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WEATHER MODIFICATION: LAW AND ADMINISTRATION*

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Interest in scientific weather modification techniques has recently reached a new high. The development of programs, experimental and applied, designed ultimately to affect the behavior of our atmospheric environment has attracted the attention of the scientific community and the Congress.[1]

The benefits, both social and financial, inherent in such programs are clear, and hardly require elaboration. The recent Northeastern drought,[2] coming in an area of the country which had long taken adequate water supplies for granted, illustrated for a new audience the practical value of cloud seeding research. It has been estimated that the Weather Bureau's activities in forecasting, let alone controlling, the weather results in a savings of two billion dollars each year by agriculture, industry, business, commerce and utilities.[3] Sub-

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1. *See, e.g., Hearings Before the Senate Comm. on Commerce,* 89th Cong., 1st & 2d Sess., ser. 58 & 59 (1966); *Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs,* 89th Cong., 2d Sess (1966); S. Rep. No. 1139, 89th Cong., 2d Sess. (1966); Special Commission on Weather Modification of the National Science Foundation, Rep. No. NSF 66-7, Weather Modification, Law, Controls, Operations (1966); Special Commission on Weather Modification of the National Science Foundation, Rep. No. NSF 66-3, Weather and Climate Modification (1966); National Academy of Sciences—National Research Council, Pub. No. 1350, Weather and Climate Modification, Problems and Prospects (1966); 17 Washington Science Trends 107 (1967).

2. Namias, *Nature and Possible Causes of the Northeastern United States Drought During 1962-65,* 94 Monthly Weather Rev. 543 (1966).

3. Ball, *Shaping the Law of Weather Control,* 58 Yale L.J. 213, 217 (1949). *See also* National Science Foundation, Rep. No. NSF 66-3, *supra* note 1, at 87-88.

stantial economic benefits would clearly result from the development of a capability to modify violent weather patterns of all types.[4] Hurricanes annually cause tremendous financial loss, through both actual physical damage and the high cost of precautionary measures.[5] Hail exacts a heavy toll in crop destruction. Snow, fog, lightning, and thunderstorms create conditions requiring expensive remedial measures and interfere with transportation and other governmental and commercial services.

The advantages of successful weather modification have long been recognized by scientists and commercial men; history records numerous efforts, at various levels of sophistication, to control the weather.[6] Since 1946, however, the increasingly sophisticated tools of modern science have brought to bear on the problems of weather control, supported by organized government effort, both in the United States and abroad.[7] The result has been a rapidly growing fund of knowledge regarding the behavior of atmospheric resources, along with practical developments which have taken weather modification out of the realm of the speculative. Although doubters may remain, it is now widely agreed that the techniques of weather control have reached a level where substantial results may be anticipated and where the goals and problems of a national weather control program should be evaluated.[8]

There can be no doubt that the area raises serious problems, both legal and administrative. Although few would dispute the merits of hail suppression and the elimination of tornadoes, not all segments of society favor the inducement of increased precipitation.[9] As

4. Strategic benefits may also result. *See generally* H. Kahn, On Thermonuclear War 484 (2d ed. 1961); Kotsch, *Weather Control and National Strategy,* U. S. Naval Institute Proceedings, July 1960, at 74-81; Von Neumann, *Can We Survive Technology?,* Fortune, June 1955, at 106.

5. Damages in the United States for the 1965 hurricane season have been estimated at $1,444,800,000. Sugg, *The Hurricane Season of 1965,* 94 Monthly Weather Rev. 183 (1966).

6. *See, e.g.,* J. Frazer, The Golden Bough 69-96 (abr. ed. 1950); Harrington, *Weather Making, Ancient and Modern,* 6 National Geographic Magazine, April 25, 1894, at 35-62 and bibliography collected therein; Note, *Who Owns the Clouds?,* 1 Stan. L. Rev. 43, 43-44 (1948).

7. National Science Foundation, Rep. No. NSF 66-3, *supra* note 1, at 47-50; S. Rep. No. 1139, 89th Cong., 2d Sess. 5-6 (1966).

8. See *Foreword* to S. Rep. No. 1139, 89th Cong., Sess. III (1966); National Science Foundation, Rep. No. NSF 66-3, *supra* note 1, at 7-8, 23-25.

9. Even such seemingly meritorious projects as eliminating hail and tornadoes may raise social, economic and legal problems. Scientists fear, for example, that hurricane abatement, designed to reduce storm damage, may adversely affect water levels through reduced precipitation in some areas of the country.

Lucretius observed, "What is one man's meat is another man's rank poison."[10] Some business ventures flourish better in a dry climate. Even where rain is welcome a landowner may view with suspicion the efforts of a neighbor to "intercept" rainclouds and induce the rain to fall on that neighbor's land.[11] Furthermore, the uncertainties of an infant science such as weather modification may lead to critical variations between anticipated and actual results.

Consequently, litigation between conflicting interests can be anticipated and appropriate liability doctrines must be formulated and applied to resolve these conflicts. But the broad effect of weather modification activities suggests that the basic problems cannot be adequately solved through reliance on private law doctrines. As the long standing concern over nuclear testing points out, changes in the content or structure of the atmosphere do not respect boundaries, either state or national.

That recent scientific advances have led to an increased weather modification capability is clear. Not as evident, but nevertheless pressing, is the need to establish legal structures, on a national and international basis, to supervise and administer weather modification. The first step in formulating such structures is an examination of the scientific and legal situation as it now exists.

I
HISTORICAL DEVELOPMENT

The modern era of weather modification in the United States is characterizd by the active participation of the federal government in research activities. This era can be divided into three periods.

In 1946, Langmuir, Schaefer, and Vonnegut at the General Electric Company were involved in research related to aircraft icing and the growth of cloud particles. As an incident of their experiments, they discovered that dry ice and silver iodide induced precipitation in miniature supercooled clouds.[12] One result of these discov-

10. Lucretius, De Rerum Natura 293 (3d ed. Rouse transl. 1937).

11. *See* Southwest Weather Research, Inc. v. Rounsaville, 320 S.W.2d 211 (Tex. Civ. App. 1958), *aff'd sub nom.* Southwest Weather Research, Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959). However, for a suggestion that artificial seeding does not in fact diminish the amount of moisture available to "downstream" lands, see Stark, *Weather Modification: Water—Three Cents per Acre-Foot?*, 45 Calif. L. Rev. 698, 705-06 (1957).

12. Schaefer, *The Production of Ice Crystals in a Cloud of Super Cooled Water Droplets*, Science, Nov. 15, 1946, at 457-59; Vonnegut, *The Nucleation of Ice Formation by Silver Iodide*, 18 Applied Physics 593-95 (1947); *Weather Under Control*, Fortune, Feb. 1948, at 107.

eries was the organization of several federal projects aimed at a general investigation of weather modification. The first of these, Project Cirrus, involved a study of cloud physics and the mechanics of artificially induced precipitation. This project, contracted to General Electric, was sponsored by The Army Chemical Corps, Navy and Air Force. Extensive tests were conducted between 1947 and 1952, demonstrating the possibility on a field scale of modifying supercooled clouds to both increase and retard precipitation.[13]

During the same period, a cloud physics project conducted by the Weather Bureau and other federal agencies investigated practical aspects of cloud modification as a means of both increasing precipitation and improving aircraft visibility.[14]

In 1953 the Defense Department initiated a broadly based experimental program, the Artificial Nucleation Project, designed to study the physics of precipitation control in a variety of meteorological situations.[15]

With the creation of the Advisory Committee on Weather Control in 1953,[16] weather modification activity entered its second phase. Under the auspices of the Committee a number of field projects were begun, among the better known of which were Projects Overseed and Skyfire. Overseed, employing ground based silver iodide generators in the vicinity of Mount Washington, New Hampshire, established that ground generators were able to produce significant changes in super-cooled clouds in mountainous regions.[17] Skyfire, carried out initially in selected western locations during 1956 and 1957, and since extended to other areas, had as a long-range goal the reduction of forest fires through lowering the incidence of cloud-to-ground lightning during thunderstorms.[18]

As a result of commercial interest generated by these early research efforts, the Santa Barbara Project was initiated in 1957 to

13. *See* 1 Advisory Committee on Weather Control, Final Report 5-7 (1958); S. Rep. No. 1139, 89th Cong., 2d Sess. 15 (1966).

