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WEATHER MODIFICATION: LAW AND POLICY

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In recent years there has been an increased awareness of the possibility of planned weather modification. It is timely, therefore, for lawyers to consider the problems they will face as a result of intentional modification activities on any substantial scale. When one considers that modification activities may alter or interfere with habits and patterns of human activities that have become relatively fixed in response to generally predictable patterns of weather over a period of centuries, and that the effects of these activities might be felt by most nations and cultures throughout the world, a preliminary understanding of potential problems emerges. The very size and complexity of projected modification experiments indicate that present legal concepts and institutions will be insufficient to provide adequate regulation. It seems clear that not only must careful legal consideration be given to this area, but also to the policy questions inhering in large-scale technological alteration of natural weather processes. Examination of these questions will necessarily involve consideration of the direct effects of modification on humans. Also included should be consideration of the potential impact on phenomena of collateral importance to human life. What will be the impact on plants and wildlife, on domestic animals and aquifers? How will soil fertility, composition and rates of erosion be affected? In short, the subject requires careful analysis of potential large-scale ecological consequences.

The manner of stating a problem is crucial to its resolution. Already a warning has been offered that this subject should not be approached through the use of traditional legal concepts.[1] Obviously, however, useful insight may be gained through the use of analogies

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[1] H. Taubenfeld, Weather Modification Law, Controls, Operations, Report to the

from relevant legal experience. Recognizing the hazards of too limited a point of view, it is suggested that intentional modification of the weather should, for the present at least, be viewed as an experimental enterprise with potentially great value for mankind, but accompanied by an equal potential for disaster. Even if modification proves to be, on balance, a positive good, it might still cause serious harm to large numbers of persons and interests. Successful modification efforts might, for example, seriously impair natural scenery, wildlife conservation efforts, and the recreational use of land. These are values that the law has not conspicuously favored in the past, and one of the principal problems for the law raised by modification might be that of finding the means of protecting both these values and the general interest of society in a richly diverse environment, uncontaminated and as free as possible from human interference.

The problem is one of determining the terms, if any, upon which intentional weather modification activities *and* experimentation should proceed. Obviously, the more information available concerning current experimentation and its results, the better the response of the law can be. But if the information is not available, the law will still have to respond if the activities of the modifiers go forward. There is every reason to believe that the plans of potential experimenters and modifiers are ambitious.[2] This article will examine selected legal and policy questions raised by weather modification efforts. It will include a consideration of statutory and case law developments. Particular attention will be paid to the role of the federal government in the support and control of weather modification because of the importance of that support to such research, and because of the importance of the role of the federal government in environmental affairs. The article is limited to a consideration of intentional weather modification. Inadvertent weather modification, such as that caused by automobile or aircraft emissions and stationary industrial sources, although similar in nature to intentional weather modification, presents quite distinct legal and policy questions and is a proper subject for treatment elsewhere.

I. Anticipated Human Problems Involved In Weather Modification

There is at present considerable awareness of the necessity for learning something from the past calamities inflicted upon society

Special Commission on Weather Modification of the National Science Foundation 1 (1966) [hereinafter cited as Taubenfeld Report].

[2] Approximately $11 million was spent by the federal government on weather modification programs during fiscal year 1968. National Science Foundation, Weather Modification 126 (Tenth Ann. Rep. 1968) [hereinafter cited as Tenth Annual Report].

by the unanticipated effects of technology. Efforts have been made to forecast difficulties that might be caused by weather modification. The principal work in this field has been performed by the National Science Foundation, which has issued or sponsored a number of reports concerning the social implications of weather modification.[3] These reports, containing the views of scientists, lawyers and political scientists, are noteworthy attempts to anticipate a broad spectrum of problems likely to be created by weather modification. The reports include consideration of possible direct effects of modification on man himself, and indirect effects through action on flora and fauna. They are likely to be influential documents in the development of weather modification law.

With regard to wildlife, it has been pointed out that in the United States wildlife generally subsist on "islands" of land in which natural conditions such as cover, forage and water are sufficient to support certain levels of population. These "islands" are usually surrounded by the habitat of man where the conditions of nature have been so altered that only man, with artificial life-support techniques, can survive. Ill-conceived modification programs could easily have serious effects on large segments of wildlife living on small land areas, or areas where living conditions are in delicate balance, because of the inability of the animals to migrate from the area of weather change.[4]

An ad hoc Weather Working Group of the Ecological Society of America was consulted for background information in the course of one of the principal studies.[5] The Working Group took the position that the greatest positive argument advanced for weather modification is the likelihood that it will produce an increase in rainfall on the drier parts of the land surface. Weighing heavily on the negative side, however, would be the likely increase in weeds, pests and pathogens. The species that would be most harmed by these agents could not be identified at the time of the report.[6] It is predicted, however, that changes that would be produced in insular natural communities would almost consistently be unfavorable, with a strong possibility of localized species extinction present.[7]

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[3] National Science Foundation, Human Dimensions of the Atmosphere (1968) [hereinafter cited as Human Dimensions Report] is most relevant. Other reports of the National Science Foundation also deal in part with potential human problems. See Tenth Annual Report, supra note 2, at 5; Weather and Climate Modification, Report of the Special Commission on Weather Modification to the National Science Foundation 80-97 (1965) [hereinafter cited as Special Commission Report]. A conference on economic and social aspects of weather modification was sponsored by the Foundation in 1965. A report of the conference appears in Human Dimensions of Weather Modification (W. Sewell ed. 1966) [hereinafter cited as Sewell Report].

[4] See generally Special Commission Report, supra note 3, at 66-67.

[5] Id. at 60.

[6] Id. at 69.

[7] Id. at 66-67.

It was noted that there have been few direct efforts at ecological prediction of weather modification's effects. From this, the obvious conclusion of the need for research and a long-term monitoring of the effects of modification was drawn. Most significant is the statement of one observer that we have "no assurance that proposed uses of the atmosphere will provide benefits in man's quality of living commensurate with the costs."[8]

There is in these reports evidence of increased recognition of the importance to man of biological diversity. Since animals and plants can hardly speak for themselves, there is a need for courts to evolve mechanisms that will enable concerned parties to provide for the protection of endangered species. Historically, certain legal systems have assigned legal rights and duties to animals.[9] While this might be regarded as an unimportant curiosity, or perhaps only as an expression of a type of human property interest in the animals, it is interesting to speculate on the possibility that such a practice was motivated by an appreciation of what we have only recently come to understand as the science of ecology. Although there can be no question of a return to any sort of primitive animism for modern man, it might be that there is something to be learned from primitive societies' regard for nature. In this vein, De Jouvenal has questioned whether restoring personal status to rivers, something that obtained in pagan times, might not promote their efficient and farsighted use.[10] This is illustrative of one possible method of giving recognition to interests that for one reason or another have often been without effective legal defense in modern society. The attribution of personal and legal status to animals, plants and natural features such as rivers is, of course, a fiction that need not be resorted to if courts and policy makers are willing and able to afford other protections against their meaningless destruction.[11]

The conscious evolution of measures to secure such protection might become necessary in the event weather modification or similar technological measures miscarry. The 1966 report of the Special Commission on Weather Modification concerning the technical problems of weather modification concedes that "uncertainty characterizes most thinking about the changes in natural systems that are subject

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[8] Human Dimensions Report, supra note 3, at 50.

[9] See J. Gray, The Nature and Sources of Law 42-45 (2d ed. 1921).

[10] B. de Jouvenal, The Stewardship of the Earth, appearing in The Fitness of Man's Environment 109 (1967).

[11] A method is suggested by the action of the Court of Appeals for the Second Circuit in attributing standing in the challenge of a power license to a non-profit wildlife association. Scenic Hudson Preservation Conf. v. FPC, 354 F.2d 608 (2d Cir. 1965), cert. denied, 384 U.S. 941 (1966).

to modification."[12] To emphasize this, the report notes that this uncertainty specifically relates to possible consequences for the quality of water, plants, animals and human factors as well.[13] Moreover, this uncertainty is particularly evident with regard to the human factors. Although research on human response to natural weather has been conducted by geographers, with principal emphasis on the effect of weather on agriculture, nevertheless our general knowledge of the sensitivity of human activity to natural weather is described as "imprecise and incomplete."[14]

Some attempts have been made to consider factors comprising an optimum climate for man. The geographer Huntington maintained that a climate having as its chief characteristic a moderate temperature and frequent passing of alternating pressure centers was best for human development:

> [A] relatively high degree of storminess and a relatively long duration of the season of cyclonic storms have apparently been characteristic of the places where civilization has risen to high levels both in the past and at present. Hence such places experience much variability, a condition which later work has led me to believe highly beneficial.[15]

Huntington's work and theories of climatic determinism have been criticized or refuted in part.[16] Nevertheless, these critical views themselves would seem to emphasize the apparent complexity of possible human response to weather, and the lack of any appreciable understanding of possible effects of weather on human behavior.

One factor that does seem clear is the unlikelihood that the question of human response to weather can be truly understood by the examination of only segregated weather phenomena and possible human response. Rather, it seems necessary that consideration be given to the examination of human response as a continuum over extended periods of time.[17]

A small but very valuable part of the effort to anticipate human response is in the attempt to project the possible problems for primitive or tribal societies. A decision to engage in weather modification by

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[12] Special Commission Report, supra note 3, at 84.

[13] Id.

[14] Human Dimensions Report, supra note 3, at 35.

[15] E. Huntington, Civilization and Climate 12 (3rd ed. 1948).

[16] See generally Sewell Report, supra note 3, at 399-440.

[17] As one authority has observed:

> The most pressing problems of humanity . . . involve relationships, communications, changes of trends, in other words, situations in which systems must be studied as a whole in all the complexity of their interactions.

R. Dubos, So Human an Animal 27 (1968).

and for a modern industrialized society might seem acceptable because of the relative ease with which many in such a society can invoke two of the three traditional responses to weather: adaptation, adjustment and movement. These responses are regarded by some commentators as traditional.[18] Adaptation refers to various physiological responses. Adjustment suggests the creation of an artificial environment through shelter construction, development of new strains of hardier plants, the wearing of clothing or the rescheduling of activity. The primitive society cannot, of course, adjust or move with anything approaching the degree of ease available to the modern society.

