

Weather Modification and Control: Some International Legal Implications

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AS MAN'S KNOWLEDGE about weather increases, and it has increased dramatically in the last decade, it seems safe to predict that there will be substantial wide-scale experimentation with weather modification.¹ It also seems likely, though this is less certain, that man will also develop the capacity to some degree to control weather—that is, to modify it on a greater than local scale.²

This possibility gives rise to great hopes. Yet it also seems clear that even a modest ability to alter the weather will probably give rise to conflict between interested nations just as local experiments and modification activities have led to litigation, legislation and even gunfire within the United States.³ As the World Meteorological Organization (WMO) has pointed out:

It is not unrealistic to expect that mankind will eventually have the power to influence weather, and even climate, on a large scale. However, the complexity of the atmospheric processes is such that a change in the weather induced artificially in one part of the world will necessarily have repercussions elsewhere. This principle can be affirmed on the basis of present knowledge of the mechanism of the general circulation of the atmosphere. However, that knowledge is still far from sufficient to enable 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 earth may give rise elsewhere, nor even in fact to predict whether these effects will be beneficial or detrimental. Before undertaking an experiment on large-scale weather modification, the possible and desirable consequences must be carefully evaluated, and satisfactory international agreement must be reached.⁴

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¹ The definition used in a 1966 Report of the National Academy of Sciences is useful here: "The subject of weather and climate modification is concerned with any artificially produced changes in the composition, behavior, or dynamics of the atmosphere. Such changes may or may not be predictable, their production may be deliberate or inadvertent, they may be transient or permanent, and they may be manifested on any scale from the microclimate of plants to the macrodynamics of the worldwide atmospheric circulation." COMMITTEE ON ATMOSPHERIC SCIENCES, NAT'L ACADEMY OF SCIENCES—NAT'L RESEARCH COUNCIL, WEATHER AND CLIMATE MODIFICATION—PROBLEMS AND PROSPECTS (Pub. No. 1350, 1966).

² For a discussion of present programs for gaining information about weather and suggestions as to how major changes might be precipitated, see, e.g., *Hearings on S. 23 & S. 2916 Before the Comm. on Commerce*, 89th Cong., 1st & 2d Sess., pts. 1 & 2, at 116, 347, 351-52 (1966) (testimony of Dr. Walter Orr Roberts) [hereinafter cited as *Hearings*].

³ See generally authorities cited notes 17 and 22 *infra*.

⁴ WORLD METEOROLOGICAL ORGANIZATION, SECOND REPORT ON THE ADVANCEMENT OF

That the international implications of weather modification activities cannot be ignored at present is indicated by the number of countries already conducting studies in this field. In addition to the United States,⁵ other countries with field programs include the Soviet Union, with a program two or three times as large as that of the United States,⁶ Argentina, Australia, Canada, France, Italy, Japan, Kenya, Korea and Tunisia. Studies are also under way in Germany, Great Britain, India, Israel and Switzerland.⁷

Since it is clear that weather knows no boundaries,⁸ even local weather modification activities may have an unintentional impact in other countries.⁹ Of greater concern is the possibility that major weather modification and control activities may prove to be zero-sum games.¹⁰ Because some countries must be losers or, at least, will so regard themselves, international conflict over changes is inevitable. In commenting on these

ATMOSPHERIC SCIENCES AND THEIR APPLICATION IN THE LIGHT OF DEVELOPMENTS IN OUTER SPACE 19 (1963). Resolution 1721 of the United Nations General Assembly, G.A. Res. 1721, 16 U.N. GAOR Supp. 17, at 6, U.N. Doc. A/500 (1962), specifically mentioned weather modification and control as a subject to be studied. For recent WMO comments on the need for more information before attempts are made to modify weather on a large scale, see *New York Times*, Oct. 22, 1966, at 20, col. 3. The dangers of large-scale weather modification are discussed in Ackerman, *Weather Modification and Public Policy*, in *SCIENCE AND RESOURCES: PROSPECTS AND IMPLICATIONS OF TECHNOLOGICAL ADVANCE* 63, 66 (H. Jarrett ed. 1959); Byers, *What Are We Doing About Weather?*, in *id.* at 37, 52-53.

⁵ On United States programs see NATIONAL SCIENCE FOUNDATION, *WEATHER MODIFICATION*, ANN. REP. (1965) [hereinafter cited as NSF].

⁶ NSF 25.

⁷ NSF 25-30; see SENATE COMM. ON COMMERCE, *WEATHER MODIFICATION AND CONTROL*, S. REP. NO. 1139, 89th Cong., 2d Sess. 45-46 (1966); see generally *id.*

⁸ See generally C. Anderson, *Towards Greater Control: High Risks, High Stakes*, in *SCIENCE AND RESOURCES*, *supra* note 4, at 54, 58-59. The existence of national boundaries has already caused limitations on programs of weather modification. *Hearings* 405 (testimony of Dr. Kirk concerning the Columbia River Basin).