14. 1 Advisory Committee on Weather Control, Final Report 6 (1958).

15. *Id.*

16. Act of Aug. 13, 1953, ch. 426, 67 Stat. 559. The life of the committee was to be until June 30, 1956. This was extended to June 30, 1958, by the Act of July 9, 1956, ch. 522, 70 Stat. 509.

17. 2 Advisory Committee on Weather Control, Final Report 130 (1958).

18. 1 Advisory Committee on Weather Control, Final Report 18 (1958). Project Skyfire has been continued under the auspices of the National Science Foundation, and some promising results have been obtained. See National Science Foundation, Rep. No. NSF 67-9, Eighth Annual Report on Weather Modification 27-29 (1967).

evaluate weather control methods being used by commercial operators in response to public demand for rainmaking services. Concentrated on the West Coast, this project involved cooperation between state and federal agencies to analyze the behavior of seeded as compared with non-seeded storms. One of its primary accomplishments was the collection of much needed statistical information on artificial precipitation attempts.[19]

The third period began in 1958 when, subsequent to the statutory termination of the Advisory Committee on Weather Control,[20] Congress directed the National Science Foundation to investigate the field of weather modification.[21] Pursuant to this direction, the Foundation has made an increasing amount of support available for weather research and experimentation. This has taken the form of grants and contracts to universities, private and corporate research organizations, and other groups such as the National Center for Atmospheric Research.[22] Grants totaling over two million dollars for weather modification projects were made by the Foundation in fiscal year 1966.[23] Areas being investigated under funded grants include, among others, basic cloud physics, precipitation control, storm modification, and suppression of hail, lightning, and fog.[24]

In addition to the National Science Foundation, other federal agencies have been active in recent years in weather control research. During fiscal 1966, seven other agencies sponsored projects involving or closely related to weather modification, with a total expenditure of $5,030,000.[25]

State financial support of weather modification activities has not been widespread. A National Science Foundation survey reveals that only nine states made financial outlays for research, commercial operations, or both during the period 1959-1964.[26] This support

19. 1 Advisory Committee on Weather Control, Final Report 20 (1958); 2 *id.* at 191-96.

20. See note 16 *supra*.

21. 42 U.S.C. § 1862 (1964).

22. *See* National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 20-25, 45-85; National Science Foundation, Rep. No. NSF 66-4, Seventh Annual Report on Weather Modification 31-40, 60-89 (1966); National Science Foundation, Rep. No. NSF 65-9, Sixth Annual Report on Weather Modification 15-22, 32-57 (1965); National Science Foundation, Rep No. NSF 63-29, Fifth Annual Report on Weather Modification 5-21 (1964).

23. National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 20.

24. *Id.* at 20-25, 45-84; S. Rep. No. 1139, 89th Cong., 2d Sess. 129-32 (1966).

25. National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 85-91.

26. National Science Foundation, Rep. No. NSF 66-7, *supra* note 1, at 16.

does not seem substantial when amortized over the five-year period. Although many state universities have undertaken research projects funded by federal grants,[27] state supported experimentation as such does not appear to have been a significant factor contributing to the development of weather modification.

Early research into the possibilities of artificially increasing precipitation created a demand, particularly in the arid West, for practical application of theory to increase the supply of water for commerce and agriculture. In response, a number of commercial cloud seeding companies were organized during the late 1940's and early 1950's.[28] Some of these companies, staffed by capable individuals trained in the meteorological sciences, made a substantial contribution to weather modification techniques. Most of the commercial projects have been in the rainmaking field, employing the introduction of silver iodide, and in some cases dry ice, into cloud formations. Recently, however, there has been emphasis on other aspects of weather modification.[29] The number and scope of commercial operations in recent years have been surprisingly large. In fiscal 1966, for instance, 100 thousand square miles were treated in the course of 70 individual projects in 30 states.[30] As knowledge of weather modification techniques increases, we can reasonably anticipate a further expansion of commercial activity.

Weather modification activities have not been limited to the United States. Members of a 1964 U.S. delegation to the Soviet Union estimated that country's program was two or three times as large as that of the United States.[31] In addition to an extensive hail suppression effort, the Russians are reported to be active in the areas of artificially induced precipitation and airport fog dissipation.[32] At least thirteen other nations have carried on research and applied operations in various aspects of weather control.[33]

27. *See* National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 45-84.

28. *See* 1 Advisory Committee on Weather Control, Final Report 7-8 (1958); National Science Foundation, Rep. No. NSF 60-24, First Annual Report on Weather Modification 13 (1960).

29. 1 Advisory Committee on Weather Control, Final Report 7 (1958); *Compare* National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 25 *with* National Science Foundation, Rep. No. NSF 66-5, *supra* note 22, at 9.

30. National Science Foundation, Rep. No. NSF 67-9, *supra* note 18, at 24.

31. National Science Foundation, Rep. No. NSF 66-4, *supra* note 22, at 25.

32. *Id.* at 25-26; S. Rep. No. 1139, 89th Cong., 2d Sess. 6 (1966).

33. National Science Foundation, Rep. No. NSF 66-4, *supra* note 22, at 26-30; S. Rep. No. 1139, 89th Cong., 2d Sess. 6 (1966).

II

DEVELOPMENT OF PRIVATE LAW DOCTRINES

As previously noted, numerous situations leading to possible liability may arise from attempts to modify the weather. Where the purpose of the operation is to increase precipitation by seeding storm clouds, protests may be made by persons allegedly damaged by the increased rainfall,[34] or by those who claim that the rainmaking efforts diverted precipitation which would otherwise have fallen on their property.[35] Attempts to reduce precipitation may give rise to similar claims. In any instance, negligent operations may damage neighboring property owners.

Whatever the situation, fundamental questions of private law are raised by the unusual source of the harm. Suppose the action is grounded on allegedly illegal diversion of cloud formations, which, if left undisturbed, would have benefited the plaintiff's property. What is the nature of that plaintiff's property right, if any, in the clouds? Is there some "natural right" in the use of the atmosphere or in preventing detrimental uses? What if, by design or miscalculation, modification operations produce undesired precipitation on plaintiff's property and result in flooding, hail damage, or interference with a specific land use? Has there been a trespass? Can liability be grounded on negligence? Nuisance?

Assuming the availability of a proper conceptual basis for an action, the very nature of weather control, given our present knowledge of cloud physics, may make proof of causation difficult.[36] Indeed, the more ambitious the project, the more widespread are its likely effects, and the less the probability that an injured party will be able to show causation—or even be aware that a modification operation is in progress.

When weather modification is attributable to a government or its agents, the injured party is likely to encounter even greater difficulty in pursuing his remedy. Sovereign immunity may block his suit,[37] and details of government research projects are frequently

34. *See, e.g.*, Slutsky v. City of New York, 197 Misc. 730, 97 N.Y.S.2d 238 (Sup. Ct. 1950).

35. *See, e.g.*, Southwest Weather Research, Inc. v. Jones, 160 Tex. 104, 327 S.W.2d 417 (1959).

36. *See* National Science Foundation, Rep. No. NSF 66-3, *supra* note 1, at 102; Ball, *supra* note 3, at 230.

