

WEATHER GENESIS AND WEATHER NEUTRALIZATION: A NEW APPROACH TO WEATHER MODIFICATION

On October 13, 1947, General Electric's Project Cirrus¹ seeded an Atlantic hurricane off the east coast of Florida.² The seeded portion of the hurricane showed visible alteration.³ Then, apparently as a result of the seeding,⁴ the hurricane veered westward nearly 120 degrees⁵ sending rain and wind into the Florida, Georgia, and South Carolina coasts, causing damage totalling \$5,000,000.⁶ The area was sparsely populated, but a deeper penetration was equally probable and would have resulted in untold destruction in several large cities. Shortly thereafter, General Electric withdrew from all hurricane modification activities.⁷

General Electric's apparent failure did not mark the end of scientific inquiry into the artificial modification of hurricanes. In 1961, the United States government created Project Stormfury,⁸ a cooperative effort between the United States Navy and the United States Weather Bureau. Its first experiment involved the seeding of Hurricane Esther. Analysis of the data gathered

1. Davis, *The United States and Mexico: Weather Technology, Water Resources, and International Law*, 12 NATURAL RESOURCES J. 530, 540 (1972) [hereinafter cited as Davis].

2. *Id.*

3. *Id.* at 541.

4. A. ROSENTHAL, H. KORN & S. LUBMAN, CATASTROPHIC ACCIDENTS IN GOVERNMENT PROGRAMS 30 (1963).

5. *Id.*

6. *Id.*

7. Davis, *supra* note 1, at 541.

8. Project Stormfury is presently under the direct auspices of the Department of Commerce's Environmental Science Services Administration. It operates with the assistance of the United States Navy and Air Force. The project's objective is the diminution and possible diversion of hurricanes from populated coastal cities by massively seeding a hurricane's super-cooled clouds near the eye of the storm. The theory is that by exposing the super-cooled water droplets present in these clouds to vast quantities of silver iodide, the droplets change from their liquid state into ice crystals. This process produces heat, thereby changing the pressure distribution inside the storm, and results in redistribution of the tremendous energy contained in a hurricane. It is thought that such a redistribution might reduce the intensity of the destructive winds. O'Neil, *Current and Future Weather Modification Programs of the Department of Defense*, in WEATHER MODIFICATION AND THE LAW 39-40 (H. Taubenfeld ed. 1968).

from the experiment suggested that artificial weather modification had occurred.⁹ In 1963, the experiments conducted by Project Stormfury on Hurricane Beulah were also considered successful. A reduction in wind velocity, also observed with Esther, again followed the seeding.¹⁰ In 1969, the seeding of Hurricane Debbie yielded dramatic results. The evidence gathered from the experiment suggested "that storm seeding was the catalyst which caused Debbie's winds to drop dramatically, her shape to change rapidly, and her course to meander harmlessly out to sea."¹¹

These experiments are dramatic illustrations of developing United States potential in the field of weather modification. Project Stormfury is scheduled to move to the Western Pacific where it is hoped that more hurricanes will be available for testing than were previously available in the southeastern United States.¹² Tornado research,¹³ precipitation enhancement,¹⁴ warm and cold fog dispersal,¹⁵ and suppression of lightning and hail¹⁶ are all cur-

9. Baum, *The ESSA Program in Weather Modification*, in WEATHER MODIFICATION AND THE LAW 24 (H. Taubenfeld ed. 1968).

10. *Id.*

11. Note, *Weather Modification: A Modest Proposal*, 4 GEO. J. INT'L & COMP. L. 159, 160-61 n.17 (1974) [hereinafter cited as *A Modest Proposal*]. Debbie's winds were reduced by as much as 30%. *Hearings on S. Res. 281 Before the Subcomm. on Oceans & International Environment of the Senate Comm. on Foreign Relations*, 92d Cong., 2d Sess. 63 (1972) [hereinafter cited as *Hearings*].

12. Davis, *supra* note 1, at 543.

13. J. DAY, THE SCIENCE OF WEATHER 181 (1966) [hereinafter cited as DAY]; PANEL ON WEATHER AND CLIMATE MODIFICATION, COMMITTEE ON ATMOSPHERIC SCIENCES, NATIONAL ACADEMY OF SCIENCES, NATIONAL RESEARCH COUNCIL, 2 WEATHER AND CLIMATE MODIFICATION PROBLEMS AND PROSPECTS, RESEARCH AND DEVELOPMENT 49-51 (1966) [hereinafter cited as 1966 PANEL ON WEATHER MODIFICATION]; see generally HENDERSON & CARLEY, THE AIRBORNE SEEDING OF 6 TORNADOES: PROCEEDINGS OF THE 3D NAT'L CONFERENCE ON WEATHER MODIFICATION 241 (1972).