⁹ In responding to Senator Magnuson on March 8, 1966, for example, the State Department expressed some concern over even modest modification programs, noting that: "The Department of State has reviewed Senate Bill 23 concerned with a program to increase usable precipitation in the United States. The Department of State's only concern would be in case the experimental areas selected would be close to national boundaries which might create problems with the adjoining countries of Canada and Mexico. In the event of such possibilities the Department would like to insure that provision is made for advance agreements with any affected countries before such experimentation took place." *Hearings* 321.

¹⁰ A "zero-sum game" is a term used in game theory to describe situations where the parties' objectives are inversely related, so that any gain by *A* requires a corresponding loss by *B*. In a zero-sum game there is no logical basis for cooperation between the parties. See generally T. SCHELLING, *THE STRATEGY OF CONFLICT* 83-87 (1960).

We do not here consider the direct military interest in the use of weather-forecasting, modification or control. For some interesting comments see *Hearings* 33 (testimony of Dr. Pierre St. Amand); *id.* at 156-161 (testimony of Dr. Cholmers Sherman).

potentials, Dr. von Neumann expressed great concern about the potential dangers of weather control:

Present awful possibilities of nuclear warfare . . . [among them world-wide fallout] may give way to others even more awful. After global climate control becomes possible, perhaps all our present involvements will seem simple. . . . Once such possibilities become possible, they will be exploited.¹¹

And Dr. Edward Teller told the Senate Military Preparedness Subcommittee in November 1957:

Ultimately, we can see again and again that small changes in the weather can lead to very big effects. . . .

Please imagine a world in which the Russians can control weather in a big scale, where they can change the rainfall over Russia, and that—and here I am talking about a very definite situation—that might very well influence the rainfall in our country in an adverse manner

What kind of a world will it be where they have this new kind of control, and we do not?¹²

These drastic risks must in time be considered, but at present they are highly speculative. First, while modest local modification capabilities now seem certain, it is conceivable that man, for the foreseeable future, will not be able to effect substantial changes in the world's climate. Second, while "no international agreements or conventions dealing with weather modification activities" exist, at least as of mid-1967,¹³ the United States already has over a dozen bilateral agreements with countries for meteorological training and exchanges,¹⁴ and scores of countries are participating with the United States in using satellite-derived information for forecasting. It may well be that nations will be more amenable to international cooperation in this area than in some others where they have believed vital national interests were at stake.

Despite many weather modification activities in the United States, there have apparently been no international problems with Canada or Mexico to date,¹⁵ though such activities in the United States might eventually cause concern to those neighbors.¹⁶ Nevertheless, since it is always useful to give some thought to those future possibilities which can realistically be imagined, this article will explore a few of the questions which

¹¹ von Neumann, *Can We Survive Technology?*, FORTUNE, June 1955, at 107, 152.

¹² Quoted in Anderson, *supra* note 8, at 60-61.

¹³ WEATHER BUREAU, U.S. DEP'T OF COMMERCE, WEATHER AND CLIMATE MODIFICATION 32 (1965); cf. *Hearings* 235-38 (testimony of Dr. Joyce).

¹⁴ *Hearings* 235-36 (testimony of Dr. Joyce).

¹⁵ *Id.* at 237.

¹⁶ *Id.* (colloquy between Dr. Joyce and Senator Brewster).

might be raised by probable minor interference in another nation's territory or by potential major international conflicts of interest resulting from weather modification and control activities. There will be no discussion, however, of theories of ownership, liability and the like within the domestic law context, even though they may be relevant as analogies in international matters. These problems have been explored at length in many existing studies.¹⁷

I

MINOR INTERFERENCE IN ANOTHER NATION'S TERRITORY

Among the concepts of national sovereignty are the rights to maintain the national territory free from physical interference by other states and their nationals, to control acts and persons on the national territory,¹⁸ and to protect the lives, property and interests of nationals when threatened from any quarter.¹⁹ To enforce this last-mentioned claim, many