For an example of some of the probable difficulties tribal societies might experience with weather modification programs, one need look no further than some of the remaining Indian cultures in the United States. It seems clear that even slight changes in rainfall would have disastrous effects on the present life of tribes such as the Navajo in the Southwest whose crops and technology are closely dependent upon ten inches of rain annually.[19] The Zuni, who live immediately to the south of the Navajo, are not as physically dependent upon the weather because of their partial withdrawal from agricultural pursuits to silversmithing and wage work in nearby towns. The Zuni, however, have retained an elaborate cosmology, based heavily upon weather, which serves important and contemporary functions of integration and political control.[20]

There is an importance attached to nature and weather in some tribal societies that far surpasses comparable attitudes in industrial society. One report on the Hopi personality indicates that it includes a protective attitude toward life in any of its manifestations; human, animal or plant.[21] Also, ceremonial performances specifically oriented toward weather, such as the rainmaking dance or rituals to cure the sick, are important features in some cultures in the Southwest.[22]

Although the loss of such values as Indian cosmology and personality traits might be regarded by some as at most a subject for compensation,[23] and not as requiring the cessation or avoidance of experimentation with the weather, nevertheless at the center of numerous

[18] Human Dimensions Report, supra note 3, at 29.

[19] Sewell Report, supra note 3, at 379.

[20] Id. at 383-85.

[21] H. Driver, Indians of North America 436 (2d ed. 1969).

[22] Id. at 435.

[23] Article I of the Navajo treaty of June 1, 1868, for example, requires the United States to arrest persons injuring the person or property of any Indian and to reimburse the injured Indian. 15 Stat. 667 (1868). Acts of Congress can supersede Indian treaties. The Cherokee Tobacco, 78 U.S. 1 (11 Wall. 616) (1870); Choate v. Trapp, 224 U.S. 665 (1912). Navajo treaties, however, were confirmed by Congress in 1950. 25 U.S.C. § 631 (1964).

contemporary social, political and legal conflicts is the feeling that technology and industrial activity are developing in an unrestrained manner, and at the expense of many of the very amenities that give life its diversity and interest. It would seem, therefore, that weather modification might lead to irreversible changes in ways of life for American tribal societies. It is questionable whether any amount of indemnification could truly compensate for this. In the case of tribal societies, such changes would be readily apparent at an early stage, but there is no reason to assume that a modern industrial society would prove to be immune from similar change in due time.

In the case of complaints from foreign countries regarding weather modification, the matter would likely be one subject only to political resolution in the absence of international law or agreement, particularly if the complaint is based upon major changes.[24] Of course, some experiments conducted by nationals of continental states such as the Soviet Union or the United States, while seemingly of reasonable scale to such experimenters, might assume much greater significance to many smaller states and thereby be more likely to provide grounds for serious complaint. Thus, hurricane diversion in the Caribbean area might deprive large sections of Mexico of needed moisture.[25]

Whereas the possibilities of the destruction of or serious harm to plant and animal species are strong, no such forecast is projected for mankind itself. However, existing primitive or tribal cultures may indeed be seriously affected, and there is general uncertainty about the possible effects of modification on the totality of civilization. It is this uncertainty that promises severe difficulty for policy makers should modification go forward on a broad scale. For the present, we must be satisfied with attempts to speculate in a very general way on the importance to man of weather, including its dramatic extremes. The Special Commission on Weather Modification asserts that no presently conceivable program can eliminate the extremes of a winter blizzard or the flash of summer lightning. Nevertheless, it "raises the question of how far the human spirit is enriched by the uncertainty and wonder and exhilaration that come with the restless, violent movements of the atmosphere."[26] The most depressing summation of where weather modification might lead us in human terms is by the zoologist, Marston Bates:

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[24] Cf. Taubenfeld & Taubenfeld, Some International Implications of Weather Modification Activities, 23 International Organization 808, 829 (1969).

[25] The Taubenfelds suggest such diversion could necessitate irrigation, retraining or population transfer. Id. at 827.

[26] Special Commission Report, supra note 3, at 86. The implication of raising this question is, of course, that while what the Commission says may be true with respect to the limitations of present technology, the history of science reveals that the possibility of an all-pervasive global control system cannot be excluded.

> I see again Brave New World looming ahead. With our growing population I suppose we must control rather than adapt, and I suppose our power gives us ownership of the planet, perhaps to destroy it. But if and when we do gain control over weather and climate—purposive and not accidental as with carbon dioxide—I hope we can leave some weather reservations where natural storms can beat upon natural vegetation. But there may not be any natural vegetation then.[27]

This represents the attitude that society is helpless before science and technology.[28] While this could prove to be the case eventually, there is no reason to concede without a struggle, and that struggle must have as its goal a reaffirmation of the principle that science and technology are the servants of mankind, and not the reverse.

II. Current Legislation Concerning Weather Modification

The potential consequences of intentional weather modification are world-wide. Even on the basis of the present knowledge of experimentation this is clear. It is equally clear that in due course the necessity for international agreement regarding this subject will appear.[29] For the present, however, it would seem that the development of federal law would necessarily be the preferred method for the adoption of standards.[30] However, the states have already taken the lead in the adoption of legislation with respect to weather modification, and attention must be given to these efforts.

A total of twenty-nine states have legislated in one way or another concerning the subject of weather modification.[31] Some states have

[27] Sewell Report, supra note 3, at 407.

[28] The concept of technological determinism has been most recently associated with the name of the French sociologist Jacques Ellul. A portion of the foreword to an American edition of one of Ellul's best-known works might have been directed toward the quotation from Bates excerpted in the text. Ellul observed: "Freedom is not static but dynamic; not a vested interest, but a prize continually to be won. The moment man stops and resigns himself, he becomes subject to determinism." J. Ellul, The Technological Society xxxiii (1964).

[29] See generally Taubenfeld, Weather Modification and Control: Some International Legal Implications, 55 Calif. L. Rev. 493 (1967).

[30] Authority for federal action might be found in the Commerce Clause or in the war-making authority. Bases for federal action and questions of the exclusivity of federal authority and state police power were ably discussed in an article several years ago. See Oppenheimer, The Legal Aspects of Weather Modification, 1958 Ins. L.J. 314 (1958). It is also suggested that the authority of the federal government to act in this area might arise out of the obviously international character of such experimentation. United States v. Curtiss-Wright Export Corp., 299 U.S. 304 (1936); United States v. California, 332 U.S. 19 (1947).

[31] See Oppenheimer, note 30 supra, and Taubenfeld Report, note 1 supra. See also Davis, State Regulation of Weather Modification, 12 Ariz. L. Rev. 35, 52 (1970) [hereinafter cited as Davis].

claimed sovereign rights in the moisture in the clouds and others have established licensing requirements for weather modifiers.[32] Thus, it seems that several states have acquired a degree of experience with weather modification problems not yet matched on the federal level. Moreover, it is evident that because of the great geographical diversity of the United States, and the consequent variation in natural conditions, individual state governments may for some time to come be in a position to reflect more accurately than the federal government the wishes of their citizens with respect to weather modification. Of course, individual state responses might not reflect the wishes of organized science or groups of scientists. These individuals and groups might be expected to seek uniform federal regulation of weather modification as a step toward modification experimentation and operation over large areas. It is possible, therefore, that a state-federal conflict over authority to regulate weather modification would reflect a more fundamental conflict between the weather modifiers and those who would oppose such activities.

Considerable positive interest in modification activities has been indicated in states containing arid regions. In some instances this has resulted in explicit legislative support for modification. Wyoming, claiming sovereign rights to the use of local moisture, has further stated through its legislature that "although little is known regarding artificial weather modification . . . ," research and experimentation "shall be encouraged."[33] Texas has legislatively excluded the plea of ultrahazardous activity, thereby relieving modifiers of that burden, in actions against modification operations conducted pursuant to a license granted by the state.[34] In California, Colorado, Nevada, New Mexico, South Dakota and Washington there have been either instances of state-supported modification research, or research in state educational institutions which are supported by outside financing.[35]

Pennsylvania and Maryland, on the other hand, where moisture is not in as short supply, have adopted or permitted prohibitions against modification activities. Maryland has prohibited it for a period

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32 Louisiana has claimed "its sovereign right to the use for the best interest of its people of the moisture contained in the clouds and atmosphere within its state boundaries." La. Rev. Stat. tit. 37, § 2201 (1964). New Mexico "claims the right to all moisture in the atmosphere which would fall so as to become a part of the natural streams or percolated water of New Mexico . . . ." N.M. Stat. Ann. § 75-37-3 (1968). Similar claims have been made by: North Dakota, N.D. Cent. Code § 2-07-01 (Supp. 1969); South Dakota, S.D. Compiled Laws Ann. § 38-9-2 (1967); and Wyoming, Wyo. Stat. Ann. § 9-267 (1957). For a discussion of state licensing requirements see Davis, supra note 31, at 53, 57-58.

33 Wyo. Stat. Ann. § 9-267(b) (1957).

34 Texas Rev. Civ. Stat. art. 8280-12, § 18 (Supp. 1970).

35 Taubenfeld Report, supra note 1, at 39-43.

ending September 1, 1971.[36] Pennsylvania had permitted local prohibition by resolution of county commissioners. While the authority for this has been terminated, Pennsylvania seems to have retained a prohibition against attempts to suppress lightning.[37] At present, Pennsylvania concedes legislatively that the public interest requires "scientific experimentation in the field of artificial nucleation, and that scientific efforts to develop and increase natural precipitation . . . be encouraged . . . ."[38] It is possible that continuing caution in Pennsylvania's attitude toward weather modification may be reflected in its legislative prohibition against the use of nucleating agents in concentrations dangerous to man.[39] This is an apparent reference to the fact that silver iodide, frequently used in seeding activities for the purpose of providing an artificial nucleus for precipitation, is a poison.[40]

Against this background of state legislative activity, the record of federal legislation is lean indeed. The National Science Foundation had authority to carry out a program of study, research and evaluation in the field of weather modification until 1968, at which time its authority was repealed.[41] One reason offered for this repeal was the recognition that the ramifications of weather modification went beyond the purely scientific.[42]

It has been argued that federal legislation should now preempt the field of weather modification.[43] However, this should not necessarily be the case, at least for the foreseeable future. The differing approaches by state legislatures, which vary from outright prohibition to the encouragement of weather modification, suggest that an attempt at preemption by Congress would be strongly resisted by many interests. Also, the action of Congress in the repeal of the innocuous authority of the National Science Foundation for the study of weather modification might indicate a caution and uncertainty in the face of a potentially powerful technology whose consequences are still largely unknown.

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[36] Md. Code Ann. art. 66, § 110A (Supp. 1969).