37. *See* Federal Tort Claims Act, 28 U.S.C. §§ 1346, 2671-2678, 2680 (1964); S. Rep. No. 1139, 89th Cong., 2d Sess. 85-86 (1966). *See generally* 2 F. Harper & F. James, The Law of Torts §§ 29.1—.15 (1956); W. Prosser, Torts §§ 125, 126 (3d ed. 1964).

unavailable for public inspection, particularly when the research has possible military ramifications.[38]

Litigation in the weather field has offered little aid in solving these private law problems. There are few reported cases, and only two, *Slutsky v. City of New York*[39] and *Southwest Weather Research, Inc. v. Jones*,[40] have treated substantive issues. In *Slutsky*, the owners of a resort near New York City sought a temporary injunction restraining the City from conducting experiments to induce rain artificially. It was alleged that these experiments would cause flooding in the Catskill region and would be harmful to the plaintiffs' business. In denying the injunction the court balanced the "remote possibility of inconvenience to plaintiffs' resort and its guests"[41] against the necessity of supplying New York's inhabitants with water during a period of serious drought. The City not unexpectedly prevailed. In addition to holding that the plaintiffs had not put forth sufficient proof as to damages, the court noted that the action was legally defective in that "they [plaintiffs] clearly have no vested property rights in the clouds or the moisture therein. . . ."[42]

Jones arose out of a dispute between Texas farmers who contracted for a hail suppression program and ranchers who asserted that the weather modification efforts were resulting in a loss of precipitation on their lands. The ranchers successfully sought an injunction pendente lite to restrain defendants from carrying on further operations in the vicinity of plaintiffs' properties. On appeal to the Texas Court of Civil Appeals,[43] the order was affirmed with the modification that it only apply to operations undertaken in the airspace directly over plaintiffs' land, the court specifically refusing to pass upon the question of whether an owner has the right to prevent weather modification over land not his own. In commenting on a private landowner's "rights" in the clouds, the court said:

38. The legislation authorizing the Director of the National Science Foundation to promulgate rules regarding weather modification (see footnotes 86-91 *infra*, and accompanying text) specifically excepts classified material from information to be made available for public inspection. 42 U.S.C. § 1872a(f)(4) (1964). *See* Ball, *supra* note 3, at 225-26.

39. 197 Misc. 730, 97 N.Y.S.2d 238 (Sup. Ct. 1950).

40. 160 Tex. 104, 327 S.W.2d 417 (1959).

41. 197 Misc. 730, 731, 97 N.Y.S.2d 238, 240 (Sup. Ct. 1950).

42. *Id.* at 731, 97 N.Y.S.2d at 239.

43. *Decided sub nom.* Southwest Weather Research, Inc. v. Rounsaville, 320 S.W.2d 211 (Tex. Civ. App. 1958).

> We believe that under our system of government the landowner is entitled to such precipitation as Nature deigns to bestow. We believe that the landowner is entitled, therefore and thereby, to such rainfall as may come from clouds over his own property that Nature, in her caprice, may provide. It follows, therefore, that this enjoyment of or entitlement to the benefits of Nature should be protected by the courts if interfered with improperly and unlawfully.[44]

Although this language might be taken to indicate recognition of a "natural right" of the landowner to moisture in the atmosphere, in contrast to the view expressed in *Slutsky*, doubt is cast upon its effect by the Texas Supreme Court's opinion on further appeal. There, while the order of the lower court was affirmed, care was taken to point out that the only issue presented to the appellate court, in cases involving temporary injunctions, is whether the evidence shows a clear abuse of discretion by the trial court. The Supreme Court felt that in view of the conflicting nature of the evidence presented as to the results of cloud seeding, the trial court was justified in granting an injunction pendente lite. The theory of property rights espoused by the Court of Civil Appeals was neither approved nor criticized.

In several unreported cases dealing with weather modification activities, plaintiff was denied relief because of his failure to sustain the necessary level of proof of damages or causation.[45] Other cases are pending trial on the merits,[46] involve criminal proceedings,[47] or have been disposed of on procedural grounds.[48]

With litigation insufficient to reveal what approaches the courts will employ in resolving private weather modification disputes, legal

44. *Id.* at 216.

45. Samples v. Irving P. Krick, Inc., Civil Nos. 6212, 6223, 6224, W.D. Okla., Dec. 22, 1954; Adams v. State, No. 10112, Super. Ct., Sutter County, Cal., April 6, 1964; Auvil Orchard Co., Inc. v. Weather Modification, Inc., No. 19268, Super. Ct., Chelan County, Wash., Oct. 9, 1956. These cases are discussed in Special Commission on Weather Modification of the National Science Foundation, Rep. No. NSF 66-7, Weather Modification: Law, Controls, Operations 51-52 (1966).

46. Pennsylvania Natural Weather Ass'n v. Blue Ridge Weather Modification Ass'n, No. 3 at the Jan., 1965, Term of the Fulton County Ct. C.P. (Pa.), discussed in National Science Foundation, Rep. No. NSF 66-7, *supra* note 45, at 54.

47. Township of Ayr v. Fulk, No. 53 at the Sept., 1964, Term of the Fulton County Ct. C.P. (Pa.), discussed in National Science Foundation, Rep. No. NSF 66-7, *supra* note 45, at 54.

48. Avery v. O'Dwyer, 305 N.Y. 658, 112 N.E.2d 428 (1953); Reeve v. O'Dwyer, 199 Misc. 123, 98 N.Y.S.2d 452 (Sup. Ct. 1950). These cases are discussed in Comment, *The Weathermaker and the Law*, 1 S.D.L. Rev. 105, 108-10 (1956).

commentators have not hesitated to speculate as to which established doctrines might provide appropriate analogues.[49] Thus, on the problem of moisture diversion, it has been suggested that useful analogies might be drawn to rights in clouds based on ownership of the underlying land—the *ad coelum* doctrine;[50] to the theory that a landowner has the "natural right" to enjoy the land in its natural condition;[51] to doctrines of the property rights in animals *ferae naturae*;[52] to the law respecting ownership of oil and gas;[53] and to various aspects of the law of water, including the appropriation doctrine with its corollary policy of prohibiting illegal diversions,[54] the common law doctrine of riparian rights,[55] and the law as applied to the ownership and use of diffuse surface and percolating sub-surface waters.[56]

Where disputes arise from the diversion of harmful weather onto a plaintiff's land, relief might be granted based on strict liability for trespass.[57] Even in the absence of a technical trespass, liability may still be predicated on negligence[58] or the ultra-hazardous activity doctrine.[59] Further analogies can be found in the law of nuisance,[60] the water law doctrines pertaining to water disposal,[61] and existing

49. *See* Ball, *Shaping the Law of Weather Control,* 58 Yale L.J. 213 (1949); Oppenheimer, *The Legal Aspects of Weather Modification,* 1958 Ins. L.J. 314; Comment, *The Legal Aspects of Rainmaking,* 37 Calif. L. Rev. 114 (1949); Note, *Rain and the Law,* 39 Geo. L. J. 466 (1951); Comment, *Rights of Private Landowners as Against Artificial Rainmakers,* 34 Marq. L. Rev. 262 (1951); Comment, *The Weathermaker and the Law,* 1 S.D.L. Rev. 105 (1956); Note, *Who Owns the Clouds?,* 1 Stan. L. Rev. 43 (1948); Note, *Artificial Rainmaking,* 1 Stan. L. Rev. 508 (1949); Note, *Legal Problems Raised by Artificial Rainmaking,* 4 Vand. L. Rev. 332 (1951); 73 Harv. L. Rev. 790 (1960); 37 Texas L. Rev. 799 (1959).

50. *See* Note, *Rain and the Law,* 39 Geo. L. J. 466, 470 (1951); *but see* Comment, *Rights of Private Landowners as Against Artificial Rainmakers,* 34 Marq. L. Rev. 262, 265-67 (1951).

51. *See* Note, *Who Owns the Clouds?,* 1 Stan. L. Rev. 43, 51-57 (1948); Note, *Legal Problems Raised by Artificial Rainmaking,* 4 Vand. L. Rev. 332, 333-34 (1951).

52. *See* Note, *Who Owns the Clouds?,* 1 Stan. L. Rev. 43, 49 (1948).

53. *See* Note, *Rain and the Law,* 39 Geo. L. J. 466, 474 (1951).

54. *Id.* at 475-76.

55. *See* Comment, *The Legal Aspects of Rainmaking,* 37 Calif. L. Rev. 114, 117-18 (1949); 37 Texas L. Rev. 799, 802-03 (1959).

56. *See* Comment, *The Legal Aspects of Rainmaking,* 37 Calif. L. Rev. 114, 117 (1949).

