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**Modifying the Weather: A Social Assessment, edited by W. R.
Derrick Sewell**

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BOOK REVIEWS

Modifying the Weather: A Social Assessment

Edited by
W. R. DERRICK SEWELL*
Victoria: University of Victoria
1973, 349 pp., \$4.00

Derrick Sewell has been one of the pioneer students of the societal aspects of weather modification.¹ Under the sponsorship of the National Center for Atmospheric Research, a National Science Foundation-supported organization, he organized and directed in October 1972 a Symposium on Human Interactions With the Atmosphere. He has now edited the papers prepared for that gathering and had them published as *Modifying the Weather: A Social Assessment*.

In the first chapter of the book Dr. Sewell reports on the state of the art of intentional weather modification.² Scientists have learned that atmospheric processes can be altered by artificially triggering precipitation from clouds through seeding them with substances such as silver iodide. Federal research projects have sought to obtain information about means for increasing winter snowpack, enhancing rainfall from summer cumulus clouds, suppressing lightning, dispersing fog, and altering severe storms.³ Private and governmental cloud seeders have constantly improved weather engineering technology.⁴

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1. He has edited two earlier volumes relating to the human impacts of weather modification: *Human Dimensions of the Atmosphere* (W. Sewell ed. 1968); *Human Dimensions of Weather Modification* (W. Sewell ed. 1966).

2. *Modifying the Weather: A Social Assessment 3-19* (W. Sewell ed. 1973) [hereinafter cited as *Modifying the Weather*].

3. For a number of years the Interdepartmental Committee for Atmospheric Sciences, an executive coordinating group operating within the Federal Council for Science and Technology, rendered annual reports which outlined the cloud seeding activities of federal agencies. Among the more significant reports in this series are Interdepartmental Committee for Atmospheric Sciences, *A National Program for Accelerating Progress in Weather Modification*, Rep. No. 15a (June 1971); H. Newell, Interdepartmental Committee for Atmospheric Sciences, *A Recommended National Program In Weather Modification* Rep. No. 10a (Nov. 1966).

4. Annual reports on private and governmental weather modification activities were issued by the National Science Foundation over a ten year period. Nat'l Science Foundation, 1st Annual Rep. to 10th Annual Rep., *Weather Modification* (1960 to 1969). Since that time the reporting function has been transferred to the National Oceanic and Atmospheric Administration of the Department of Commerce. M. Charak & M. DiGiulian, *Weather Modification Activity Reports: Nov. 1, 1972 to Mar. 22, 1973* (1973); Office of Ass't Adm'r for Environmental Modification, *Summary Report: Weather Modification; Fiscal Years 1969, 1970, 1971* (1973).

Mankind also has been inadvertently changing the weather. Stanley Changnon⁵ discusses atmospheric alterations from manmade biospheric changes.⁶ Through polluting the air we have unwittingly altered the weather in many areas of the globe. It is clear from Changnon's chapter that inadvertent weather modification must be studied along with intended changes in the weather.

People react differently to the weather. Rudyard Kipling expressed this notion with his famous limerick:

There once was a boy in Quebec,
Who was buried in snow to his neck,
When asked, "Are you friz?"
He replied, "Yes, I is.
But we don't call this cold in Quebec."⁷

There are also varied societal responses to man-caused changes in the weather. Dr. Sewell's book is primarily a social assessment of such human weather management. It consists of contributions by natural and social scientists on the economics, sociology, ecology, and politics of weather modification.

The general tone of the chapter on the economics of weather modification is "more than slightly negative."⁸ Dr. James Crutchfield,⁹ who wrote the chapter, sees a tendency among proponents of weather modification to overestimate benefits and underestimate costs. He asserts that the costs of weather control that have usually been reported involve only the direct costs of providing seeding materials and delivery systems. That kind of accounting, according to Crutchfield, looks only at the "visible tip of an impressively large iceberg."¹⁰

In consideration of whether precipitation enhancement is really

Progress in weather alteration knowledge and skills can be traced by examination of the technology assessment reports made by several government groups. Panel on Weather and Climate Modification, *Weather and Climate Modifications: Problems and Progress* (Rep. to Nat'l Academy of Sciences, 1973); Comm. on Atmospheric Sciences, *The Atmospheric Sciences and Man's Needs: Priorities for the Future* (Rep. to Nat'l Academy of Sciences, 1971); Special Comm'n on Weather Modification, *Weather and Climate Modification* (Rep. to Nat'l Science Foundation, 1966); Panel on Weather and Climate Modification, *Weather and Climate Modification: Problems and Prospects* (Rep. to Nat'l Academy of Sciences, 1966); D. Gilman, J. Hibbs & P. Laskin, *Weather and Climate Modification* (Rep. to the Chief, U.S. Weather Bureau, 1965); Advisory Comm. on Weather Control, *Final Report* (1957).

