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FEDERAL ORGANIZATION FOR CONTROL OF WEATHER MODIFICATION*

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This article is designed to explore the optimal institutional structures that might be adopted by the federal government to manage weather modification. Should all federal weather modification activities be managed by a new department? Should these activities be carried out by one of the existing mission agencies, or by a new one? Should the various weather modification functions of research, operations, data collection, monitoring, coordination, comprehensive planning, project review, regulation, licensing, and indemnification all be carried by one federal agency, or should they be scattered among a variety of agencies? Should some be assigned to new entities not yet created?

These are some of the questions that will be explored. No attempt will be made to design the ultimate form of federal organization that might most effectively carry out these various functions. Rather an attempt will be made to analyze the effects that a variety of different institutional arrangements might have.

One threshold question is that of definition of the term "weather modification." Some activities clearly fall within the term, such as:

1. Cloud seeding from either air or ground generators or other devices for the purpose of increasing or decreasing precipitation over a given area. Also included would be the laying of a large area of asphalt to increase the absorption of solar energy in an attempt to stimulate cloud formation to increase rainfall.
2. Hail damage suppression through cloud seeding.
3. Lightning suppression through cloud seeding.
4. Fog removal at airports (either cold or warm fog).
5. Climate modification through cloud seeding or other intentional activities.
6. Hurricane modification through cloud seeding.
7. Reducing destructiveness of severe thunderstorms and tornadoes.

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The difficulty with the above list is that it tends to exclude certain activities that have similar effects, and, for a complete understanding of man's effect on the weather, possibly should be included. Some perplexing questions may be raised as to whether to include or exclude the inadvertent weather modifier such as a pulp mill or steel mill which in its normal operation may put wastes into the air that cause a seeding effect much like a ground generator, or the commercial jet airplane that creates a contrail and starts the formation of a widespread cloud layer which reduces solar energy reaching the ground. Other illustrations can be thought of, although they may not be as important, such as the farmer who puts out smudge pots to warm his orchard, or who uses lightning rods to reduce lightning strikes, or who plants a row of poplars to reduce the wind speed near his farm house.

Needless to say, the definition of weather modification must turn upon the purpose for which the definition is to be used. If the purpose is to control inadvertent modification as well as intentional modification then the definition should include both. To date the definitions used in various bills and proposals have not been consistent on this point.

The definition that appeared in S. 2916¹ (1966) was that "the term 'weather modification' includes any intentional or inadvertent artificially produced changes in the composition, behavior, or dynamics of the atmosphere." This definition is also found in a number of departmental and industry drafts.² This definition is explicit about the inclusion of inadvertent modification. However, the definition that appeared in S. 1182³ (1969) did not include inadvertent modification. The theoretical desirability of including inadvertent modification in the definition cannot be doubted. If the weather is inadvertently being modified we should know it, and be prepared to control the modification the same as we would intentional activities. The problem is a practical one. The task of reporting, monitoring, and managing intentional weather modification is feasible with a modest effort at the present time. But the task of reporting, monitor-

1. S. 2916, 89th Cong., 2d Sess. (1966). S. 2916 appeared in various forms during the 1966 session. One form, dated October 17, 1966 contained the above definition in Sec. 102(a). This definition did not appear in the earlier copies of the bill (May 12, 1966) and it is significant to notice its inclusion in the later editions.

2. See, *e.g.*, Sec. 102, of draft bill proposed by the Weather Modification Association. The same definition was also considered in a draft considered recently by the Interdepartmental Committee for Atmospheric Sciences

3. S. 1182, 91st Cong., 1st Sess. § 8 (Feb. 28, 1969). This definition seems uncertain concerning inadvertent modification, although if taken literally would seem to be broad enough to include such modification. Certainly inadvertent modification is "artificially produced."

ing, and managing all inadvertent modification is a much greater task, and will require a very great effort indeed. It is, possibly, more of an effort than the federal government is willing to undertake at present. Furthermore, to undertake this responsibility would require careful consideration of the roles and activities of the Federal Air Pollution Control Administration, which is engaged in a program that bears a direct relationship to the problem. For these reasons it may be well to keep in mind a flexible definition of weather modification for the present. The term may be defined differently under different circumstances. It may, for example, be desirable to consider both intentional and inadvertent modification in connection with regulation or indemnification; it may be desirable to consider both types of modification from time to time in connection with program planning.

Another threshold question is whether, in fact, the weather can be modified. The initial surge of enthusiasm of the early 1950's was followed by disillusionment and doubt in the late 1950's and early 1960's. Recently a new, albeit cautious, confidence has returned. The NAS and NSF reports of 1966 both attested that the weather was modifiable by man; a host of other scientists acting individually have come to similar conclusions. Very much, indeed, remains to be learned about the subject, but for the purpose of this article we need not know all the answers to all the questions. We need only know that the weather is now modifiable to some extent by man, and that in the not too distant future it will probably be significantly modifiable, if not entirely controllable.

At the same time we must be aware that, for the most part, weather modification in this country is still in the research and experimental stage and that although many non-federal privately financed programs have been conducted on an operational basis, no federal programs have yet reached that stage. The recommended federal institutional structure must therefore be designed to accommodate a continuing period of research and experiment as well as the management over time of those programs that gradually become operational. Considerable flexibility is required because different aspects of weather modification will phase from experiment to development to operation at different times.

Is federal management essential? Clearly so with reference to certain weather modification functions which will be explained later. Some activities clearly have effects beyond the local area, and even the state area, and thus must necessarily be managed at the federal level if they are to be effectively managed at all. Some cloud seeding for precipitation augmentation and for hail or lightning suppression

will have an interstate effect and thus must be managed or at least reviewed by the federal government. An analogy can be found in the water management field where some problems are handled locally, some at the state level, and others, such as the control of large interstate rivers, at the federal level.

Many questions concerning the proper place for management can only be answered after we have more knowledge. We still do not know, for example, the total geographic reach of the so-called small or medium size cloud seeding operation. All weather is so closely inter-related that a change at one location inevitably has effects at other locations. The question is, where does the outward reach of those effects become so small as to be inconsequential? Also some so-called "small" cloud seeding operations may have negligible effect at a given distance under certain circumstances, but have substantial effect under other circumstances. One theory suggests that certain projects, though small, may "trigger" consequences that reach far beyond the local area.⁴ If this is true then federal management or review will certainly be appropriate for such projects. In fact if it is found that such "triggering" is possible, then it may be necessary to bring all weather modification under federal management to assure that only "desirable" triggering occurs. There is also the possibility that the combined effects of many small projects may cause substantial consequences beyond the immediate locale of the projects and that some overall federal management may be essential.

These organizational questions cannot yet be answered because we do not know enough about weather modification to understand fully the consequences of our efforts. As this knowledge is acquired we should be able to develop appropriate organizational patterns. In the meantime we should keep our management system as flexible as circumstances will permit.

In order to consider where control of weather modification should rest it is essential to break this activity down into separate functions. For purposes of this article ten of these functions have been identified as follows: data collection, research, monitoring, operations, coordination, comprehensive planning, project review, regulation, licensing, and indemnification. Because this classification is used throughout, each function must be described briefly.

4. See testimony of Dr. Walter O. Roberts, Director, National Center for Atmospheric Research in *Hearing on S.2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess. at 363 (1966). "On the other hand, it may be that through the release of this rainfall in the atmosphere at the right time, at the right place, by perhaps cloud seeding over the Gulf of Mexico, we may have a bigger effect ultimately on the water resources available to the Great Plains even though not one drop from the seeded clouds falls from the process of seeding and the effect of this occurrence is an indirect effect."

1. *Data collection.* In order to manage, coordinate, and plan for weather modification it is essential that some central information bank be created to gather and classify data on all weather modification activities throughout the nation. It should also gather data from outside the country. The data will be vital for research and experimentation; for example, those conducting research will have to know who is modifying what weather or they may interfere with each other's activities. It seems unlikely that such data gathering can be done properly at the state level. Experience has shown that: (a) some states will not take the trouble to collect and organize the information, (b) those states that do collect it will not have it in any standardized form, thus making it difficult if not impossible to use, and (c) no single state will have the data on weather modification activities that are interstate or international in their effect.

The precise information to be gathered will vary under different circumstances; however, it is important to know: (a) what modification is planned, (b) data concerning the effect the modification attempt actually had on the weather so far as that can be ascertained and (c) methods used and other research information.

2. *Research.* This function can be carried on at all levels of government as well as in the private and semipublic sector. However, certain research activities must necessarily be under surveillance, if not actual control, by the federal government for a number of reasons. For example, the project might have an effect on large areas of the nation. Such projects might involve attempts to affect hurricanes, or to affect the climate of regions. Also, whenever the research will have an effect beyond the borders of a single state, some federal interest would be involved, unless an interstate agreement had been consummated by the affected states. If the experiment will have an impact on federal lands or installations, then the federal government should be involved. If the experiment has any potential international implications either on the high seas or on some other land area, then the federal government must necessarily be interested in overseeing it.

3. *Monitoring.* This label actually covers two functions: policing and primary data gathering. The first, policing, is closely allied to that of data gathering. Data gathering would result from the sending of data by various modifiers to a central data collection agency. Policing would go one step further and would assure that the planned modification was in fact carried out in the manner indicated. Presumably, with the general growth of weather modification there will be an increase in the numbers of operators with an increase in po-

tential conflicts, both between modifiers and between those clients or members of the public who want one kind of weather and those who want another. It seems likely that some type of monitoring system will be required to assure that standards of operation are met and that planned modification, once approved by the appropriate government agency, is carried out in the manner approved.

A second aspect of monitoring concerns primary data gathering in connection with inadvertent modification. An analogy can be made to stream gauging in the water management field. If one wishes to know whether more or less water is in a stream now than twenty years ago, or whether the water is more or less polluted than 20 years ago, he must have records of the amount and quality of water for the previous period. The same is true for weather modification. We need to monitor the weather to find out what effect man is having on it.⁵ The weather bureau has observed and kept records on the weather for years, and these records would be helpful. Also, the Air Pollution Control Administration is now gathering, on a modest scale, data on the quality of air in various places in the nation. However, certain other types of data must now be gathered in order to ascertain man's effect on the weather.

There is no apparent agreement in the scientific community about exactly what data on inadvertent modification ought to be gathered. There is however, agreement that a closer examination should be made of the additional information that would be useful. Very possibly the monitoring should note the amount of condensation and ice nuclei as well as the concentrations of certain gaseous and particulate pollutants in the atmosphere so that we might have some means of telling what levels are being added either through intentional or inadvertent modification.⁶

There is little doubt that such monitoring would have to be undertaken by a federal agency. To be useful, the information would have to be standardized, and the location of the monitoring stations would have to be carefully selected throughout the entire nation. One obvious possibility for the monitoring function is the Weather Bureau. Selected existing stations might begin to collect certain additional data.