¹⁷ On legal issues and cases within the United States in particular, see generally TAUBENFELD, *WEATHER MODIFICATION: LAW, CONTROLS, OPERATIONS* (NSF No. 66-7, 1966); Oppenheimer, *Legal Aspects of Weather Modification*, Paper presented to the Western Snow Conference, April 21, 1965; Morris, *The Law and Weather Modification*, 46 BULL. AM. METEOROLOGICAL SOC'Y 618 (1965); Oppenheimer, *The Legal Aspects of Weather Modification*, 1958 INS. L.J. 314; Stark, *Weather Modification: Water—Three Cents per Acre-Foot?*, 45 CALIF. L. REV. 698 (1957); Comment, *Legal Problems of Weather Control*, 12 BAYLOR L. REV. 113 (1960); Note, *Legal Remedies for Cloud-Seeding: Nuisance or Trespass?*, 1960 DUKE L.J. 305; Comment, *Rights of Private Land Owners as Against Artificial Rainmakers*, 34 MARQ. L. REV. 262 (1951); Note, *Artificial Rainmaking*, 1 STAN. L. REV. 508 (1949); Note, *Who Owns the Clouds?*, 1 STAN. L. REV. 43 (1948); Note, 14 SW. L.J. 425 (1960); Note, *Are There Individual Property Rights in Clouds?*, 15 WYO. L.J. 92 (1960); see generally ARTHUR D. LITTLE, INC., ON CREDIBLE CATASTROPHIC EVENTUALITIES IN SELECTED AREAS OF GOVERNMENT SPONSORED ACTIVITIES 101-04 (1963); A. ROSENTHAL, H. KORN & S. LUBMAN, *CATASTROPHIC ACCIDENTS IN GOVERNMENT PROGRAMS* 34-38 (1963); Goldie, *Liability for Damage and the Progressive Development of International Law*, 14 INT'L & COMP. L.Q. 1189, 1264 n.244 (1965); see also Harry, *Another Headache*, 26 AUSTR. L.J. 527 (1953). As to the general handling of international claims see W. BISHOP, *INTERNATIONAL LAW* 626-743 (2d ed. 1962); 5 G. HACKWORTH, *DIGEST OF INTERNATIONAL LAW* 471-851 (1943); Sohn & Baxter, *Responsibility of States for Injuries to the Economic Interests of Aliens*, 55 AM. J. INT'L L. 545 (1961).

¹⁸ The right of a state to control (have jurisdiction over) acts and persons on its territory is unquestioned in international law. See generally W. BISHOP, *supra* note 17, at ch. 7. Certain persons, such as diplomats, are exempted from this rule.

¹⁹ On possible damages due to weather modification activities see A. ROSENTHAL, H. KORN & S. LUBMAN, *supra* note 17, at 30. "In Project Cirrus, a hurricane which was traveling off-shore was chemically seeded. Apparently as a result, it veered by about 120 degrees and sideswiped a coastal area. Fortunately, the area was lightly populated; yet damages of \$5,000,000 were reported. Such a hurricane might have penetrated the mainland more deeply and inflicted damage on a number of cities. . . . One cloud-seeding experiment in California was followed by the worst floods in nearly one hundred years. Damage suits totalling \$23,000,000 are now pending."

states, though not all, claim "jurisdiction" over an act or actor when the *effects* of the action are felt in the nation or by a national.²⁰

Moreover, and of importance for our purposes, all states claim absolute rights of sovereignty (ownership) in the airspace above their national territories and national waters. While the question of whether a private landowner "owns" the clouds (or "the weather") over his property is still being argued in domestic cases in the United States,²¹ it seems clear that nations are likely to assert rights of control over clouds and other weather phenomena in their national airspace.²² This involves, on the one hand, a right to "use" the weather over their territory, and, on the other, a claim to "receive" weather due to arrive from over another country.

Although there are few cases, those which do exist suggest the right of a state, for itself and its citizens, to claim compensation for damage arising out of activities conducted in another state.²³ Various theories have served as a basis for such claims, including nuisance²⁴ and abuse of rights.²⁵

General international law thus imposes limitations upon actions that one state may take which would cause injury in the territory of another state.²⁶ This principle runs throughout the range of state-to-state relationships. In the well-known (and in a sense unique) international case in point, the *Trail Smelter Arbitration* between the United States and Canada,²⁷ Canada was held responsible for the injury and damage resulting in the United States from fumes and "fallout" emitted from a smelter located in British Columbia and deposited over a large area of the State of Washington. The tribunal concluded that, "under the principles of international law, as well as of the law of the United States, no State

²⁰ See The S.S. "Lotus" [1927] P.C.I.J., ser. A, No. 9; W. BISHOP, *supra* note 17, at 443-69. See generally Dickenson, *Jurisdiction with Respect to Crime*, 29 AM. J. INT'L L. SUPP. 435 (1935). The United States has historically opposed this basis of state jurisdiction. See, e.g., The Cutting Case, [1887] FOREIGN REL. U.S. 751 (1888).

²¹ See *Slutsky v. City of New York*, 197 Misc. 730, 97 N.Y.S.2d 238 (Sup. Ct. 1950); *Southwest Weather Research, Inc. v. Duncan*, 319 S.W.2d 910 (Tex. Civ. App. 1958); authorities cited note 17, *supra*.

²² On rights in airspace, see, e.g., P. JESSUP & H. TAUBENFELD, *CONTROLS FOR OUTER SPACE* 201-05 (1959).

²³ See generally W. BISHOP, *supra* note 17, at 626-743; Lay & Taubenfeld, *Liability and Space Activities: Causes, Objectives and Parties*, 6 VA. J. INT'L L. 252 (1966).

²⁴ See, e.g., Lauterpacht, *Sovereignty Over Submarine Areas*, 1950 BRIT. Y.B. INT'L L. 376, 391.

²⁵ 1 L. OPPENHEIM, *INTERNATIONAL LAW* 345-47 (8th ed. 1955).