[37] Pa. Stat. Ann. tit. 3, §§ 1115(b), 1117. (Supp. 1970).

[38] Id. § 1101.

[39] Id. § 1111(c).

[40] M. Gleeson, R. Gosselin & H. Hodge, Clinical Taxicology of Commercial Products (2d ed. 1963).

[41] Act of July 18, 1968, Pub. L. No. 90-407, § 11(1), 82 Stat. 365.

[42] S. Rep. No. 1137, 90th Cong., 2d Sess. (1968); U.S. Cong. & Admin. News 2658 (1968).

[43] See Taubenfeld Report, supra note 1, at 7; Weather Modification and the Law 141 (Taubenfeld ed. 1968). Explicit preemption by Congress might be possible. See, e.g., The United States Warehouse Act, 7 U.S.C. § 269 (1964). Such an action, however, might not overcome state regulation based upon the police power, as that relating to air and water pollution problems. See Huron Portland Cement Co. v. City of Detroit, 362 U.S. 440 (1960) (city smoke abatement code upheld as applied to federally licensed shipping in interstate commerce).

Of course, there is need for a degree of uniformity with regard to the question of controling weather modification, and this need will probably become more pressing as time passes. While the Congress might seem the obvious institution in which this need for control will be resolved, there are no clear signs of the shape of possible future legislation emanating from this source. Also, while vesting regulation exclusively in the states is subject to many criticisms, the states are at least in a position to be more responsive to and perceptive of the human difficulties created by weather modification within their jurisdictions.

III. The Case Law of Weather Modification

Although the litigation of individual suits in weather modification matters might not be a primary means of control over these activities, it is important not to overlook the fact that courts are certain to be a leading forum in which conflicts arising from modification will be aired and settled. Lawyers can reasonably hope that this process will tend to cause the articulation and resolution of competing values in such a way as to assist in the development of policy by legislators and administrators.

A potential recurring difficulty in weather modification litigation concerns questions of proof. At least seven cases dealing with modification have been decided in American courts.[44] Two decisions were based on failures of proof. *Samples v. Irving P. Krick, Inc.*[45] arose out of actions by landowners who claimed damages from a cloudburst and flood that occurred coincident with defendant's seeding operations. The plaintiffs claimed that the defendant was negligent in seeding under the existing weather conditions. A jury gave verdicts for the defendant and the court issued no opinion. In *Pennsylvania Natural Weather Ass'n v. Blue Ridge Weather Modification Ass'n*,[46] the court denied a request for an injunction against a hail suppression program because the plaintiff failed to show more than a possibility of harm.

Because of the primitive state of knowledge and technology concerning the efforts of weather modifiers, it is unlikely that future plaintiffs in similar cases will be able to surmount the difficulties of proof which faced the plaintiffs in these cases. One obvious issue that arises, then, is that of the possible application of the doctrine of strict liability on the theory that weather modification is an ultrahazardous activity. If this theory were accepted with regard to weather modification activities, a plaintiff would be freed of the necessity of showing

[44] The cases are discussed or summarized in Taubenfeld Report, supra note 1, 50-70, and in Sewell Report, supra note 3, at 281-83. See Davis, supra note 31, at 43-44.

[45] Civil Nos. 6212, 6223, and 6224 (W.D. Okla. 1954).

[46] 44 Pa. D. & C.2d 749 (C.P. Fulton County 1968).

fault on the part of the modifier, a particularly difficult matter when dealing with a technology in its infancy. A plaintiff would merely have to show a causal connection between the loss suffered and the risk caused by the modifier.

The application of this doctrine was avoided in the case of *Adams v. California*.[47] It is noteworthy that the defense in the *Adams* case was able to prove that the rainmaking activities of the modifier, although presumably successful, did not contribute to a disastrous flood which caused plaintiff's loss. It was shown that rain presumably caused by defendant's activities was totally impounded in a lake that did not overflow. Thus, it would seem that even if the doctrine of strict liability had applied, there would have been no causal relationship between the induced rain and the damage. In the view of Prosser[48] and the American Law Institute[49] this would seem to be an adequate defense. In the context of the *Adams* case, at least, the application of the doctrine of strict liability probably would not have led to an unfair burden on the modifier.

The novelty of the technology and the limited fund of knowledge concerning weather and its modification, viewed in light of its great potential for harm, lead one to conclude that this is an area in which the theory of strict liability should indeed apply.

Roscoe Pound has provided a valuable historical perspective in which to place this question. He noted that toward the end of the 19th century certain departures from previously-held fundamental ideas in jurisprudence became manifest, one of which was an increasing tendency to find liability without fault.[50] He indicated that an important motive behind this change in attitude was an evolving higher valuation of persons over property. Thus, in weather modification litigation, to insist on a strict burden of proof for the plaintiff seems regressive in nature.

Of course, it might be claimed in some cases that the conflict is properly viewed as being between personal rights and science, and that the latter is a value deserving of higher consideration by the law. This seems to be implicit in the position that has been advanced by the Special Commission on Weather Modification.[51] Nevertheless, individuals likely to be injured by weather modification activities are not likely to be well represented in the decision making which will

[47] No. 10112 (Super. Ct. Sutter County, Cal., April 6, 1964).

[48] W. Prosser, Law of Torts 532-33 (3d ed. 1964).

[49] Restatement of Torts § 519 (1968).

[50] 1 R. Pound, Jurisprudence 445-46 (1959).

[51] See, e.g., the recommendation of the Special Commission that federally supported experimenters should be indemnified and immunized from interference by state and local government. Special Commission Report, supra note 3, at 111.

ultimately lead to state or federal sponsorship, or to the licensing of weather modification. If the courts do not recognize weather modification activities as being ultrahazardous, this might deprive such persons of all reasonable hope of influence over important decisions affecting their own lives and property.

Of course, modification activities are imaginable in a variety of circumstances. A licensed experiment by competent researchers in remote, sparsely populated areas would be quite different from a commercial operation under contract to a single business in a heavily populated urban area. It is quite conceivable that the rationale of *Rylands v. Fletcher*[52] would apply the principle of strict liability to the latter situation and exempt the former. The difference is, of course, between the usual and normal and the exceptional and abnormal.[53]

The first reported weather modification case is *Slutsky v. City of New York*.[54] This involved a conflict between a resort owner's desire for clear weather and the city's desire, or demand, for rain for its reservoirs. The plaintiff resort owner sought an injunction against the city's modification attempts, claiming that the experiments would cause inundations, and that the actual or threatened rainfall would harm the resort business. The court applied a somewhat crude benefit analysis and entered upon a comparison of claimed benefits. The resort owner's business interest was compared with the need of the city and its millions of residents for water and, when put this way, the result was not in doubt. The court did not purport to conduct a cost-benefit analysis, and thus did not attempt to consider the total costs of the modification attempts.

The court stated that experts for the city had shown that the modification experiments had reached a stage where it might reasonably be expected that rainfall would be induced and controlled. It then proceeded to the question of balancing interests:

> This court must balance the conflicting interests between a remote possibility of inconvenience to plaintiff's resort and its guests with the problem of maintaining and supplying the inhabitants of the City of New York . . . with an adequate supply of . . . water.[55]

In dicta, the court referred to plaintiff's lack of "vested property rights in the clouds or the moisture therein" as a defect in his suit.[56] But what was the warrant for the manipulation of the weather by the

[52] L.R. 1 Ex. 265 (1866).
[53] W. Prosser, supra note 48, at 520.
[54] 97 N.Y.S.2d 238 (Sup. Ct. 1950).
[55] Id. at 240.
[56] Id. at 239.

city? The court did not amplify. The court's conclusion appears to flow simply from its perception of the extreme need of the city for water.

The *Slutsky* case might serve as an illustration of the limitations of any system in providing for the settlement of disputes involving a comparatively small number of interests or interests of limited scope. It is possible to agree with the suggestion that the plaintiff had no vested property interests in the state of natural weather without agreeing with the result. It was the city, after all, that was seeking to modify a natural process, and it is doubtful whether the proponents of such change should inevitably prevail upon a showing that those challenging the proposal lack property interests in the process in question. There is a general interest in seeing that ill-founded interventions with natural processes are not approved routinely. Of course, the regulation of such matters would seem to be something for institutions other than the courts. But, in the absence of conflicting statute or regulation, it would seem appropriate for courts to consider private litigants as representative of the public interest to the extent that such litigants can show, in addition to a private cause of action, that a proposed intervention is not in the best interests of society.[57]

Southwest Weather Research, Inc. v. Jones[58] involved a dispute between ranchers and farmers over a hail suppression seeding program sponsored by the farmers. The ranchers claimed that the program suppressed rain as well as hail and thereby damaged their lands. The Supreme Court of Texas sustained the trial judge's action in granting an injunction *pendente lite* against the program as not being an abuse of discretion.

The Court of Civil Appeals of Texas had substantially sustained the trial court earlier, and issued a thoughtful opinion in the matter, after concluding that there was ample evidence in expert and lay testimony that the actions of the defendants did dissipate clouds over the property of the plaintiffs, and that temporary restraint against such actions was appropriate. The court appeared to suggest that a natural right theory might apply: "We believe that under our system of government the landowner is entitled to such precipitation as Nature deigns to bestow."[59]

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[57] This proposal is suggestive of action in the public interest by a private litigant against an illegal act by a government agency where the litigant is acting in the capacity of a "private attorney general." Under this theory, advanced by Frank, J., in Associated Indus. v. Ickes, 135 F.2d 694 (2d Cir. 1943), the private litigant must act pursuant to an authorizing statute.

[58] 160 Tex. 104, 327 S.W.2d 417 (1959).

[59] Southwest Research, Inc. v. Duncan, 319 S.W.2d 940, 945 (1958). Companion case, Southwest Research, Inc. v. Rounsaville, 320 S.W.2d 211 (1958). Both aff'd sub nom., Southwest Weather Research, Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959).

Thus, the opinion of the Texas court, while contrary to the New York court in *Slutsky*, also avoids any competing benefit or cost-benefit analysis. It is based upon a traditional common law approach, the finding of a right attached to land with no clear suggestion that the right is anything but absolute. The court did emphasize, however, that it was dealing with a purely private dispute, and that there was no regulation or state or federal agency involved. Quite conceivably, therefore, the reasoning of the court might have differed had it been presented with some public interest expressed through legislation or regulation.