57. *See* Note, *Artificial Rainmaking,* 1 Stan. L. Rev. 508, 532 (1949).

58. *Id.* at 533. Note, *Legal Problems Raised by Artificial Rainmaking,* 4 Vand. L. Rev. 332, 334-36 (1951).

59. *See* Note, *Legal Problems Raised by Artificial Rainmaking,* 4 Vand. L. Rev. 332, 336 (1951).

60. *See* Ball, *supra* note 49, at 239.

61. *See* Ball, *supra* note 49, at 235.

statutes providing for liability, either strict or grounded upon negligence.[62]

Irrespective of the merits of each of these theories and the difficulties inherent in resolving problems by borrowing established doctrines from supposedly "analogous" situations,[63] the central objection to such theorizing lies in its discouraging variety. A reading of the literature leads to a growing conviction that the commentators cannot agree on a preferred analogue and, indeed, that no one of the suggested doctrines really fits the weather modification model. Where uncertainty grips the scholars, it is hardly to be expected that the courts will come up with a workable solution in the foreseeable future.[64] Although scientific progress in the field of weather control has not, until recently, been especially rapid, it is still running alarmingly ahead of the development of legal doctrine in this area.

III

REGULATORY MEASURES

Given the present failure of the common law to resolve private weather modification disputes, one might anticipate that legislators at the state and federal levels would have filled the vacuum. In fact, no statutes have been passed which purport to affect the liability of operators to landowners, although there has been substantial legislation seeking to regulate weather modification operations.

Of the fifty states, twenty-three have enacted statutes which deal specifically with the subject of weather modification.[65] Others have

62. *See* Note, *Artificial Rainmaking,* 1 Stan. L. Rev. 508, 535 (1949).

63. *See* Special Commission on Weather Modification of the National Science Foundation, Rep. No. NSF 66-3, Weather and Climate Modification 23 (1966); Ball, *supra* note 49, at 236-37.

64. In this regard, the pace which the common law has set in the past in modifying established property concepts to fit new situations has not been an encouraging one. For an entertaining discussion of the slow rate of change prevailing in the law of property, see C. Callahan, Adverse Possession 11-28 (1961).

65. Ariz. Rev. Stat. Ann. §§ 45-2401 to -2407 (1956); Cal. Water Code §§ 400 to 415, *as amended,* Cal. Water Code §§ 401, 403, 406, 409 (West Supp. 1967); Colo. Rev. Stat. Ann. §§ 151-1-1 to -12 (1963); Conn. Gen. Stat. Ann. §§ 24-5 to -8 (1960), *as amended,* Conn. Gen. Stat. Ann. § 24-5 (Supp. 1966); Fla. Stat. Ann. §§ 373.261-.391 (1960), *as amended,* Fla. Stat. Ann. § 373.381(2) (Supp. 1966); Hawaii Rev. Laws § 86-5 (Supp. 1965); Idaho Code Ann. §§ 22-3201 to -3202 (Supp. 1965); La. Rev. Stat. §§ 37-2201 to -2208 (1964); Md. Ann. Code art. 66C, § 110A (Repl. 1967); Mass. Ann. Laws ch. 6, § 7 (1966); Neb. Rev. Stat. §§ 2-2401 to -2449 (1962), *as amended,* Neb. Rev. Stat. § 2-2407 (Supp. 1965); Nev. Rev. Stat. §§ 544.010-.240 (Supp. 1966); N.H. Rev. Stat. Ann. § 432.1 (1955); N.M. Stat. Ann. §§ 75-37-1 to -15 (Supp. 1965); N.D. Cent. Code §§ 2-07-01 to -13 (Supp. 1967); Ore. Rev. Stat. §§ 558.010-.990 (Supp. 1965); Pa. Stat. Ann. tit. 18, §§ 3871-3874 (Supp. 1967); S.D. Code §§ 4.2301-.2308

statutory provisions, encompassing the general area of water resources, which might be interpreted as covering weather modification but do not refer to it expressly.[66] Although the state statutes cover a wide spectrum,[67] a general approach can be discerned among the more comprehensive statutes. Several assert the state's right to, or to the use of, the moisture in the atmosphere over the state.[68] Such provisions raise interesting legal questions which the courts have not yet considered.

Licensing requirements are common. Fifteen states require prospective weather modifiers to obtain a license before initiating operations.[69] Of these, fourteen either require a showing of the applicant's qualifications or empower the issuing agency to examine qualifications,[70] although it is far from clear in all cases that the "qualifications" need be of a professional or scientific nature.[71] Two states without licensing provisions nevertheless compel registration of prospective weather modification operations,[72] and one other calls for prior notice to be sent to a designated meteorologist at the state university.[73] In several states, exceptions to the licensing provisions are made for research and experimentation.[74]

Statutes requiring operators to inform the public of prospective modification efforts are unfortunately uncommon. Only six states direct that a notice of each operation be published in a newspaper of general circulation.[75]

(Supp. 1960); Tex. Rev. Civ. Stat. Ann. art. 8280-12 (Supp. 1967); Utah Code Ann. §§ 73-15-1 to -2 (1953); Wash. Rev. Code Ann. §§ 43.37.010-.200 (1965); Wis. Stat. Ann. § 195.40 (1957), *as amended,* Wis. Stat. Ann. § 195.40(5) (Supp. 1967); Wyo. Stat. Ann. §§ 9-267 to -276 (1957), *as amended,* Wyo. Stat. Ann. §§ 9-271, -272 (Supp. 1967).

66. *See, e.g.,* W. Va. Code Ann. § 2312(15) (Supp. 1965).

67. They range from empowering a state agency to investigate the possibilities of rainmaking (Hawaii) to temporary prohibition of artificial weather modification in or over a state (Maryland). For citation to appropriate statutes here and in notes 68, 69, 70, 72, 73, 74, 75, 76, 77, and 78 *infra,* see statutes cited note 65 *supra.*

68. Colorado, Louisiana, Nebraska, New Mexico, North Dakota, South Dakota, and Wyoming.

69. Arizona, California, Colorado, Florida, Louisiana, Massachusetts, Nebraska, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Texas, Washington, and Wyoming.

70. All except Massachusetts.

71. *See, e.g.,* Cal. Water Code § 404.

72. Idaho and Wisconsin.

73. Utah.

74. Nevada, Texas and Washington (no license required for research and experimentation); Nebraska and South Dakota (license fee waived for research and experimentation).

75. California, Florida, Nevada, Oregon, Texas and Washington.

Sixteen states provide in one way or another for the systematic collection and evaluation of data arising out of weather modification, both operational and experimental.[76] This may take the form of a requirement that the individual modifier collect information and report it to the appropriate state agency, or a direction to the agency to collect and evaluate data. Provision is frequently made for public disclosure of such information.[77]

In the critical area of liability for damages caused by weather control, state legislation has fallen somewhat short of the mark. Statutes dealing with this subject fall into two categories: those providing for non-liability of the state or its employees and those calling for proof of financial responsibility as part of the licensing procedure.[78] With one exception, where liability between private parties is mentioned, it is only for the purpose of establishing that state statutes shall not be construed as in any way interfering with private rights, liabilities or duties.[79]

Up to the present, Congress and federal agencies have been primarily concerned with investigating and coordinating weather modification, rather than with regulating it. Although earlier bills had been introduced,[80] the first enactment of legislation applicable to the field occurred in 1953 with the creation of the Advisory Commit-

76. Arizona, California, Colorado, Florida, Idaho, Louisiana, Massachusetts, Nevada, New Mexico, Oregon, South Dakota, Utah, Texas, Washington, Wisconsin, and Wyoming.

77. Florida, Louisiana, Nevada, Oregon, South Dakota, Texas and Washington.

78. Non-liability of the state or its employees: Nevada, North Dakota, Texas, Washington, Wyoming; proof of financial responsibility: Colorado, Florida, Nevada, New Mexico, Oregon, Texas, Washington.