14. R. POPKIN, THE ENVIRONMENTAL SCIENCE SERVICES ADMINISTRATION 236-38 (1967); Hobbs, *The Scientific Basis, Techniques, and Results of Cloud Modification*, in WEATHER MODIFICATION: SCIENCE AND PUBLIC POLICY 31-38 (R. Fleagle ed. 1969) [hereinafter cited as Hobbs]; 1966 PANEL ON WEATHER MODIFICATION, *supra* note 13, at 8-33; BATTAN, HARVESTING THE CLOUDS 73-89 (1969) [hereinafter cited as HARVESTING THE CLOUDS]; COMMITTEE ON ATMOSPHERIC SCIENCES, NATIONAL RESEARCH COUNSEL, THE ATMOSPHERIC SCIENCES AND MAN'S NEEDS: PRIORITIES FOR THE FUTURE 44 (1971) [hereinafter cited as ATMOSPHERIC SCIENCES]; Battan, *The Scientific Aspects of Weather Modification*, in CONTROLLING THE WEATHER 35-37 (H. Taubenfeld ed. 1970) [hereinafter cited as *Scientific Aspects*]. See generally FOURTH CONFERENCE ON WEATHER MODIFICATION OF THE AMERICAN METEOROLOGICAL SOCIETY (1974).

15. DAY, *supra* note 13, at 200; PANEL ON WEATHER AND CLIMATE MODIFICATION, COMMITTEE ON ATMOSPHERIC SCIENCES, NATIONAL ACADEMY OF SCI-

rently under experimentation. In recognition of this advancement, the National Advisory Commission on Ocean and Atmosphere has stated that, "we stand on the threshold of a new era of environmental control."¹⁷ Modest changes in the weather can now be effected, with the possibility of a startling breakthrough in major modification techniques in the next decade.¹⁸

Serious international questions have arisen in conjunction with the capability to modify the weather. For example, do countries have the right to take unilateral action in all weather modification activities? What liability might a country incur for its weather modification operations which destroy life and property in a foreign State? On what theory could and should that State base its claim? The international ramifications of weather modification are obvious, and in time may lead to potentially major international controversy.¹⁹ As one writer has noted:

[M]uch has already been written on the technological possibilities But too little has been done by way of preparation for the international legal complications which this technology may present.²⁰

ENCES, NATIONAL RESEARCH COUNCIL, SCIENTIFIC PROBLEMS OF WEATHER MODIFICATION 19-20 (1964) [hereinafter cited as 1964 PANEL ON WEATHER MODIFICATION]; Hobbs, *supra* note 14, at 42; 1966 PANEL ON WEATHER MODIFICATION, *supra* note 13, at 43-47; HARVESTING THE CLOUDS, *supra* note 14, at 59-70; ATMOSPHERIC SCIENCES, *supra* note 14, at 45-46; *Scientific Aspects*, *supra* note 14, at 33-35; Jiusto, Pilie, & Kolmond, *Fog Modification with Giant Hygroscopic Nuclei*, 7 J. APPLIED METEOROLOGY 860 (1968).

16. M. UMAN, LIGHTNING 1 (1969); 1964 PANEL ON WEATHER MODIFICATION, *supra* note 15, at 11-13; Hobbs, *supra* note 14, at 38-40; 1966 PANEL ON WEATHER MODIFICATION, *supra* note 13, at 37-43; HARVESTING THE CLOUDS, *supra* note 14, at 90-105; ATMOSPHERIC SCIENCES, *supra* note 14, at 46; *Scientific Aspects*, *supra* note 14, at 37-39; Taylor, *Lightning—Agent of Change in Forest Ecosystems*, 69 J. FORESTRY 477 (1971); Goyer, Howell, Schaeffer, Schleusener & Squires, *Project Hailswath*, 47 BULL. AM. METEOROLOGICAL SOC'Y 805 (1966).

17. *Hearings*, *supra* note 11, at 154. The developing technology has been thoroughly reviewed by other authors and is mentioned here only to emphasize that modification of the weather is not scientific fantasy, but technological reality. See Davis, *supra* note 1, at 530-31 nn.1-7; Roberts, *The State of the Art in Weather Modification*, in WEATHER MODIFICATION AND THE LAW 2-11 (H. Taubenfeld ed. 1968); Davis, *Weather Warfare: Law and Policy*, 14 ARIZ. L. REV. 659, 663 nn.22-29 (1972).

