WEATHER MODIFICATION GOES PUBLIC

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The theme of this presentation is "the people get involved". On the occasion of the WMA's Silver Anniversary, I thought it would be appropriate to focus on the latest theory and data in the social aspects of weather modification, rather than on historical events. We know that, historically, interest in and demand for weather modification has arisen from the grass-roots -- especially on the part of those who stood to benefit from weather changes. Since the late 1940's, there has been a scientific basis for cloud seeding. Where are we (some 30 years later) in understanding the social implications of a scientifically-based weather control technology?

We have learned to distinguish weather modification as a type of innovation quite different from those such as hybrid seed corn or the birth control pill. The latter are innovations that may be adopted by individuals. Weather modification, by contrast, is an innovation rarely adopted by individuals, but is, instead, adopted by organizations and communities. Certainly, the effects of weather modification respect no political or legal boundaries, and tend to be experienced on a community-wide, or even regional, basis. The adoption of hybrid seed corn is an "individual" innovation decision; the adoption of cloud seeding is a "collective" innovation decision.

One theory of diffusion states that satisfaction with innovation decisions is heightened when those affected by the decision have a voice in it. If we assume the theory to be correct (and some empirical evidence exists to support it), then the greater the degree of public participation in decisions to adopt weather modification, the greater the public satisfaction with the decision should be. And while many believe that decision makers should be responsible for setting policy on weather modification, they may be overlooking the fact that in most project areas, the decision to adopt cloud seeding is a non-routine decision. That is, there are few shared expectations about how such a decision should be made. Whether or not to have a cloud seeding project is a decision that has been made in a variety of ways by a variety of organizations.

Experts in weather modification vary in their opinions about how ready for operational application various technologies are. For example, accord-

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ing to our survey of expert opinion, conducted by mail in March/April of 1975 with 551 respondents, cloud seeding for snowpack augmentation is considered by a larger proportion of respondents to be capable of effective application (68%) than for, say, hurricane suppression (4%). Among the 12 technologies studied, there was general agreement on seven that they were or were not ready for operational application, and general disagreement on five. The five technologies on which there was disagreement are presented in Table 1, and include summertime precipitation augmentation and hail suppression. Disagreement on these technologies occurred on the basis of organizational affiliation (with respondents affiliated with weather modification firms more likely to state that the technology is ready for operational application than respondents from research institutes or Federal agencies); of organizational responsibility (with those responsible for or interested in applications more likely to assess technologies ready for operations than those engaged in physical research and development); of academic background (with those trained in agriculture, engineering and social science more likely to assess technologies as operationally ready than those trained in meteorology, atmospheric science, physics and statistics). In general, the higher the educational level of the respondent, the less likely he is to assess these five technologies as ready for applications; and the age category of respondents made little difference in assessment, with a slight tendency for the oldest category to be more inclined toward operational readiness. (I can show the data on these later if there is time).

The implication of these differences in expert opinion for our discussion is that in some areas the adoption decision to be made is a decision with regard to a scientifically uncertain technology (from the points of view of citizens and some decision makers like state legislators). The uncertainty implies that a degree of risk is involved (the degree may be quite limited, but may be said to exist); in general, risk-takers prefer to adopt their own risks, rather than have such decisions made for them.

To illustrate the two interrelated points I am discussing -- public participation and scientific consensus -- I would like to cite the San Luis Valley example. Omitting extra-area effects from consideration, the San Luis Valley is an extroadinary case where a strong organized opposition to a hail suppression project (one of the five problematic technologies) actually agreed to a snowpack augmentation project (one of the technologies with a higher degree of consensus). They offered their tolerance in the context of a meeting with those who wanted to sponsor and run the project -- that is, they were consulted about the project prior to the permit application process. Although the opponents still worry that precipitation might be decreased as a result of the project, they have agreed to tolerate its existence on the condition that they participate in a citizen committee to monitor its progress and effects.

What about the South Dakota situation? On the face of it, at least, South Dakota's weather modification program had a decision process with a high theoretical level of public participation. I say "theoretical" because the county commissioners decided whether or not each county should participate in the state program, and the county commissioners are elected representatives of the people. How accurately they assessed and represented their constituencies' opinion in their decisions is not yet fully known.

The sequence of events in South Dakota was as follows. Between the third and fourth seasons of operation, a grassroots opposition to the SDWMP organized on the grounds that the Program was causing drought. During the fourth operational season (1975), the opposition, Citizens Against Cloud Seeding, were successful in halting operations in a few counties. They engaged in a variety of activities -- such as circulating petitions against the Program, appearing on radio and television, publishing advertisements, mailing brochures, and holding public meetings -- with the purpose of bringing the SDWMP to a halt. They were successful, too, in persuading some state legislators to represent their cause in the 1976 short session of the legislature. The SDWMP had been institutionalized by being included in the Governor's General Appropriations Bill, but the Joint Appropriations Committee removed it from the Bill, along with two other controversial programs. The chairman of the Joint Appropriations Committee then introduced a Special Appropriations Bill to support the Program for Fiscal Year 1977.