79. Texas, with the most recently enacted weather modification legislation, has entered the arena of private litigation to the extent indicated by Sec. 18 of Tex. Rev. Civ. Stat. Ann. art. 8280-12 (Supp. 1967):

> Nothing in this Act shall be construed to impose or accept any liability or responsibility on the part of the state or any state officials or employees for any weather modification and control activities of any private person or group, or to affect in any way any contractual, tortious or other legal rights, duties or liabilities between any private persons or groups, provided, however, that any operation conducted pursuant to the license and permit requirements of this Act shall not constitute an "ultra-hazardous activity" such as to subject the participants therein to liability without fault. However, the fact that any private person or group of persons, corporation, organization, or any other entity has secured a license or permit or otherwise complied with this Act, or the rules and regulations promulgated pursuant to this Act, shall not be admissible evidence in any legal proceeding brought against such private person or group.

80. For a summary of legislative proposals in the weather modification field, *see* S. Rep. No. 1139, 89th Cong., 2d Sess. 143-147 (1966).

tee on Weather Control to study and evaluate public and private experiments in weather modification.[81] Following the recommendations of the Advisory Committee,[82] Congress in 1958 amended the National Science Foundation Act[83] to authorize the Foundation

> to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon.[84]

The amendment empowered the Director of the National Science Foundation to require by regulation the keeping of records concerning weather modification activities.[85] The Director has promulgated such regulations.[86] These provide in short for thirty days advance notice to the Foundation of any weather modification activity, followed by quarterly reports of operations, on forms provided by the Foundation.[87] Daily logs of activities must be kept by the operators containing "all relevant facts"[88] presumably to insure accuracy and completeness in the reports. The records must be retained and are subject to inspection by the Foundation for five years.[89] Information developed by the Foundation is to be made public, subject to certain exceptions, on a periodic basis.[90] A fine is imposed for failure to comply with the regulations.[91]

One other area of legislation is worth noting in light of current proposals before Congress. The 1965 Public Works Appropriation Act was passed by the House of Representatives without mention of weather modification research.[92] Subsequently the Senate, follow-

81. Act of Aug. 13, 1953, ch. 426, 67 Stat. 559.

82. 1 Advisory Committee on Weather Control, Final Report 26-27 (1958).

83. 64 Stat. 149 (1950), *as amended* 72 Stat. 353 (1958), 42 U.S.C. §§ 1861-1881 (1964).

84. 42 U.S.C. § 1862(a)(9) (1964).

85. 42 U.S.C. § 1872a(f)(1) (1964).

86. 45 C.F.R. §§ 635.1-.7 (1967).

87. 45 C.F.R. § 635.3 (1967). During the period January to June, 1966, 92 "project intents" were filed with the Foundation. National Science Foundation, Rep. No. NSF 67-9, *supra* note 18 at 23.

88. 45 C.F.R. § 635.4 (1967). The regulations provide guidelines indicating material to be included in the daily logs.

89. 45 C.F.R. § 635.5 (1967).

90. 45 C.F.R. § 635.6 (1967).

91. 45 C.F.R. § 635.7 (1967).

92. H.R. 11579, 88th Cong., 2d Sess. (1964). For passage by House, see 110 Cong. Rec. 13974 (1964).

ing a resolution of its Committee on Irrigation and Reclamation, amended the House version to include a two million dollar appropriation for the Bureau of Reclamation, to be used for weather modification research.[93] This amount was reduced to one million dollars in conference and included in the general investigation appropriation to the Bureau.[94] The one million dollar appropriation, representing a sharp increase over prior Bureau of Reclamation funding in this area, was expanded further in the years following.[95] Spending at this level has been used as support for Interior's claim of experience and expertise in the weather modification field.[96]

IV
PROPOSED LEGISLATION

At the present time, the Senate has before it S. 373, a weather modification measure introduced by Senator Warren Magnuson of Washington, Chairman of the Commerce Committee. This bill is the latest in a series of proposals which have stemmed from a conflict between the Departments of Commerce and Interior over control of weather modification activities. Before examining S. 373 in detail, some legislative history is perhaps in order to put the bill in its proper historical perspective.

On a number of occasions over the past eight years, Senator Clinton P. Anderson of New Mexico, a member of the Committee on Interior and Insular Affairs, has proposed legislation designed generally to increase the scope of weather modification activity carried on by the Department of the Interior, particularly in the area of increasing usable water supplies.[97] Up until the second session of the 89th Congress, these bills were, with one exception,[98] referred to the Senate Commerce Committee where, not surprisingly, they died without great ado. For example, S. 23, introduced by Senator An-

93. 110 Cong. Rec. 18521 (1964).

94. Public Works Appropriation Act of 1965, Tit. II, 78 Stat. 685 (1964); H.R. Rep. No. 1794, 88th Cong., 2d Sess. 39 (1964).

95. *Hearings Before the Senate Comm. on Commerce,* 89th Cong., 2d Sess., ser. 58, at 222 (1966) (statement of Dr. Thomas F. Bates).

96. *See Hearings on S. 2875 Before the Subcomm. on Water and Power Resources of the Senate Comm. on Interior and Insular Affairs,* 89th Cong., 2d Sess. 33-42 (1966) (statement of Hon. Stewart L. Udall).

97. S. 943, 86th Cong., 1st Sess. (1959); S. 1020, 88th Cong., 1st Sess. (1963); S. 23, 89th Cong., 1st Sess. (1965); S. 2875, 89th Cong., 2d Sess. (1966).

98. S. 1020, 88th Cong., 1st Sess. (1963), referred to the Senate Committee on Interior and Insular Affairs, where no further action was taken on the bill.

derson early in the first session of the 89th Congress,[99] directed the Secretary of the Interior to carry out a twenty million dollar program, in at least five areas of the United States, aimed at increasing the annual average supply of usable water from rainfall and snowfall. Hearings were conducted by the Commerce Committee[100] but there was no further action during that session.

Apparently anticipating that S. 23 would not be favorably reported by the Commerce Committee, Senator Anderson sponsored further legislation during the second session of the 89th Congress.[101] S. 2875 directed the Secretary of the Interior to "formulate and carry out a comprehensive program of scientific and engineering research, experiments, tests and operations directed at increasing the yield of water from atmospheric sources for beneficial uses in all areas of the United States . . . ." One hundred fifty-five million dollars was authorized to be appropriated over the first three years of the program, a sum considerably in excess of expenditures then being made in the field. Other federal agencies were directed to participate in the comprehensive program on the basis of agreements with the Secretary.

Two sections of S. 2875 are of particular note:

> Sec. 201. The United States will compensate for the taking of property or rights, or for damage, injury, or for other just claims arising out of execution of the comprehensive program in the manner provided in the Act of August 30, 1954, an Act to amend the Atomic Energy Act of 1946.
>
> Sec. 202. Activities intended to affect, or determined by the Secretary to be likely to affect, the atmospheric resources of the United States may be carried on only pursuant to license issued by the Secretary in the same manner as licenses issued pursuant to the Act of August 30, 1954.

Although this proposal specifically provided that, except for the licensing requirements, the authority of other federal agencies in the weather modification field was not to be limited, it is clear that S. 2875 would have given Interior the major role in weather modification. Senator Anderson succeeded in having the bill referred to his

99. 111 Cong. Rec. 167 (1965).

100. *Hearings Before the Senate Comm. on Commerce,* 89th Cong., 1st Sess., ser. 58, pt. 1 (1965).

101. 112 Cong. Rec. 2106 (1966) (remarks of Senator Anderson).

own Interior and Insular Affairs Committee[102] but, ironically, the measure died in that committee after hearings.

The conflict between Commerce and Interior[103] was brought into sharper focus with the introduction by Senator Magnuson of S. 2916,[104] which authorized the Secretary of Commerce

> to carry out a program of applied research, development, and experimentation in the field of weather modification and climate control, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena.[105]

Enactment of S. 2916, in its original form, would have transferred the weather modification responsibilities of the National Science Foundation to the Secretary of Commerce. Indeed, that bill adopted the language of the National Science Foundation Act's weather modification provisions virtually intact, and repealed the Foundation's authority in the area.[106] The practical effect of enacting S. 2916 would have been to make Commerce the lead agency in the federal weather control program.