4. *Operations.* This function can be carried on at all levels of the public and private sectors. There seems to be no reason why a variety of weather modification operational activities cannot be car-

5. Such monitoring was recommended in the "Newell" report, H. Newell, A Recommended National Program in Weather Modification, 10a Interdepartmental Committee for Atmospheric Sciences, at 21, 25 (1966).

6. *Id.* at 21. A comment on the ESSA Benchmark Program.

ried on outside the federal government. On the other hand, some operations would most appropriately be handled by federal agencies.

Operational activities that might desirably be carried on by federal agencies include lightning suppression over national forest or grazing lands, precipitation augmentation or storm control over federal lands or areas where the added water would flow into federally operated reservoirs, weather modification in furtherance of U.S. defense programs, and modification efforts that have an impact in more than one state. Within the next five years or so probably two important operational programs that may be carried on by federal agencies are the lightning suppression program of the Department of Agriculture, over national forest lands, and the precipitation augmentation program of the Department of the Interior over the Southwestern United States.

5. *Coordination.* Coordination, for purposes of this analysis, is effected by voluntary exchanges of information and cooperation rather than by outright control by a single government agency. Project review, discussed later, endows some agency with authority to require compliance with an overall plan and national objectives.

The coordination function is one that will need to apply to all levels of weather modification activity, private as well as public. Certainly it will be essential for all experimenters and operators in a given area to coordinate their activities so that they do not interfere with each other. Some of this coordination will occur naturally and informally. However, as more modifiers enter the scene some organized method of coordination will be required. Such institutional coordination can be located at the local, state or federal level, or even in some nongovernmental entity. As projects become more numerous and larger, and as more federal agencies become involved, there will be an increasing need for some federal institutional means of coordination.

To date, coordination among federal agencies has been performed largely by the Interdepartmental Committee for Atmospheric Science (ICAS)⁷ with an assist from the annual Inter-Agency Conference on Weather Modification formerly sponsored by NSF,⁸ now sponsored by ICAS.

6. *Project Review.* This function must be compared to comprehensive planning. If a new department of weather modification were created, comprehensive planning might be accomplished by such a

7. For a description of this coordination see S. Rep. No. 1139, 89th Cong., 2d Sess. 65-70 (1966).

8. *Id.*

department; however, in view of the diversity of goals for which weather might be modified, such an organizational centralization seems unlikely. If weather modification is carried on by a variety of departments, as it is now and as it probably will continue to be, then planning will probably occur to some extent in each of these departments. Nonetheless, some kind of review of departmental projects seems desirable, if not essential, to assure that institutional enthusiasm remains consistent with the best interests of the nation. The project review function is not now performed in the weather modification field, except through the standard review processes of the Bureau of the Budget and of Congress.

Project review as used here means some kind of outside, non-mission-oriented departmental review of projects, both experimental and operational, to determine if they are in the best interests of the nation and are the most efficient means of achieving the goals sought. Ideally, this review might best be effected by an entity separate from the mission-oriented operating agency which carries out the project. Such an entity could have the political as well as legal power to require changes in the project, or even its cancellation. Such a review entity was recommended for the water management field in the 1949 Hoover Commission Report,⁹ the 1955 Hoover Commission Report,¹⁰ the 1950 Cooke Commission Report¹¹ and by numerous political analysts. The same arguments that favor a review board for water management speak for one here.

Project review for the federal agencies must of necessity occur at the federal level. Also, if state sponsored or operated projects are to be reviewed, the review would probably have to occur at the federal level, although it might be possible in some states to obtain an effective review at the state level, either through another state agency or through a private research organization.

7. *Regulation.* This function is well known and is the standard function performed by a host of federal agencies at present, for example, the FCC,¹² ICC,¹³ and CAB.¹⁴ As more weather modification occurs, the need for regulation will increase. In particular, standards

9. Task Force on Natural Resources, Report [Appendix L] prepared for the Commission on Organization of the Executive Branch of the Government, at 6, 7 (1949).

10. Task Force on Water Resources and Power, Report Prepared for the Commission Organization of the Executive Branch of the Government, at 77 (June, 1955).

11. The President's Water Resources Policy Commission, *A Water Policy for the American People* 49 (1950).

12. 48 Stat. 1064 (1934), 47 U.S.C. § 151 (1964).

13. 24 Stat. 379 (1887), 49 U.S.C. § 1 (1964).

14. 52 Stat. 984 (1938), 49 U.S.C. § 1324 (1964).

of operation will be needed, for example, to assure quality performance of cloud seeding, especially where larger operations are involved, or where any interstate or specific federal interests are involved. If a regulatory system is created, the coordination function among non-federal entities would probably occur through that system. Regulation of the federal agencies would also be possible through an independent federal regulatory agency. However, whether such regulation would be politically possible is an open question. The analogy of the water management field suggests this might not be easy, although the possibility should certainly be considered. Similarly the project review function, even for the federal agencies, could occur through a regulatory agency and should be considered as one possible institutional arrangement.

A regulatory agency might also perform the monitoring function assuring that standards of operations were being met by both intentional and inadvertent weather modifiers. The licensing function would also be a natural function for such an agency.

Regulation of weather modification now occurs in a number of states through a variety of state agencies. It is conceivable that for those operations having a limited geographic effect, regulation at the state level could continue. It seems likely, however, that as weather modification becomes more widespread the overall effect of a multitude of small operations might be so pervasive as to require a single federal management system. Those projects, of course, having an interstate or international effect must be regulated at the federal level.

8. *Comprehensive planning.* Some federal agency might be assigned the responsibility for preparing and maintaining a comprehensive plan of weather modification, identifying national goals and methods for achieving them. Of course the Office of the President, and the Congress perform this task regularly in many areas. They are often assisted by such outside entities as the National Academy of Sciences and the National Academy of Engineering. Also assisting are various ad hoc commissions, such as the 1953 Advisory Committee on Weather Control¹⁵ and the more recent Special Commission on Weather Modification appointed by the National Science Foundation.¹⁶ The President might, by executive

15. This Commission was created by the Act of Aug. 13, 1953, ch. 426, 67 Stat. 559.

16. Dr. A. B. Chamberlain, Colorado State University, Chairman of this Commission, reported on its mandate and recommendation in *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess., at 94-107 (March 21-23, 1966).

order, assign the responsibility for such comprehensive planning to the Office of Science and Technology as he has done with other new technologies. Alternatively, Congress might assign the responsibility by statute (as prepared in S. 2916) which would have placed it in the Office of the President. Such an assignment might occur with the implied understanding that the planning would actually be carried out by the Office of Science and Technology, probably through ICAS, with an assist by the Department of Commerce. Senate Bill 2875 was more limited in scope, being concerned only with the atmospheric water resources;¹⁷ comprehensive planning for this activity would have been assigned to the Secretary of the Interior.

9. *Licensing.* As more operators come into the field this function will become essential to assure that operators are competent to perform as weather modifiers. Similar licensing functions are performed by numerous other federal, state and local agencies, and even by non-governmental entities, such as bar and medical associations. So long as the weather modifier is operating on a limited scale and performs no act that has an interstate or international effect there may be no need for federal licensing. However, as weather modification becomes more widespread it seems likely that the desirability of a federal licensing system will increase. Not only might it be desirable to assure standards of competency for interstate and international operators, but it may also be desirable to assure that incompetent operators do not cause harm in those states that fail to design adequate licensing systems.

10. *Indemnification.* This function concerns the indemnification of persons harmed by weather modification activities, both for the protection of those harmed, and to encourage research. To what extent should this responsibility be carried by the federal government and to what extent by private insurance carriers, state and local governments and others? Should the federal government attempt to regulate the indemnification activities of non-federal modifiers in the field? Senate Bill 2875 would have adopted the approach of the Atomic Energy Act of 1946 as amended in 1954;¹⁸ S. 2916 would have studied the question and reported on it at a later time to Congress.¹⁹

17. Under a broad interpretation of section 202 of S. 2875, 89th Cong., 2d Sess. (1966) one might argue that virtually all weather modification could come under the control of the Secretary of the Interior. Such interpretation is discussed more fully later.

18. S. 2875, 89th Cong., 2d Sess. § 201 (1966).

19. See Section 304 (a), S. 2916, 89th Cong., 2d Sess. (1966).

I

ORGANIZATION OF THE WEATHER MODIFICATION EFFORT

Although weather modification is a new technology, it does not pose any truly novel problems of governmental organization. Because it is not yet fully institutionalized, it provides an opportunity for applying our best wisdom to its management. In recent years much thought has been given to governmental organization in water management, a field that has many similarities to weather modification.

One critical threshold question is whether this activity is important enough to be an "organizing" idea for the structuring of government. That is, is it important enough to justify creation of a department or special agency for the explicit purpose of carrying out weather modification?²⁰ It should be remembered in this connection that the basic problems to be solved are not weather modification problems, but problems of agricultural production, forest protection, airport safety, and quality of environment. It should also be remembered that weather modification is merely one of a variety of means of achieving these diverse ends. Weather modification has little value except as it is designed to achieve one or more of these broader goals.

An analogy can be seen in the water management field where some years ago it was thought that those federal agencies that carried water resources responsibilities should surrender them to a new agency that would encompass all such activities. Professor Fesler criticized this view²¹ however, saying that there was no agreement on the problem to be solved by such an administrative water resources organization. Fesler argued that inasmuch as administrative organizations are designed to solve human problems, not merely to regulate resources, it would be exceedingly difficult to organize a government around water. Fesler pursued the water example by observing that those who analyzed the question further usually realized that although water is valuable in the channel where it flows, much of its value exists only in relation to the land on which it is used. This fact requires a shift in the organizing idea from water to natural resources. (Other analysts of government have shifted away from water to the drainage basin as an organizing idea.²²) Carrying

20. A multiagency approach was recommended in S. Rep. No. 1725, 89th Cong., 2d Sess., at 8 (1966).

21. J. Fesler, *National Water Resources Administration*, in *Economics and Public Policy in Water Resource Development 368* (S. Smith & E. Castle eds., Iowa State University Press, 1966).

22. *Supra*, note 11.

this analysis a step further, Fesler argued that natural resources have, in the past, been used as one means of bringing about economic development, and that possibly the organizing idea should be shifted more in this direction. In recent years man's use of natural resources seems to be shifting again as he becomes more interested in the quality of his environment. Economic development and environmental quality are now sometimes competitors for the central role in the use of these resources.

One of the major constraints that must be dealt with in any such analysis is the fact that a well-established government system already exists. This system is built around organizing ideas deemed important at some earlier time. Thus we have Departments of Agriculture, Commerce, Interior, Defense and others and subdepartments within those organizations. It is true that our notions of organizing ideas have changed from time to time over the years (see creation of ESSA). However, they do not change easily and will undoubtedly persist unless compelling reasons for change can be advanced.

