Rain on Demand: Regulating Weather Modification Throughout the United States

Adriana Vélez-León*

During a severe drought period that lasted approximately five months in 2015, Puerto Ricans endured seventy-two consecutive hours with water cutoffs, intensified forest fires, and a decline in agriculture production that elevated losses to thirteen million dollars.[1] The Puerto Rican government set up water trucks throughout the island that served as an "oasis" in moments where water was shut off.[2] In times where there were no water trucks in sight, Puerto Ricans resorted to the water in toilet tanks to clean their hands, children took bucket baths, and, in restaurants, plastic cups replaced glass ones.[3]

In August 2015, the U.S. Drought Monitor[4] reported that thirty-four of seventy-eight municipalities in Puerto Rico were experiencing extreme drought.[5] As a result, Puerto Rico's Aqueduct and Sewer Authority was forced to implement a strict water-rationing plan that commenced in March 2015, and cost the public agency close to twelve million dollars per month.[6] For approximately 340,000 households and businesses on the island, about 28% of the island's total, water was turned off for seventy-two hours and then back on for only twenty-four hours, while others were going without water in forty-eight hour cycles, sending people into desperation and a frenzy of water collection.[7] Weather modification was the last shot at rain amidst a dire situation in Puerto Rico where water was scarce and with no signs of improvement.

As a result of what has been labeled as one of the worst, if not the worst, drought in Puerto Rico's history, in July 2015 the Aqueduct and Sewer Authority entered into a three-month contract with Seeding Operations & Atmospheric Research in hopes of creating rain clouds over three of the island's main water reservoirs.[8] By the end of the contract, on October 31st, 2015, the water-rationing plan in Puerto Rico ceased and certain rain events, which brought approximately one foot of rainfall, were attributed to the weather modification operations that took place in the island.[9]

As temperatures rise and precipitation decreases, the environmental effects of climate change threaten freshwater supplies across the United States and, as a consequence, droughts are intensified, exemplified by the extreme situations in Puerto Rico and California.[10] Internationally, the United Nations predicts that by 2025, 1.8 billion people will be living in countries with absolute water scarcity,[11] and two-

* *Adriana Vélez-León is a 2017 J.D. Candidate at The George Washington University Law School. She received her B.A. in Journalism from the University of Puerto Rico, Río Piedras campus, and is Senior Articles Editor of the* George Washington Journal of Energy & Environmental Law. *The author would like to thank her family and friends for their constant love and support. She would also like to thank Professor Andrew Satten and Lauren Schaedig for their insight and guidance throughout the Note writing process.*

1. Agencia EFE, *Advierten la Sequía que Afecta a Puerto Rico Puede Ser la Peor de la Historia*, Primera Hora (June 6, 2015, 7:35 PM), http://www.primerahora.com/noticias/puerto-rico/nota/advierten lasequiaqueafectaapuertoricopuedeserlapeordelahistoria-1089443/.
2. Lizette Alvarez, *Water Crisis Brings Out Puerto Rico's Creative Side*, N.Y. Times, July 14, 2015, http://www.nytimes.com/2015/07/15/us/in-drought-puerto-rico-rations-water-setting-off-a-collection-frenzy.html?_r=0.
3. *Id.*; *see also* Chris Bury, *How Puerto Rico Is Coping With the Worst Drought in Decades*, PBS Newshour (Dec. 29, 2015, 6:30 PM), http://www.pbs.org/newshour/bb/how-puerto-rico-is-coping-with-the-worst-drought-in-decades/.
4. The U.S. Drought Monitor is produced through a partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln, the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. U.S. Drought Monitor, Nat'l Drought Mitigation Ctr., http://droughtmonitor.unl.edu (last visited Apr. 2, 2016).
5. Alvarez, *supra* note 2.
6. Maricarmen Rivera, *Vuelve la Siembra de Nubes*, El Vocero de P.R. (Sept. 11, 2015, 4:00 AM), http://elvocero.com/vuelve-la-siembra-de-nubes/.
7. Agencia EFE, *supra* note 1.
8. Rivera, *supra* note 6.
9. Harry Rodríguez, *Exitosa Siembra de Nubes en PR*, Metro (Oct. 21, 2015), http://www.metro.pr/noticias/exitosa-siembra-de-nubes-en-pr/pGXoju!vr4wpWBDRJ9q2/.
10. Justin Gillis, *California Drought Is Made Worse by Global Warming, Scientists Say*, N.Y. Times, Aug. 20, 2015, http://www.nytimes.com/2015/08/21/science/climate-change-intensifies-california-drought-scientists-say.html.
11. *Water Scarcity Factsheet*, UN-Water 2014 (May 17, 2013), http://www.unwater.org/publications/publications-detail/en/c/204294. The United Nations defines water scarcity as "[t]he point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully." *International Decade for Action "Water for Life" 2005–2015: Water Scarcity*, United Nations, http://www.un.org/waterforlifedecade/scarcity.shtml (last updated Nov. 24, 2014). The United Nations further explains that "[w]ater scarcity is a relative concept and can occur at any level of supply or demand[ ]"and that "[s]carcity may be a social construct . . . or the consequence of altered supply patterns—stemming from climate change for example." *Id.*

thirds of the world population could live under water stress conditions.[12] Given this disturbing background, weather modification activities are gaining momentum because of the technology's ability to artificially create rainfall through cloud seeding. Weather modification may be a crucial key in staving off a possible freshwater shortage crisis.