5. Head of the Atmospheric Sciences Section, Illinois State Water Survey and Director of Project Metromex.

6. *Modifying the Weather* at 135-84.

7. *Lots of Limericks* 31 (L. Untermeyer ed. 1961).

8. *Modifying the Weather* at 221.

9. Professor of Economics and Public Affairs, Univ. of Wash.

10. *Modifying the Weather* at 196.

worth it, Professor Crutchfield asserts that there must be analysis of regional and national, as well as local, impact; that overhead costs and external costs which result in income redistribution should be taken into account; that planners should look to the costs and benefits from alternative means of dealing with water problems; and that there at least should be an effort in the direction of providing for cost reimbursement to the government by those persons who benefit from the atmospheric water harvest. To do less would be to replicate the errors and inadequacies of much governmental resource development accounting in the past. There is, or at least should be, a chance to do a better job in economic analysis of atmospheric water resources development projects.¹¹

Two of the participants in the Symposium on Human Interactions With the Atmosphere, Mary Barker and Ian Burton,¹² pursue the question of potential contributions of behavioral research to the management of atmospheric resources. They make the point that the benefits from cloud seeding depend upon both the physical results of artificial precipitation and on human perception of those results.¹³ They urge that research be conducted on both long-term and short-term responses to atmospheric change,¹⁴ on attitudes about man-made as contrasted with natural weather, and on whether responses differ between inadvertent and intentional alteration of the atmosphere. There should be an inquiry into how people respond to information about weather modification; if individuals and groups do respond differently, then these differences have major implications for policy formulation and implementation.¹⁵

A group of behavioral scientists at the University of Colorado are to some extent doing what Barker and Burton recommend. Working under the leadership of Dr. Eugene Haas they have examined and reported on attitudes about weather modification in a number of different parts of the nation.¹⁶ In spite of such work the Barker and

11. Two of the best analyses done thus far concern rainmaking in Illinois and snowpack augmentation in Colorado. Huff & Changnon, *Evaluation of Potential Effects of Weather Modification on Agriculture in Illinois*, 11 *J. Applied Meteorology* 376 (1972); L. Weisecker, *Technology Assessment of Winter Orographic Snowpack Augmentation in the Upper Colorado River Basin* (Rep. to Stanford Research Institute 1971).

12. Both are geography professors, Barker at Simon Frasier Univ. and Burton at the Univ. of Toronto.

13. *Modifying the Weather* at 234-35.

14. *Id.* at 248.

15. *Id.* at 253.

16. For some of the reports of this group, see J. Haas, *Social Implications of the National Hail Research Experiment* (1974); Haas, *Social Aspects of Weather Modification*, 54 *Bull. Am. Meteorology Soc'y* 647 (1973); Haas, *The Many Views of Planned Weather Modification* (paper prepared for Third Nat'l Conf. on Weather Modification, 1972); Haas, *Response*

Burton thesis that more sociological research needs to be done is essentially accurate. So also is another of their recommendations: the findings from behavioral studies should be incorporated within the decision framework through cooperation between social and natural science researchers, planners, and managers. Until now attitudes about weather modification have surfaced only when special interest groups have become involved in promoting legislation¹⁷ or adjudication.¹⁸

Because weather modification activities are intended to affect the environment, cloud seeding has given rise to environmental concerns. Large concentrations of silver iodide and some other chemicals used as seeding agents can be harmful to biota, precipitation alteration may change the composition of plant and animal communities, and putting seeding and monitoring equipment in wilderness areas involves a human intrusion upon their pristine character. In response to such concerns the Bureau of Reclamation in the late 1960's commissioned a group at the University of Michigan led by Dr. Charles Cooper to consider and report on the ecological effects of weather modification. Their report¹⁹ is the starting point from which current inquiries about ecology and weather modification begin. Dr. Sewell was fortunate in getting Cooper to participate in his symposium and book.