It is also appropriate to note explicitly that weather modification is a new technology that does not serve merely one purpose, but rather a whole range of purposes. It can be used in theory, for example, to augment or reduce rainfall, to clear fog from airports, to reduce hailstorms, to reduce lightning and possibly to make climatic changes over a whole region. The principal similarity between these different activities is the technology involved, and even this can vary substantially. Certainly, the same human goals are not served by all these different activities. One question that ought to be answered is whether goals are already being served by existing agencies of government, and whether the particular weather modification activity should be located in those existing agencies as merely another means of achieving those goals.

II

THE ALTERNATIVES CONCEPT

Identification of goals is vital to analysis of federal organization for management of weather modification. Not many years ago national policy concerning natural resources was concerned primarily with the most economic means for their development. However,

events of the recent past reveal that social objectives considered desirable by society have been significantly broadened, and that certain objectives desired by society may not be consistent with the most economically profitable use of resources. The public interest in recrea-

tion, quality of environment, and esthetics implies a willingness to forego opportunity or to spend money in a way that does not necessarily yield the highest benefit-cost ratio as we are now able to compute it: the public is willing to pay for intangibles.²³

One of the factors that makes the question of government organization for weather modification complex is the fact that it serves many goals, including esthetics and quality of environment.

As a general approach to governmental organization for the accomplishment of a given goal, responsibility assigned should encourage consideration of the broadest range of possible approaches to the problem.²⁴ If, for example, the goal is the economic production of food, then ideally the government agency charged with responsibility for that activity would have jurisdiction over food production from: (a) irrigated agriculture in the Southwestern U.S., (b) non-irrigated agriculture from the middle west or east, (c) hydroponics, (d) importation of food from other countries and (e) other food sources. Such an ideal organization can seldom exist, however, because a variety of other human goals constantly contend for priority and require that compromises be made. Thus the agencies actually created can seldom consider more than a limited number of possible approaches to their goal. The result is the mission-oriented agency, with its sometimes limited approach to the human goals it is meant to serve, and its sometimes overblown enthusiasm for its particular approaches. The Bureau of Reclamation was designed to aid in providing water for agriculture in the west. A variety of other goals might be articulated which the Bureau has attempted to serve, such as food production, employment, economic growth, and preservation of environmental quality. The Bureau has been distinctly limited, however, in the means available to it to achieve these goals, and it has often been accused of using something less than the most efficient means—because it used the means legally available.

Such problems of organization will never be susceptible of total solution because of the contending goals that must be considered in designing the framework of government. Nonetheless, recognition of this organizational problem may assist in designing the optimum

23. Comm. on Water Division of Earth Sciences of the National Academy of Sciences—National Research Council, *Alternatives in Water Management*, Pub. No. 1408, at 9 (1966). This report contains an excellent analysis of the problems of water management much of it highly relevant to an analysis of weather modification management.

24. *Id.*

form of governmental structure for management of weather modification and provide a basis for analysis in this study.

III

EXISTING INSTITUTIONAL STRUCTURE—HISTORY

Over 20 years ago, in 1946, Irving Langmuir, Vincent J. Schaefer and their associates proved that certain rain and fog clouds could be modified. Although legislation was introduced as early as 1948 concerning federal participation in weather modification, the disagreement within the scientific community concerning the feasibility of weather modification was so serious that no major federal program was practicable. In 1953 Congress enacted P.L. 83-256²⁵ creating the Advisory Committee on Weather Control, whose purpose was to conduct a complete study and evaluation of experiments in weather control. Following a modestly favorable report on the potentials of weather modification by the Commission in 1957, Congress enacted P.L. 85-510 under which the NSF was authorized and directed to:

. . . initiate and support a program of study, research and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and Congress thereon.²⁶

This appeared to be the first attempt at designing or encouraging the design of a federal program. Considerable disagreement has arisen over the intent of this legislation, specifically over whether NSF should have been more aggressive in moving from its historic research mission into a mission more concerned with operational engineering aspects of weather modification and with overall coordination of the efforts of other federal agencies.²⁷ In any event, NSF did not so conceive its function and only partially moved into these other activities.

Between 1958 and 1966 NSF gathered data on weather modification research and operations on a voluntary basis. Then in 1966 it issued regulations requiring advance notice of all weather modification. These regulations also required the maintenance of records, and the submission of reports from all commercial and private

25. Act of Aug. 13, 1953, Pub. L. No. 83-256, ch. 426, 67 Stat. 559.

26. Act of July 11, 1958, Pub. L. No. 85-510, 72 Stat. 353.

27. See the discussion in S. Rep. No. 1725, 89th Cong., 2d Sess. 4 (October 13, 1966).

weather modifiers. Such records were kept by NSF from 1958 to 1968 when Congress terminated this authority in the apparent expectation that it would be assigned to another agency during the same session. However, no authorizing law was enacted in 1968 locating this responsibility and the only agency now collecting data is NSF which has continued to obtain voluntary reports.

NSF also undertook a modest effort to coordinate the various federal programs by organizing an annual, two-day InterAgency Conference on Weather Modification. At these conferences scientists and others from the different departments get together to discuss their projects and exchange ideas and data.

NSF has, of course, continued its support of basic research in the field of weather modification as have a number of other federal departments and agencies. As early as 1947-1951 the three military departments jointly sponsored a variety of field experiments. The Department of Agriculture has supported Project Skyfire, a research effort into the possible reduction of lightning over national forest land. The Departments of Commerce, Navy and Air Force have supported Project Stormfury, designed to learn whether hurricanes can be modified. The Department of the Interior has been conducting research in precipitation augmentation in the Colorado River Basin and elsewhere in the western states. The only federal program which now appears to be preparing for operational activity, is the Department of the Interior pilot precipitation augmentation program for the Colorado River basin.

In 1966 all of these efforts cost the federal government the modest sum of about \$7 million,²⁸ and this figure has grown to only about \$11.3 million in 1969,²⁹ and \$11.8 million in 1970.

Coordination of weather modification among federal agencies has occurred to date largely through the Interdepartmental Committee for Atmospheric Sciences (ICAS), currently chaired by an Assistant Secretary of Commerce. ICAS is under the Federal Council for Science and Technology and is composed of representatives from all the federal departments and agencies involved in research, development and operations in weather modification. It is interesting that although ICAS is under the Federal Council of Science and Technology, and thus potentially wields a piece of the Executive Office's power to coordinate, it is chaired by an Assistant Secretary from the Department of Commerce, one of the operating departments in the

28. *Id.* at 5.

29. Interdepartmental Comm. for Atmospheric Sciences of the Federal Council for Science and Technology, *National Atmospheric Science Program—Fiscal Year 1970*, 13 Interdepartmental Comm. for Atmospheric Sciences, at 8 (January, 1969).

field. Apparently this coordination effort has been reasonably effective to date, possibly in part because of the modest and widely dispersed efforts of the various federal agencies in the field.

No federal institution is currently charged by Congress with the responsibility for preparing and keeping up to date a comprehensive national plan for weather modification. Within the Executive Department the President's Special Assistant for Science and Technology has by letter recently authorized and directed the Chairman of ICAS to design a national program in the field.³⁰ This effort is now under way. Outside the federal government the NAS is also working on recommendations toward a national program. Although it was initially thought that the NAS report might be forthcoming in September 1969, the forecast now seems to be that it might not be available until well into 1970.

Licensing of operators has been undertaken by a number of states but has not been attempted by any federal agency. No federal organization has yet become involved in regulation, monitoring or indemnification.

IV

PROPOSED FEDERAL INSTITUTIONAL STRUCTURES

A variety of proposals have been made for the institutional structure of the federal government to manage weather modification. Some of these have reached bill stage and some have even gone through committee hearings. Others have been, or still are being considered by different agencies of the federal government, or are being proposed by respected private individuals or organizations.

These proposals are analyzed here not to record their historical existence, but rather to demonstrate analytically several of the more plausible ways that the various weather modification functions can be grouped among existing and proposed federal agencies. They are important in this respect in that they were the most nearly "politically possible," and contain themes that will undoubtedly be given most serious consideration as this question arises again.

The first serious attempt at structuring the federal government for managing weather modification came in 1966. Two principal bills were introduced at that time, S. 2875 and S. 2916. Before commenting on these, however, it is appropriate to note briefly an earlier, and much more modest bill introduced in the Senate, S. 1020³¹. This bill directed the Secretary of the Interior, in coopera-

30. Interview with Mr. Myron Tribus, Assistant Secretary of Commerce and Chairman of Interdepartmental Committee for Atmospheric Sciences.

31. This bill is identical with S. 23, 89th Cong. 1st Sess. (1966).

tion with NSF, to initiate and carry out a program directed at increasing precipitation in water-short areas of the nation. The governors of the states affected were to have a power to veto any proposed program for their state. Studies and investigations of precipitation augmentation possibilities were to be made at not less than five different locations in the nation. The bill provided for a \$20 million authorization over an eight-year period from 1963 to 1971.

S. 1020 produced extensive hearings and was introduced again in 1966 as S. 23, at which time the Secretary of the Interior testified³² against it. He pointed out that it was identical to S. 1020, and that subsequent to its earlier introduction, the Department of the Interior had greatly expanded its atmospheric water resources program under the general authority of the reclamation laws. He added that Interior was doing this in close cooperation with NSF, and that it was operating under a budget of \$1,126,000 in 1965, \$2,980,000 in 1966, and planned \$3,000,000 for 1967. This was substantially more than the amounts envisioned in S. 23. Since the purposes of S. 23 had already been met within the existing law, there was no need for passage of a new one and the bill died.

S. 23 (and S. 1020) made only a partial attempt to handle the functions of research, operations and coordination, and made no attempt to handle the functions of data collection, monitoring, comprehensive planning, project review, regulation, licensing, or indemnification. These bills were designed simply to beef up the Bureau of Reclamation's research and operational program in precipitation augmentation, in cooperation with the ongoing research effort of NSF. These bills also would have explicitly removed any geographic limitation on the Bureau of Reclamation's operations, giving it authority to perform weather modification operations anywhere in the United States.³³

Senate Bills 2875 and 2916 were much more ambitious, calling for substantial assignments of various weather modification functions to some old and some newly created federal agencies. Senate Bill 2875 authorized and directed the Secretary of the Interior to formulate and carry out a comprehensive program of scientific and

32. *Hearings on S. 23 and S. 2916 Before the Senate Comm. on Commerce*, 89th Cong., 2d Sess., ser. 89-59, pt. 2, at 320 (April 1, 1966).