²⁶ See *Corfu Channel Case*, [1949] I.C.J. 4, 22. See also INTERNATIONAL LAW COMM'N, *SURVEY OF INTERNATIONAL LAW*, U.N. DOC. A/CN.4/1.34 (Rev. 1, 1949).

²⁷ *Trail Smelter Arbitration* (United States v. Canada), 3 U.N.R.I.A.A. 1905, 35 AM. J. INT'L L. 648 (1941).

has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the property or persons therein when the case is of serious consequence and the injury is established by clear and convincing evidence."²⁸ Canada was therefore obliged to pay damages on the general theory that a state incurs liability under international law when it permits or fails to act reasonably to prevent conduct within its territory which causes injury in the territory of another state.²⁹

Thus, where there has been an injury to a state because of a violation of international law, there is a resulting obligation of the offending state to make reparation in an appropriate manner.³⁰ The nature of the reparation varies, of course, according to the facts and circumstances of the particular case. The recognized manner of reparation for injury of a physical nature is pecuniary compensation, and its measure extends at least to damages for the actual loss.³¹ There is a division among the authorities as to whether the measure includes consequential damages, but the better view is that it does.³²

The problems involved in making claims against governments are well known; and they may prove to be as difficult for injuries caused by weather modification activities as they are in other spheres.³³ Nations

²⁸ *Id.* at 1965, 35 AM. J. INT'L L. at 716.

²⁹ See also Corfu Channel Case, [1949] I.C.J. 4, 22; 1 L. OPPENHEIM, *supra* note 25, at 290-91, 365.

³⁰ Case Concerning the Factory at Chorzów, [1927] P.C.I.J., ser. A, No. 9, at 21.

³¹ See Case Concerning the Factory at Chorzów, [1928] P.C.I.J., ser. A, No. 17, at 31, 46-48. See generally 1 L. OPPENHEIM, *supra* note 25, at 352-54; M. WHITEMAN, DAMAGES IN INTERNATIONAL LAW (1937-43); Eagleton, *Measure of Damages in International Law*, 39 YALE L.J. 52 (1929).

³² See generally INTERNATIONAL LAW ASS'N, REPORT OF THE 51ST CONFERENCE 182, 184 (1964) (remarks of Professor Olmstead).

³³ On non-liability for exercise of "discretionary functions," see *Dalehite v. United States*, 346 U.S. 15, 35-36 (1953). The United States has recently been held liable, however, where a careless and negligent report of weather conditions contributed to the crash of an airliner in 1962. *Ingham v. Eastern Airlines, Inc.*, 3 AV. L. REP. (10 AV. CAS.) 17, 122, 17129-30 (2d Cir. Feb. 14, 1967); see Note, 33 J. AIR L. & C. 185 (1967). See also *Hearings* 174-75 (testimony of Dr. Holloman).

On the domestic liability problems arising out of United States government programs, see generally A. HALEY, SPACE LAW AND GOVERNMENT 233-57 (1963); Lay & Taubenfeld, *supra* note 23, *passim*; E. STASON, S. ESTEP & N. PIERCE, ATOMS AND THE LAW (1959); A. ROSENTHAL, H. KORN & S. LUBMAN, *supra* note 17, at 30; WEATHER BUREAU, *supra* note 13, at 33-34; Berger, *Some Aspects of Civil Liability for Space Craft and Vehicle Accidents*, 33 PA. BAR ASS'N Q. 301 (1962); Note, *Space Law: Surface Impact Liability of Space Vehicles*, 14 OKLA. L. REV. 89 (1961); Schrader, *Space Activities and Resulting Tort Liability*, 17 OKLA. L. REV. 139 (1964).

An interesting illustration of the problems involved is found in M. HASSIALIS, J. BERNSTEIN & L. O'NEILL, SOME MAJOR HAZARDS IN GOVERNMENT SPONSORED SPACE ACTIVITIES 131-32 (1964), discussing "Project Cirrus," the seeding of a tropical hurricane in 1947. Within six hours after the seeding the direction of the storm changed so that a coastal

have apparently been willing to accept concepts of absolute liability, in effect making themselves insurers, in certain new technological fields such as outer space activities.³⁴ They might well do the same for weather modification activities to speed the process of experimentation.³⁵ This would certainly ease the burden on claimants of establishing liability; but, absent an international agreement covering the matter, the claimant's task will remain difficult at best.

II

INJURY AND DEPRIVATION OF RESOURCES: INTERNATIONAL RIVERS

One possible analogy to the problems raised by use of weather resources can be found in rules relating to the shared use and pollution of international rivers and drainage basins. While the principles of equitably shared use and of restraint in pollution have long been considered desirable, there are at present no uniformly accepted general rules of international law ensuring free access to international rivers or barring pollution or special restrictive uses by riparian states.³⁶

area of Georgia was subjected to the storm. "It is by no means certain that the change in course of this storm was causally related to the seeding equipment. Such storms have been known to change their directions before. Contrary-wise it cannot be said that the change in course was not due to the experimentation—the probability is that it was."