18. Hassett, *Weather Modification and Control: International Organizational Prospects*, 7 TEX. INT'L L.J. 89, 114 (1971).

19. Taubenfeld, *Weather Modification and Control: Some International Legal Implications*, 55 CALIF. L. REV. 493, 505 (1967).

20. Samuels, *International Control of Weather Modification Activities: Peril or Policy?*, 13 NATURAL RESOURCES J. 327 (1973).

Such preparation at this time would be far from premature. It would be naive to think that the United States would hesitate to use newly developed technology to divert or diminish a hurricane like Camille or Betsy, each of which caused over 1.4 billion dollars worth of property damage.²¹

This comment will examine the current approach taken by legal analysts to the international problems created by the advent of weather modification technology. A review of the varying weather modification activities will reveal a basic analytical misconception by a number of legal writers. This misconception stems from conceptualizing weather modification operations as a single set of activities differing only in degree but not in kind. Because of this misconception, suggested models for international control of weather modification activities do not adequately meet or solve many fundamental problems. Furthermore, this misconception clouds the issues of responsibility and liability for harm occasioned by weather manipulation.

This comment proposes that weather modification is in fact two distinct and dissimilar activities—*weather genesis*, the carefully planned and analyzed creation of a desired atmospheric condition, and *weather neutralization*, the diminution, diversion, or elimination of large-scale emergency inclement weather. Having failed to recognize this distinction, the writers to date have focused on only half the problem, that of weather genesis. The more serious problem of weather neutralization, where the potential for destruction is greater, has largely been ignored.

21. *A Modest Proposal*, *supra* note 11, at 159. The destructive capability of a hurricane is enormous. Fifteen thousand people have been killed by hurricanes since 1900. ATMOSPHERIC SCIENCES, *supra* note 14, at 66-67. The 1965 hurricane season produced \$1,444,800,000 worth of damage in the United States alone. Sugg, *The Hurricane Season of 1965*, 94 MONTHLY WEATHER REV. 183 (1966). Death and destruction are synonymous with the word "hurricane". "[T]he Great Hurricane that slashed across the Florida Keys in 1935 [killed] 405." N.Y. Times, Aug. 19, 1969, at 24, col. 5. Recently, Hurricane Eloise was responsible for at least sixty-one deaths and \$150,000,000 worth of damage. S.D. Union, Sept. 25, 1975, at A-2, col. 5. The inland states are far from immune from the destructive forces of hurricanes. Pennsylvania was severely flooded by tropical storm Agnes in June of 1972, during which time damage reached \$3 billion." S.D. Union, Sept. 27, 1975, at A-4, col. 5. Tornadoes also wreak destruction and are responsible for vast amounts of property damage and an average of 230 deaths a year. L. BATTAN, NATURE OF VIOLENT STORMS 76 (1961).

I. WEATHER MODIFICATION:
ANALYTICAL MISCONCEPTION IN DEFINITION

The current approach to weather manipulation fails to recognize basic differences between various forms of weather modification activities. While writers may differ in the particular activities which they believe comprise the science of weather manipulation, all employ one phrase, "weather modification", to describe the entire range of activities which have as their purpose the alteration of atmospheric conditions.

One definition of weather modification includes "rainmaking and hail suppression but excludes fog dispersal as unlikely to cause controversy and hurricane modification as affecting only a few nations."²² Another definition includes cloud seeding, fog dissipation, hail and lightning suppression, and possibly hurricane modification.²³ A third definition defines the activity in terms of its function rather than by example. Under this approach weather modification includes:

[O]perations which have as their purpose, or one of their purposes, or one of their principle effects, changes in the atmospheric conditions over any part of the earth's surface. *Without restricting the generality of this definition*, the term shall include operations designed to increase precipitation, decrease precipitation, suppress hail, suppress lightning, dissipate fog, and suppress or divert storm systems.²⁴

These current definitions all adopt a singular concept of weather modification by including such diverse activities as fog dispersal and hurricane diversion within the same definition. This approach will be referred to as the "singular concept theory".