According to Dr. Cooper the ecological ramifications of weather modification are difficult to assess. The first problem is the close correlation between temperature and precipitation in natural weather change. Artificial weather change has little impact on temperature. Therefore existing agronomic and ecological studies of weather change have considered a different set of variables than weather modification presents. Seeding strategy poses another problem. Weather engineers can seek to change the timing and intensity of

to *Planned Weather Modification: Implications for Urban Resource Management*, in 1970 Western Resources Conf. 251.

17. Opponents of weather control lobbied for adoption of the present restrictive legislation in Pennsylvania and West Virginia. Pa. Stat. Ann. tit. 3, §§ 1101-1118 (Supp. 1973); W. Va. Code Ann. §§ 29-2B-1 to -15 (Supp. 1973). The opponents succeeded for a while in barring all weather modification in Maryland. Md. Ann. Code art. 66C, § 110A (1970). The ban expired in September 1971.

18. Among the recent cases which have been launched by the opposition to cloud seeding are *Montana Wilderness Ass'n v. Hodel*, 380 F. Supp. 879 (D. Mont. 1974); *Atmospherics, Inc. v. Ten Eyck*, Civil No. 4569 (Alamosa County Ct., Colo., filed April 4, 1973); *Shawcroft v. Dep't Natural Resources*, Civil No. 4480 (Alamosa County Ct., Colo., filed Sept. 20, 1972); *Farmers & Ranchers for Natural Weather v. Atmospherics, Inc.*, No. 7594 (Lamb County Ct., Tex., filed May 3, 1974); *In re Complaint of Bosco* (Colo. Dep't Natural Resources, April 22, 1974).

19. C. Cooper & W. Jolly, *Ecological Effects of Weather Modification: A Problem Analysis* (Rep. to Bureau of Reclamation, May 1969).

precipitation as well as its amount and location. Earlier studies have only considered the latter two variables. And there are problems of interpretation of data. Until relatively recently ecologists dealt with environmental responses of individual organisms or populations of a single species. It is difficult to use such data when considering the response of whole ecosystems to weather control. Also it must be realized that ecosystems are dynamic rather than static. It will not be obvious whether observed ecological changes are the result of weather modification activities or are due to natural variation.²⁰ The possible contribution of inadvertent weather modification adds another complication in interpretation of data.

In spite of these problems Cooper gives a fairly optimistic reading to existing ecological studies which can be related to weather modification. He sees little danger from hail or lightning suppression—unless they do affect precipitation. Local fog modification seems to have little ecological consequence.²¹ On the other hand precipitation management poses important ecological questions²² and alteration of tropical storms could bring many important side effects.²³ Wide dispersion of cloud seeding activities, dilution of seeding agents to insignificant concentrations, and inability of weather modifiers to produce precipitation changes outside the range of normal variation all account for much of the optimism about environmental impact of weather modification expressed among members of the cloud seeding profession.²⁴ On the last point, however, Dr. Cooper warns that if continued cloud seeding changes rainfall and snowfall averages, plant and animal communities must eventually adjust to the new average conditions.²⁵ He also sounds the call for both ecological and multi-disciplinary studies about weather modification. There is a pressing need for more information.²⁶

Matthew Holden²⁷ contributed a chapter on politics and weather modification to *Modifying the Weather: A Social Assessment*. His

20. *Modifying the Weather* at 100-03.

21. *Id.* at 120-21.

22. *Id.* at 108-18.

23. *Id.* at 123-24.

24. Dilution of silver iodide is the basis on which one author pegs his optimistic assessment of the environmental impact of seeding. See Kahan, *Weather Modification Effects on Man's Environment*, 1967 Western Resources Conference 81, 84-86.

25. *Modifying the Weather* at 105-06.

26. Montana State University has for several seasons conducted field research to ascertain the ecological impact of increasing snow depth and of increasing summer rains. These studies show that there clearly is an ecological consequences from deepening snow. The area involved, however, is relatively small. Interview with Dr. Don Collins at China Lake, Cal., Mar. 27, 1974.