After hearings,[107] S. 2916 was substantially amended by the Commerce Committee.[108] The amendments apparently represented an effort at compromise in the Commerce/Interior dispute, although the thrust of the bill continued to be a concentration of responsibility and authority in the Secretary of Commerce.

As amended, S. 2916 provided for the assignment of weather modification functions to various agencies: Commerce was to be responsible for a "comprehensive program," including specifically the control of tornadoes, hurricanes, and other severe storms; Interior was to be authorized to augment and improve usable water resources; Agriculture was to control lightning and hail, and otherwise protect vegetation from the effects of the weather; Health, Education, and Welfare was to carry out a program in such aspects of weather modification as relate to the control of air pollution; the

102. 112 Cong. Rec. 2107 (1966).

103. For a background discussion of the inter-agency conflicts, see Carter, *Weather Modification: Senate Bills Stir Agency Rivalries,* 151 Science 805 (1966).

104. 112 Cong. Rec. 2915 (1966) (remarks of Senator Magnuson).

105. S. 2916, 89th Cong., 2d Sess. § 2 (1966).

106. S. 2916, 89th Cong., 2d Sess. §§ 4, 7 (1966).

107. *Hearings Before the Senate Comm. on Commerce,* 89th Cong., 2d Sess., ser. 58 & 59 (1966).

108. S. Rep. No. 1725, 89th Cong., 2d Sess. (1966).

Federal Aviation Agency was to study and conduct operational activities for fog and cloud cover dispersal; and the National Science Foundation was to be responsible for initiating and supporting basic and applied research, and programs of education and training, in the weather sciences.[109]

In addition to his responsibilities under the "comprehensive program," the Secretary of Commerce was authorized: (1) to issue regulations governing the weather modification activities of private business concerns not under arrangement with the government, (2) to study the need for regulation in the weather modification field and to recommend further legislation in this regard, and (3) to cooperate, through the Secretary of State, in international weather modification activities, including representing the United States at international conferences.[110]

The Secretary was also directed to study (1) the liability aspects of weather modification, including indemnification and insurance of *contractors* and grantees of the United States, (2) the social and economic effects, and (3) the biological and ecological effects of weather modification.[111] The result of such studies were to be communicated to the Congress.

The bill, as thus amended, was passed by the Senate[112] as referred to the House Interstate and Foreign Commerce Committee.[113] No action was taken on it by the House.

At the beginning of the 90th Congress in January, 1967, Senator Magnuson introduced S. 373, identical to S. 2916, as amended and passed by the Senate in 1966.[114]

Regardless of one's preference for centralizing weather modification authority in Commerce, Interior or neither, S. 373 represents a modest recognition, if not solution, of legal and administrative problems which must be reckoned with soon if scientific inventiveness is not to dangerously outdistance society's controls. The immediate

109. S. 2916, 89th Cong., 2d Sess. § 201 (1966).

110. S. 2916, 89th Cong., 2d Sess. §§ 205, 302 (1966).

111. S. 2916, 89th Cong., 2d Sess. § 304 (1966).

112. 112 Cong. Rec. 25781-83 (daily ed. Oct. 14, 1966).

113. 112 Cong Rec. 26143 (daily ed. Oct. 17, 1966).

114. 113 Cong. Rec. 338 (daily ed. Jan. 17, 1967). Representative Staggers has introduced a bill which differs from S. 373 in only minor respects; its treatment of weather modification administration is essentially identical to that of S. 373. H.R. 9212, 90th Cong., 1st Sess., 113 Cong. Rec. 4737 (daily ed. Apr. 26, 1967).

Another bill introduced during the first session of the Ninetieth Congress was S. 2058 by Senator Dominick, which provides for a practicable weather modification program for the Upper Colorado River Basin and is not concerned with the problem of comprehensive administration. 113 Cong. Rec. 9157 (daily ed. June 29, 1967).

need is to resolve the difficulties presented by weather modification in three primary areas: (1) centralized control of modification operations, research, and experimentation, including adequate supervision of the qualifications of individuals or groups conducting them; (2) provision for the systematic collection and evaluation of data developed through weather modification activities, followed by effective dissemination of the resulting information to interested parties; and (3) resolution of the liability questions arising between modifiers and those affected by their operations.

Present capabilities in the science of weather control suggest that the need for a comprehensive program at the national level is imperative. In addition, the promise of further developments and the global implications of modifying the atmosphere indicate that any administrative structures, to have long-range effectiveness, should be international in scope.

V

NEED FOR A DIFFERENT LEGAL APPROACH

As has been pointed out above, existing law on weather modification has evolved around the familiar structures of property rights and remedies for the invasion of these rights.

However, the inadequacy of those structures is apparent. Immense problems of proof of causation exist. Where two or more cloud seeders operate on the headwaters of a single drainage, which efforts are responsible for the flood? Would there have been a flood absent any weather modification practices?

If State *A* wrings the moisture out of a cloud before it blows over into State *B*, does State *B* enjoin State *A*? Can the drought-ridden farmers collect from State *A* or from the contractor?[115]

If moisture laden air from the Gulf of Mexico will produce rainfall when it meets the eastbound jet stream over Kansas, is there any recourse if, by weather modification techniques conducted by the Japanese in the Kurile Islands, the impact of the jet stream is reduced, or the collision occurs over Nebraska or South Dakota instead? The chain reaction set off by relatively innocuous experiments in distant lands is seemingly endless.[116] How are consequent damages

115. Cases cited notes 34, 35 and 46, *supra.*

116. World Meteorological Organization, *First Report on the Advancement of Atmospheric Sciences and Their Application in the Light of Developments in Outer Space,* App. E (Geneva, 1962):

> Para. 3. The complexity of atmospheric processes is such that an artificially induced change in the weather in one part of the Earth will necessarily have repercussions in other parts. This principle can be affirmed on the basis of our

to be measured?[117] When does an Act of God become an Act of Man? And what about sovereign immunity? Is the act of a government in weather modification a governmental activity, and hence not actionable, or a proprietary act for which redress can be obtained?

When the damage—and the problems—move from the field-by-field, case-by-case area to broad effects upon the welfare of entire states and nations, legal structures dare not lag too far behind. As the movements of moisture laden clouds cannot and do not recognize state or national boundaries, neither can regulation or reparation succeed on a parochial basis.

Probably the first and most apparent need is for establishment of a central administrative agency to supervise all weather modification activity in each country. In the United States, as pointed out, several agencies and departments participate in weather modification experimentation, and any administration or co-ordination is voluntary only. Rivalry and duplication, with corresponding waste of funds and effort, are not unknown.

No administration is possible unless the central administrating agency is aware of all the activity in the field. For this reason, registration of operators would seem to be a minimum requirement.

The next logical step is the licensing of operators, with reasonable requirements as to disclosure of plans and ability to execute them in a safe and proper manner. Because the use of weather modification techniques, even on a small scale, may trigger chain reactions which can be virtually limitless in extent, care must be taken that controls exist which can be imposed in the interests of national welfare and security.[118]

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present knowledge of the mechanism of the general circulation of the atmosphere. Our knowledge, however, is still very far from enabling us to forecast with confidence the degree, nature or duration of the secondary effects to which a change in weather or climate in one part of the globe may give rise, nor even to predict whether these effects may be beneficial or detrimental.

Para. 5. Therefore, before starting an experiment on large-scale weather modifications, we must be sure of our capability of forecasting accurately the expected modification in the heat balance and the circulation of the atmosphere. Otherwise we could face some day the dangerous situation of undesired irreversible weather and climate change.

117. For a discussion of the international aspects of weather modification, including remedies and damages which might be available, *see generally* Taubenfeld, *Weather Modification and Control: Some International Legal Implications,* 55 Calif. L. Rev. 493 (1967).