The opinion of the Court of Common Pleas of Fulton County in the *Pennsylvania Natural Weather Ass'n* case, alluded to above, is the most comprehensive judicial treatment of some of the principal issues involved in weather modification. Essentially, the court denied a requested injunction against a program of commercial hail suppression on the dual grounds that no more than a mere possibility of harm from the activities of the defendants was shown, and that the plaintiff had an adequate remedy at law. The former ground was based upon Pennsylvania law to the effect that the drastic remedy of the injunction would not be granted in the face of a mere possibility of harm. There must be clear and convincing evidence of an intended or threatened injury which must be practically certain.[60]

Despite this result, the court included in its opinion a discussion of theories of ownership and use of land, air and clouds. With regard to the plaintiff's land title, the court seemed to suggest the natural right theory that land ownership includes as one of its natural incidents the right to receive weather in its natural forms. The court then argued that if this were so, it must necessarily follow that such a landowner has some right in the clouds or to the moisture in the clouds. The court criticized the conclusion of the *Slutsky* case that the resort owner had no such rights. Following this discussion, the court proceeded to a consideration of the Aeronautical Code of Pennsylvania,[61] of leading federal litigation over the question of air rights,[62] and of Pennsylvania air pollution litigation,[63] to suggest various theories such as a qualified *ad coeleum* doctrine and simple negligence upon which protection of the plaintiff's interest could be based. Then, the court concluded:

> We are of the opinion that clouds and the moisture in the clouds, like air and sunshine, are part of space and are com-

[60] See W. Prosser, supra note 48, at 624.

[61] Pa. Stat. Ann. tit. 2, § 1460 et seq. (1963).

[62] United States v. Causby, 328 U.S. 256 (1946); Hinman v. Pacific Air Transp., 84 F.2d 755 (9th Cir. 1936).

[63] Hack v. Beryllium Corp., 424 Pa. 140, 226 A.2d 87 (1966).

> mon property belonging to everyone who will benefit from what occurs naturally in those clouds. There could be just as much injury or harm from weather modification activities as there could be from air and water pollution activities. We hold specifically that every landowner has a property right in the clouds and the water in them. No individual has the right to determine for himself what his needs are and produce those needs by artificial means to the prejudice and detriment of his neighbors.[64]

The court then qualified this with the statement that beneficial effects from weather modification are possible, and that modification in the public interest and under the direction and control of government authority should be permitted.

Thus, in *Pennsylvania Natural Weather Ass'n* is found the suggestion of a theory of common property rights in natural weather processes susceptible to individual action for protection. The court's view is in sharp contrast with that espoused by the New York court in *Slutsky*, where the presumed lack of individual property interests in weather was important in the plaintiff's failure to prevail.

The broader issue of whether the earth and its atmosphere can withstand still further interventions by man and his technology is a question that does not seem to have been explicitly or consciously faced by the courts in these cases except through the suggestion that this might be a subject for legislation. But the present day has, as one of its "felt necessities,"[65] a need for the understanding and control of technology, particularly the side effects that hitherto do not seem to have concerned the progenitors of technical developments. In pursuit of this, courts should have brought before them in weather modification disputes the fullest possible exposition of evidence concerning the long-term interests of society and the long-term effects of modification efforts.

IV. Competing Policy Considerations in Weather Modification

The cases discussed above involve a conflict between those opposed to weather modification and those involved in commercial

[64] 44 Pa. D. & C.2d 749, 759-60 (C.P. Fulton County 1968).

[65] The reference is, of course, to Justice Holmes' famous opening of The Common Law. It bears repetition here:

> The life of the law has not been logic: it has been experience. The felt necessities of the time, the prevelant moral and political theories, institutions of public policy avowed or unconscious, even the prejudices which judges share with their fellow-men, have had a good deal more to do than the syllogism in determining the rules by which men should be governed.

O. Holmes, The Common Law 1 (1923).

activities. They do not raise the question of conflict between natural weather advocates and those who favor scientific experiments in the field. Large-scale government-supported modification attempts, such as hurricane diversion,[66] are more likely to be viewed as scientific experiments, and many future conflicts will involve government-supported experiments such as these. Disputes over this type of experiment will undoubtedly call into question basic scientific values, such as the claims to freedom of experimentation and of scientific inquiry.

It was observed in the preceding section that the traditional methods of dispute settlement between two parties involving only local considerations would not necessarily lead to the best basis of settlement from the societal point of view. This section will examine those competing policy considerations in weather modification research and operations that might be overlooked in typical litigation.

What should be the attitude of the law and the policy makers toward weather modification? Some of the literature discussing the legal and other problems involved in weather modification appears to embody the point of view that one of the more important tasks for lawyers in this field is to work for the creation of a receptive legal climate for the work of the modifiers and the experimenters. Thus, a 1967 conference on the subject of weather modification, which included both scientists and lawyers, expressed a concern over the dangers of inhibition of experimentation by courts and legislatures even though the conference also appeared to recognize that weather experimentation was substantially unpredictable in its results.[67] The possibility that weather modification might alter the broad psychological outlook of some people was advanced at this conference, but it was agreed that there should be no inhibiting legislation enacted on this account.[68]

Possibly the most explicit and far-reaching expression that the law should favor this field of research is found in the report of the Special Commission on Weather Modification.[69] The Special Commission stated in part:

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[66] Project Stormfury was established in 1962 as a federal government project for hurricane research and modification. L. Battan, Harvesting the Clouds: Advances in Weather Modification 114 (1969) [hereinafter cited as Battan].

[67] Weather Modification and the Law (Taubenfeld ed. 1968).

[68] Id. Generally, of course, the law would require a physical invasion to redress injuries through damages. However, in recent decades, American courts have shown some willingness to find liability for mental stress where conditions of extreme outrage are attributable to the defendant's conduct. See generally W. Prosser, Law of Torts (3d ed. 1964) and Restatement of Torts § 46 (1965).

[69] Weather and Climate Modification: Report of the Special Commission on Weather Modification to the National Science Foundation (1965) [hereinafter cited as Special Commission Report].

> Fulfillment of the objectives of the program recommended in this report requires that research have a very high priority. This means that State and local legal rules cannot be permitted to interfere with research objectives. Interference can be of two kinds. First, the local rules may impose liability for injuries caused by research projects; the threat of liability may act as a deterrent to researchers. . . .[70]

Then, with reference to the possibility of injunctions, the report asserted:

> Provision should be made to ensure that all properly conducted experiments including those conducted by contract or grant should be immune to local interference.[71]

There is also some indication that the scientific community, or a portion of it, is inclined to scoff at those opposed to weather modification. The legal report to the Special Commission on Weather Modification described groups hostile to researchers, experimenters and commercial operators as "irate uninformed local publics."[72] The legal report was based upon questionnaires sent to state governments, research and experimental organizations, commercial operators and federal agencies. No private groups of citizens which may have been opposed to weather modification appear to have been included in this survey, and, other than the fact that this seems to have been the opinion of numerous respondents, no substantial basis for the description of the opposition as "irate and uninformed" appears.[73]

The opposing view to that of total freedom for experimentation is that weather modification operations and experiments in the field should be brought to a halt.[74] Presumably this viewpoint is held by some members of the "irate publics." Before concluding that every-

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[70] Id. at 109.

[71] Id. at 110.

[72] H. Taubenfeld, Weather Modification Law, Controls, Operations, Report to the Special Commission on Weather Modification of the National Science Foundation 5-6 (1966) [hereinafter cited as Taubenfeld Report].

[73] It seems quite possible that groups hostile to the commercial operators and the experimenters are well informed as to the modification attempts in the sense that there is an appreciation of the unpredictability of the technology being used. Thus, the hostile groups may have very sound reasons for being irate.

[74] Oppenheimer has suggested a spectrum across which possible legal attitudes toward weather modification might be arranged. At one extreme, a land owner would have complete natural rights and modification would be totally prohibited. At the opposite extreme, weather would be treated as oil, gas or wild animals, subject to private appropriation, with liability only for negligence or nuisance. A middle ground would balance the safety of society with the advance of science, and permit a reasonable invasion of airspace for modification activities. Oppenheimer, The Legal Aspects of Weather Modification, 1958 Ins. L.J. 314, 320-21 (1958).

one opposed to weather modification is an unlettered rustic, it is necessary to note that the World Meteorological Organization has expressed the view that *climate* modification should not be attempted at the present time.[75] Also, a working group of the Ecological Society of America has expressed a very skeptical view concerning the net effects of weather modification, and stated that large-scale operations, from a biological point of view, should not be undertaken with the present state of knowledge.[76]

With these points of view in mind, some of the arguments made by the proponents of modification experimentation, such as the apparent suggested abrogation by the Special Commission on Weather Modification of all state tort law, do give one pause. The phrase "freedom for experimentation" has been advanced as part of a request for federal indemnification.[77] Also, it is argued that "weather research needs the laboratory of nature . . . ."[78] It is with respect to this point that a fundamental distinction exists between much of modification research and most laboratory science. The modifier's laboratory of nature is mankind's planet, and no amount of rhetoric concerning freedom of scientific inquiry can change this. The fact is that severe injury, damage and fatalities involving persons and property unrelated to the experiment are possible as a result of experimentation in this particular laboratory.

If there is a general right of experimentation, the right, as with all similar rights to engage in useful activity, should be qualified and made generally subject to the law. To exempt an entire category of human activity, such as research or experimentation, from the traditional concepts of liability for tortious acts, would be in this instance an extraordinary step without any clear showing of necessity or utility.[79]

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[75] "Before undertaking an experiment on large-scale weather modification, the possible and desirable consequences must be carefully evaluated, and satisfactory international arrangements must be reached." World Meteorological Organization Third Report on the Advancement of Atmospheric Sciences and Their Application in the Light of Developments in Outer Space (1964).

[76] Special Commission Report, supra note 69, at 69. To this, the meteorologist Battan asserts that the need for greater amounts of fresh water is likely to overwhelm the need for better understanding. See Battan, supra note 66, at 134.

[77] See, e.g., Special Commission Report, supra note 69, at 95: "Freedom for Experimentation: In order to permit field experiments . . . it is essential to provide for indemnification of investigators . . . ."

[78] Taubenfeld Report, supra note 72, at 5. However, much can apparently be accomplished by way of computer simulation. As the size of the modification simulation increases, however, computer capacity becomes a limiting factor. It is conceivable that future generation computers will be able to simulate global atmospheric systems. See generally National Science Foundation, Weather Modification 91-101 (Tenth Ann. Rep. 1968) [hereinafter cited as Tenth Annual Report].

