and organizations are withholding judgement on the notion of permanent operations until they know a good deal more about orographic seeding's techniques and impacts. Research is seen in just about everybody's interest, but operations are another matter.

Position toward the proposed Sierra Project. Given these findings, it is not surprising that 63% of the organizational sample favored the proposed Sierra Project about a third were neutral or undecided, and 8% were opposed. In general, the reasons cited for these positions were those given for the stated positions on hypothetical projects. The experimental nature of the proposed project increases its social acceptability as far as organizational response is concerned.

Organizational respondents were asked whether they thought most members of their organization would feel the same way as they did about the proposed Sierra Project. Most assessed their organizational opinion as similar to theirs.

When respondents indicated an unfavorable position toward the proposed Sierra Project, we asked them whether there were any conditions under which the project could be made more acceptable to their organizations. One explained that the results of the EIR would be helpful. Another indicated that the area would have to be "rather desperate for water" before he would favor it. Another organization indicated that if the uses of the water were for other than agricultural purposes -- if the water were used for hydropower and ecological purposes -- it would be more acceptable. The point was also made that research itself should be conducted by organizations independent of the Bureau in order to improve the credibility of the results. Communication and cooperation with area fruit growers was also recommended as a way of making the project more socially acceptable.

The organizational sample was more favorable toward the concept of the Sierra Project than the citizen sample, although a direct comparison between the two samples cannot be drawn on this point because the items

asked of each were somewhat different. In general, however, overall favorability was clearly higher in the organizational sample than in the more polarized citizen sample.

One implication of the findings is that the Sierra Project could be designed in such a way that the kinds of issues raised -- technical, meteorological, economic, socio-political, environmental and legal -- be addressed in a definitive manner. If the research design or level of funding are insufficient to provide these answers, organizations and the public need to be informed in advance about what they can expect by way of research results, in order that their levels of expectation for the research will be realistic. The organizational sample displays a fairly sophisticated grasp of the complex nature of the problems involved, and simplistic explanations would probably contribute to skepticism. They are largely favorable because they hope the experiment will be well-done, and will ultimately contribute to man's ability to solve problems.

Decision Making

Citizens in several surveys of public opinion on weather modification have consistently expressed a preference for local control over the technology's implementation. For example, data from the March 1976 survey in South Dakota showed that 54% of the population favored a vote of some kind to decide participation in the state's cloud seeding program (Farhar, 1976b). Weather modification experts, on the other hand, have been much less favorable than citizens to the idea of a referendum to decide on either research or operational programs (Farhar and Clark, forthcoming). Thus, we were interested in discovering how organizational respondents would view the matter of voting.

We asked them the following open-ended item:

"Some people have argued that weather modification is too scientific a matter for people in an area to vote on whether to have it. Others disagree. What do you think?"

Results show that 59% of the organizational sample agreed that weather modification should not be voted on by the public and about a third thought that it should.

Those opposing the concept of a vote argued that the public are not "qualified," that they do not know enough about it, that they would not understand it, and that only a small proportion would vote. Some quotes representative of this point of view are as follows:

"I don't think the average person can receive enough digestible material to make an intelligent decision."

"It shouldn't go to a vote - it's like flurodiation. You can't get the information around -- it's pretty technical and they're not knowledgeable enough, and it should be left to elected representatives."

"Fooling with nature is an emotional thing. We need to ask what are the needs of this area and the needs for the rest of the country. We don't want a dictatorship. We produce an amount of food and fiber that is unprecedented in the world. If we could get another million acres under production and produce that much more food, let's do it. No vote."

Another respondent felt that both types of input (scientific and public) are needed, saying that "the people have to make the decision ultimately," but was unsure that a vote was the best way to achieve public input. Others argued that referenda were inefficient, and that the political system is set up to make these types of decisions through representative democracy.

One respondent refused to answer the item, explaining:

"I may agree that it is too scientific but whoever made the statement is a dumb a---. You start talking like that and you get a lot of people p----- o---. You don't ever tell the people (to their faces) they have no right to decide."

The minority who felt the decision should come to a vote argued that the public were capable of understanding and judging the issue. Some quotes representative of this point of view are as follows:

"Never underestimate the intelligence of the population."

"I have personally great faith in the public. I would not be afraid of an election. The burden is on the proposer to adequately explain the program, then leave it to the public."

"Science involves as much faith as the more widely accepted belief that public decisions are irrational decisions. The people should decide since they are paying for it. The experts who hide behind science are not fulfilling their responsibilities. To hide behind the complexities of science is not fair. Technologies can be communicated to the public clearly in order for them to decide."

Having explored the issue of voting, we asked respondents the following open-ended item:

"There are a variety of ways to make decisions about beginning and continuing a cloud seeding program. By what means do you think decision about research and operational programs in your area could best be made?"

The modal response to this item was that federal and state officials and scientists should decide for both research and operational programs (mentioned by 17 respondents). Nine respondents further thought that agency responsibility should include utilization of public hearing processes for environmental review and societal questions.

The third most popular decision process in the organizational sample was for the County Boards of Supervisors to make the ultimate decision,

following inputs from experts and the public (mentioned by ten respondents). Local governmental decision making was defended on the grounds that these elected representatives provided for the necessary public input to the decision. One additional respondent felt that county and state governments should share the decision-making responsibility.

Several other suggestions concerning how to decide, or who should decide, were offered by one or two respondents each. One idea offered was creation of a special board or commission with decision-making authority -- a board representing a cross-section of agencies, interests and citizens. Another respondent recommended a vote of the population affected by the project. Two respondents thought that the Forest Supervisors should have ultimate authority, and one thought the California Department of Water Resources should decide.

These data provided some information on which to design socially acceptable decision processes in connection with the Sierra Project, at least from an organizational point of view. It is clear that virtually all respondents felt that technical experts and governmental officials should be involved in the process, with a sizable proportion calling for some form of citizen or community input.

Summary of Organizational Findings

A major theme running through the study's findings is that organizations tend to adopt a position toward the proposed snowpack augmentation project in keeping with their assessment of how it will affect their interests. If that effect is anticipated to be beneficial, whether in terms of increased knowledge, increased availability of water, or other values, then the organizational response is favorable. If harmful effects are anticipated, the organization tends to be opposed. If no effects relevant to the organization are expected, their position tends to be one of neutrality or indifference.

We found a high rate of agreement that the area of northern California needs more water, although not everyone would agree that a snowpack augmentation project is the most desirable or satisfactory way to develop water supplies. Most respondents believed cloud seeding to be effective in increasing snowfall. The area is characterized by a heterogeneity of weather needs with respect to its economic and social activities. The economy appears to be relatively healthy in each of the study counties; however, severe recent damage was estimated for principal weather-related economic interests in the area. There is a history of prior cloud seeding projects with no occurrence of grassroots organized opposition. However, a current organized opposition is recognized in the Boards of Supervisors of area counties. Assessment of prior projects was not unfavorable, and the reputability and credibility of weather modifiers in the area seems to be neither high nor low. Media position toward cloud seeding have been either non-existent or mildly favorable. Some trade-offs between the Bureau and area agencies have been negotiated. Organizational positions toward weather modification is mixed, with some favorable and some opposed; yet,

for the sample as a whole, favorability to the concept of the Sierra experiment was expressed. On balance, and without weighing any of these variables, the social acceptability of the Sierra Project from an organizational perspective appears to be reasonably high.

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