The singular concept theory fails to distinguish between the significantly different activities which make up the field of weather modification—weather genesis and weather neutralization. They have been absorbed by these general definitions, their identity lost in an effort to pool all meteorological activities into a single conceptual framework. These two activities must be distin-

22. McLaren, *Weather Modification and the Law*, 34 SASK. L. REV. 1 (1969).

23. Hassett, *supra* note 18, at 106.

24. S. 281, 92d Cong., 2d Sess., art. II (1972). Other definitions simply include any activity which decreases or increases precipitation, suppresses hail and lightning, removes fog, modifies hurricanes, or reduces the destructiveness of tornadoes. Johnson, *Federal Organization for Control of Weather Modification*, 10 NATURAL RESOURCES J. 222 (1970).

guished and analyzed, for they are sufficiently distinct in character to require separate treatment.

Weather genesis is the artificial creation or regulation of weather, the long range, well-planned and analyzed manipulation of atmospheric conditions. Long term increase or decrease in precipitation comprises the body of this activity. The essential characteristic of weather genesis is that it involves activities which lend themselves to planning and consultation. As such, precipitation manipulation, hail suppression, lightning control, and fog dispersal are all specific examples of weather genesis.

Weather neutralization, on the other hand, is the immediate, large scale diversion, diminution, or elimination of emergency inclement weather. These activities require minimum reaction time to save life and property in immediate jeopardy. Hurricane, tornado, and severe thunderstorm control are prime examples of conditions to which weather neutralization might apply.

This distinction suggests an approach which bifurcates weather modification into two conceptual groups; this approach will be referred to as the "dual concept theory".

The inadequacy of the singular concept theory is twofold. First, the problems peculiar to weather neutralization have been ignored. In an effort to protect the international community from potential disaster caused by weather modification, legal scholars have advocated various international controls. Having misperceived the problem, however, they have proposed solutions viable only for weather genesis. Second, the problem of defining an acceptable international liability theory has been left unresolved, hindered by an approach so nebulous that it only invites confusion.

A. Singular Concept Theory: Only Half the Answer

The first major problem created by the singular concept theory is that it stresses the creation of one centralized body to deal with all weather modification operations. However, while currently proposed regulatory schemes appear particularly appropriate to weather genesis activities, they are unsuited for neutralization. For example, one commentator suggests an international licensing agency composed of, *inter alia*, scientists, economists, and lawyers, with jurisdiction over those weather modification activities which create a possible risk of harm to other States.²⁵

25. Samuels, *supra* note 20, at 339.

Others have suggested that the approach to the regulation of atomic energy be used as a guideline for weather modification.²⁶ This concept embodies the idea that:

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 authority which can refuse or limit as well as consent. This means an international, supra-national system of licensing, inspection and reporting.²⁷

On the other hand, review of each proposed activity in weather neutralization takes time, a precious commodity in weather neutralization operations. Time consuming licensing and authorization procedures can only impede operations whose success depends upon immediate reaction to rapidly developing hurricane or tornado conditions. Such proposals are not well suited to the diversion of emergency inclement weather. The essence of licensing procedure is review and compliance with predetermined standards. Licensing proposals are aimed at regulating weather genesis activities where time consuming licensing procedures are practical. These activities, such as increase in precipitation over an arid region or the suppression of hail over farmland, lend themselves to appraisal, inspection and licensing before the activity commences.

Still another proposal urges that an advisory panel be created under the auspices of the United Nations to deal with the international problems of weather modification.²⁸ This recommendation concludes that the panel

[W]ould function on a voluntary basis, eventually securing an agreement from as many states as possible to seek the panel's counsel before proceeding with any large scale weather manipulation operation.²⁹

Such a proposal is predicated upon the assumption that submission of plans for specifically defined operations for advice, perusal, or appraisal will apply to all weather modification activities. This position fails to recognize weather modification activities which

26. Corbridge, Jr. & Moses, *Weather Modification: Law and Administration*, 8 NATURAL RESOURCES J. 207 (1968) [hereinafter cited as Corbridge].

27. *Id.* at 234.

28. Weiss, *International Responses to Weather Modification*, 29 INT'L ORG. 805 (1975).

29. *Id.* at 823.

must act in emergency situations where there is no time for such procedures. Again, weather neutralization operations have been ignored.

The nebulous singular concept theory spawns catchall solutions such as "regional and global institutions of information gathering, data assessment, crisis management, and regulatory control."³⁰ An international monopoly³¹ of all weather modification operations has also been suggested and is a further illustration of the generalized solutions precipitated by the singular concept theory. Suggested solutions employing this theory are either inapplicable to weather neutralization or too general to be of any constructive value.