Although weather modification technology has existed for approximately seventy years in the United States,[13] both state and federal governments' involvement in its regulation has been limited.[14] Most legal control of cloud seeding, if any, in the United States has been carried out at local and state levels. Nevertheless, one of the biggest problems with state regulation of weather modification is that, since weather recognizes no political or territorial boundaries, the effects of weather modification are commonly interstate and, therefore, result in conflicting, varied, and weak state regulations.

Given the interstate effects, discussed *infra* Part III.A, that arise from weather modification activities and the value of water as a commodity, Congress, by the powers vested in it under the Commerce Clause, should enact the National Weather Modification Control Act, a law that will establish comprehensive federal regulation of weather modification activities. This Act will serve to regulate the weather modification field and establish federal standards that the states shall comply with under a program of cooperative federalism.

In advancing this proposal, by way of background, Part I will briefly review what weather modification is, how it functions, and its different benefits. Furthermore, this part will explain some concerns that surround weather modification activities. Part II will focus on the legal development of weather modification in the United States and will address the lack of federal regulation in this field. This part will also detail the different and weak weather modification regulations across the states. Ultimately, this part will broadly illustrate the serious flaws that make current state regulations ineffective to lay the foundation for the argument that the regulatory system of weather modification should no longer be left to the discretion of the states, but should be vested in the federal government. Part III analyzes why weather modification should be regulated on a federal level to minimize the possibility of adverse effects from cloud seeding activities and to avoid interstate legal issues. Part IV will introduce and explain the proposed solution, the National Weather Modification Control Act. Furthermore, this part will identify and analyze any challenges and obstacles the proposed Act might confront, highlighting legal obstacles.

I. Overview of Weather Modification, Its Benefits, and Concerns

Weather modification is a complex technology that is not yet well understood by many. The basics of weather modification and its different uses are discussed below. Although a convoluted technology, weather modification provides many different benefits, such as storm suppression and rain augmentation. Nevertheless, as explained further below, this technology is a cause for concern among those who believe weather modification can be used in the future as a new kind of powerful weapon.

A. The Basics of Weather Modification

Despite almost seventy years of use,[15] weather modification is one of the least understood environmental practices currently taking place. Weather modification is a form of atmospheric environmental alteration based on the theory that the introduction of correct amounts of particular "seeding agents" into some types of clouds will alter the precipitation formation process.[16] Specifically, according to a report by the National Science Foundation, weather modification "is taken to mean artificially produced changes in the composition, motion, or dynamics of the atmosphere, whether or not such changes may be predictable, their production deliberate or inadvertent, or their duration transient or permanent."[17]

Currently, most weather modification projects are used to either enhance or stop precipitation, or to suppress hail.[18] Other forms of modification include lightning suppression, hurricane diversion, and fog dissipation.[19] The usual technique involved in these types of weather modification projects consist of "seeding clouds" with silver iodide, either by dropping it from planes or launching it from a station on the ground, in order to serve as nuclei around which cloud droplets might form ice crystals.[20] These nuclei help the cloud produce precipitation by freezing supercooled liquid water,

12. Water stress refers to "[t]he ability, or lack thereof, to meet human and ecological demand for water. Compared to scarcity, water stress is a more inclusive and broader concept. It considers several physical aspects related to water resources, including water scarcity, but also water quality, environmental flows, and the accessibility of water." Peter Schulte, *Defining Water Scarcity, Water Stress, and Water Risk: It's Not Just Semantics*, Pacific Inst. (Feb. 4, 2014), http://pacinst.org/water-definitions/.
13. James N. Corbridge, Jr. & Raphael J. Moses, *Weather Modification: Law and Administration*, 8 Nat. Resources J. 207, 209–10 (1968).
14. *See id.* at 217–19.
15. In 1946, General Electric had its scientists inject dry ice into a cloud in what is known as the earliest, if not the first, attempt at manipulating the clouds. Corbridge & Moses, *supra* note 13, at 209.
16. Ray J. Davis, *Weather Modification Law Developments*, 27 Okla. L. Rev. 409, 409 (1974) [hereinafter *Weather Modification Law Developments*]; *see also* Ray J. Davis, *Weather Modification Interstate Legal Issues*, 15 Idaho L. Rev. 555, 555 (1978–1979) [hereinafter *Weather Modification Interstate Legal Issues*].
17. Special Comm'n on Weather Modification, Weather & Climate Modification 7 (1965), https://www.nsf.gov/nsb/publications/1965/nsb1265.pdf.
18. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.
19. Guive Mirfendereski, *An International Law of Weather Modification*, 2 Fletcher F. 41, 42 (1978).
20. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555; *see also* W. Water States Council, Water Laws & Policies for a Sustainable Future: A W. States' Perspective vii (2008); Zev Levin, On the State of Cloud