While 45 counties had participated during the 1975 season, about half that number had signed contracts for the 1976 season with the Division when the legislature began deliberations. The appropriations bill provided for a much-reduced weather modification budget from the prior year, with plans for a program in 19 counties. When the Bill came to the Senate floor for debate and voting, it received a simple majority, but failed to achieve passage by the requisite two-thirds majority. The Division of Weather Modification will close its doors on July 1, 1976.

Within a few weeks of the legislative decision, we conducted our citizen survey in South Dakota, with interviewing begun on March 8, 1976. The sample of 430 respondents was drawn in such a way as to be representative of the state as a whole, with 60% from counties participating in the weather modification program in 1975, and 40% from non-participating counties. We hand-tallied two key items from the survey especially for this paper.

In terms of favorability or opposition to the South Dakota Weather Modification Program, we find that, overall, 46% favor it and 33% opposite it. (see Table 2). Interestingly, the proportion of the sample favorable to the Program is higher in <u>non-participating</u> counties (49%) than in participating counties (36%) than in non-participating counties (28%). The results from this most recent survey in comparison with the last one (taken in September 1974), show that the proportion of those opposed has almost tripled in the last 1.5 years, while the proportion of those favorable has declined 14%. Overall, more people are still favorable than opposed, and opinion has become more polarized over time.

With regard to how citizens think cloud seeding decisions should be made (see Table 3), we find that voting is preferred by the majority of respondents (54% of the sample as a whole). This particular finding lends empirical support to the hypothesis mentioned earlier that public participation in decision making would heighten citizen satisfaction with weather modification adoption decisions. It is worth noting that 4% of the sample indicated that county commissioners should decide.

South Dakota's Program did not have adequate funding for evaluation of project effects on rainfall and hail. Two recent reports (one by the

Division in rainfall effects, and one by Arnett Dennis on hail) presented encouraging results, but when legislators were asked how they viewed the reports, they had not read them. The reports concentrated on meteorological effects rather than on agricultural economic benefits, and thus may not be persuasive to farmers interested in dollar profit as the reason to support weather modification programs.

The drought certainly contributed to the Program's problems since there was not as much opportunity for cloud seeding to "show its stuff" as there would have been otherwise. The opponents either attributed the drought to cloud seeding, or felt disappointed that cloud seeding was not effective in preventing damaging drought.

County commissioners varied in the extent to which they attempted to assess constituency opinion on the issue. A properly-controlled mail balloting procedure was used in one county; others engaged in no systematic methods to canvass the county. These variations may help explain why weather modification became more controversial in some counties than in others.

Our impression is not that majority wishes were thwarted by an activist minority in South Dakota, but rather that there were two contending minorities -- those actively supporting the program, and those actively opposing it -- with a large camp in the disinterestedly favorable or neutral category. As far as we know, the impressive hoped-for economic advantages of increased rainfall did not materialize in the state's economy over the four years of operations.

When opponents began to research the scientific status of cloud seeding for rainfall enhancement and hail suppression, they discovered that considerable scientific debate existed on these two technologies. This discovery seemed to lend a certain amount of credence to their argument that cloud seeding was not effective.

In recent weeks, several South Dakota counties have banned together in the Northwestern and Southeastern parts of the state to conduct operations during 1976. The funds remaining to the Division of Weather Modification can legally be utilized to financially assist these county consortiums in their efforts. The counties planning 1976 operations are among those signing contracts with the Division for the 1976 season -- apparently they have sufficient interest and constituency support to go ahead with cloud seeding more-or-less independently.

Events in South Dakota underscore two significant needs in weather modification relative to social acceptance: first, the development of the scientific aspects of summertime precipitation augmentation and hail suppression and evaluation of effects, and second, the development of satisfactory decision, funding and responsibility structures for cloud seeding technologies to be applied for the benefit of society. These two needs are inter-dependent.

Finally, although the demise of the SDWMP may have temporary negative effects on the development of weather modification, the potential for reversal of this negativism is present. Events in South Dakota, among other things, allowed those at the grassroots level to feel that they have retained a voice in deciding on the application of cloud seeding. They can just as well decide another way another time (as they did in the San Luis Valley).

TABLE 1

Code Categories

The technology . . .	is ready for operational application. can be effectively applied; research should continue.	Applications
	is ready for field research only. should remain at the level of laboratory research.	Research

Five Technologies

Precipitation enhancement, summer convective clouds, continental (PESC)

Precipitation enhancement, summer convective clouds, maritime (PESM)

Hail Suppression (HS)

Precipitation enhancement in combination with hail suppression (PE+HS)

Precipitation enhancement, general storms (PEGS)

Variables Studied

Primary Organizational Affiliation

Primary Organizational Responsibility or Interest in Weather Modification

Primary Academic Background

Highest Level of Education Completed

Age

TABLE II

- March 1976 -

Based on your understanding of the South Dakota Weather Modification Program, how do you feel about it? Do you favor or oppose it?