33. An opinion from the Office of the Solicitor, Department of the Interior of July 13, 1966 (G-66-1042.3) advised the Commissioner of Reclamation that there was authority under existing law to authorize the Secretary of the Interior to carry out an engineering and scientific research program in atmospheric water resources wherever necessary and advantageous throughout the United States. Reprinted in *Hearings on Progress in Weather Modification Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 90th Cong., 1st Sess. 4 (April 4, 1967).

engineering research, tests and operations for increasing the yield of water from atmospheric sources throughout the nation. In the conduct of this comprehensive program the advice and participation of other federal agencies would be required. A central scientific and engineering facility, and regional research and operations centers would be established. General contract and grant authority would be provided and the Secretary of the Interior would be required to make an annual status report on the program to Congress. Compensation for damages as well as licensing authority over all activities affecting U.S. atmospheric water resources would be provided in the same manner as in the Atomic Energy Act of August 30, 1954. The bill also provided that except for licensing authority the bill was not intended to give the Secretary of the Interior authority over research conducted by other federal agencies under other laws.

The bill was criticized by a number of other departments and agencies, the gist of the criticism being summed up in the comments on the bill by the Bureau of the Budget.³⁴ These comments indicated that there was a broad need for further research and development in the whole field of weather modification, and that research was now being conducted throughout the federal establishment by a variety of different agencies. It then criticized S. 2875 because the bill dealt with a multitude of problems by granting the Secretary of the Interior broad leadership responsibilities in the whole field in order to advance the nation's capability to use modification techniques in only one, albeit critical aspect of this field—precipitation augmentation.³⁵ The Bureau of the Budget argued that due to the breadth of national interest and federal effort in weather modification, it would appear unwise to subordinate all federal weather modification activities to the water resources problem.³⁶ In addition, the regulatory and indemnification matters dealt with in the bill were

34. *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Sen. Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess. 10-11 (1966).

35. Thus, in formulating and conducting a comprehensive program of research, experiments, test and operations to increase atmospheric water yield, the Secretary is authorized to sponsor, among other things, scientific analyses of cloud systems and general continental or hemispheric circulation; economic, legal and other research; and the training of scientists and engineers. Other federal agencies are directed to participate in the comprehensive program; any activities by these other agencies that might affect the program can be carried on only pursuant to license issued by the Secretary.

36. Further criticism was voiced by Dr. J. Herbert Hollomon, Assistant Secretary for Science's Technology, Department of Commerce, to the effect that Section 202 of S. 2875 might be construed as giving the Secretary of the Interior control over virtually all weather modification activity in the nation whether or not directly concerned with precipitation augmentation. See *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess. 69 (March 21-23, 1966).

said to be of great importance and complexity, and most of the issues involved should be thoroughly studied before comprehensive legislation is enacted.

The second major bill introduced in 1966 was S. 2916. The revised version of this bill that finally passed the Senate was called "The Weather Modification Act of 1966." It would have established the Department of Commerce as the leading federal agency on weather modification. Further, the major responsibility for a research and development program would be in the Secretary of Commerce. Each of the other agencies with missions that might be aided by weather modification was given responsibilities for research and development allied to those missions. The Secretary of Commerce was authorized to issue regulations governing research, development and operations of private business concerns that conflicted with federal research and development programs. The Secretary was to report within a year after passage of the Act on the need for additional legislation concerning regulation of weather modification.

The bill authorized the President to establish national goals for weather modification through the Office of Science and Technology. The Secretary of Commerce was authorized to engage in international activities but only with the prior approval of the Secretary of State. The bill required the President to inform specified congressional committees of any federal agency weather modification program that was intentionally designed to affect the atmosphere more than 150 miles from the source of such activity, and required any federal agency conducting *operational* weather modification activities to obtain prior approval of Congress unless already authorized (the FAA was so authorized by Sec. 201(e)(2) of the bill). It also authorized the Secretary to engage in a study program to determine the extent to which the U.S. should be liable for damages including indemnification of contractors and grantees. The Secretary was to report to Congress on this study within one year. Further, the Secretary of Commerce was instructed, in cooperation with other agency heads, to conduct studies and investigations on the social, economic, biological, and ecological effects, deliberate and inadvertent, of weather modification, and to report to Congress in two years.

The bill was criticized by the Secretary of the Interior's representative, among others, because it would have given substantial leadership in the field to the Department of Commerce in contrast to S. 2875 which would have put that leadership in the Department

of the Interior.³⁷ Others pointed out that the Department of Commerce's Weather Bureau, the principal focal point in Commerce's claim to weather modification, had in the past demonstrated a marked coolness toward the activity.³⁸ Secretary Udall argued that S. 2916 was really only a starting point and that definitive congressional action could only come after the studies envisioned in the bill were completed. He argued that the bill might be construed as a "blank check" for the Department of Commerce; that the President, rather than the Secretary of Commerce should be responsible for conducting studies and reporting to Congress on the need for further legislation; and that the bill should authorize all relevant agency heads, not only the Secretary of Commerce, to cooperate in appropriate international weather modification activities (with the approval of the Secretary of State). He also wanted to change the provision requiring Congressional approval before new agency programs could become operational and urged that this restriction might, if left in the bill, take too much time in the event of a drought, when cloud seeding might provide some relief. Instead, the President should establish regulations to be followed by all federal agencies in carrying out weather modification programs.³⁹

The National Science Foundation and others criticized the 150-mile provision arguing that it would, in effect, require a specific act of Congress approving the activity and that this would "seriously impede some of the best current research on large scale storm systems, as well as present efforts on hail suppression, lightning suppression and hurricane modification." Instead, NSF urged that prior reports of such activities be made to the President through the Office of Science and Technology for the President's approval.⁴⁰ The bill gained substantial support through compromises made during the 1966 session, but it passed the Senate a few days prior to adjournment and did not pass the House.

Senate Bill 2875 contained no explicit provision for handling

37. See statement of John A. Carver, Jr., Under Secretary of the Interior in *Hearings on S. 23 and S. 2916 Before the Senate Comm. on Commerce*, 89th Cong., 2d Sess., ser. 89-59, pt. 2, at 319-21 (1966).

38. See discussion between Senator Clinton P. Anderson, New Mexico and Dr. J. Hebert Hollomon, Assistant Secretary for Science and Technology, Department of Commerce in *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess. 73 (1966).

39. See letter of Stewart L. Udall, Secretary of the Interior in S. Rep. No. 1725, 89th Cong., 2d Sess. 16-20 (1966).

40. Letter of Leland J. Haworth, Director, National Science Foundation, in S. Rep. No. 1725, 89th Cong., 2d Sess. 24 (1966).

the data gathering function, although the authority granted to the Secretary of the Interior in Sec. 100 (to formulate and carry out a comprehensive program of research and operations regarding precipitation augmentation), in Sec. 101 (to require participation by other federal agencies working in the field) and in Sec. 202 (to license all operators in the field, federal, state, public and private) was broad enough to empower the Secretary to require full reporting both before and after any and all precipitation augmentation experiments and operations in the nation. Whether this function was being planned by the Secretary in the event of passage of S. 2875 was not clear from the Senate hearings on the bill, although some effort in this direction might be implied from the responsibility to issue licenses. Presumably no data gathering was envisioned for hail or lightning suppression or other weather modification activities not having to do with precipitation augmentation.

Also, S. 2916 does not explicitly mention data gathering but seems to grant ample authority to the Secretary of Commerce to carry out this function, both as to federal agencies and other public and private entities. Certainly if the President assigned the Secretary of Commerce the responsibility for preparing his annual report to Congress on all federal and non-federal weather modification, the Secretary would be expected to gather the relevant data to prepare such a report. Presumably the one-year study on the need for further regulation called for in Sec. 205(b) of the bill would also include the question of the need for further data gathering.⁴¹

The regulatory function was provided for to some degree in Sec. 205(a) of S. 2916 in that private weather modifiers could be regulated by the Secretary of Commerce when their operations might conflict with or impede federal programs. The bill also provided for a one-year study by the Secretary of Commerce of the need for additional regulatory power. Bill 2875 did not provide for any regulatory power, although Sec. 202 did require other agencies involved in precipitation augmentation to obtain first a license from the Secretary of the Interior. Conceivably, regulations might have issued to effectuate this power, in spite of the limitation in Sec. 204 of the bill that the Secretary of the Interior was not to have any authority or surveillance over other federal agencies.

41. The authority to gather data might also be derived from Sec. 101, an objective of the act being the "development of the necessary scientific basis," from § 201(a)(1) authorizing the Secretary of Commerce to "carry out a comprehensive program in the field of weather modification," from § 202(1) authorizing the Secretary to issue regulations pursuant thereto, and § 205(a) authorizing the Secretary to regulate private weather modifiers whose operations conflict with or impede federal agency programs.

Section 202 of S. 2875 would have given the Secretary of the Interior authority through the licensing power to control all "activities intended to affect, or determined by the Secretary to be likely to affect the atmospheric water resources of the U.S." Because of the atmospheric inter-relationship of all weather modification, this provision might have given the Secretary effective licensing authority over virtually all weather modification in the nation. One can even postulate that he might, through this clause, have jurisdiction over inadvertent weather modifiers, such as industries whose waste burning might inadvertently cause cloud seeding, and "affect the atmospheric water resources." Needless to say, this licensing authority is much broader than the mere authority to determine the professional credentials of the modifiers. It would seem to grant the power of review over every federal, state, local or private entity or person operating in the field. The review function aspects of this power will be taken up later. Suffice it to say that the Secretary of the Interior would, under this provision, have authority to establish a system for licensing all operators and for determining their professional credentials if he believed it wise to do so. Senate Bill 2916 made no explicit reference to licensing, although it did give the Secretary of Commerce sufficient power to undertake this responsibility as part of his regulatory function if he deemed it appropriate to do so.

Both bills left the research function in the various mission agencies concerned with the particular activity, although each provided for a focal point for research, in Interior or Commerce respectively. Especially S. 2875 would have put Interior in the central role regarding all precipitation augmentation research and any other research that might affect it. Since the same techniques are used for hail and lightning suppression and various other weather modification activities, this could have put Interior in the leading role in the whole research effort. Bill 2916 provided that each mission agency would continue research relevant to its mission, and directed the Secretary of Commerce only to coordinate these programs.

Senate Bill 2875 placed all authority for operational precipitation augmentation in the Secretary of the Interior (Secs. 100-05). Other weather modification operational programs were to be carried out by appropriate mission agencies. Bill 2916 authorized only the FAA to conduct operational weather modification at that time (Sec. 201(e)(2)). New operational programs would have to be approved by Congress.