which are cloud droplets still in liquid form at temperatures colder than thirty-two degrees Fahrenheit.[21] Often, natural ice nuclei are "[i]nefficient or lacking in sufficient numbers in the atmosphere."[22] Thus, adding more efficient silver iodide nuclei through cloud seeding can increase precipitation production of the cloud.[23] The aim of cloud seeding is to ultimately control both the type and quantity of these ice nuclei in clouds in order to release, or stop precipitation.[24]

The weather modification process is not as simple as it may seem. It is important to point out that cloud seeding will operate only within *existing* clouds.[25] Clouds must already be in the atmosphere in order for any cloud seeding to be done. Weather modification does not "create weather;" rather, it takes existing weather and alters it.[26] Therefore, planning ahead of time, and before a serious drought scenario, will be imperative for any potentially successful cloud seeding operation. Moreover, not all clouds are good candidates for cloud seeding. To be successfully seeded, clouds must possess a sustained updraft of moist air, a lack of natural ice, and be significantly cold enough to contain supercooled liquid water.[27]

Furthermore, cloud seeders must insert an appropriate amount of material into the right sort of cloud, and they must do so at the correct time and place in order to obtain desirable results.[28] For example, in order to effectively produce precipitation through cloud seeding, each liter of air needs only one artificial ice nucleus.[29] If a cloud is overseeded it becomes glaciated, or made mostly of ice crystals, leaving few supercooled water droplets in the cloud.[30] As a result, ice crystals are not able to grow in the cloud and, thus, evaporate dissipating the cloud.[31] Despite the complexity of this science, different groups of weather modifiers are able to successfully conduct weather modification activities.

Most cloud seeding projects are conducted by a handful of highly specialized commercial firms working under contract for a variety of sponsors.[32] The usual sponsors include municipalities, hydroelectric utilities, and agricultural organizations.[33] Municipalities are mostly interested in weather modification projects because of its ability to increase water supplies.[34] On the other hand, hydroelectric utilities can generate additional hydroelectric power[35] from augmented runoff, which flows into reservoirs, or from enhanced flows in rivers, which have hydroelectric generation facilities.[36] Finally, agricultural organizations desire "additional runoff for irrigated agriculture or direct precipitation on crop or range lands during the growing season."[37] Weather modification has provided a variety of benefits to all interested sponsors.

B. Benefits of Weather Modification

The scientific community and private commercial operators have long recognized the advantages of successful weather modification.[38] Although weather modification activities are mostly recognized by their rain-augmenting benefits, this science has also proven valuable for numerous other reasons, such as storm suppression. Since weather events can have severe adverse effects on property and economic activity, the gross benefits of successful weather modification activities are, in comparison, very high.[39]

Although difficult to measure exactly, the operational costs of weather modification activities are small relative to its gross benefits.[40] For example, "annual losses due to drought are approximately eight billion dollars, which is a higher estimate than for any other natural hazard."[41] On the other hand, "the cost of a project depends upon the target area size, season and topography, types of seeding to be conducted, needed equipment and personnel, and the length of the desired project period."[42] The state of Wyoming conducted the Wyoming Weather Modification Pilot Program ("WWMPP"), from 2005 to 2014, to assess the feasibility of increasing the state's water supplies through winter cloud seeding.[43] At the culmination of the program, based on a potential increase in precipitation from seeded storms of 5-15%, the evidence from statistical, physical, and modeling analysis suggested that cloud seeding was a viable technology to augment existing water supplies in Wyoming.[44] The estimated annual costs per winter season for a purely operational

---

Seeding for Rain Enhancement 2 (Cypress Inst., 2009), http://www.cyi.ac.cy/system/files/Report_EEWRC_omformat.pdf.