B. Singular Concept Theory Confuses the Problem of Liability

Having conceived of weather modification as a single set of similar activities, the tendency has been to search for a single theory to determine the rights and duties of nations involved in weather modification. Because there is no one theory of liability that works well for all such activities, the law is in a state of confusion. Indeed, there is no accepted international principle of liability in the area of weather modification. The law in the United States and in Canada surrounding weather modification has been described as "chaotic,"³² and international law on this subject as "practically non-existent."³³

It has been stated that "where the government or its agent is the operator, there is no doubt that the State bears responsibility for the harm which occurs in neighboring territories."³⁴ But what type of responsibility is this? On what theory of liability should a claim be based? A reading of the literature in the area leads to a

[G]rowing 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. . . . Although scientific progress in the field of weather control has not, until recently, been especially rapid, it is still

30. R. FALK, *A STUDY OF FUTURE WORLDS* 129 (1975).

31. Samuels, *supra* note 20, at 340.

32. Hassett, *supra* note 18, at 99.

33. *A Modest Proposal*, *supra* note' 11, at 165.

34. Samuels, *supra* note 20, at 335-36.

running alarmingly ahead of the development of legal doctrines in this area.³⁵

The lack of an international theory of liability was illustrated by the recent Agreement Between the United States and Canada Relating to the Exchange of Information on Weather Modification Activities.³⁶ Both countries agreed only to an exchange of information on proposed unilateral weather modification activities and specifically refused to address the issue of liability. Article VII of that agreement states:

Nothing herein relates to or shall be construed to affect the question of responsibility or liability for weather modification activities, *or to imply the existence of any generally applicable rule of international law.*³⁷

This is the only weather modification agreement of its kind into which the United States has entered³⁸ and is limited to unilateral reporting³⁹ and consultation.⁴⁰ Both parties retain their capacity to act unilaterally.⁴¹ In short, neither the legal scholars nor the international diplomatic machinery has been able to develop an acceptable international standard of liability for a nation's weather modification activities.

II. DUAL CONCEPT THEORY: A MORE RATIONAL ANALYSIS

A. *Dual Concept Theory and The Control of Neutralization Activities*

The reconceptualization of weather modification as two separate and distinct activities will promote dual efforts to solve the unique organizational problems of each of the two component

35. Corbridge, *supra* note 26, at 217.

36. Agreement on the Exchange of Information on Weather Modification Activities with Canada, March 26, 1975, (—) — U.S.T. —, T.I.A.S. — [reproduced in 14 INT'L LEGAL MATERIALS 589 (1975)] [hereinafter cited as Exchange of Information].

37. *Id.* art. VII (emphasis added).

38. The United States made an agreement with the Philippines on April 23, 1969, in which the United States agreed to conduct rain enhancement operations over that country. The Philippines were experiencing a very dry period and sought such assistance from the United States. The agreement with Canada is concerned with the mutual appraisal of unilateral weather modification activities.

39. Exchange of Information, *supra* note 36, art. II, § (1), art. III.

40. *Id.* art. V.

41. *Id.* art. VI.

parts of weather modification. Such redefinition will discourage attempts to formulate a single solution applicable to the entire field.

International licensing organizations and arbitration panels, supervisory and monopolistic bodies, while offered as solutions to the entire problem of weather modification, have in fact been addressing the problem of weather genesis only. They encourage discussion, foster debate, contemplate compromise, and generally protect the good will and friendly relations between neighboring countries. Inundated with diplomacy, circumscribed by politics, and steeped in bureaucracy, such organizations do little to affect the unilateral activities of a State's weather genesis activities, nor should they. It is imperative that each State be allowed as much latitude and freedom from restraint as is reasonably prudent. Though weather modification technology is rapidly advancing, the science is still in its infancy. To foster scientific progress, only the most necessary restraints should be placed on experimentation. No nation need give up control of these operations.

Because weather genesis activities require extensive planning, potentially affected nations should be forewarned and should have ample opportunity for response. Time is not a factor in weather genesis. No country should be expected to relinquish control over activities where the chance of affecting other nations is comparatively small. Thus, a scheme which seeks to set operating standards through a licensing mechanism, but which leaves the ultimate control to each individual State, adequately protects the international community without sacrificing scientific progress. However, the factors which make such a scheme desirable for genesis activities make it particularly inapplicable for weather neutralization.