See also ARTHUR D. LITTLE, INC., ON CREDIBLE CATASTROPHIC EVENTUALITIES IN SELECTED AREAS OF GOVERNMENT SPONSORED ACTIVITIES, 98-104 (1963); NATIONAL SCIENCE FOUNDATION, WEATHER AND CLIMATE MODIFICATION 26-29, 117-25 (NSF Doc. No. 66-3, 1965).

³⁴ Article 7 of the Outer Space Treaty, signed January 27, 1967, by more than 60 countries, provides: "Each state party to the treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each state party from whose territory or facility an object is launched, is internationally liable for damage to another state party to the treaty or to its natural or juridical persons by such object or its component parts on the earth, in air space or in outer space, including the moon and other celestial bodies." 55 DEP'T STATE BULL. 953-55 (1966). *See also* Lay & Taubenfeld, *supra* note 23, *passim*; Goldie, *supra* note 17, *passim*.

³⁵ "Properly conducted weather control is a socially beneficial activity. In the present state of art, however, some individual, or group, may be called upon to suffer undue hardship for the general welfare. Whilst it would be unnecessarily harsh and contrary to the common advantage to prohibit weather control activities, people suffering from such activities have a genuine claim for recompense. Hence the proposal here is that, at least as far as international law is concerned, the principle of expropriation by risk creation should be applied, and that the neighboring State (or enterprise in a trans-national situation) carrying out the activity should be held to be strictly liable for harms resulting in the claimant State's territory from weather modifications. But, unless these modifications are performed recklessly, or without compliance with the standard of skill and care generally recognized as obtaining in this type of enterprise, States should not take diplomatic steps to seek the prohibition of weather control activities in neighboring countries. They should be satisfied with compensation." Goldie, *supra* note 17, at 1264 n.244.

³⁶ *See, e.g.*, INTERNATIONAL LAW ASS'N, *supra* note 32, at 119. The study of river problems is of special interest since efforts at rainmaking have a direct effect on the rivers. There are, of course, special treaty arrangements dealing with use and control of specific rivers

Past controversy over river and basin pollution may nevertheless be instructive with respect to the placing of "contaminants" in the air to effect atmospheric changes.³⁷ While the law is not fully settled, the principle of permitting no use which will harm the interests of another state has been applied by some international and national tribunals.³⁸ Treaties and other agreements have frequently dealt with this problem.³⁹ Even where the pollution is unintentional, as where irrigation projects in the nation of first use leave a poisonous salt residue in the water delivered to the second using state, there seems to be a tendency today to make reparation to the second user, though not to discontinue the offending use.⁴⁰

Summing up the matter, a State Department memorandum⁴¹ suggested that:

an international tribunal would deduce the applicable principles of international law to be along the following lines: . . .

2(a) Riparians are entitled to share in the use and benefits of a system of international waters on a just and reasonable basis. . . .

3(a) A riparian which proposes to make, or allow, a change in the existing regime of a system of international waters which could interfere with the realization by a coriparian of its right to share on a just and reasonable basis in the use and benefits of the system, is under a duty to give the coriparian an opportunity to object.

(b) If the coriparian, in good faith, objects and demonstrates its willingness to reach a prompt and just solution by the pacific means

such as the Rhine and the Danube. *See* 1 L. OFFENHEIM, *supra* note 25, at 772. There are also special treaty arrangements concerning pollution: The Euratom Treaty, for example, deals with potential radioactive pollution of all waters. INTERNATIONAL LAW ASS'N, *supra* note 32, at 122-23.

³⁷ *See generally* INTERNATIONAL LAW ASS'N, *supra* note 32, at 119-213. Local weather modification to date has normally involved the use of cloud "seeding" with dry ice pellets or smoke generated from silver iodide crystals. Other suggestions for modification attempts in the future have included the use of nuclear explosions (to alter hurricanes or to create clouds of steam from the oceans), the deposit of carbon monoxide or other gases at high altitudes to alter temperature distribution, and the like. *See, e.g., Hearings* 116, 351-352 (testimony of Dr. Walter Orr Roberts); Byers, *supra* note 4, at 52-53; Lovell, *Does Space Research Threaten Life on Earth?*, SATURDAY EVENING POST, Feb. 22, 1964, at 10, 14.

³⁸ *See, e.g., Lake Lanoux Arbitration (France v. Spain)*, 25 I.L.R. 101, 123 (1957).

³⁹ *See* Manner, *Water Pollution in International Law*, in WORLD HEALTH ORGANIZATION, ASPECTS OF WATER POLLUTION CONTROL 53, 57 (1962). *See generally* Lester, *River Pollution in International Law*, 57 AM. J. INT'L L. 828 (1963).

⁴⁰ For United States-Mexico arrangements concerning the Colorado River, see Treaty with Mexico, Feb. 3, 1944, 59 Stat. 1219, T.S. No. 994; Timm, *Water Treaty Between United States and Mexico*, 10 DEP'T STATE BULL. 282 (1944). In recent years, the United States has had to make adjustments due to pollution of Mexican land by water from the Colorado which, on delivery to Mexico, was laden with salt pollutants picked up in the course of irrigation use in the United States.