The coordination provided for under S. 2875 affected only precipitation augmentation. The Secretary of the Interior would have

licensing power, and thus presumably some coordinating power, over all other federal agencies operating in this field. The bill did not provide specifically for coordination of research or operations of hail or lightning suppression or other types of weather modification, although some coordination would probably have resulted naturally from the leadership role given to Interior in precipitation augmentation and other activities affecting it. ICAS might well have continued to play a role here also, although probably a less important one. Bill 2916 provided more explicitly and broadly for coordination, placing this responsibility in the Office of the President. This would be done with the apparent understanding that the President would use the Federal Council for Science and Technology and the ICAS for coordinating research, and the Federal Coordinator for Meteorological Services and Supporting Research or some similar entity in Commerce for coordinating operational weather modification.⁴²

Senate Bill 2875 provided for the development of a comprehensive program by the Secretary of the Interior, but only regarding precipitation augmentation. All other programming for other types of weather modification and for other agencies was left to those other agencies. Of course, because of the importance and pervasiveness of precipitation augmentation, the development of a comprehensive program for that activity would be a significant move in the direction of programming for the entire field. It would, however, suffer the defect of starting from a single focal point rather than from an overview of the whole field.⁴³ Bill 2916 explicitly provided for comprehensive planning and establishment of goals for the entire weather modification field, placing this responsibility in the President. It would authorize him to consult with the NAS, National Academy of Engineers, and others on "scientific and technological developments and new opportunities for the beneficial application of weather modification."⁴⁴

International cooperation was not mentioned in S. 2875. This function would be left to the normal processes of government through the Department of State and the various mission agencies whenever their programs made such cooperation appropriate. Bill 2916 expressly authorized the Secretary of Commerce to "cooperate in any international activities relating to weather modification,"

42. See comments on proposed coordination in S. Rep. No. 1725, 89th Cong., 2d Sess. 9 (October 13, 1966).

43. See this criticism voiced in *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess., 7, 11 and 96 (March 21-23, 1966).

44. *Id.* at 301(5).

but only with the approval of the Secretary of State; any actual negotiations with foreign countries or agencies were to be carried on by the Secretary of State.⁴⁵ The Secretary of State was directed to appoint the Secretary of Commerce or his designee as a member of the delegation attending all international meetings or conferences relating to weather modification.

The indemnity function was provided for in S. 2875 by a brief but comprehensive provision stating that the U.S. would compensate for the taking of property or for other just claims arising out of execution of the comprehensive program. This would be done in the manner provided for in the Act of August 30, 1954, an Act to amend the Atomic Energy Act of 1946.⁴⁶ Bill 2916 used a more cautious approach, providing that the Secretary of Commerce should study the entire indemnification question for both the U.S. and private parties and report to Congress within a year.⁴⁷

Bill 2875 provided partially for the project review function by placing the Secretary of the Interior in a position to require other agencies participating in the comprehensive precipitation augmentation program to do so on the basis of agreements with him. It also gave the Secretary licensing power over both federal and non-federal entities engaged in weather modification activities "intended to affect, or determined by the Secretary to be likely to affect, the atmospheric water resources of the U.S."⁴⁸ This coverage is, of course, very broad and might have given the Secretary of the Interior licensing and thus reviewing authority over virtually all weather modification activities in the nation. This would be true whether or not they were directed specifically at precipitation augmentation, because the Secretary of the Interior might determine that they are "likely to affect the atmospheric water resources of the U.S." Criticism of this approach in recent years has been based on the notion that the reviewing function, to be effective, must not be performed by a mission agency that is itself operating and competing for projects and funds in the field. The review, it is said, should be conducted by some independent entity, such as the FPC, ICC or FCC.

45. See *Hearings on S. 2916 Before the Senate Comm. on Commerce*, 89th Cong., 2d Sess., ser. 89-59, pt. 2, § 302 (1966).

46. This approach was criticized on the ground that the indemnification issue was both important and complex and should be studied further before enactment of such comprehensive legislation. See *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs*, 89th Cong., 2d Sess. 11 (1966).

47. *Hearings on S. 2875*, *supra* note 42, at § 304 (a).

48. *Hearings on S. 2916*, *supra* note 44, at § 202.

Bill 2916 was not so explicit about the project review function. It placed general responsibility in the President for establishing goals, resolving priorities between different federal agencies, and coordinating federal programs. In many ways this was merely an explicit statement of the responsibilities already carried by the President in connection with all departments in the executive branch. The bill also provided for a one-year study of the need for further legislation including possible additional regulation. This study might well have included the question of the need for some kind of independent review board. Essentially, S. 2916 did not envisage a project review function other than that normally performed in the executive branch through the Office of Science and Technology and the Bureau of the Budget.

It will be seen from the above analysis that the approach of 2875 was designed to place the Department of the Interior in the lead position regarding weather modification, but on the basis of only one activity, precipitation augmentation, rather than on the basis of an overall weather modification program. This limitation on the Department of the Interior's authority applied to all other functions too, such as comprehensive planning, coordination, regulation, licensing and indemnification. The Secretary of the Interior could perform these functions only as they related to precipitation augmentation. Bill 2916 undertook to cover all weather modification activities, including precipitation augmentation, hail suppression, lightning suppression, fog removal, etc. It placed the Secretary of Commerce in a leading role in the field, although placing in the President the specific responsibility for coordination, comprehensive planning, and reporting to Congress. Coordination would probably have been effected by the ICAS of the Office of Science and Technology and by the Federal Coordinator in the Department of Commerce. Overall planning would probably have been effected by the Department of Commerce and the Office of Science and Technology. The general approach of the bill was considerably more cautious than S. 2875, providing for one- or two-year studies of the need for regulation in the field, the need for additional research facilities, the indemnification question, and the social, economic, biological and ecological effects of weather modification.

At least five different proposals have been made since 1966 that would change or affect the existing federal institutional structure for management of weather modification. One, H.R. 8977⁴⁹ would

49. H.R. 8977, 91st Cong., 1st Sess. (Mar. 13, 1969) (introduced by Mr. Staggers).

entirely prohibit intentional weather modification anywhere in the nation. It would not affect inadvertent weather modification.⁵⁰

A second proposal, S. 1182, the Weather Modification Commission Act of 1969,⁵¹ takes a study approach to the subject, recommending that a nine-member Commission be appointed by the President from the state and federal governments, universities, and private industry to study the need for regulation and coordination in the field, and the appropriate areas of responsibility for the federal agencies. It would specifically study the "development of an organization plan for a federally sponsored permanent commission designed to carry out a regulatory program consistent with the purposes of [the] Act."⁵² The Commission's report is to be transmitted to the President and Congress within two years after the Commission's first meeting.

This Bill caused concern among some government and other people in the field who feel that it would unnecessarily delay the development of weather modification. A number of studies have already been completed of the scientific, institutional and legal aspects of weather modification, and another study of these same issues would not necessarily add anything and might well delay action for another two years or more. There are, of course, aspects

50. This legislation apparently resulted from pressure from the Tri-State Natural Weather Association with membership or support claimed from a few people in Pennsylvania, West Virginia, Virginia, Maryland. The recent drought in this region has been attributed by the Association to weather modification, although both official and unofficial investigations reveal no weather modification in the area. Some of the people of the region are, however, convinced otherwise, as indicated by statements reported in the 1969 annual meeting of the Tri-State Association: ". . . since 1 Sept. 1968 there has been no federal law regulating or even recording cloud-seeding activities. . . . current seeding is the work of a vicious underground. . . . no rain has ever been 'made' by seeding—it has been moved around from here to there, and the results are floods here, drought there. . . . the record shows that 18 lbs. of (Portland Cement) will entirely dissipate a large storm in 8 minutes. The average time varies from one to 12 minutes and rain was stopped in all cases. Note that this data cannot be got from the USA experiments—here it is all kept secret." Mr. Hoke then referred to the 9th Annual Report, NSF, which states that ESSA is engaged in making cirrus clouds; jet aircraft produce contrails that spread into cirrus clouds which cover the sky. This action of jet planes can keep cumulus clouds from forming when they are not needed. "I . . . have seen this done over Baltimore day after day, 12 months of the year, for 3 years. . . . Four motor jets are used for this, and no one but the federal government would own a sufficient supply. Thus this is another example of a lie told by Wyckoff, when he says that the federal government is not seeding. Lies are a big problem in the capital. . . ." Minutes of 3rd annual meeting of the Tri-State Natural Weather Association, Inc., held at the Ranch, Lincoln Way East, Chambersburg, Pennsylvania, March 22, 1969.

51. S.1182, 91st Cong., 1st Sess. (Feb. 28, 1969) (introduced by Mr. Young of North Dakota).

52. *Id.* § 5(5).

of the problem that all agree need further study, but S. 1182 does not distinguish these and lumps everything together in the study responsibility for the new commission.

A third proposal, made by the Weather Modification Association, "Weather Modification Act of 1969,"⁵³ is one of the most comprehensive yet designed. It would create a weather modification commission "in order to provide for the general purpose of monitoring and regulation . . . of both federal and non-federal activities in the field of weather modification."⁵⁴ The Commission would be composed of five members, appointed by the President with the advice and consent of the Senate and would have authority to study and review all relevant data, enunciate national policies, develop a national organizational plan, and conduct whatever regulatory and monitoring functions are required.⁵⁵ The idea is apparently to develop regulations for those few aspects of weather modification that now justify regulation. The idea is also to design a national organizational plan for the future for those areas where greater organization and regulation may be required in coming years. Included in the proposed Commission's regulatory authority is an explicit power to set up a certification system to determine the qualifications of weather modifiers throughout the nation,⁵⁶ thus evidently taking this function away from the states that have already initiated such certification programs. The Commission would also promote the research and development programs of other agencies of federal and local government as well as weather modification interest and activity in universities and in private industry.

The proposal provides that the various federal departments and agencies now involved in weather modification, the Departments of Commerce, Interior, Agriculture, HEW, the FAA and NSF are all authorized to consider weather modification as an appropriate vehicle for carrying out their existing missions.⁵⁷ However, while each of these departments is authorized to carry out a weather modification program relating to its particular mission, the Secretary of Commerce is more specifically authorized to carry out a "comprehensive program in the field" to "include a specific program designed to control or modify tornadoes, hurricanes, or other severe storms."⁵⁸ This difference in authority is similar to that reflected in S. 2916 (1966) and would apparently put the Department of

53. Draft prepared by Weather Modification Association and circulated in 1969.

54. *Id.* § 201.

55. *Id.* § 203.

56. *Id.* § 204(e).

57. *Id.* § 301.

58. *Id.* § 301(b).

Commerce in somewhat of a lead position in the field, although with no authority over the activities of the other departments and agencies. Interestingly the Defense Department is not mentioned in the bill.⁵⁹

The Commission would make a report each year on its own activities as well as on the activities of the other federal agencies. It would study and report to Congress on the need for legislation in the area of international cooperation. In the meantime, each federal agency would be authorized to cooperate in international activities in the area related to their respective missions and with the approval of the Secretary of State.