[79] One of the reforms of Solon in ancient Athens was to enable larger numbers of persons to have recourse against those who caused them injury. By this, it was said,

By analogy, medical experimentation is a distinct and equally important area of scientific investigation. Although the goals, methods and scale of operations of weather and medical experimentation differ greatly, the two fields have important similarities, and it is possible that the experience gained in the field of medical experimentation might be of value to the present study. Of immediate interest is the fact that medical experimentation also involves the possibility of direct harm to the person and yet co-exists with the law, albeit somewhat uncomfortably.[80] Here, too, there seems to be a measure of disagreement, in this case by segments of the medical profession, with the legal restrictions on experimentation. One physician has put it as follows: "It has been most unwise to try to extend the principle of 'a government of laws, not men' into areas of such great ethical subtlety as clinical investigation."[81] This is most blunt and disturbing in its full implications. It is illustrative, however, of where the extreme freedom of experimentation position might carry us in at least one area of science and law.

In weather modification, as well as in medical experimentation, there is an implied claim by the experimenters of a right to engage in an activity that may prove injurious to property or human life. Of course, the principal justification for these activities will normally be that their results may be of extreme value to society and will outweigh any short-term or individual injury caused in experimental stages. In medical experimentation, a principal method of striking a proper balance and of securing a subject who will undergo the risk of injury or death for the benefit of society is by securing an "informed consent" to the experiment.[82] In the modification of the weather, an approach that has been adopted by some states is to grant a form of consent to experiments through licensing mechanisms by the government. This is not individual consent, however, and the licensing action by a state should not constitute a defense in liability actions by injured persons against weather modifiers.[83]

In many commonplace activities, as well as in medical experimentation, society approves of or permits activities to continue even though their costs, including personal injuries and death, may be quite

he intended "to accustom the citizens, like members of the same body, to resent and be sensible of one another's injuries." Plutarch's Lives 108 (Modern Library ed.).

[80] See generally Preface, 98 Daedalus No. 2 (1969).

[81] Jaffe, Law as a System of Control, 98 Daedalus 406 (1969).

[82] Freund adds that for liability-free medical experimentation, there must also be the exercise of due care in the experiment, and the experiment itself must be sound in the sense that the possible results must not be disproportionate to the known risks. Freund, Legal Frameworks for Human Experimentation, 98 Daedalus 321 (1969).

[83] Legislation in Washington with regard to licensing of modification operations explicitly disclaims any intent to affect private liability questions. Wash. Rev. Code Ann. § 43.37.190 (1970).

substantial. One commentator cites the continued use of grade crossings, automobiles and aircraft as examples.[84] Such examples as the use of automobiles traditionally have at least four conditions attached to them, however, which for one reason or another make them tolerable to society: (1) they are necessary for some positive value; (2) the persons threatened by their continued operation are virtually unidentifiable in advance; (3) the cost of avoiding adverse effects would be quite high and, accordingly, is regarded by society as unacceptable;[85] and (4) it is possible for individuals to take reasonable steps to avoid some danger by conscious safe driving habits, avoidance of flights in bad weather, and similar action.

In the case of weather modification, consideration of the first factor, the existence of positive value, would involve seeking possible alternatives to weather modification such as improved forecasting, irrigation, saline water purification, development of drought-resistant crops, improved forest-fire protection systems, and improved construction or design in areas historically threatened by violent weather. Further research on the effects of present day modification activities and their direct and indirect consequences might provide information that would remove the second condition, the anonimity of potential victims, as a factor tending to favor the public toleration of modification: that is, persons or groups potentially threatened might have more reasonable bases in fact to regard themselves as threatened than at present. With regard to the third factor, the prohibitive cost of avoiding harmful effects, it would seem that now, during the infancy of modification technology, the costs of avoiding the adverse effects of weather modification are lowest. It is only after large investments are made in a technology, such as the automobile or the jet engine, that change becomes expensive. The fourth factor, the ability of individuals to avoid the dangers of weather modification, is, of course, a function of many variables. For the present, however, it should be noted that the ability of persons to avoid adverse effects would seem to diminish as the change in weather becomes more permanent. Also, as suggested above in connection with the discussion of tribal societies, the ability to avoid the adverse impacts of weather modification will vary greatly between individuals and groups because of the varying degrees of dependence on, or sensitivity to, natural weather.

All of the foregoing considerations might, with the passage of time and further research, provide the focus for the more refined development of major legal and political issues regarding weather

[84] Calabresi, Reflections on Medical Experimentation in Humans, 98 Daedalus 387 (1969).

[85] Id. at 389-90.

modification operations and research. The reasonableness of a researcher's claim to the use of the natural laboratory of nature would be subject to serious question, for example, if it could be shown that an improvement in the accuracy of weather forecasts could achieve the goals of a particular modification experiment and at a smaller cost. Similarly, if plaintiffs seeking injunctions against precipitation enhancement experiments or operations were able to show with reasonable certainty that the defendant's action would deprive the plaintiff's land of moisture, the likelihood of favorable court action would be increased. Similarly, there is an increasing public awareness of the formerly hidden costs to society of such things as automobile pollution and personal injuries caused by poor design. This awareness might translate eventually into an insistence that such costs be borne by the users and producers of the particular instrumentality. In the case of weather modification, this would, of course, increase the burden on modifiers of showing the net value of their activity.

On the scale of *local* weather modification, the issues may often seem to be clearly perceptible. Positive values such as fog suppression around airports and highways, tornado and lightning suppression in general, hurricane diversion, and rainfall enhancement or suppression may be quite obvious depending upon the locale to be benefited and the presence or absence of harmful indirect effects. Similarly, potential negative effects may also be obvious. In the case of fog suppression, there may be crop or forest land nearby with a dependence upon the moisturizing effect of fog. This, of course, would lead to a clear conflict between the adjacent landowners, and might suggest one further reason for some form of rational weather modification planning in the United States. If we discard or fail to adopt a natural rights theory of weather under which the land owner is entitled to the receipt of weather untouched by man-made interference, any substitute theory would have to include some attempt at defining the best use of land,[86] which could significantly affect the question of whether or not to modify the weather. In the case of hurricane diversion there may be a similar conflict between the avoidance of destruction by a seacoast area spared the hurricane's path, and an inland area dependent upon the moisture that is normally delivered to it by seasonal hurricanes or their overland remnants.

These are the most obvious issues. The best resolution of these

[86] For example, under the British Town & Country Planning Act, 1947 (1 & 2 Eliz. 2 c. 16) anyone proposing "development," defined as including the carrying out of any "operations in, on or over or under land," must obtain planning permission. Conceivably, disputes concerning modification could be resolved by a referral of the proposed use to the plan which would be periodically renewed. See generally R. Megarry & H. Wade, The Law of Real Property 951-52 (1957).

conflicts will remain unclear as long as the question of secondary effects is unsettled. The fact that potential local conflicts might be readily subject to resolution through agreement, litigation, or even well-intentioned legislation or administrative action, does not in the present state of knowledge give any assurance that the interests of society in avoiding harmful interference with natural weather processes will be protected.[87]

V. Methods and Standards of Control

Weather is vital to mankind, and there is a common interest in seeing that it is not subjected to unnecessary interference by man. It should not be subject to unilateral appropriation or interference by any interest. Where intentional modification or experimentation occurs, every precaution should be taken to avoid interference with the proper claims of others to the use of natural weather.

There is a considerable tradition in positive law and in the writings of commentators that provides well-defined conceptions which might prove relevant in seeking the above objectives. Weather would seem to fall within that category of substances that legal systems have traditionally recognized as not being subject to appropriation as private property. A concept of common property, or of substances not subject to appropriation, appears in Roman law.[88] The principle of permitting common use of such a substance, without its impairment, is also found in the common law and is described in Blackstone, as follows:

> But, after all, there are some few things, which, notwithstanding the general introduction and continuance of property, must still unavoidably remain in common; being such wherein nothing but usufructuary property is capable of being had; . . . Such (among others) are the elements of light, air and water. . . . All these things . . . every man has a right to enjoy without disturbance; but if they escape from his custody, or he voluntarily abandons the use of

[87] Hail suppression has been described as an area of modification activities in which everyone wins and no one is hurt. The basis for this contention is that a properly conducted experiment on suppression merely eliminates the hail but not the precipitation. Weather Modification and the Law 205 (Taubenfeld ed. 1968). However, nearly all hail suppression in the United States is attempted with massive doses of silver iodide. Tenth Annual Report, supra note 78, at 42. Thus, while local agreement that hail suppression is desirable might easily be achieved, the long-term interests of society might be ignored through repeated release of chemical pollutants into the atmosphere, a rather typical occurrence in the history of environmental pollution.

[88] The air, running water and the sea were, by the law of nature, considered common to mankind, and *res communes*. Justinian, Institutes 90 (Sandars 9th ed. 1898); R. Sohm, The Institutes, A Textbook of the History and System of Roman Private Law 303 (3d ed. 1907).

> them, they return to the common stock, and any man else has an equal right to seize and enjoy them afterwards.[89]

To apply a common resource concept to natural weather processes would not be rigid adherence to archaic tradition, but a common sense recognition of the importance of weather to mankind.

A. *A Concept of Public Trust*

Pound found, with regard to natural resources, a historical tendency to shift from a viewpoint of *res communes* and *res nullius* to that of *res publicae*. In this shift, he saw an increased tendency on the part of the law to protect natural resources and to recognize that in an increasingly crowded world, acts which tend to destroy or waste natural resources should be restrained.[90] Thus, common assets such as wildlife and running water are regarded as not falling within a total legal void, but as being assets of the state or of society, incapable of being subject to private appropriation, except under such regulation which protects the social interests in their use and consumption.[91]

The above thinking might find contemporary expression with regard to governmental weather programs in a public trust concept. Under this concept, the government is held to a high standard of trust in its administration of certain of its property. In the leading case of *Illinois Central R.R. v. Illinois*,[92] the Supreme Court held void a grant by the Illinois legislature of certain submerged lands under the navigable waters of Lake Michigan. The Court found that the lands were held in trust for the people of the state, and that the grant to a railroad was in violation thereof.[93]

Of course, a state government must be capable of divesting title to much of the property that comes into its possession, and the case presents, among other problems, the difficulty of determining what category of property is subject to the trust concept. It is apparent from a reading of the case that the Court could not accept the magnitude of the property interest that the state sought to alienate. Great emphasis was laid by the Court on the size and importance of the submerged lands under Chicago harbor which would have passed into private hands. The trust, it was suggested, was governmental in

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[89] 2 W. Blackstone, Commentaries 480 (Lewis ed. 1900).