⁴¹ W. GRIFFIN, LEGAL ASPECTS OF THE USE OF SYSTEMS OF INTERNATIONAL WATERS, S. Doc. No. 118, 85th Cong., 2d Sess., 89-91 (1958) (State Dept. memo).

envisaged in article 33(1) of the Charter of the United Nations, a riparian is under a duty to refrain from making, or allowing, such change, pending agreement or other solution.

The memorandum then goes on to note:

Comment. It seems clear that there is no rule of international law that a riparian must have the consent of coriparians as a condition precedent to the use and development within its territory of a system of international waters. In other words, a coriparian does not have what in effect would amount to a veto over changes in the system.

However, in current international practice no riparian goes ahead with exploitation of its part of a system when a coriparian may possibly be adversely affected, without consulting the latter and coming to an understanding with it. It is to be noted that the latter's consent need not be expressly given; having been given an opportunity to object, its silence may be taken as consent.⁴²

Similar patterns may well emerge for national weather modification activities where effects and deprivations are likely to be felt across borders.

Yet in time this concept of non-obligatory accommodation may not prove adequate. States can already control river flow to a considerable degree, and charges of deprivation have strained international relations on several occasions. Certain Arab states have stated that Israel's attempt to interfere with their present or prospective use of the River Jordan would amount to "aggression" and would lead to an armed resistance; and Israel has taken the same position with respect to the Arab states involved.⁴³ No doubt any major attempt to modify the world's climate would elicit a similar response from potential "losers," whether such an attempt deprived them of an accustomed resource or threatened to impose a new climate on them. Moreover, the number of potentially affected states would almost assuredly be greater than in the case of international rivers. While this theme requires far more speculation and investigation, it seems obvious that there is a strong need for international regulation of certain resources to accommodate interests which vitally concern the nations involved.

III

CHANGES IN THE GENERAL ENVIRONMENT WITHOUT SPECIFIC LOSSES

Two experiments in the space field which involved changes in the earth's environment without causing identifiable specific losses offer another parallel to what may well occur when national efforts are directed to making substantial changes in weather. Both cases involved primarily

⁴² *Id.*

⁴³ See Doherty, *Jordan Waters Conflict*, INTERNATIONAL CONCILIATION, May, 1965, at 35.

American experiments: One was Project West Ford, an attempt to place copper needles in orbit around the earth in 1961 and 1963 to test communications possibilities; the other was the series of high altitude nuclear explosions conducted before the partial Nuclear Test Ban Treaty of 1963 barred its parties from testing in the atmosphere and outer space.

In general, nations and their scientists have demanded an unobstructed, freely observable outer space. Project West Ford was attacked by scientists in several countries and by government spokesmen in a few as a potential interference with radio astronomy and other observation techniques as well. The loss, if any, would have been to science and hence to all men, rather than to any particularly affected nation. The project was denounced as a dangerous, unilateral interference with the cosmos and, when it was pointed out that such allegations were excessive, the project was still opposed as at least the forerunner of a scientifically undesirable "cluttering up" of space.⁴⁴

In like manner, high altitude nuclear explosions were opposed by some scientists as creating distortions in the Van Allen Belt, making the study of the earth's natural environment more difficult, causing interference with scientific and other satellites in orbit and creating a menace to man in space.⁴⁵ The Soviet bloc labeled such experiments "acts of aggression" and contrary to international law, the United Nations Charter and United Nations resolutions.⁴⁶ Yet the high altitude tests were

⁴⁴ On Project West Ford, see generally Johnson, *Pollution and Contamination in Space*, in *LAW AND POLITICS IN SPACE* (M. Cohen ed. 1964). For attacks on West Ford, see Lovell & Ryle, *Interference to Radio Astronomy from Belts of Orbiting Dipoles (Needles)*, 3 J. ROYAL ASTRONOMICAL SOC'Y 100-08 (1962); Blackwell & Wilson, *Interference to Optical Astronomy from Belts of Orbiting Dipoles (Needles)*, *id.* at 109-14.

The Space Science Board of the National Academy of Sciences has concluded that the West Ford dipoles did not in fact interfere with radio or visual astronomy, but it was stated in the report that this "should not be taken either as an endorsement of the experiment or as tacit agreement to the launching of another similar belt without further discussion." Nat'l Academy of Sciences—Nat'l Research Council Press Release, March 26, 1964; SPACE SCIENCE BOARD, NAT'L ACADEMY OF SCIENCES, U.S. SPACE SCIENCE PROGRAM: REPORT TO COSPAR 153-54 (1964).

⁴⁵ See MASSEY, *SPACE PHYSICS* 208 (1964); Johnson, *supra* note 44, at 39-46; Taubensfeld, *Nuclear Testing and International Law*, 16 SW. L.J. 365, 397 (1962).