	Participating		Non-Participating		Total	
	%	N	%	N	%	N
Strongly Oppose	14	(38)	11	(17)	13	(55)
Oppose	22	(61)	17	(25)	20	(86)
Neutral	12	(33)	14	(21)	13	(54)
Favor	35	(98)	38	(57)	36	(155)
Strongly Favor	9	(26)	11	(17)	10	(43)
Undecided/Don't Know	8	(22)	8	(12)	8	(34)
	100%	(278)	99%	(149)	100%	(427)

	Participating	Non-Participating	Total
Favor	44%	49%	46%
Oppose	36%	28%	33%

TABLE III

- March 1976 -

How do you think any future decisions about cloud seeding in South Dakota should be made?

	Participating		Non-Participating		Total	
	%	N	%	N	%	N
Vote of County residents	27	(74)	41	(61)	31	(135)
Vote of county agriculturists	10	(27)	7	(10)	9	(37)
Statewide referendum	9	(26)	5	(8)	8	(34)
Combinations including vote	7	(19)	3	(5)	6	(24)
Combinations excluding vote	2	(5)	2	(3)	2	(8)
County commissioners	3	(10)	4	(6)	4	(16)
State legislature or gov't	9	(25)	9	(13)	9	(38)
Scientists	5	(14)	1	(1)	3	(15)
Other	7	(20)	7	(10)	7	(30)
Don't know	21	(58)	21	(32)	21	(90)
	100%	(278)	100%	(149)	100%	(427)
Total preferring a vote:	53%	(146)	56%	(84)	54%	(230)

ASSESSMENT OF OPERATIONAL READINESS BY PRIMARY ORGANIZATIONAL AFFILIATION

Primary Organizational Affiliation	PESC	PESM	HS	PE+HS	PEGS
Weather Modification Firm (N = 39)	85%	87	82	77	62
State Agency (N = 57)	60	54	65	42	42
Other Business (N = 33)	56	55	67	51	47
Federal Agency (N = 137)	39	41	41	19	16
University (N = 179)	32	32	37	23	15
Research Institute (non-Federal) (N = 64)	27	26	23	13	10

ASSESSMENT OF OPERATIONAL READINESS BY ORGANIZATIONAL RESPONSIBILITY

Organization's responsibility for or interest in weather modification	PESC	PESM	HS	PE+HS	PEGS
Applications (N = 87)	75%	73	75	63	50
Sponsor (N = 26)	76	44	82	33	42
Public Policy/ Administration (N = 46)	56	45	45	45	36
Related Research (N = 29)	34	34	44	28	10
Physical Research and Development (N = 312)	41	32	32	18	13

ASSESSMENT OF OPERATIONAL READINESS
BY ACADEMIC BACKGROUND

Primary Discipline	PESC	PESM	HS	PE+HS	PEGS
Agriculture (N = 25)	68%	52	69	59	64
Engineering (N = 82)	58	49	63	34	31
Social Science* (N = 31)	57	48	67	43	27
Chemistry (N = 15)	47	47	43	27	40
Meteorology (N = 161)	43	47	45	32	21
Atmospheric Science (N = 117)	32	37	30	18	15
Physics (N = 62)	24	21	33	13	18
Statistics (N =12)	17	17	17	8	8

*Includes: Economics, Geography, Law, Sociology, Journalism, Political Science.

ASSESSMENT OF OPERATIONAL READINESS
BY HIGHEST LEVEL OF EDUCATION COMPLETED

Educational Level	PESC	PESM	HS	PE+HS	PEGS
Less than Baccalaureate (N = 31)	92%	74	82	57	72
Baccalaureate (N = 33)	75	68	71	47	55
Graduate work, less than a Master's (N = 77)	64	58	66	50	44
Master's or equivalent professional degree (N = 61)	60	60	58	44	23
Graduate work beyond Master's, less than a doctorate (N = 96)	23	27	33	16	14
Doctoral degree (N = 236)	29	30	33	20	13

ASSESSMENT OF OPERATIONAL READINESS
BY AGE

Age	PESC	PESM	HS	PE+HS	PEGS
≤ 25 (N = 13)	42%	42	50	25	8
26 - 35 (N = 154)	35	38	42	23	19
36 - 45 (N = 140)	39	36	44	33	20
46 - 55 (N = 133)	52	48	51	34	31
56 - 65 (N = 82)	49	49	44	30	34
66 - 75 (N = 14)	50	27	70	50	54