[90] 3 R. Pound, Jurisprudence 305 (1959).

[91] 1 R. Pound, Jurisprudence 449 (1959).

[92] 146 U.S. 387 (1892).

[93] Id. at 452. The case and the subsequent history of the public trust doctrine are discussed in Sax, The Public Trust Doctrine in Natural Resources Law: Effective Judicial Intervention, 68 Mich. L. Rev. 471 (1970).

nature, and the lands subject to the trust thus could not be permanently alienated.[94]

A concept of public trust as applicable to the federal government has never been enunciated. Thus, the doctrine of the *Illinois Central* case does not, in the present view, apply to the federal government. While the public trust concept was touched upon by the Supreme Court in the tidelands oil controversy of the post-World War II period, the result was to avoid the concept of a binding public trust.

The tidelands controversy involved a contest between the federal and certain state governments over the ownership and control of minerals found in coastal waters. In the opinions reported in connection with this controversy, the Supreme Court suggested that the public trust theory would not be held to be applicable to the federal government in a way that would permit judicial review of actions by the Congress.[95] Nevertheless, a trust of sorts was said to exist. In *United States v. California*,[96] the Court held that the federal government, with reference to the three-mile marginal belt of sea in question, had "paramount rights in and power over that belt, and incident to which is full dominion over the resources of the soil under that water area, including oil."[97]

In reaching this conclusion the Court uttered two concepts of probable application to natural weather processes. It said that the political claim of the executive to the three-mile belt was binding on the Court,[98] and that the question of control and protection against harm to this particular resource was inherently an international question, thus necessitating resolution of the state-federal conflict in favor of the federal government.[99] In answer to a claim by the state that federal representatives had waived any rights the federal government may have had, the Court stated that, even assuming government agencies had been negligent, a waiver was impossible because the interests in the resources were held "in trust for all the people" by the government.[100]

Subsequently, Congress enacted the Submerged Lands Act of 1953,[101] by which it ceded the marginal three-mile belt and its natural resources to the coastal states. Here was presented a possible test of

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[94] 146 U.S. 387, 455 (1892).

[95] United States v. California, 332 U.S. 19 (1947); United States v. Texas, 339 U.S. 707 (1950); United States v. Louisiana, 339 U.S. 699 (1950). For a critical discussion of these cases, see E. Bartley, the Tidelands Oil Controversy (1953).

[96] 332 U.S. 19 (1947).

[97] Id. at 38-39.

[98] Id. at 34.

[99] Id. at 35.

[100] Id. at 40.

[101] 43 U.S.C. § 1301 et seq. (1964).

a federal public trust theory. Alabama and Rhode Island duly filed motions in the Supreme Court for leave to file their complaints to challenge the constitutionality of the Act, but the Court denied the motions *per curiam* with a reference to Article 4, Section 3, Clause 2 of the Constitution.[102]

In a concurring opinion, Justice Reed elaborated on a possible public trust theory, but indicated his agreement with the apparent view of the Court that the authority of Congress with regard to "other Property belonging to the United States" is supreme: "The United States holds resources and territory in trust for its citizens in one sense, but not in the sense that a private trustee holds for a *cestui que trust*."[103]

Neither Justice Black nor Justice Douglas in separate dissents were willing to make so sweeping a declaration, and both raised the question of what the Court would do were the Congress to "sell" the Mississippi or the Columbia or one of the other great navigable rivers of the nation.[104] It is apparent that the Court was influenced in its decision not to hear the challenge to the disposal of the submerged lands by the fact that an Act of Congress was at issue, and by the language of the Constitution which, in the Court's view, creates an enclave for congressional supremacy. If this is a correct view of the Court's action, it might leave the Executive's execution of its programs open to challenge on a trust theory where no challenge to legislation is involved.[105]

The peculiar nature of weather would seem to indicate that concepts of trust and proprietary interest do not present likely bases for challenges to some federal actions concerning the weather. Reference to tort law will more likely be made by litigants seeking redress against the effects of federal support of weather modification. Nevertheless, the rhetoric of trust law is often used with regard to governmental administration of natural resources, and it is not without value to examine policy questions of weather modification in connection with a public trust theory.

Under what conditions could the licensing or financial support of experimentation be regarded as constituting a violation of trust or

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[102] Alabama v. Texas, 347 U.S. 272-73 (1954). The clause in question reads: The Congress shall have power to dispose of and make all needful Rules and Regulations respecting the Territory and other Property belonging to the United States.

[103] 347 U.S. 272, 277 (1954).

[104] Id. at 280, 282.

[105] Conceivably, a particular trust could be implied by the terms of a statute. Cf. Mississippi Valley Generating Co. v. United States, 364 U.S. 520 (1961), in which the Court found a contractual remedy for the United States in a statute that was silent on the point.

an improper alienation of public property rights in the weather without concomitantly adequate protection of the social interest? With regard to commercial weather modifiers actively seeking to modify weather for a single client's interest, it would be difficult under public trust theory to see an adequate justification for granting a governmental license where it can be shown that the modifying activity is objectionable to others. The modifying party and approving agency normally could not show that they are not interfering with the common use and enjoyment of the weather by others. A properly cautious attitude toward environmental alteration would seem to dictate that the proponent of the alteration, such as a commercial modifier, bear the burden of proof in license proceedings that its actions will not harm others.[106] The modifier is the proponent of the action and will normally occupy, or should occupy, a position of superior knowledge concerning the technology and science in question.

The question becomes more difficult when a proposal for scientific experimentation is tested in the light of the public trust theory. The claim of the experimenter would presumably be accorded a higher value than that of the commercial modifier, particularly if the experiment is a broadly-based attempt to secure as much knowledge as possible and is surrounded by proper safeguards.

B. *Legislation and Administrative Responsibility*

A major consideration will be that most large experiments will be supported by federal funding through the direct action of a federal agency or through a federal grant or contract. Where this happens, any attempt by the states to regulate modification might run afoul of traditional considerations of federal supremacy.[107] There can be no question that in supporting modification experimentation, federal agencies should assume a large measure of responsibility for conducting a proper experiment and for maintaining a reasonable balance between the value of a successful experiment and the risks involved.

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[106] Colorado seems to have taken a step in this direction by requiring that the license applications demonstrate "skill and experience reasonably necessary to the accomplishment of the weather control without actionable injury to property or person." Colo. Rev. Stat. Ann. § 151-1-6 (1963). Other states have established more limited requirements for licenses such as a showing of past experience, scientific qualifications, and the area and timing of proposed operations. See, e.g., Ariz. Rev. Stat. Ann. § 45-2403 (1956); Fla. Stat. Ann. § 403.311 (1970 Supp.).

[107] Federal contractors have been held immune from state licensing statutes, Leslie Miller, Inc. v. Arkansas, 352 U.S. 187 (1956); and state minimum price regulation, Paul v. United States, 371 U.S. 245 (1963), where such state action was found to conflict with an explicit policy of Congress expressed by statute. Of course, there could be voluntary consent by the federal government to its support of modification experimentation being subject to state law.

This should be so regardless of whether or not technical concepts of public trust doctrine apply to the federal government.[108]

In medical research, supporting federal agencies have taken the step of subjecting proposed medical experiments to terms and conditions designed to insure the safety and well-being of the subjects of the experiments.[109] A similar judgment seems necessary by any federal agency approving financing for weather modification experimentation. In order to exercise this judgment, such agency should first establish some reasonable measure of the value of the experiment, including a cost-benefit analysis where the necessary factors can be ascertained, and including explicit articulation of unknown or unquantified costs or benefits that might be expected from the project. Also, the agency should consider standards for scientific experimentation, including standards of ethics promulgated by private scientific societies. Most important of all, in the consideration of federal support for weather modification experimentation, congressional expressions in the environmental field should control.

In the National Environmental Policy Act of 1969,[110] Congress expressed policy preferences that might be difficult to reconcile with large-scale weather modification programs. A harmony between man and his environment, improved understanding of ecological systems, a trusteeship for posterity, preservation of historic, cultural and natural aspects of our national heritage, and the maintenance of an environment supportive of diverse and individual choice, are among the principal purposes and goals of this legislation.[111]

Proponents of weather or climate modification programs might well argue that their programs will actively assist in the achievement of some or all of the above goals. However, the Congress has in effect placed a burden of persuasion upon advocates of new programs that might be extremely difficult to sustain. Congress has stated that if there is substantial doubt as to the entire effect of a new program,

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108 There is a long history in federal procurement practice of subjecting the procurement contract to numerous social and economic policies which are based upon either legislative or executive policies. See generally Pearson & Whelan, Underlying Values in Government Contracts, 10 J. of Pub. L. 298 (1961).

109 In the case of the National Institute of Health, individual assurances from institutional grant recipients are required. The assurances relate to the grantee's warrant that certain standards and procedures are observed in medical experimentation that are designed to safeguard the rights and well being of the subjects of the experiments. In December, 1966, the Surgeon General issued a clarifying statement regarding earlier guidelines, and stated that the grantee institution is also responsible for complying with the laws of the community in which the experimentation takes place. Curran, Governmental Regulation of the Use of Human Subjects in Medical Research: The Approach of Two Federal Agencies, 98 Daedalus 542, 577 (1969).

110 P.L. 91-190 (1970), 83 Stat. 852.

111 Id.

then, at the very least, the proponents should report that fact. Specifically, the proponents in federal agencies of "legislation and other major Federal actions significantly affecting the quality of the human environment" shall include in their legislative recommendations or reports a statement on unavoidable adverse environmental impacts, alternatives to the proposal, the relationship between long and short-term considerations, and any irreversible and irretrievable commitments of resources involved if the proposal is supported.[112] It is clear that many modification attempts will significantly affect the environment, and that all of these factors will have to be reported. If these factors are presently unknowable, then it would seem a clear implication of this legislation that this must be so stated. Of course, a great deal will depend on the manner in which this Act is interpreted and administered. If it is subject to reasonable interpretation, it is possible that certain of its provisions, such as the requirement for a report on possible irreversible and irretrievable commitments of resources, might be sufficient to delay or postpone indefinitely many questionable technological applications and programs.

C. *The Value and Limitation of Cost-Benefit Analysis*

Cost-benefit analysis is increasingly regarded as a useful tool for the examination of government programs,[113] and should assist in resolution of some issues of weather modification. It merits attention with regard to questions raised by the legislation discussed above and the ethical requirements discussed below.