The NSF would sponsor and convene an annual Interagency Conference on weather modification as it does now and make an annual report to Congress on the information elicited at the Conference.⁶⁰ Indemnity for the taking of property or rights or for other claims arising out of execution of the comprehensive weather modification program would be provided in the same way as in the Act of August 30, 1954, an Act to Amend the Atomic Energy Act of 1946.⁶¹

This bill would give the new Commission authority to carry out the data gathering and monitoring functions. Research and operations would be carried out by the various mission agencies in accordance with their missions. NSF would also be involved in appropriate basic research. The crucial functions of comprehensive planning, project review, coordination, regulation, and licensing, would all be carried out by the new Commission. The indemnification provision of the bill is the same as that in S. 2875 (1966).

Some criticism of this proposal has come from those who believe that, although such a new and independent regulatory agency may someday be appropriate, it is not yet time for its creation. It is appropriate to note also that this Commission would have full regulatory power over all the mission agencies in the weather modification field with the exception of the Defense Department. It should also be noted that the mission agencies have not in the past taken lightly the notion of such regulation. The Commission's authority would also include the reviewing of agency projects and programs. This particular idea has been suggested repeatedly in

59. The failure to include the Defense Department may result from the fact that the proposal purports to give very comprehensive control over all weather modification to the new Commission. Presumably the Defense Department would reject such comprehensive control and the enactment of the bill would be politically difficult if not impossible if they were opposed to it.

60. *Id.* § 401 (Weather Modification Association draft).

61. *Id.* § 403.

the water management field (*i.e.*, that some independent reviewing agency be created to review all agency projects and proposals) but has met with such vigorous opposition from water-oriented agencies and others that it has never been adopted. It seems questionable whether it would gather enough support to be adopted here.

The indemnification provision of this proposal is the same as that in S. 2875 (1966) and is therefore subject to the same criticism that it may be too comprehensive for the knowledge we now have available. In 1966 insufficient study had been given to the implications of such a provision to justify its adoption, and no study has been forthcoming in the intervening years; thus, it is said, the same criticism applies today.

The fourth 1969 proposal is still informal, but it is one that has the support of a number of individuals closely associated with weather modification in the federal government.⁶² It would be similar to S. 2916 in assigning relevant weather modification activities to the various mission agencies consistent with their ongoing programs, but placing in the Department of Commerce a leadership responsibility for carrying out a "comprehensive program" in weather modification.⁶³ The most significant innovation of this proposal would be the creation of a new weather modification panel within the Office of the President, responsible for "continuous coordination" in the field.⁶⁴ The membership of the panel would consist of representatives of each of the mission agencies involved in weather modification: Commerce, Defense, Interior, Agriculture, HEW, Transportation, NASA, and NSF; the chairman would be the Director of OST. The panel would be responsible for "review of weather modification activities" of the various agencies and departments and "for making recommendations to each department or agency for coordination or cooperative inter-agency programs that will avoid waste and duplication and will foster maximum productive efforts. . . ."⁶⁵ The panel chairman would have authority to call meetings whenever necessary to accomplish the work of the panel. In addition, the panel would sponsor and convene at least once annually an Interagency Conference on Weather Modification (until now sponsored and convened by NSF) at which each agency would present a comprehensive review of its program. The panel then would compile the information thus

62. Draft prepared by a "Select Panel" of the ICAS during summer of 1969. The author had the opportunity to speak with a number of these individuals recently in Washington, D.C.

63. *Id.* § 201.

64. *Id.* § 301.

65. *Id.* § 301(b).

presented into a report which the President would forward annually to Congress.⁶⁶

Each agency involved in weather modification would be authorized to cooperate in international activities relevant to its own program, but only with the approval of the Secretary of State.

The Secretary of Commerce would be authorized to promulgate regulations to maintain complete information on all weather modification in the nation, whether performed by public or private persons or entities.⁶⁷

Indemnity was provided for in a rather lengthy section authorizing each agency to enter into agreements of indemnification with contractors or grantees. These agreements would require appropriate financial protection to persons who might be injured or damaged, and would provide for "excess insurance" for losses greater than the required coverage.

Studies would be called for similar to those provided for in S. 2916 (1966). The Secretary of Commerce would study the need for further regulation and report to Congress within two years. NSF would study the social and economic effects of both deliberate and inadvertent weather modification and report to Congress within two years (in S. 2916 this study was to be done by Commerce). The Secretary of Agriculture would study the biological and ecological effects of weather modification and report to Congress within two years (in S. 2916 this study was to be done by Commerce).⁶⁸

This proposal would thus place the data gathering function in the Department of Commerce. Although the monitoring function is not explicitly provided for it would seem that the data gathering authority given the Department of Commerce is broad enough to include this. In any event the Secretary of Commerce through the Weather Bureau probably already has sufficient authority to set up a monitoring system throughout the nation. What is needed is not further legal authority but money to pay for performance of this function. Research and operations under this proposal would be carried on by the relevant mission agencies, with NSF carrying forward its role in basic research. Comprehensive planning is not specifically provided for and presumably would be expected to result naturally from the composite efforts of the mission agencies and the weather modification panel. This panel would be specifically charged with responsibility for coordination and project review. Although it would have no regulatory authority over other federal

66. *Id.* § 301(c).

67. *Id.* § 401.

68. *Id.* § 501.

agencies, its charge to make recommendations to each department or agency for coordinated or cooperative interagency programs, combined with the fact that its chairman would be from OST would give it considerable authority and weight in bringing about essential coordination.

The last of the 1969 proposals is now being considered by some ICAS members. It is a compromise proposal designed as a bare minimum bill in order to glean enough support for passage this year. It would do two things: (1) provide for the data gathering function by placing this responsibility in the Secretary of Commerce, and (2) provide for the dissemination of this information through channels available to the Department of Commerce. The bill would thus only take care of the data collection function and would leave all other functions to be considered at a later time.

V

OPTIMUM INSTITUTIONAL STRUCTURE FOR DIFFERENT FUNCTIONS

In examining the possibilities for different institutional structures it is essential to consider the state of the art. If weather modification were to become a full-blown operational activity in government or private industry, then it might be well to establish an independent regulatory body for its management. The reasons for this are more apparent than in some other fields. Here the potential effect on large portions of the public is obvious. Very often the particular modification activity would not and could not be limited in its effect to a well-defined geographical area or to a particular group. People not intending to participate in either the costs or benefits will be affected. There will be, in the economists' terms, externalities that will make the control through the "market place" a virtual impossibility. Too many individuals will receive benefits who have not paid for them, and too many who are not being compensated will bear the cost. Even the weather modification activities of government agencies may have such a pervasive and widespread effect that they will have to be regulated. An analogy might be drawn to the communications field where the FCC was created to regulate the use of radio space in a situation where the externalities were so great that the "market place" could not possibly provide adequate controls.⁶⁹

But weather modification is not yet a completely operational activity, and in its present stage of development the creation of an

69. See K. Davis, *Administrative Law Text* 14 (1959).

entirely new and independent regulatory agency for its management would seem premature. At the same time it is certain that the organizational pattern established now is likely to have a substantial effect on the patterns of the future. Care must therefore be taken to assure that the optimum patterns are created now.

In spite of the 22 years since the first weather modification experiment, we are still just emerging from the experimental stage in many aspects of weather modification, such as fog dispersal, precipitation augmentation, hail suppression and possibly lightning suppression. There is still widespread disagreement within the scientific community as to how advanced our technology is in these activities. All would agree, however, that in respect to climate modification and severe storm control we are very far away indeed from any operational stage. At the same time we must be aware of the increasingly wide agreement among scientists that the weather can be modified in significant respects, and that within a few years almost certainly will be operationally modified as our knowledge continues to grow. Recent visits by U.S. experts to the USSR indicate that a major operational hail suppression program is already under way in that country. There is also strong political pressure in this country for operational precipitation augmentation in the Southwest and for hail suppression and fog control in other areas. To sum up, it seems likely that we will be moving into a more operational phase of weather modification reasonably soon, and that we should think seriously about the governmental organization that will be most appropriate when that occurs.

We could, of course, consider weather modification as merely another technique for accomplishing the various goals of the mission agencies, and regulate it no more nor less than the other activities of those agencies. Indeed, there are some who believe this is the best approach. The difficulty, again, is with "externalities." The pervasive and widespread effects of weather modification are such that they might well reach outside the areas of responsibility of the particular mission agencies, thus creating effects reaching beyond the capacity and responsibility of the agency to manage. Not only will there be members of the public directly affected, there may also be other federal, state or local agencies engaged in weather modification which would pose conflicts. It may therefore be essential at some point to create an independent regulatory body to manage this activity.

If and when such an independent regulatory body is created, it might well have most of the responsibilities provided for in the Weather Modification Association proposal referred to above;

i.e., it might have responsibility for comprehensive planning, coordination, project review, data gathering, monitoring, regulating and licensing. Research would be in the mission agencies and NSF, and operations would be in the mission agencies. Indemnification might be provided for in any one of a variety of ways, including those suggested in S. 2916 or S. 2875.

Such a major organizational rearrangement seems premature at this time. Thus the question is, what should be done now? For the present, while further research and development is proceeding, and while some operational weather modification is being undertaken, several possibilities for governmental organization seem sufficiently attractive for serious consideration. These might best be approached by considering how the various functions can be handled, and then considering how the overall arrangement might appear.

A. Research

First, it seems clear that research should be continued by the same agencies that have carried this responsibility in the past. Each mission agency has performed research in the weather modification activity that was related to carrying forward its mission. Such research should continue, to assure a maximum feedback between operations and research. NSF should continue its support of basic research in the colleges and universities as it is now doing. It may however be time to create one or more new research laboratories similar to NCAR to carry out more extensive research into the physical makeup of the atmosphere. Such matters are beyond the competence of this article and may best be commented on by the scientists. There is, at present, a view among some respected scientists that weather modification might move along more rapidly if the various federal research enterprises were brought together and were funded far more extensively than at present. If the total research effort is to be substantially increased, then serious consideration should be given to placing a major share of the responsibility for that increased effort in one place. That place could be the Department of the Interior and Bureau of Reclamation where the largest expenditures of funds have been made to date, and probably will continue to be made in the future for precipitation augmentation. However, the important lessons to be learned at present probably concern the physical makeup of the atmosphere and the weather, and will apply across the board to all weather modification activities, and to all agencies working in the field. Thus it

might be better to locate such an increased research effort in the Department of Commerce, somewhat further removed from the other mission agencies, and with a somewhat more detached perspective.