27. Professor of Political Science, Univ. of Wis.

primary focus is upon federal institutional arrangements in the field of weather modification and the political factors that shaped them. Congress, pushed by members from arid states, appropriated nearly \$100 million for weather modification between 1961 and 1972.²⁸ This money has been divided among at least seven agencies with the Departments of Commerce, Defense, and Interior getting the largest slices. The National Science Foundation has also had a key role. These agencies have struggled among themselves for fiscal and regulatory primacy in the field of weather control. The Weather Bureau, now the National Weather Service, initially assumed a position adverse to cloud seeding. During the 1960's, however, its parent, the Department of Commerce, struggled mightily with the Department of Interior over which organization would be the federal "lead agency." During that time the National Science Foundation was given a regulatory role by virtue of legislation which designated it as the organization authorized to collect reports from cloud seeders.²⁹ Now the Department of Commerce has been given the power to require reporting³⁰ and the Department of Interior is active in pushing toward operational precipitation enhancement programs.³¹ The role of the Department of Defense has shrunk since the Viet Nam War when the Air Force used rainmaking as a weapon.³²

Appropriations and reporting legislation mark the present extent of enacted federal weather modification bills. There have, however, been enacted extensive weather control laws in many of the states.³³ Holden does not analyze the state and local political ramifications of weather modification. Neither does he explore the possibilities involved in application of general federal environmental legislation to

28. *Modifying the Weather* at 286.

29. Act of July 11, 1958, Pub. L. No. 85-510, § 14, 72 Stat. 353, repealed by Act of July 18, 1968, Pub. L. No. 90-407, § 11, 82 Stat. 360.

30. Act of Dec. 18, 1971, Pub. L. No. 92-205, § 6, 85 Stat. 736 (codified at 15 U.S.C. § § 330 to 330e (Supp. III, 1973)).

31. A current major thrust of the Interior program is the High Plains Cooperative Program which involves working with the states in resolving the scientific uncertainties involved in summer rainmaking. Miles City, Montana, Colby, Kansas and Big Springs, Texas are the three sites from which seeding will be conducted. News Release from the Dep't of Interior, May 9, 1974. See also Division of Atmospheric Water Resources Management, Proceedings: Skywater Conference VIII: Review of Conceptual Plan for a High Plains Cooperative Program (Rep. to Bureau of Reclamation, Mar. 1974).

32. Only recently has the Defense Department acknowledged the truth of previously circulated reports of such military weather modification. *Ariz. Daily Star*, May 19, 1974, at 2, col. 1. For analysis of the legal questions raised by use of weather modification as a weapon, see Davis, *Weather Warfare: Law and Policy*, 14 *Ariz. L. Rev.* 659 (1973).

33. The state laws are studied in Davis, *Weather Modification Law Developments*, 270 *Okla. L. Rev.* 409 (1974); Davis, *State Regulation of Weather Modification*, 12 *Ariz. L. Rev.* 35 (1970); R. Davis, *The Legal Implications of Atmospheric Water Resources Development and Management* §§ 11.1 to .7 (1968).

cover cloud seeding activities. These state and federal rules are involved in current and recent lawsuits which show how the governmental structure works with respect to cloud seeding and how various power groups interact.

The first of these cases, *Atmospherics, Inc. v. Ten Eyck*,³⁴ involved an unsuccessful effort by a rainmaker to obtain renewal of a permit to conduct cloud seeding in the San Luis Valley of Colorado. Barley growers, with the backing of the politically powerful brewer for whom their crops were earmarked, favored the seeding, but many farmers and ranchers in the valley opposed it. A question was placed on the ballot at the 1972 general election: "Do you favor weather modification?" The negative response of the voters was relied upon by the Department of Natural Resources hearing officer as one of the reasons for denying renewal of the permit. His use of the vote and interpretation of the Colorado law was upheld on appeal to the local district court.

In May 1974 a group known as Farmers and Ranchers for Natural Weather filed suit to enjoin weather alteration efforts in the area of Littlefield, Texas.³⁵ They are seeking to stop what they refer to as interference with natural precipitation. Texas has an extensive weather control law under which the project involved is being conducted.³⁶ Its effect and reach will be tested in this lawsuit.

In January 1974 the Montana Wilderness Society filed suit to stop cloud seeding under a federal contract in the Hungry Horse Reservoir area.³⁷ One of the allegations was that there had been inadequate compliance with the National Environmental Policy Act.³⁸ Similar lawsuits are likely to follow elsewhere in the country.