One of the most obvious benefits that might flow from successful weather modification efforts would be the elimination of some of the destructive effects of weather. Estimates of the cost of annual weather destruction in the United States are quite high,[114] and substantial reduction of such losses might be obtained through weather modification. Thus, it has been estimated that annual losses from hurricanes might be reduced by as much as one-third by only modest reductions in storm intensity or slight changes in storm paths. Similar cost-benefit estimates have been made by a West Coast utility with respect to rainfall enhancement upstream of its dam, and by an airline with respect to fog dispersal.[115]

Although this is an inappropriate place for an extended discussion of cost-benefit analysis problems, some consideration of the

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[112] Id. § 102, 83 Stat. 853.

[113] See, e.g., National Science Foundation, Human Dimensions of the Atmosphere 50 (1968) [hereinafter cited as Human Dimensions Report].

[114] Estimated annual figures are $250 million for tornadoes, $200 million for hurricanes, and $290 million for floods. Id. at 103.

[115] Special Commission Report, supra note 69, at 86-87.

subject is valuable. Courts and legislatures have historically relied upon evidence of the projected costs and benefits of proposed decisions, and improvement of these processes of forecasting is worth study. Often, in the case of courts, cost-benefit analysis has been a crude and intuitive process that is easiest to adopt in a novel situation such as that posed in a dispute over weather modification. Also it might appear in nuisance cases in an examination of the relative hardships to the plaintiff and defendant in deciding whether to abate an alleged nuisance.[116] For the problem of weather modification, cost-benefit analysis might attempt to assess the value of natural weather in a given area through a determination of what losses would occur to every interest in the area as a result of a given modification. All of these losses would have to be added to the direct costs of the modification project in order to arrive at an approximation of the *true cost* of the effort.[117]

In the *Slutsky* case,[118] it was shown that the New York court balanced the benefits presumed to flow from the defendant's activity to the millions living in the city against the possibility of loss to the resort owner and his guests. It is quite easy, by means of a comparative examination of the numbers of people involved and of the respective interests claimed by the competing parties (rain for life, as opposed to clear weather for a resort owner), to decide that the claim of the proponent of weather modification should prevail. Indeed, this may have been the proper resolution of the *Slutsky* case. The point raised here is that the New York court appeared not to consider the difficult and, under present knowledge and technology, probably unknown factor of indirect and long-term costs of the modification effort. Cost-benefit analysis, aided by greatly increased scientific knowledge, and competent trial counsel, could remedy this lack of thorough analysis in cases such as *Slutsky*.

In the case of hurricane diversion, the reduction of a substantial annual loss from storm destruction by a factor of one-third is likely to be very persuasive in any dispute over the possible merits of a hurricane seeding program. Accordingly, it is necessary to consider the sense in which loss from hurricanes, or any form of extreme

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[116] Restatement of Torts §§ 827-28 (1938).

[117] Such an analysis might illustrate a larger category of problems in the law and political processes—that of the rational balancing of competing interests. See generally Pound, A Survey of Social Interests, 57 Harv. L. Rev. 1 (1943), and a critical discussion of the difficulty of quantifying interests in J. Stone, The Province and Function of Law 361-64 (1950). Pound himself came to the feeling that the quest for an unvarying method of balancing given social interests was futile. See 3 R. Pound, Jurisprudence 100 (1959). In the event of a conflict between competing interests, one of which could be the protection of a natural resource, the best that could be hoped for was a reasoned choice. See Patterson, Some Reflections on Sociological Jurisprudence, 44 Va. L. Rev. 395 (1958).

[118] 197 Misc. 730, 97 N.Y.S.2d 238 (Sup. Ct. 1950).

weather, is caused by the weather itself. It has been argued that the relationship between the damaged property and the agent causing the damage is reciprocal, and that the so-called agent of the injury, such as a hurricane, is in no sense principally or solely responsible for the injury.[119] Many forms of weather are subject to fairly accurate long-term prediction, and the damaged property or injured person, by being in the storm's path, is as much responsible for the injury as is the storm. Thus, persons who knowingly build homes or businesses on flood or coastal plains, where it is known that serious flooding or destruction will occur periodically, seemingly accept the flood risk. The same is true of persons who construct in coastal areas known to be exposed to periodic hurricane danger.

These considerations demonstrate the necessity for the close consideration of alternatives to storm diversion activities. Improved construction, design and siting of buildings,[120] more public expenditure for weather forecasting, and the planning of cities to avoid known natural threats such as periodic hurricanes and flooding, all seem possible alternatives to weather modification. These alternatives must be considered when the direct value of weather modification proposals is in question, and the total cost of the proposal must be established to the best extent possible.

It is not unusual for analyses such as those used to arrive at potential savings through hurricane diversion to ignore the potential indirect effects of the proposal under consideration. Often this occurs because such effects are unknown. Thus, the analyses might be limited to direct effects on target areas and to the direct financial cost to the client ordering the modification.

Current thinking regarding economic analysis of the side effects of productive activity would compensate for this lack. Such analysis of indirect effects refers to them as "externalities," and argues for proper recompense for these where harmful and where they can be identified.[121] Because it is not always possible to identify external or indirect effects, it is often quite convenient for proponents of new technology to rely on such a state of affairs as a reason for proceeding with their program without attempting to account fully for its costs. Such an

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119 See generally J. Stockfisch, External Economies & Diseconomies, International Encyclopedia of the Social Sciences 269-70 (1968).

120 Some construction practices in coastal areas in the eastern United States are regarded as highly improper uses of land. An extensive storm in 1962 destroyed many coastal homes in New Jersey. Many homes were spared, however, where the natural protection of coastal dunes had not been destroyed by man through the destruction of dune grasses and breaching of the dune itself. See I. McHarg, Design With Nature 17 (1969).

121 J. Stockfisch, supra note 119, at 269-70.

attitude effectively ignores the side effects of the proposed technological intervention.

The law is often unable to cope with the problem of indirect effects, and, on occasion, dismisses them as *damnum absque injuria*.[122] The propensity of courts to require direct proof concerning quantifiable values is understandable because of the requirement of giving judgments in exact monetary terms. The use of evidence concerning easily quantifiable values, such as loss of profits, is easier for judges and juries because it provides seemingly exacting standards for decision, and frees the trier of fact from the difficult task of judging intangibles. It is nevertheless clear that the weighing of intangible and unquantifiable values will soon become more necessary. As already noted, there are limited signs that courts are willing to assume this task. In the well known *Scenic Hudson* case, the Court of Appeals for the Second Circuit required the Federal Power Commission to give consideration to matters of scenery, beauty and wildlife in connection with a challenge of a power construction project.[123] Although this case was based in large part on the legislative history of the Federal Power Act, the Supreme Court has already referred to it favorably, and without any such limitation.[124]

In the National Environmental Policy Act of 1969, the Congress addressed itself to the problem of protection of unquantifiable values in a somewhat oblique manner by directing that "all agencies of the Federal Government shall . . . identify and develop methods and procedures . . . which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision making along with economic and technical considerations."[125] Moreover, it is clear that in other sections of this legislation the Congress established general policies that will necessitate the protection of numerous explicitly designated values "such as esthetically . . . pleasing surroundings," that are not subject to quantification.[126]

This emphasizes important limitations on cost-benefit analysis. It is clear that litigation and questions of legislative policy in the

[122] See Davis, State Regulation of Weather Modification, 12 Ariz. L. Rev. 35, 48 (1970).

[123] 354 F.2d 608 (2d Cir. 1965), cert. denied, 384 U.S. 941 (1966).

[124] Association of Data Processing Service Organizations v. Camp, 397 U.S. 150 (1970). Resistance to the thinking in *Scenic Hudson* has already manifested itself, cf. Sierra Club v. Hickel, 433 F.2d 24 (9th Cir. 1970), cert. granted sub nom. Sierra Club v. Morton, 39 U.S.L.W. 3359 (U.S. Feb. 23, 1971), in which the court denied standing to a conservation group in a challenge to recreational and commercial construction in a national park. The *Data Processing* opinion was limited as dealing with litigation by a "competitor".

[125] P.L. 91-190 § 102(2)(B) (1970), 83 Stat. 853.

[126] Id. § 101(b), 83 Stat. 852.

field of weather modification, as well as in many other areas, will often involve issues of rights or values so superior or compelling that cost-benefit analysis of the question would be not only unnecessary but dangerous because it would involve the suggestion that the right or value in question is subject to quantification and impairment or destruction for a price. As was suggested earlier, some modification results conceivably would set in motion irreversible changes in society or would impair the biotic potential of numerous animal or plant species. Such changes could not be compensated for or repaired by any means known to man.

D. *The Role of Private Societies*

The ethical question of most importance posed for proponents of weather modification is the extent to which they are willing to accept responsibility for the results of their efforts. In large part, the difficulties that have been caused by science and technology stem from an inability on the part of society to perceive the consequence of the chain of events initiated by new techniques. Presumably, those with deeper perception and broader understanding of weather processes are better able to anticipate some of the results of weather modification programs, or are better able to perceive where anticipation of results is impossible. Because of this they bear a heavier responsibility in their advocacy of weather modification. The problem thus might become one of introducing weather scientists into a law-making role in the best possible manner. This is a type of concern that has been the subject of a great amount of discussion in the period since the end of World War II, and there is no need to expand on the proposal for scientific advisory bodies to be established at differing levels of government.[127] With regard to weather modification control, the inevitable proposal for the creation of a special administrative agency for this purpose has been made.[128] It is quite possible that, in due course, such an agency will be formed, but the numerous difficulties and limitations of present administrative agencies must not be overlooked in considering such proposals.[129]

There is no assurance that a newly-established agency charged

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[127] See, e.g., C. Snow, Science and Government (1960); Price, The Scientific Establishment, 31 Geo. Wash. L. Rev. 713 (1963); D. Price, Government and Science (1962).

[128] Corbridge & Moses, Weather Modification: Law and Administration, 8 Nat. Res. J. 207, 226 (1968).

[129] Rexford Tugwell has argued that the failure of federal regulatory agencies stems in part from the fact that the agencies are extra-constitutional. He would remedy this in his proposed constitution by explicitly bringing them into the basic law and by subjecting their activities to the supervisory powers of a "watchkeeper." See The Constitution for a United Republics of America; A Model for Discussion, 3 Center Magazine 37, 58 (1970).

with administration of the weather would not, in time, align itself with business and scientific groups who maintain professional enthusiasm for the exploitation of the very medium the agency is supposed to protect.[180] There is need for a constant vigil over environmental matters, even absent weather modification. It is questionable whether any governmental regulatory agency for weather modification control could long maintain the sense of purpose and vigor that would be needed to contest the numerous challenges it would face. Thus, along with the establishment of an administrative agency, there should be examined the question of measures that would act to check, spur or supplement the role of the agency as circumstances require.