118. Significantly, pending legislation exempts weather modification activity "which is intentionally designed in whole or in part to affect the atmosphere more than one hundred and fifty miles from the source of such activity." S. 373, 89th Cong., 2d Sess. § 303 (a) (1966). *Quaere,* who makes this initial, all-important determination?

Unless there be a central registration agency where all plans must be filed, unless this agency is likewise qualified to evaluate the potential benefits and hazards of each proposed experiment, unless the same agency can require adequate assurance of financial responsibility in the event of damage, and, finally, unless that agency can restrict or prohibit irresponsible or dangerous alteration of weather patterns, no one is secure from mishandling of atmospheric resources.

In addition, such centralization establishes a focal point for the accumulation of data, and creates a natural source for dissemination of information concerning significant successes and failures.

Centralization may carry with it all of the evils of bureaucracy—size, rigidity, delay and lack or fear of imagination, but it would appear that all these are preferable to the waste, dissipation, duplication and real danger which the present lack of regulation spawns. Unfortunately, in the United States, the trend appears to be toward splintering rather than consolidation.[119]

The single feature of protection of the unsuspecting from damage raises tremendous problems because of the potential size of damage claims. Just as the world's greatest insurance companies refused to write liability policies on atomic power plants until the federal government agreed to carry the excess risks, so, perhaps, must the national government underwrite the prospective damage claims resulting from large-scale, modern weather modification schemes.[120]

VI

ANALYSIS OF POSSIBLE LEGAL AND ADMINISTRATIVE SOLUTIONS

As has been inferred above, there may be considerable parallel between the way atomic energy has been administered by the government of the United States and the way weather modification ought to be administered.

Let us examine the Atomic Energy Act as one possible model for control of weather modification, licensing weather modifiers, collection of data, dissemination of information gained through experimentation, and protection of property rights.

The parallel is made apparent by substituting the words "weather modification" for "atomic energy" in the congressional declaration of policy in the Atomic Energy Act.[121]

119. *See* note 103, *supra*.

120. 42 U.S.C. § 2210 (1964), *as amended* (Supp. II, 1967).

121. 42 U.S.C. § 2011 (1964).

> Atomic energy is capable of application for peaceful as well as military purposes. It is therefore declared to be the policy of the United States that—
> (a) the development, use, and control of atomic energy shall be directed so as to make the maximum contribution to the general welfare, subject at all times to the paramount objective of making the maximum contribution to the common defense and security; and
> (b) the development, use, and control of atomic energy shall be directed so as to promote world peace, improve the general welfare, increase the standard of living, and strengthen free competition in private enterprise.

Likewise, the Congressional findings in the Atomic Energy Act can easily be modified to apply with equal validity to weather modification, although in this instance we must ask the reader to substitute the words "weather modification" for the language in brackets quoted here:[122]

> The Congress of the United States makes the following findings concerning the development, use, and control of [atomic energy]:
> (a) The development, utilization, and control of [atomic energy] for military and for all other purposes are vital to the common defense and security.
> . . . .
> (c) The . . . utilization of [source, by-product, and special nuclear material] affect(s) interstate and foreign commerce and must be regulated in the national interest.
> (d) The . . . utilization of [source, by-product, and special nuclear material] must be regulated in the national interest and in order to provide for the common defense and security and to protect the health and safety of the public.
> (e) [Source and special nuclear material, production facilities, and utilization facilities] is affected with the public interest, and regulation by the United States of [the production and utilization of atomic energy and of the facilities used in connection therewith] is necessary in the national interest to assure the common defense and security and to protect the health and safety of the public.
> (f) The necessity for protection against possible interstate damage occuring from the operation of facilities for [the production or utilization of source or special nuclear material] places the operation of those facilities in interstate commerce for the purposes of this chapter.
> (g) Funds of the United States may be provided for the development and use of [atomic energy] under conditions which will pro-

122. 42 U.S.C. § 2012 (1964).

vide for the common defense and security and promote the general welfare.

. . . .

(i) In order to protect the public and to encourage the development of [the atomic energy industry], in the interest of the general welfare and of the common defense and security, the United States may make funds available for a portion of the damages suffered by the public from [nuclear] incidents, and may limit the liability of those persons liable for such losses.

Moving on then to the third section of the Atomic Energy Act, there is similar ease of translation from atomic energy to weather modification. Again, the only alteration required is the substitution of "weather modification" for the material in brackets:[123]

It is the purpose of this chapter to effectuate the policies set forth above by providing for—

(a) a program of conducting, assisting, and fostering research and development in order to encourage maximum scientific and industrial progress;

(b) a program for the dissemination of unclassified scientific and technical information and for the control, dissemination, and declassification of Restricted Data, subject to appropriate safeguards, so as to encourage scientific and industrial progress;

(c) a program for Government control of [the possession, use, and production of atomic energy and special nuclear material, whether owned by the Government or others], so directed as to make the maximum contribution to the common defense and security and the national welfare and to provide continued assurance of the Government's ability to enter into and enforce agreements with nations or groups of nations for the control of [special nuclear materials and atomic weapons];

(d) a program to encourage widespread participation in the development and utilization of [atomic energy] for peaceful purposes to the maximum extent consistent with the common defense and security and with the health and safety of the public;

(e) a program of international cooperation to promote the common defense and security and to make available to cooperating nations the benefits of peaceful applications of [atomic energy] as widely as expanding technology and considerations of the common defense and security will permit; and

(f) a program of administration which will be consistent with the foregoing policies and programs, with international arrangements,

123. 42 U.S.C. § 2013 (1964).

> and with agreements for cooperation, which will enable the Congress to be currently informed so as to take further legislative action as may be appropriate.

It is not the purpose of this article to draft legislation, but proceeding to the next section of the Atomic Energy Act, involving "definitions,"[124] it may be observed that, out of 27 definitions in the section, at least twenty can be applied equally well to a Weather Modification Act. The only real differences lie in the definitions of "source materials," "special nuclear materials," and their production.[125]

In the Atomic Energy Act there is provision for cooperation with the states,[126] research assistance,[127] either by the Atomic Energy Commission,[128] or through others,[129] or for others,[130] licensing, both at home[131] or abroad,[132] reporting,[133] control of information, both internally[134] and internationally,[135] and licensing and control of investigations developed through sponsored research or employment.[136]

We have previously referred to the analogy between federal indemnification for damages resulting from weather modification and the risks assumed by the federal government under the provisions of the Atomic Energy Act. Briefly, the licensee is required to obtain and maintain financial protection to the extent available from private sources, unless the Atomic Energy Commission establishes a lesser amount. The Commission then agrees to indemnify and hold harmless the licensee and other persons indemnified from public liability arising from nuclear incidents in excess of the financial protection of the licensee and up to a maximum of 500 million dollars in connection with each nuclear incident. In cases of nuclear incidents occurring outside the United States the limit is 100 million dollars.[137]

124. 42 U.S.C. § 2014 (1964), *as amended* (Supp. II, 1967).
125. 42 U.S.C. § 2014 (s), (t), (w), (x), (y) (1964), *as amended* (Supp. II, 1967).
126. 42 U.S.C. § 2021 (1964).
127. 42 U.S.C. § 2051 (1964).
128. 42 U.S.C. § 2052 (1964).
129. 42 U.S.C. § 2051 (1964).
130. 42 U.S.C. § 2053 (1964).
131. 42 U.S.C. §§ 2073, 2092, 2093, 2111, 2131, 2133-2138 (1964); 42 U.S.C. § 2139 (1964), *as amended* (Supp. II, 1967); 42 U.S.C. §§ 2140, 2232-2241 (1964).
132. 42 U.S.C. §§ 2074, 2094, 2112, 2151-2154, 2291 (1964).
133. 42 U.S.C. § 2095 (1964).
134. 42 U.S.C. §§ 2161-2163, 2165 (1964).
135. 42 U.S.C. § 2164 (1964).
136. 42 U.S.C. §§§ 2181-2190 (1964).
137. 42 U.S.C. § 2210 (1964), *as amended* (Supp. II, 1967).

The energy in the atom and the moisture in the cloud are each a national natural resource, not one belonging to any one state or political subdivision, and certainly not something out of which an individual or private corporation should make money, other than in supplying services in connection with the development of a natural resource belonging to all the people.