Until fairly recently most pre-assessments of federal actions have not included analysis of their potential environmental impacts. Now under NEPA there must be social and environmental assessments, as well as the traditional technical analyses. Section 102(2)A directs that, "to the fullest extent possible," federal agencies shall—

Utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment.³⁹

34. Civil No. 4569 (Alamosa County Ct., Colo., filed April 4, 1973).

35. *Farmers & Ranchers for Natural Weather v. Atmospherics, Inc.*, No. 7594 (Lamb County Ct., Tex., May 3, 1974).

36. Tex. Water Code Ann. §§ 14.001 to .112 (1972).

37. *Montana Wilderness Ass'n v. Hodel*, 380 F. Supp. 879 (D. Mont. 1974).

38. 42 U.S.C. §§ 4321-4347 (1970).

39. 42 U.S.C. § 4332(2)A (1970).

Natural and social scientists must be consulted in the early planning stages of federal projects and must participate in the process of reaching decisions about them. Accordingly, "program formulation will be directed by research results rather than . . . [research efforts being] designed to substantiate programs already decided upon."⁴⁰ This legally "mandated approach makes planning no longer the sole concern of the engineer and the cost analyst, and assures consideration of the relationships between man and his surroundings."⁴¹

The Act's major action-forcing provision, subsection C of section 102(2), requires filing of environmental impact statements, but it is applicable only to "major Federal actions significantly affecting the quality of the human environment."⁴² Subsection A is not limited to "major actions" but applies whenever federal plans and decisions "may have an impact on man's environment."⁴³ Multidisciplinary studies put agencies in a position to answer the threshold question whether the proposed action would necessitate prior filing of an impact statement. With information from them in hand agencies can either proceed with the impact statement process, or can prepare a written explanation of reasons why a filing is not necessary.⁴⁴

Derrick Sewell's *Modifying the Weather: A Social Assessment* is a general multidisciplinary study which can serve as the prototype of studies that must in the future precede federal weather modification projects. Although it breaks little new ground, it does point to those areas in which more social and behavioral research is needed and to the need for more ecological information. A theme running through it is the plea for accumulation of more information from the physical sciences about the results of weather management. That in turn could be the foundation for a better understanding of the non-meteorological ramifications of weather modification.

40. *Environmental Defense Fund v. Hardin*, 325 F. Supp. 1401, 1403 (D.D.C. 1971).

41. *Environmental Defense Fund v. Corps of Eng'rs*, 348 F. Supp. 916, 928 (N.D. Miss. 1972).

42. 42 U.S.C. § 4332(2)C (Supp. 1973). The major study of the action-forcing provisions of the Act is F. Anderson, *NEPA in the Courts: A Legal Analysis of the National Environmental Policy Act* (1973).

43. 42 U.S.C. § 4332(2)A (1970). See *Hanly v. Kleindienst*, 471 F.2d 823, 834 (2d Cir. 1972), *cert. denied*, 412 U.S. 908 (1973).

44. See *Arizona Pub. Ser. Co. v. Federal Power Comm'n*, 483 F.2d 1275 (9th Cir. 1973); *Scientists' Inst. for Pub. Information v. AEC*, 481 F.2d 1079 (D.C. Cir. 1973). For examples of techniques used to comply with the mandate of subsection A, see *Scenic Hudson Preservation Conference v. Federal Power Comm'n*, 453 F.2d 463, 481 (2d Cir. 1971), *cert. denied*, 407 U.S. 926 (1972) (public hearings); *Environmental Defense Fund v. Corps of Eng'rs*, 348 F. Supp. 916 (N.D. Miss. 1972) (use of available scientific data and literature); *Citizens for Reid State Park v. Laird*, 336 F. Supp. 783, 788 (S.D. Me. 1972) (consultation with other agencies); *Environmental Defense Fund v. Hardin*, 325 F. Supp. 1401, 1403 (D.D.C. 1971) (in-house research).

Lawyers in particular would do well to search out relevant physical and social information about weather control before seeking to understand the legal implications of cloud seeding. We have been trained to focus on issues that we have defined as narrowly as possible. Indeed Thomas Reed Powell has said: "If you think that you can think about a thing inextricably attached to something else without thinking of the thing which it is attached to, then you have a legal mind."^{4 5} Sewell shows us what we must do in one area to become more broadminded.

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45. M. Mayer, *The Lawyers* 86 (1967).

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