This raises a question about the Department of Commerce as a "mission" agency. That it is such an agency there can be no doubt. That ESSA and the Weather Bureau are mission oriented is also clear. However, the nature of the missions of these organizations may make them more appropriate for certain weather modification functions than some of the other mission agencies. The mission of the Weather Bureau is to gather data and predict the weather for the public. Much of its current effort is in research, monitoring and data gathering. Its mission has to do with the weather generally, not with modifying it. It is therefore perhaps less inclined as an institution to become overly enthusiastic about modifying the weather as a means of accomplishing its mission. Its mission does not really benefit by weather modification. On the other hand this lack of mission orientation may also have contributed to the coolness of the Weather Bureau toward weather modification when it first had an opportunity to move ahead in the field during the 1950's. Recent actions and statements of Department of Commerce representatives, however, indicate a more affirmative attitude and a desire to move ahead in the field.

B. Operations

Operational weather modification should be carried forward by the federal mission agencies as well as by state and local governments and private business. This new technology should be added to those already available to these entities in carrying out their various roles.

There seems no valid reason for concentrating all weather modification operational activities in a single department of the federal government, or denying this technology to either the federal, state, or local governments, or to private industry. It is a new technology that can potentially bring many benefits to man, and should be considered in that light. The special problems it poses, primarily concerning externalities, can best be controlled by regulation rather than by usurpation of the field by one or more existing or new federal departments.

C. Data Collection

Data collection is a vital function that must necessarily be performed by a federal agency if it is to be performed effectively. It

would, of course, be possible to create a new, independent regulatory body at the federal level that would include this function among its responsibilities. The decision on this question depends in part on how rapidly it is predicted that weather modification will move ahead in the nation. The slow rate of development over the past twenty years, combined with the continuing shortcomings in relevant scientific knowledge suggest that the growth over the next few years will continue to be slow. Until there is a significant breakthrough in knowledge of the physical properties of the atmosphere and how modification attempts affect those properties, we can expect continuing reluctance by Congress and private industry to spend large sums on operational weather modification.⁷⁰ The evidence is still too uncertain that dollars spent here will result in as certain, or as large benefits as dollars spent elsewhere. At the same time it would appear that the potentials for extremely favorable benefit-cost ratios in the future are high and that considerably more money and time might justifiably be spent on research and development than are expended at present.

These factors suggest that it may not yet be time to create a new regulatory agency, and that the best approach may be to add the data collection function, as well as certain others discussed below, to the responsibilities of one or more of the existing mission agencies. The most appropriate agency for this function would seem to be the Department of Commerce, whose ESSA and Weather Bureau are already engaged in similar activities and could add this function with relative ease and efficiency.

There seems little reason to worry here that the data collected would be used to give disproportionate support to the mission orientation of the agency. Neither ESSA's nor the Weather Bureau's missions would bring such pressure to bear on those who collected the data. Nor is NSF the proper entity for data collection. Its role is to support research in the colleges and universities, and it is neither staffed nor appropriately expert in data collection, in spite of its brief experience in this field. Data collection was and would continue to be an unfortunate diversion of the energies of this organization.

To be effective the data collection function must be mandatory, and the data standardized for all sources throughout the nation. The data must be comprehensive, and the requirement for submission of data must apply to all persons or entities who purport to modify the weather anywhere in the nation.

70. At the same time, without major federal funding, a technological breakthrough will be difficult to achieve, thus tending to make a closed circle.

It is unrealistic to expect the data collection function to apply to inadvertent weather modification, at least at this time. For one thing we suffer from an enormous lack of knowledge about the extent of inadvertent modification by man. As we gain that knowledge however, it would be appropriate to begin to collect data from those sources of inadvertent modification capable of providing it, and to provide authority to an appropriate governmental agency to begin gathering data as it becomes available.

D. Monitoring

The monitoring function should be located in the same federal agency as the data collection function. Both activities are clearly inter-related. Data collection is the submission of reports in intentional (and possibly inadvertent) weather modification. Monitoring encompasses at least two activities: (1) checking periodically to assure that intentional modifiers are reporting accurately, and (2) monitoring the atmosphere generally to have a continuing record of its composition and the changes that are occurring.

For the information to be optimally useful it should be standardized and integrated with the data obtained from reports of intentional weather modifiers. This can best be done by having the same entity perform both functions. The Weather Bureau is already in the data gathering business with weather stations located throughout the nation. One of the most appropriate and efficient ways of handling this function would be to add it to the responsibility of the Weather Bureau, or place it somewhere in ESSA so it could be run in close cooperation with Weather Bureau activities.

E. Comprehensive Planning

Comprehensive planning can be handled in any of several ways. It can be left to the composite efforts of the existing governmental agencies. For example, in the water management field such plans are the product of the efforts of the various water resource agencies and the "overview" efforts of the Water Resources Council. The Forest Service prepares comprehensive plans for use of the nation's forests. These various entities prepare and operate under comprehensive plans designed to further the accomplishment of their various missions. Weather modification would be considered merely an additional technique to be used in achieving those goals. On the other hand, weather modification might be considered sufficiently unique and important that planning for it should be done separately, especially during the current research and developmental stage.

Without specific planning this activity may inch along in a far less effective and uncoordinated manner than if an overall plan is designed for its future.

If special comprehensive planning is to be accomplished for weather modification, then the responsibility might be assigned to OST. It would then either be assigned to ICAS, or ICAS would advise OST. It could also be given to one of the mission agencies, such as Commerce or Interior. It would seem, however, that the most effective assignment would be OST, where it could be assigned to ICAS, or some similarly composed group. A particular problem is posed by the fact that OST is not a creature of Congress. It would be possible, however, to assign the responsibility to the Office of the President with the understanding that the planning would actually be done by OST.

As for the methodology of creating a comprehensive plan, it will be essential to have a direct input of the views and plans of the mission agencies. Planning accomplished without direct participation by these agencies is likely to be unrealistic, and is sometimes ignored. At the same time, experience in the water management field has demonstrated that planning carried out by a group composed only of representatives of mission agencies too often turns out not to be planning but merely trading of information and projects. One method of alleviating this tendency is to appoint a chairman from some entity other than a mission agency; in this case the chairman might be appointed from OST. He would thus carry authority of the Office of the President as well as his own authority as a scientist and as chairman. Comprehensive planning may also be materially assisted in areas where new science and technology are involved by the efforts of such nongovernmental bodies as the National Academy of Sciences, the National Academy of Engineering, and various ad hoc Commissions.

F. Coordination

Coordination applies to two different aspects of the problem: coordination to avoid wasteful duplication among various programs, and coordination to assure that different weather modification activities do not interfere with each other. Coordination can be approached informally, through the meetings of representatives of different agencies. This may or may not result in effective coordination, depending on the voluntary efforts of the agencies involved. Or, at the other end of the spectrum, coordination could be accom-

plished by a regulatory body with full authority to control the agencies involved. Probably the most desirable approach falls somewhere in between.

The problem with the first alternative is that too often the mission agencies use a voluntary coordination mechanism for tradeoffs rather than for real coordination, and the public suffers a new loss from the effort. The second alternative—a fully empowered regulatory body—is premature at this time, and in any event is politically unrealistic. This suggests that some approach in between may be best suited to the situation. That approach might be through ICAS or some similarly constituted body with representatives from the different mission agencies, and with a chairman directly responsible to the chairman of OST. Although such a body would not have direct legal authority to control the activities of the agencies, it would, through the active participation of the chairman and through the authority he wields from the Office of the President, be able strongly to encourage the necessary coordination.

Needless to say, other organizational patterns might be designed to achieve a greater or lesser degree of coordination, and it is likely that at this early stage of development a fairly flexible and informal structure will suffice. However, as the technology progresses, more intensive coordination will become essential.

G. Project Review

The arguments favoring a project review function in the water management field apply equally, if not more strongly, to weather modification. If such a function is to be designed for weather modification, now is the time to consider it, while the technology is still developing and before too many vested interests exist.

To be effective, this function must be the responsibility of some entity different than the mission agencies that are designing and carrying out the projects. Someone needs to be specifically concerned with the potential externalities of each weather modification project, to assure that the total benefit to the nation is greater than the total cost, and to review the potential effect of the activity on the environment and other unmeasurables such as recreation and quality of life. We need also to be assured that the particular weather modification project is, in fact, the most effective means of arriving at the goal sought, and not merely the most effective means by which the particular agency can achieve that goal.

If such a function is established it might become the responsi-

bility of one of several entities. It might, for example, become the function of a new weather modification agency, created specifically for the purpose of managing this new technology. Such an agency might also have regulatory powers as indicated earlier. However, such a major organizational effort still seems premature at this stage.

Two of the more plausible options (both of which have drawbacks) are: (a) the Office of the Federal Coordinator in the Department of Commerce, and (b) the ICAS, or some similarly constituted body in OST.

The difficulty with assigning a project review function to the Federal Coordinator is that this office lacks the institutional independence desired for accomplishing it. The Coordinator is too closely woven into the fabric of the Department of Commerce to be entirely independent of the pressures that a large department always carries within it. Nor does it seem reasonable to believe that, for this purpose alone, the Department of Commerce is likely to grant the Federal Coordinator the independence that might be necessary. Conceivably, if this office were some how sorted out from the Department and provided greater independence in staff and responsibility, it would be a more likely contender for the project review function.

The other principal possibility is the ICAS, or some similarly constituted body. However, one of the problems posed by this notion is that the ICAS is a creature of OST and thus of the President's office, and not of Congress, and Congress feels constrained not to assign responsibilities directly to it. It would, however, be possible for Congress to spell out its intention that the project review function be performed by some independent entity within the Office of the President, and possibly obtain an informal understanding that the function would, in fact, be performed by ICAS, or otherwise through OST (OST, through its chairman, might assign it to NAS-NAE).

In any event there are too many variables involved to say definitively at this writing how the project review function might best be handled. The points to be made here are that (1) the function does merit most serious consideration, (2) that it can almost certainly be established at this stage of development of weather modification more easily than at any later state, (3) that there are several existing federal entities that might be considered for its location, and (4) that institutional independence is essential to the effective performance of the function.

H. Regulation

A comprehensive regulatory regime for weather modification may be premature at this time. The timing for its creation depends upon how rapidly Congress and the various departments decide to move ahead in the field. However, one fact should be borne in mind: considerable lead time is essential for the drafting and promulgation of regulations in a new field. Extensive interagency discussions must occur, hearings must be held to receive industry and public views, and drafts must be prepared, circulated and revised. All these actions take time and it is not unusual to find a lapse of three or four years between the intention to create such regulations and their actual promulgation. Thus if a significant increase in weather modification activity is to occur in the next four or five years, serious consideration should be given now to starting toward the creation of regulations.