Weather neutralization activities must be dealt with differently because the meteorological activities themselves are quite different than those associated with weather genesis. Weather neutralization largely deals with hurricanes, tornadoes, and severe thunderstorms, all physical phenomena capable of inflicting tremendous destruction and injury within hours. Time is a critical factor. An activity which attempts to diminish or divert such weather systems must mobilize personnel and machinery quickly and efficiently. Consultation and diplomacy may be appropriate for contingency planning. However, once a storm front threatens,

the neutralization organization must possess the authority and autonomy to act immediately, with no political or diplomatic interference.

Because of the great potential for damage, all weather neutralization activities ought to be performed by an international body, and no State should be allowed to unilaterally engage in neutralization activities. No nation has the right to choose if lives and property in another State will be endangered; it strains imagination to suppose that a State could objectively balance the lives and property of its own citizens against those of another country. It is appropriate that this power should be assumed by an international organization acting for the benefit of all nations within a geographic location. Established for the protection of its members from this common enemy, such an organization could react quickly for the purpose of saving lives and property.

An international joint enterprise could implement weather neutralization operations, alleviating the burden of responsibility from each of its members. The logistics of such an operation and the desire to alter a potential weather front necessitate the creation of a specific international organization to deal with large scale emergency inclement weather.

A joint enterprise of nations concerned with weather neutralization will be responsible to each member for its long range operation and will receive from individual members their suggestions and criticisms concerning the overall methods of weather control.⁴² However, the moment the organization goes into operation against a particular weather front, it must become an entity separate from the demands and hinderances of any one member. As with most emergency operations, this separation is the key to efficiency and success.

In this respect, weather neutralization activities are analogous to military operations.⁴³ Their similarities make it feasible to em-

42. It should be stressed that the diversion or elimination of inclement weather cannot be regarded as universally desirable. *A Modest Proposal*, *supra* note 11, at 163; Roberts, *supra* note 17, at 9-10. Hurricanes, while wreaking destruction on one area, may bring needed rain to another. While it would be naive to suggest that this fact would preclude the defense of areas in the path of a hurricane, every effort must be made to minimize the destructive potential without destroying the beneficial effects of such weather systems. While basically a scientific problem, this paradox must be recognized in plans for weather modification.

43. In fact, the effort to modify a hurricane has many of the characteristics of a military campaign. It is interesting to note that the seeding of Hurricane

ploy the United States-Canadian North American Air Defense Command (NORAD)⁴⁴ as a working model for the structure of an international weather neutralization organization.⁴⁵ An agreement creating an effective defense against military attack is quite similar to the creation of an effective defense against a natural "attack" of emergency inclement weather. Both require immediate action. Both lend themselves to a strategy of using a joint enterprise directed at repelling a common foe rather than using two separate, non-coordinated defenses. The NORAD agreement recognizes that the air defense of both countries has to be considered as a "single problem"⁴⁶ and that past arrangements did not provide for any coordination of air defense weapons between the two countries.⁴⁷ The defense of lives and property in two or more countries against a storm front must also be considered as a single problem. Yet no authoritative body controlling all inclement weather defense systems has been suggested.

The NORAD agreement provides a framework for a coordinated defense system capable of immediate response to an attack on the North American continent.⁴⁸ Similarly, the successful diversion of a potentially dangerous hurricane or tornado depends upon early warning and a quick response to the developing storm front by an international joint effort.

The NORAD agreement also provides centralized control of all air defense activities.⁴⁹ NORAD's "integrated headquarters"

Debbie has been described as an *attack* on the hurricane, the seeding as *bombing runs*, and the entire operation as "the most ambitious *assault* ever made on a storm." N.Y. Times, Aug. 18, 1969, at 22, col. 4 (emphasis added); N.Y. Times, Aug. 20, 1969, at 27, col. 3; N.Y. Times, Aug. 21, 1969, at 26, col. 2 (emphasis added).

44. North American Air Defense Command Agreement with Canada, May 12, 1958, 9 U.S.T. 538, T.I.A.S. No. 4031 [hereinafter cited as NORAD Agreement].

45. Confronted with the problem of air defense, noting that minimum reaction time was required, the United States and Canada effected an agreement for the joint air defense of their two countries.

46. NORAD Agreement, *supra* note 44, 9 U.S.T. at 538.

47. *Id.* at 538-39.

48. *Id.* at 539.

49. The agreement stated that:

It was essential . . . to have in existence . . . an organization, including the weapons, facilities and command structure which could operate at the outset of hostilities in accordance with a *single* air defense plan approved in advance by national authorities. . . .