⁴⁶ U.N. Doc. No. A/AC.105/C.2/SR.5/5 (1962) (Mr. Misha, Albania); *American Diversion in Space*, INTERNATIONAL AFFAIRS, Moscow, Dec. 1961, at 117-18; Pokrovsky, *Crime in Space*, New Times, June 20, 1962, at 9-11 (on their illegality as interference with science, radio, health, cosmic flights and as a projection of the arms race into space).

On interference generally, see DAVID DAVIES MEMORIAL INSTITUTE OF INT'L STUDIES, DRAFT RULES CONCERNING CHANGES IN THE ENVIRONMENT OF THE EARTH, *passim*; see also sources cited *id.* at 5, 9.

For other attacks on high altitude needles and other experiments, see Stagg, *Possible Effects on Climate of Contamination of the Upper Atmosphere*, in REPORT OF CONFERENCE ON LAW AND SCIENCE, 12-16 (1964); Ryle, *The Effects on Astronomy of Tests in Earth's*

themselves, in part, designed as an interesting scientific experiment. Some of these criticisms have obviously been politically self-serving—the Soviet Union, for example, has conducted its own high altitude tests.⁴⁷ But objections have been sufficiently widespread to indicate a world-wide interest in protecting the natural order even where no damage to specific nations, persons or property was foreseeable.

Indeed, the Soviet Union proposed in 1963 that no space experiments with potentially harmful effects be conducted without the prior consent of all interested states. More precisely, the Russian draft declaration of basic principles governing outer space use provided that:

Cooperation and mutual assistance in the conquest of outer space should be a duty incumbent upon all states; the implementation of any measures that might in any way hinder the exploration or use of outer space for peaceful purposes by other countries shall be permitted only after prior discussion of and agreement upon such measures between the countries concerned.⁴⁸

The United States delegation successfully opposed this provision on the ground that it was an attempt to interpose a veto on a state's activities in outer space.⁴⁹ However, the American representative conceded that some form of international consultation was desirable:

His Government believed that, according to established principles of international law, states should take all reasonable steps to avoid activities which restricted the free use of outer space by other countries. It was prepared to consult with scientists of other countries whenever consistent with the national security. The possible harmful effects of space experiments should be studied by competent and objec-

Environment, in *id.* 17-23. Sir Bernard Lovell has also stated that "experiments such as putting needles into orbit or detonating nuclear warheads in the Van Allen Belt might do irreparable damage to pure scientific research in space." *The Times* (London), May 15, 1962, at 6, col. 7.

⁴⁷ Compare U.N. Doc. A/AC.105/C.1/1 (1962) (Statement by the Soviet Government on the United States high altitude nuclear explosions: "The high-altitude nuclear weapon tests being carried out by the United States of America can have extremely harmful consequences—the disturbance of the upper conducting layers of the earth's atmosphere over vast areas, the appearance of radio-wave absorption areas and the appearance of a new radiation zone in space immediately surrounding the earth.") with *N.Y. Times*, Jan. 24, 1963, at 5, col. 4. ("The Telstar satellite has come up with a new find: A flood of radiation poured into space immediately after the Soviet Union's high altitude nuclear tests in late October.")

⁴⁸ U.S.S.R., Proposed Declaration of the Basic Principles Governing the Activities of States Pertaining to the Exploration and the Use of Outer Space, U.N. Doc. A/AC.105/C.2/L.1 (1962). See 17 GAOR, 1st Comm. 3 (1962) (A/AC.1/SR.1289) (Mr. Morozov, U.S.S.R.); U.N. Doc. A/AC.105/C.2/SR.7/5-6 (1962) (Mr. Tunkin, U.S.S.R.).

⁴⁹ U.N. Doc. A/AC.105/C.2/SR.7/8-11 (1962) (Mr. Meeker, U.S.A.). However, the Soviet representative and the delegate from Czechoslovakia stated that the provision was not to be construed as involving a veto. *Id.* at 11 (Mr. Tunkin, U.S.S.R.); U.N. Doc. A/AC.105/C.2/SR.8-15 (1962) (Mr. Spacil, Czechoslovakia).

tive scientific bodies and his Government welcomed the establishment of a consultative group for that purpose by COSPAR.⁵⁰

The United Kingdom,⁵¹ France⁵² and Australia⁵³ also appeared to be in favor of a certain measure of prior discussion between states concerning experiments by one state which might impair the use of outer space for other states. Indeed, the Outer Space Treaty, signed by some sixty nations in January 1967, provides in article 9 that:

states parties to the treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a state party to the treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities of other states parties in the peaceful exploration and use of outer space, including the moon and other celestial bodies, it shall undertake appropriate international consultations before proceeding with any such activity