Whether regulation will be necessary at some time may be arguable, but it is the view of this author that the pervasive effect of weather modification activities, and the difficulty of predicting the exact effect of a given modification attempt, indicate that at some point soon regulation will become necessary. One possible approach to this function was suggested in S. 2916 which provided that the Department of Commerce should promulgate regulations to prohibit interference by private modifiers in federal programs. This approach has much to be said for it in getting a modest regulatory system going. It does, however, pose the problem of placing in a mission agency the power of regulation that is best effected by an independent entity. With all of their apparent drawbacks, the experience of the FCC, ICC, FPC and other independent regulatory agencies has proven that such regulation is better accomplished by an independent entity.⁷¹ Recent attempts by the AEC to sort out and give greater independence to its regulatory functions further attest to this fact. Nor is independence important only in connection with the regulation of other federal agencies. If a mission agency is charged with regulating private operators it may find itself in a position of conflict of interest with its own programs.

Within the existing federal structure it is difficult to see where the regulatory function would most ideally rest. Again the Federal Coordinator in the Department of Commerce comes to mind, and it is possible that if that office were given the regulatory power at this time it could be moved when the function grew larger. The Federal Coordinator is, however, in the Department of Commerce,

71. See Davis, *supra* note 69, at ch. 13, "Separation of Function," at 225-44.

and as noted, suffers the constraints imposed by his institutional association.

The ICAS is not designed as a regulatory body and would hardly seem the appropriate entity for that function. Similarly, the NSF is not properly constituted for handling this function. This leaves the problem of either identifying some different agency or of creating a new one. Both of these avenues offer advantages and disadvantages. One of the drawbacks of creating a new agency for this purpose is that such an agency would be so small at this time that setting it up with separate staff and facilities would seem unduly wasteful—at least until weather modification takes on greater proportions than at present. One approach is temporarily to attach this function to one of the smaller existing regulatory agencies, with the understanding that it would attain separate identity when the size of the role justified it.

I. Licensing

The licensing power over weather modifiers is an effective way to assure competence to operate in the field. To the extent that the competency of operators is now controlled at all, it is controlled in the private sector by diverse state licensing laws, and in the federal government by the judgment of various departmental administrators. At this early stage of development an informal approach to licensing is probably appropriate; however, as more operators enter the field it may be necessary to establish specific standards of competence. In view of the highly diverse methods that can be used to modify the weather, including seeding from aircraft, ground generators, rockets, and artillery, considerable sophistication will be required to work out rational and meaningful standards.

For the time being, this function might well be left to the states and to the federal agencies as is now done. As weather modification efforts grow, and as the impact of this activity becomes more widespread, it seems likely that the interstate implications may require federal control of operator qualifications.

J. Indemnification

This function should not be allocated until more study of the issues occurs. There seems adequate, albeit imperfect, insurance coverage available in the private sector at the present time. In addition, the federal departments are working out their indemnity needs on a case by case basis. Before major changes are made in

this informal system a comprehensive study of the question must be made.

VI

A COMPARISON WITH THE FEDERAL POLLUTION CONTROL PROGRAM

Some important lessons can be learned about the management of weather modification by comparison with the federal-state cooperative program for the management of water pollution. This is not to suggest that the two problems are entirely analogous; however, enough similarity exists that a comparison will identify some useful approaches to difficult management questions.

A brief sketch of the federal water pollution control program is an appropriate starting place. Until the 1956 amendments to the 1948 Water Pollution Control Act, the federal government did not seriously concern itself with water pollution. Prior to this, water pollution had been controlled by three means: (1) the market system, (2) the common law system (through the law of riparian rights and nuisance), and (3) state and local governments. The market system did not work because those who profited from use of rivers for waste disposal did not bear the costs. The market system did not permit those who bore the costs to charge them against the polluters. The common law system was effective when the problems were limited to only a few involved people. The system gradually failed as the problems became more complex and sustained management became necessary. Lastly, the state and local governments had, prior to 1956, accomplished much. Some had reasonably good pollution control systems but they entirely lacked adequate controls. In general the states were limited by finances, and overly responsive to the pressures of industries and cities which found it difficult and expensive to change their methods of waste disposal. The result was that in 1956 Congress substantially strengthened the 1948 WPC Act. The 1956 amendments did several things: (1) they reaffirmed the federal government's policy of recognizing the primary state and local responsibility for pollution control, (2) they authorized increased technical assistance to states and broadened and intensified research, (3) they directed the Surgeon General to encourage interstate compacts and uniform state laws, (4) they authorized grants to states and interstate agencies for water pollution control activities, and to municipalities for construction of waste treatment plants, (5) they simplified procedures for federal abatement actions against interstate pollu-

tion, (6) they authorized appointment of a Water Pollution Control Advisory Board, and (7) they set up a program to control pollution from federal installations. Further amendments in 1961 extended and strengthened federal abatement procedures, increased the federal financial assistance to municipalities for construction of waste treatment works, and intensified research. They also continued to affirm primary responsibility in the states for this function.

The next major change was in the 1965 Water Quality Act which required all fifty states to submit to the Department of the Interior proposed water quality criteria or standards for interstate or navigable waters. These state proposals were submitted in June, 1967, and included plans for enforcement. By now they have been approved and put into effect in virtually all states.

There are, of course, some marked differences between the problems of water pollution control and management of weather modification. When the federal government moved into water pollution control, the pollution of the nation's rivers and lakes was a well established fact and was growing steadily worse as industry and technology advanced. A vast and complex system of local and state laws and institutions had been established to deal with the problem. Solutions could come only through the expenditure of billions of dollars, through a vast public education program, and through major changes in existing state laws and institutions.

As for intentional weather modification the problem is quite different. "Relatively few" industries and cities have vested interests in the activity to date, and "relatively few" local and state laws and institutions have been designed to control it. This is not so, however, of inadvertent weather modification. To begin with, we are not at all certain how much inadvertent weather modification is occurring from industrial waste, automobile exhausts, and the like. Significant changes in the weather from these sources seems highly likely. To the extent that such changes are occurring, the problems would seem to have many of the same characteristics as those in the water pollution control field. Industries, cities, and individuals who are discharging wastes into the atmosphere which cause inadvertent modification are causing a loss to others, and neither the market system nor the common law is competent to manage the problem.

One particular aspect of the federal water pollution control system that seems especially relevant to weather modification concerns the function of a federal agency as a watchdog over a state. One of these factors is the creation of federally designed operating standards. At the present stage of development of weather modifica-

tion, the federal government may wish to leave as much management as possible in the hands of state officials, regarding both intentional and inadvertent modification. At the same time Congress may feel that the welfare of the nation calls for the creation of at least minimum federal standards which state and local governments must meet in managing this activity. These standards might have to do with the qualification of weather modifiers, or with the testing system used to determine when the weather should be modified and to determine the effect of a given attempt. The standards might also deal with the atmospheric conditions under which weather modification will be permitted. As technology develops there will be a growing need for various mixtures of technology, public awareness, and community decision-making. In this event the experience of the FWPCA in requiring establishment of satisfactory standards at the state level might be quite useful. Both the standards of operation and the methods of enforcement could be reviewed by an appropriate federal agency. At the same time however, the actual creation of the standards and the enforcement procedures could be left to the state and local governments.

A second experience in water pollution control that seems especially relevant to weather modification is the conference technique. It will be recalled that under the 1956 and 1961 Federal Pollution Control Act Amendments the governors of states affected by the pollution of an interstate stream can call a conference to examine the problem. The Conference is not an adversary proceeding, and no strict rules of evidence are followed. Rather it is a public hearing at which all views are invited and presented on the nature and solution of the problem. The purpose is both to educate the public and to work toward a voluntary agreement on corrective action. This type of conference has made impressive progress through consensus recommendations and conclusions. One of the chief reasons for this is the presence and participation of the public. Similar public awareness and participation will surely be necessary in the area of weather modification as technology continues to move ahead. For example, at least two questions might be raised: (1) how much inadvertent weather modification will be permitted in the future, and (2) what intentional weather modification will be permitted. The second question is not so readily perceived as a problem requiring public attention so long as the modification is to occur over a remote mountain area, providing the effect does not extend far downwind. However, as the knowledge of this technology increases there will be increasing pressure to modify the weather over more heavily populated areas. The experience with the Tri-state Natural Weather

Association in Maryland, Virginia, West Virginia, and Pennsylvania is illustrative of the type of problem that can arise from the lack of understanding of the nature of technology, or of the consequences of its use. Certainly public education will be an important ingredient in the future of this field. At the same time, it is quite possible that some people will be benefited and others harmed by a given weather modification program. It is possible that all of those affected should be fully informed on the possible consequences and be able to participate in deciding what weather should be modified.

One other experience of the federal water pollution control program is relevant to the weather modification problem. That experience is the mandate in the 1956 Act directing the Surgeon General to encourage interstate compacts and uniform state laws. It would be appropriate for Congress to direct an appropriate federal agency to encourage interstate compacts and uniform state laws in the weather modification field also. These things often do not occur spontaneously, even when they are beneficial to the citizens of states involved. One reason is the considerable staff and background work that must be done and, states are often either politically or financially unsuited to accomplish this work. Thus the direct interest, encouragement, and support of an appropriate federal official can be a critical factor.

If Congress decides to leave as much authority and as much management responsibility as possible at the state level, then there will undoubtedly be other aspects of the federal pollution control program that should be examined for relevant analogies. This program has proven to be a good model for responsible federal-state cooperation in an important natural resources field.

CONCLUSION

In the above analysis I have attempted to explore some of the more plausible institutional arrangements that could be designed for federal management of weather modification. The approach has been to break down the activity into its different functions, and consider the optimum ways that each function might be handled, keeping in mind the overall goals to be served by this new technology.

Much, of course, depends upon the pace of development of this new activity. Aside from this there are a few basic notions that should be kept in mind about the relevant governmental organization. First, it must be remembered that weather modification is not an end in itself. It is merely a new technique for achieving cer-

tain of man's already identified goals, such as the growth of food from irrigated agriculture, the protection of forests from fire, and the safety of aircraft in landing and taking off. In nearly every case there are other ways of achieving these same goals. Because these goals are already served by various government agencies, it seems appropriate to place most of the operational activity in these agencies. Although they may not be ideal governmental organizations, they have generally been effective in accomplishing their missions, and are about as efficient as practical politics will permit for achieving the nation's most pressing needs.

The above analysis suggests that governmental organization for the management of weather modification, especially in the areas of comprehensive planning, project review, and coordination, should be designed to permit consideration of the broadest possible range of choices in the achievement of the desired goals. Increasingly, as government grows bigger, it is essential to keep in focus these basic human goals to be served, and to design institutions to allow achievement of them by as many different routes as possible.

Lastly, although some specific suggestions about governmental organization are made, the intent is not to argue that these are the only possible answers. Rather the intent is to illustrate the nature of the technological and organizational problems and to suggest some of the most plausible approaches to solving them.