[The] problem of air defense . . . could best be met by delegating to an integrated headquarters the task of exercising operational control

theory is well suited to weather neutralization. Recognizing the common enemy and the need for immediate response, an organization responsible for weather neutralization would operate most efficiently by implementing one unified plan directed by a single command structure.

B. *Dual Concept Theory and Analysis of Liability*

The dual concept approach to weather modification facilitates the resolution of the problem of liability. Since weather genesis and weather neutralization are distinct in character, each requires a separate theory of liability.

Plans for weather genesis may be handled effectively in arbitration or compromise negotiations, should potential damage and liability appear likely. The use of arbitration or compromise is possible because time considerations in weather genesis are of minimal importance. For example, the long-term increase in precipitation over an area of the northwestern United States could easily affect Canada. However, there is no emergency, as lives and property are not in imminent danger. There is time for submission and analysis of plans, for consultation, compromise, and the cancellation or modification of potentially harmful activities.

A State, sufficiently appraised of the possibility of harmful effects from its weather manipulation activities, should be held strictly liable for the harm caused. Strict liability embodies the concept that any person who engages in any abnormally dangerous activity which "necessarily involves a risk of serious harm to the person, land or chattels of others which cannot be eliminated by the exercise of the utmost care, and . . . is not a matter of common usage,"⁵⁰ will be held liable without fault for any injury suffered by another because of that activity.⁵¹ It would appear that the

over combat units of the national forces made available for the air defense of the two countries.

NORAD Agreement, *supra* note 44, 9 U.S.T. at 539 (emphasis added).

50. RESTATEMENT OF TORTS § 520 (1938).

51. Strict liability is an expanding concept. It has been applied to injuries from rockets, *Berg v. Reaction Motors Div., Thiokol Chemical Corp.*, 37 N.J. 396, 181 A.2d 487 (1962); *Smith v. Lockheed Propulsion Co.*, 247 Cal. App. 2d 774, 56 Cal. Rptr. 128 (1967); and proposed for genetic manipulation. Comment, *Genetic Manipulation: Research Regulation and Legal Liability Under International Law*, 7 CALIF. W. INT'L L.J. — (1976). Professor Prosser states that "it may be predicted with a good deal of confidence that [nuclear energy] is an area in which no court will . . . refuse to recognize and apply the principle of strict liability. . . ." W. PROSSER, *LAW OF TORTS* 516 (4th ed. 1971).

application of strict liability to weather genesis activities is both plausible and appropriate, the defendant having been properly assessed of possible damage to others due to what certainly can be considered an ultra-hazardous activity.⁵²

Moreover, the suitability of strict liability is reinforced by the inadequacies of applying conventional theories of negligence to weather genesis operations. Under a conventional theory of negligence, a plaintiff would have the impossible burden of proving that damage was caused by negligent acts of artificially induced weather modification rather than by natural meteorological activity. In addition, a standard of care would be extremely difficult to define at this stage of technological development.

Weather genesis operations, unilateral in nature, are amenable to a strict liability theory. Such a theory places a premium on sound planning and thorough appraisal, hopefully leading to a minimum of mistakes and misjudgment. Precisely because there is ample time for advance planning and consultation, it is not unreasonable that those controlling the activity be held responsible for any harm their weather genesis may cause.

Unlike weather genesis, an essential element of weather neutralization is minimum reaction time. Hurricane and tornado control require immediate response. Because of the inherent dangers of weather neutralization, an international body created by treaty to control these activities is suggested as the only reasonable means of protecting the international community. The decision to divert a storm front is properly delegated to a body which reacts for the benefit of a geographical division, rather than a political one. Because the logistics involved in the control of a hurricane lend themselves to an international joint effort, the liability theory of joint enterprise is more appropriately applied to weather neutralization activities than is strict liability.

Joint enterprise is commonly defined as follows:

A joint adventure arises out of, and must have its origin in, a contract, express or implied, in which the parties thereto agree to enter into an undertaking in the performance of which they have a community of interest, and further, a contract in which each of the parties has an equal right of control over the agencies used in the performance. Thus we note (1) a contract, (2) a common purpose, (3) a community

52. Corbridge, *supra* note 26, at 216; Taubenfeld, *supra* note 19, at 499.

of interest, (4) equal right to a voice, accompanied by an equal right of control.⁵³

This principle is applicable to an international organization responsible for weather neutralization. By becoming signatories to an agreement or a treaty creating such an international organization, a contractual relationship is established. A common purpose and community of interest are embodied in the desire to protect life and property from destructive storm activity. Equality of voice and control are internal matters, but ones which are easily satisfied by an international organization which represents all members, showing partiality to none.