Although it is somewhat conjectural, there might be a considerable part to play in the government of weather control matters for private scientific societies, such as the American Meteorological Society. While it is virtually impossible to demonstrate empirically that a practical delegation of government authority to a private society would be a valuable supplement to the authority of a public administrative body, there would probably be much to commend such a step. It is likely that a private society would be able to retain the best talent in the field, if only for part-time work. Although federal personnel policy and salaries have been liberalized in recent years, it is probably true that career choices of individual scientists tend to favor the private sector.[181] If the talent is effectively employed, a private non-profit society might be better able to maintain the necessary vigor in the scrutiny of the technology practiced by its members and, more importantly, the society could bring to the matter the capacity to perceive, as far as possible, the potential long-term benefits and costs of particular modification attempts. Whether such a society would possess the necessary sense of detachment and commitment to the broader interests of society is not as clear. Recently there has been some interest on the part of scientific societies in the United States regarding the question of the development of ethical standards for members, including the development of written codes.[182] The American Meteorological Society has addressed itself in somewhat general terms in its by-laws to questions arising from relationships between the meteorologist and the general public. The meteorologist is directed to base his practice "on sound scientific principles," and

[180] G. Kennan, To Prevent a World Wasteland, 48 Foreign Affairs 401 (1970). In connection with domestic administrative agencies it has been pointed out that much recent environmental litigation has been conducted by citizens against the very governmental agencies charged with protection of the public interest.

[181] D. Price, Government and Science 76-77 (1962).

[182] Coffin, Congress Loses Its Sacred Powers, 23 Bulletin of the Atomic Scientists 35 (1967).

to avoid "practices generally recognized as being detrimental to or incompatible with the general public welfare."[133]

The ethical problem of whether a proposal for weather modification should be supported is not clearly soluble by reference to the code of the society. The code appears to be principally concerned with ethical standards with respect to private forecasting services, and weather modification is not mentioned. In its general statement that the practice of the meteorologist shall be based on "sound scientific principles," the code creates the familiar problem of finding meaning for general terms in particular instances.

Thus, considerable effort has been expended to anticipate the problems of weather modification, and these attempts reveal that very little is known about what results large-scale modification would produce. From this it would seem to follow that modification experimentation should be temporarily prohibited. On the national scale, however, the recommendations in reports published by the National Science Foundation seem to urge further modification experimentation with parallel research in other fields to learn of the effects of actual modification. An appropriate standard for modification research, therefore, might be to permit modification experimentation only in cases where simultaneous investigation effects on humans, animals and plants is conducted. This would apply with particular force where large numbers of people might be affected by particular experiments, or where any number of people might be subject to sustained modifications of weather.

In considering medical experimentation and the problems it poses for the experimenter, Margaret Mead has pointed to the model of anthropological field work in which the investigator seeks to enlist the participation of members of the society under investigation. Since the members are the equal of the investigator, the relationship is one of collaborators and not that of experimenter and subject. Professor Mead regards the more traditional model of research *on* human beings with repugnance, with the subject being seen as a victim and the experimenter as brutalized.[134] This might be very similar to the public perception of weather modification experimentation and operation in some cases. However, a model modification experiment might include within its protocol steps to enlist the participation of individuals or groups in the study of the human dimensions of the experiment. Thus, a fundamental change would occur in relationships between the researchers and the persons likely to be affected. Both

[133] American Meteorological Society Code of Ethics, art. VIII(C) (1969).

[134] Mead, Research with Human Beings: A Model Derived from Anthropological Field Practice, 98 Daedalus 361, 374 (1969).

researchers and members of the public woud gain some benefits from such an arrangement. The procedure would necessarily involve securing the voluntary cooperation of groups likely to file suit, a step that is vastly preferable to the proposed alternatives of proceeding against the will of affected communities and relying on a government-funded indemnification program to insulate the experiment from community objection. The procedure would afford the community to be affected by the experiment with timely notice of the proposed experiment, and the sponsors of the experiment would be in a position to determine potential long-term dangers in their work at the earliest time.

It is conceivable that private scientific societies concerned with weather modification could assist materially in the development of standards, such as those discussed above, for modification experimentation. This could occur through the deliberate and quasi-legislative development of codes of ethics or similar formal developments. It could also derive informally through the development of a standard of custom or usage, although this is not likely in the near future.[185] As in the case of the by-laws of the American Meteorological Society, such codes could be addressed directly to the relationship of the scientist or the technologist with the public. To the extent this is so, individuals claiming injury through breach of the code provisions might qualify as third party beneficiaries of the contract between the society and its members.[186] In other situations, the codes could be held enforceable by the society directly against an errant member, as is often the case with by-laws of an association or a corporation.[187]

VI. Conclusion

The development of public policy with regard to science and technology is in a high state of flux. There is an intense public awareness of both the value of science and technology and the potential danger in thoughtless scientific and technological applications. Because of the widespread consciousness of environmental problems, however, it seems likely that some form of greater institutional control of technology might come to pass in the near future.[188]

[185] Courts are reluctant to make judgments in scientific matters, and it is probably fair to say that there often is simply no evidence regarding custom or usage in some scientific matters. In Seaboard v. Crowther, Nos. 1702, 1712 (D.C. Colo., March 16, 1970), the court rejected a public interest group's challenge to the proposed detonation of an underground atomic bomb partly because the issues involved a "scientific controversy of great sophistication" that the court could not evaluate.

[186] See Corbin's discussion of the donee third party beneficiary theory. 4 A. Corbin, Contracts § 782 (1951).

[187] See, e.g., Kelley v. Weiss, 328 Mass. 197, 102 N.E.2d 93 (1951); Boston Club v. Potter, 212 Mass. 23, 98 N.E. 614 (1912).

[188] Wheeler has proposed a public corporation for the control of "developmental science," i.e., that which is almost immediately converted into technology. This corpo-

Numerous questions are posed by the development of weather modification technology, and one of the most important is created by the conjunction of this technology with extensive federal support and administration. Although the doctrine of sovereign immunity has eroded considerably, it is still possible for federally supported actions to be immune from effective impediment even though serious environmental issues might be created by the federal action.[139] There appear to be adequate bases for agencies sponsoring weather modification research or operations to insist that attention be paid to the ecological and human dimensions of weather modification. Otherwise modification efforts might result in litigation leading to a judicial expression of constitutionally based environmental rights. The Ninth Amendment might prove to be well suited to such an effort.[140]

Weather modification problems should also be examined at a level other than that of litigation which, after all, results only from a breakdown in society's mechanisms for harmonious functioning. There should be more critical examination of the intensity with which new scientific ideas are promoted for publication or testing, particularly where government sponsorship is present.[141] This is especially necessary where immediate technological application is planned.

An ethic of self-restraint in the application of new knowledge might well supplement the ethic of boundless accumulation and publication of new knowledge. The microbiologist Rene Dubos has become a leading spokesman for the cause of environmental awareness, and some of his views seem quite appropriate to these problems. He has written movingly about the biological inheritance of man and the limitations that this has placed on his ability to adapt to the modern

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ration would have certain traditional features familiar to lawyers that would provide for a system of adjudication of disputes and the hearing and processing of public complaints regarding science. It would also have quasi-legislative organs and functions for the initiation and planning of scientific projects that would take into account both scientific and "civilian" viewpoints. Wheeler, Bringing Science Under Law, 2 Center Magazine 59, 65 (1969).

[139] Cf. Dugan v. Rank, 372 U.S. 609 (1963). This case involved a project of the Bureau of Reclamation involving major redistribution of water between natural basins which decreased natural water flow in some streams. It was held that the activity was immune from interference by injunction on the ground of sovereign immunity.

[140] See generally Kent, Rights Retained by the People Under the Ninth Amendment, 29 Fed. Bar. J. 219, 228-32 (1970).

[141] Official federal policy regarding patents developed with federal financial support is based on the premise that "the Government has a responsibility to foster the fullest exploitation of the inventions for the public benefit." The explicit policy is that the patents "and the technological advances covered thereby" shall be available and "brought into being in the shortest time possible." President's Memo of Oct. 10, 1963, 3 C.F.R. 861,864 (1959-63 compilation). This policy statement is apparently innocent of any consideration that the technological development covered by patents may be the source of considerable social disruption. The policy simply assumes that the invention and development necessarily constitute an "advance" and should be exploited immediately.

conditions of a life that has been determined by science and technology.[142] He maintains that living beings can survive as individuals and species only by continuously interacting with their environment and thereby modifying some aspect of their own being. Thus, he seems to raise the crucial question of whether man can long survive in an increasingly artificial environment.

Self-restraint in technology application would not be revolutionary. Although Leonardo da Vinci's sketches and designs for military machines are familiar, Leonardo did not intend his notebooks for publication, and he sought to prohibit the release of his ideas for a submarine because he recognized its potential for evil.[143] This attitude of da Vinci, it has been said, was consistent with a tradition that the results of scientific thought were not to be reduced to practical affairs, and, in particular, were not to be used for destructive purposes.[144] These statements oversimplify complex historical phenomena,[145] but an attitude of restraint did exist and it is instructive for present purposes to note it.

To attempt a mass return to this state of mind, such as through prohibition of scientific application by government fiat is almost inconceivable. It does seem necessary, however, that those areas of science having potential for immediate public impact, such as the proposals for weather modification, should be subject to selective controls for the public good. These controls will be determined by public methods, but there is an opportunity for concerned private societies and individuals to address themselves to the development of standards for their own work. Although there are risks in the slowing of technological application, the risks in a continuation of a doctrine of laissez faire technology seem incomparably greater.

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[142] R. Dubos, So Human an Animal (1968).

[143] A. Nef, Western Civilization Since The Renaissance: Peace, War, Industry and the Arts 48, 118 (1963).

[144] Id. at 117-25.

[145] Just as not every contemporary scientist or technologist is driven to immediate application of new concepts, not every ancient or medieval thinker would resist application of his ideas where compelling reasons were present. A just defense of one's homeland probably has been the best known justification for practical application of scientific knowledge from the time of Archimedes' assistance in the defense of Syracuse against Roman invasion, to the work of the western atomic scientists in World War II.