Each is a natural resource having both military and peaceful significance. In today's world, perhaps the military applications of weather modification techniques are matters of national security, around which a cloak of secrecy must be maintained. On the other hand, maximum progress requires wide dissemination of all information obtained. Because of security restrictions, the layman cannot assess the gap between military and peaceful applications of atomic energy, but must assume that refinements utilized by the military do not become available for peaceable uses until the military has good reason to assume no necessity for security remains. Historically, the military attitude has been an extremely conservative one.

They are natural resources which must be handled with care, and whose cataclysmic effects, if misapplied, could cause damage beyond the financial capability of even the largest private corporation. Each is properly the subject of international concern and, ultimately supranational control.

Small scale programs, aimed at increasing precipitation or suppressing hail or tornadoes in a relatively small area or a single river basin, might well be the concern of river basin commissions—either those already established, or those established under the Water Resources Planning Act of 1965.[138] Some of these commissions have means and staff available to plan, finance, supervise and evaluate such activities. Presumably, if they desired, they could acquire the authority to do so, if they do not already have such authority.

Just as a group of states can operate a relatively small scale program in the United States, so, by treaty, could a group of nations carry out a similar program where the effects would be limited in scope. Treaties concerning surface rivers can be patterns for treaties concerning what Secretary Udall calls "Rivers in the Sky."[139]

But in the final analysis, when the people of the world come to treat weather as an entire resource, to utilize it for the benefit of all mankind, such treatment must be carried out on an international

138. 42 U.S.C. § 1962 (Supp. II, 1967).

139. Address by Secretary of the Interior Stewart L. Udall, American Meteorological Society, Jan. 26, 1966.

basis with every nation participating and sharing in the benefits of successful control or suffering from failures.

As we have referred to the provisions of the Atomic Energy Act in the United States as a possible pattern for this country to follow in regulation of weather modification, we turn now to a possible analogue in international organization, which can likewise be examined as a pattern for international regulation and control.

There is already in existence an international organization peculiarly appropriate for this function, albeit perhaps ill-armed for the task. The World Meteorological Organization, a specialized agency affiliated with the United Nations, is already considered as a regulatory institiution for outer space. Outer space and weather modification are perhaps mutually exclusive, but the World Meteorological Organization has been active in outer space functions, including World Weather Watch and the Year of the Quiet Sun.[140]

Much attention has been devoted to the legal aspects of the peaceful uses of outer space, and a distinguished legal sub-committee on the U.N. Committee on Peaceful Uses of Outer Space has been struggling for some time on problems concerning the the rescue of astronauts, the return of space vehicles and personnel, and on liability for space vehicle accidents.

On December 13, 1963, the General Assembly of the United Nations, in a landmark action,[141] unanimously adopted resolution 1962 (XVIII).[142] The declaration covered the following points:

(1) the use of outer space for the benefit of all mankind;

(2) freedom of exploration and use of outer space and celestial bodies by all States in accordance with international law;

(3) prohibition of national appropriation of outer space and celestial bodies;

(4) the carrying out of activities of States in the exploration and use of outer space in accordance with international law, including the United Nations Charter, and in the interests of international peace and security, cooperation and understanding;

(5) international responsibility of States for activities in outer space by their governmental agencies or by non-governmental

140. A. G. Haley, Parameters of Space Law: Present and Future, in Proceedings of the Eighth Colloquium on the Law of Outer Space 218 (International Institute of Space Law of the International Astronautical Federation 1966) [hereinafter cited as Eighth Colloquium].

141. C. Jenks, Space Law xiii (1965), calls this resolution "the Magna Carta of Space."

142. 1963 United Nations Yearbook 101.

entities and responsibility of any international organization and the States participating in it for activities carried on in outer space by that international organization;

(6) observance of corresponding interests of other States in outer space, and conduct of appropriate international consultations if an outer space activity or experiment planned by a State or its nationals would cause potentially harmful interference wtih activities of other States;

(7) retention of ownership of objects launched into outer space and of jurisdiction of the State of registry over such objects and personnel thereon, while in outer space; return of such objects found outside the State of registry to that State and the furnishing of identifying data upon request prior to return;

(8) international liability of States for damage caused by objects launched ino outer space; and

(9) rendering of all possible assistance to, and return of, astronauts in the event of accident, distress, or emergency landing.

It is readily apparent that, with the relatively minor substitutions of "atmosphere" for "outer space," the nations of the world have, tailor-made, a charter for international development and protection of weather modification techniques for the welfare of all.

In the area of liability alone, there are other established precedents from which we can learn and, if deemed desirable, borrow. Two European entities come to mind. They are the European Space Research Organization (ESRO/CERS) and the European Organization for the Development and Construction of Space Vehicle Launchers (ELDO/CECLES).[143] These are organizations of an institutional character. The institutions themselves have responsibility of their own, in addition to the responsibility of their member States. The institutional organizations have concluded agreements with States authorizing the use of territory by the organizations.

The agreements concluded by ESRO/CERS and ELDO/CECLES fall into three categories:

The agreements between ESRO and France, Italy and Norway require the organization to take out insurance.

The agreement between ELDO and Australia makes Australia responsible for settling third party claims with the understanding that ELDO guarantees total reimbursement.

143. The textual material regarding (ESRO/CERS) and (ELDO/CECLES) is drawn from M. G. Bourely, International Organizations for Cooperation in Space and the Problem of Liability for Space Activities, in Eighth Colloquium, *supra* note 140 at 1.

The ESRO-Sweden agreement is an intermediate system. Certain categories of damage are settled directly with the third parties by Sweden, which receives a fixed annual fee for that purpose. Other categories are insured against by ESRO.

A detailed examination of the COMSAT agreements would undoubtedly provide additional analogies which could be applied to weather modification.[144]

However, the same general fundamental requirements exist in international structures for control of weather modification as arise in connection with national controls: registration of operators, licensing, registration and evaluation of plans, notice to those affected, assurance of responsibility in the event of damage, and accumulation and dissemination of data.

We return, as is so often the case where cause and effect do not respect national boundary lines, to the need for a supra-national control system. Atomic energy furnishes a pattern and a guide. Just as no nation should be permitted to pollute the atmosphere with potentially fatal nuclear fallout, no nation should have the power or the right, unilaterally, to decide on a weather modification program that might cause distant droughts or floods.

CONCLUSION

If the scientists can control the weather, the people of the earth have the right to look forward to improved conditions in agriculture, climate and health. Enroute to this goal, however, there will necessarily be pitfalls and failures. Because the scientist employs the methods of trial and error, some way must be developed to safeguard the nations of the earth from possibly devastating results of the errors. Safeguards mean controls, and controls of value must be based on knowledge of proposed experiments, sound appraisals of their validity, and a license based on an authority which can refuse or limit as well as consent. This means an international, supra-national system of licensing, inspection and reporting.

Hugo da Cunha Machado lists these essentials:

> 1. A new juridical order for space problems with clear and accurate definitions and concepts must be formulated.
> 2. A new law must preside [*sic* (precede?)] the space activities

144. A. G. Haley, Communications in Space: Existing Structures and Foreseeable Problems, in Eighth Colloquium, *supra* note 140 at 156.

> . . . without adhering too much to past juridical doctrines or being dominated by political order considerations of the moment.
> 3. Space law must be international-universal . . . .
> 4. An international-universal specific law designed to judge space problems must be established.
> 5. A coordinating agency of space activities in which all participate and to which all are technically subjected must be created.[145]

The obvious locus of such a system is in the United Nations. Under the World Meteorological Organization or under a new and separate sub-organization there should be established the kinds of controls we have attempted to outline above. Only then can the world be assured of sane, logical, progressive development of the science of weather modification on a scale significant enough to achieve the desired results.

145. H. da C. Machado, General Remarks on the Problem of Liability, in Proceedings of the Ninth Colloquium on the Law of Outer Space 106 (International Institute of Space Law of the International Astronautical Federation 1967).