⁵⁰ 17 U.N. GAOR, 1st Comm., 214 (1962) (Mr. Gore, U.S.A.). COSPAR, the Committee on Space Research, performs the coordinating function for national space programs begun during the International Geophysical Year (IGY). COSPAR was at first composed of representatives from countries engaged in launching rockets or satellites (Australia, Canada, France, Japan, the U.S.S.R., the U.K. and the U.S.A.) together with three representatives from states engaged in tracking vehicles, chosen on a rotational basis, plus representatives from the nine international scientific unions interested in space research. The political realities of space progress soon required changes; the Soviet Union within the first year demanded a form of "veto" in this formally nongovernmental organization. Under the threat of a Soviet boycott the arrangements were changed to permit either great space power to "veto" proposed activities of the organization. Thus each in effect controls the election of three of the seven members of COSPAR's Bureau of the Executive Council and a vote of two-thirds of this Bureau is necessary to confirm decisions made by the Executive Council. Despite this perhaps inevitable handicap, COSPAR has been active in arranging for the exchange of information and reporting on national space activities. Both major powers have been actively concerned with the questions of radio frequencies for space research and operations, potentially harmful space experiments and the sterilization of space vehicles. Annual meetings are held with an increasingly large attendance of scientists from several dozen nations. *See, e.g.,* STAFF OF S. COMM. ON AERONAUTICAL AND SPACE SCIENCES, S. DOC. NO. 56, 89TH CONG., 1ST SESS., INTERNATIONAL COOPERATION AND ORGANIZATION FOR OUTER SPACE 378-400 (Comm. Print 1965); P. JESSUP & H. TAUBENFELD, CONTROLS FOR OUTER SPACE 231-32 (1959).

⁵¹ United Kingdom, Proposed Declaration of Basic Principles Governing the Activities of States Pertaining to the Exploration and Use of Outer Space, U.N. Doc. A/C.1/879 (1962): ". . . the conduct of scientific research, and the landing on and exploration of celestial bodies, . . . shall be exercised by all states with due regard to the interests of other states in the exploration and use of outer space, and to the need for consultation and co-operation between states in relation to such exploration and use." *See also* U.N. Doc. A/AC.105/C.2/SR.10/3 (1962) (Miss Gutteridge, U.K.).

⁵² U.N. Doc. A/AC.105/C.2/SR.9/3 (1962) (Mr. Patey, France).

⁵³ U.N. Doc. A/AC.105/C.2/SR.4/4-5 (1962) (Sir Kenneth Bailey, Australia).

or experiment. A state party to the treaty which has reason to believe that an activity or experiment planned by another state party in outer space, including the moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the moon and other celestial bodies, may request consultation concerning the activity or experiment.⁵⁴

While this treaty is self-policed and involves no enforcement technique, it indicates the likelihood of international accommodations to prevent perceived general dangers. Yet nations which believe that a particular experiment is truly vital to their national interests may well be willing to risk the censure which such an act might involve, as the Soviet Union did in renewing its nuclear testing program in the fall of 1961.

Even before the Outer Space Treaty, in 1962, the Committee on Space Research (COSPAR) established the Consultative Group on Potentially Harmful Effects of Space Experiments⁵⁵ consisting of scientists from the Soviet Union, India, Sweden, the Netherlands, the United States and the United Kingdom. The group was to study all questions relating to possible harmful effects of proposed space exploration and to make recommendations to COSPAR. The United States has reported its efforts to COSPAR and presently consults with other states concerning these delicate matters.⁵⁶ Such prior consultations are certainly the minimum accommodation necessary to maintain international amity in the face of prospective changes in man's environment due to weather experimentation, even when damage to a particular nation is not expected.

CONCLUSION

It appears that seemingly inevitable progress in the field of weather modification will in time lead to minor and possibly major international controversy. If weather modification causes only minor interference in another nation's territory, the interests of the affected nation might well be safeguarded by the assurance of prompt and adequate compensation. At the same time, the genuine world interest of increasing control over the forces of weather can effectively be pursued through good faith scientific efforts and experiments. Major international disturbances present far more difficult problems of accommodation; but the cooperative attitude shown in other areas such as the activities of COSPAR and the

⁵⁴ 55 DEP'T STATE BULL. 953-55 (1966).

⁵⁵ STAFF OF SENATE COMM. ON AERONAUTICAL AND SPACE SCIENCES, 89TH CONG., 1ST SESS., INTERNATIONAL COOPERATION AND ORGANIZATION FOR OUTER SPACE 390 (Comm. Print 1965). On this Consultative Group, also see U.N. Doc. A/AC.105/C.2/SR.78-9 (1962) (Mr. Meeker, U.S.A.).

⁵⁶ 17 U.N. GAOR, 1st Comm. 214 (1962) (Albert Gore, U.S.); U.N. Doc. A/AC.105/15 (1963) (Letter from Adlai Stevenson, U.S.).

negotiation and signing of the new space treaty offers encouragement that international agreements can be reached instituting appropriate controls and procedures and acceptable mechanisms for sharing in national and international weather programs. Hopefully, a greater knowledge and appreciation of the significant potential of weather modification and control will increase international desire to establish these agreements before unfortunate and perhaps unnecessary conflicts occur.