A joint enterprise embodies the principle that "each is the agent . . . of the others, and . . . the act of any one within the scope of the enterprise is to be charged vicariously against the rest."⁵⁴ This common liability for activities of the weather neutralization organization prevents its joint enterprise members from claiming damages arising out of those very activities. From this it follows that no signatory may seek restitution from another, since all would have attempted jointly to divert a storm front through participation in an international program of common defense.

This does not necessarily mean that a member state will not be compensated for losses suffered as a result of organization activities. Plausible compensation schemes already in existence in other international organizations may be adapted to fit the needs of a weather neutralization body. One scheme might involve an organization relief fund similar to the relief fund administered by UNICEF. UNICEF is an international organization created by the United Nations to deal specifically with the world's children. Its relief fund is comprised of voluntary contributions of member governments, and supports programs of education, welfare, emergency relief and rehabilitation. For example, in 1973, one hundred and twenty-four governments voluntarily contributed over 70 million dollars to the UNICEF funding program. The weather neutralization organization could administer a similar fund. Each country could voluntarily contribute to a general fund, although compulsory contribution based on economic ability is perhaps more realistic. Provisions similar to those established for disaster

53. *Carboneau v. Peterson*, 1 Wash. 2d 347, 95 P.2d 1043 (1939).

54. W. PROSSER, *LAW OF TORTS* 475 (4th ed. 1971).

relief through the United Nations Working Capital Fund might also be implemented. In 1970, the United Nations allocated \$150,000 from its Working Capital Fund for disaster relief, with allocations limited by a stated maximum per disaster. Compensatory relief might also be acquired through an intra-organizational insurance plan with each member paying into the fund on a premium basis, withdrawing compensation should the need arise.⁵⁵

III. CONCLUSION

If weather modification continues to be viewed as a single activity, the problems associated with weather genesis and neutralization will remain inadequately treated by singular solutions. This comment has stressed the unique qualities of the two activities and proposed the creation of a separate international organization which would deal exclusively with weather neutralization. The solution proposed is meant to be a starting point in the formulation of the principles needed in the creation of an organization concerned with emergency inclement weather only.

An agreement between the United States and Canada would provide a sound foundation from which to build an international weather neutralization organization. Since both are highly developed countries with similar cultures and sophisticated scientific societies, formation of the international organization would be unlikely to encounter significant diplomatic difficulties.

For the international weather neutralization organization to be truly effective, the United States and Canada would have to seek the cooperation and the participation of the Caribbean countries, Mexico, and the South American States. Here there will be differences in ideology, culture and technological capability. However, a weather neutralization organization would certainly have very strong appeal to all of those countries having an interest in hurricane control.⁵⁶ Moreover, a successfully organized international program of weather defense would offer lesser developed

55. Of course, the relationship between the organization and non-member States adversely affected by the organization's activities is yet another problem in international law and beyond the scope of this Comment.

56. Hurricane Eloise recently took at least 61 lives in the Caribbean area and was responsible for record devastation. S.D. Union, Sept. 25, 1975, at A-2, col. 5. She left thousands of people homeless in Puerto Rico, the Dominican Republic, and in Cuba. She also threatened Mexico's Yucatan Peninsula. S.D. Union, Sept. 21, 1975, at A-2, col. 4.

countries a technological capability which they are presently unable to develop independently.

In return for providing new member states with technical training and capabilities, the United States and Canada would be benefitted by a decrease in the likelihood of international conflict resulting from weather neutralization activities. The new member states could also offer land for bases in diverse geographic locations and manpower for the facilities which the organization would surely need for optimum efficiency.

If an international organization responsible for weather neutralization in the Western Hemisphere can effectively defend its members against emergency inclement weather and, at the same time, reduce international tension due to those activities, then it might serve as a prototype for other areas of the globe. The Atlantic storms which ravage the European continent might be effectively controlled by a similar effort. This solution might find application also in the Western Pacific where tropical typhoons have wreaked devastation in Japan, Southeast Asia, and Australia.

The dual concept theory redefines weather modification by distinguishing between weather genesis and weather neutralization. It is hoped that this reconceptualization will spawn better solutions to those international problems certain to develop with the increased technological capabilities in this area.

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