21. *Common Questions and Answers About Cloud Seeding*, N.D. Atmospheric Res. Bd., http://www.swc.state.nd.us/arb/ndcmp/pdfs/q_a.pdf (last visited Apr. 2, 2016).
22. *Id.*
23. *Id.*
24. Virginia Simms, *Making the Rain: Cloud Seeding, the Imminent Freshwater Crisis, and International Law*, 44 Int'l Law. 915, 918 (2010).
25. Barry B. Coble, Benign Weather Modification 12 (June 1996); *see also* Simms, *supra* note 24, at 919.
26. Coble, *supra* note 25, at 22.
27. *Common Questions and Answers About Cloud Seeding*, *supra* note 21.
28. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.
29. Coble, *supra* note 25, at 12.
30. *Id.*
31. *Id.*
32. *Frequently Asked Questions (FAQs) Concerning Cloud Seeding Activities Designed to Increase Precipitation*, Weather Modification Ass'n, http://www.weathermodification.org/faq.php (last visited Apr. 2, 2016).
33. *Id.*
34. *Id.*
35. Hydroelectric power or hydropower is "using water to power machinery or make electricity." *How Hydropower Works*, U.S. Dep't Energy: Off. Energy Efficiency & Renewable Energy, http://energy.gov/eere/water/how-hydropower-works (last visited Apr. 2, 2016).
36. *FAQs Concerning Cloud Seeding Activities Designed to Increase Precipitation*, *supra* note 32.
37. *Id.*
38. *See* Corbridge & Moses, *supra* note 13, at 208.
39. *See* Steven T. Sonka, *Economics of Weather Modification: A Review*, 89 Ill. Inst. Nat. Resources Rep. Investigation 51 (1979), http://www.isws.illinois.edu/pubdoc/ri/iswsri-89.pdf.
40. *See id.*
41. *The Weather Modification Research and Technology Transfer Authorization Act of 2005: Hearing on S. 517 Before the Subcomm. on Sci. & Space & the Subcomm. on Disaster Prevention & Prediction of the S. Comm. on Commerce, Sci., & Transp.*, 109th Cong. 28 (2005) (statement of E. Benjamin Nelson, Sen. from Neb.) [hereinafter *Weather Modification and S. 517*].
42. *Information Resources: Frequently Asked Questions*, Weather Modification Incorporated, http://www.weathermodification.com/resources.php (last visited Sept. 25, 2016).
43. *The Wyoming Weather Modification Pilot Program: Level II Study*, Wyo. Water Dev. Commission (Dec. 2014), http://wwdc.state.wy.us/weathermod/WYWeatherModPilotProgramExecSummary.html.
44. *Id.*

program using remotely controlled ground based generators ranged from $375,500 to $526,400.[45] Thus, the investment in cloud seeding operations, such as the WWMPP, is relatively low when considering benefit-to-cost ratios. For the purposes of this Note, I will discuss the benefits and advantages of precipitation augmentation and hurricane diversion, although my proposed solution will impact all weather modification activities.

1. Benefits of Precipitation Augmentation

Weather modification activities are mostly recognized by the benefits cloud seeding may provide to avert drought.[46] Economic studies show that precipitation augmentation has the greatest potential economic impact compared to other weather modification activities.[47] And as these studies have shown, "precipitation augmentation through cloud seeding has enormous potential to help us moderate the adverse . . . economic costs of wide fluctuations in weather and climate."[48] Droughts in the United States cause average annual economic losses between six and eight billion dollars.[49] Weather modification projects help exponentially reduce these losses.[50]

Cloud seeding studies show an increase in rainfall which results in an increase in both free-flowing and stored water supplies.[51] Thus, since only 5-15% of available moisture in clouds naturally reaches the ground as precipitation, rain-augmenting operations could increase U.S. water supplies significantly.[52] For example, during 2009 and with a $155,000 budget, the Desert Research Institute ("DRI") in Nevada, considered leaders in both research and practice of cloud seeding, seeded at Lake Tahoe.[53] DRI seeded fifty-six weather events with an estimated increase of about 20,000 acre-feet of snow water or nearly 6.6 billion gallons of water.[54] From 1997 through 2010, DRI "[h]as augmented snow water an average of about 18,000 acre-feet for the Tahoe-Truckee region."[55] This snow water increase is enough to supply approximately 40,000 households with water annually.[56] From the results of these studies, it is clear that precipitation augmentation is a viable method of addressing drought problems in the United States.

45. *Id.*
46. Lance D. Wood, *The Status of Weather Modification Activities Under United States and International Law*, 10 Nat. Resources Law. 367, 373 (1977).
47. *See* Arnett S. Dennis, Weather Modification by Cloud Seeding 228 (Acad. Press, 1980).
48. *See* Comm. on Climate Uncertainty and Water Res. Management et al., Managing Water Resources in the West Under Conditions of Climate Uncertainty: A Proceedings 301 (Nat'l Acads. Press, 1991).
49. Weather Mitigation Research and Development Policy Authorization Act of 2009, S. 601, 111th Cong. (1st Sess. 2009) [hereinafter Weather Act of 2009].
50. During the 1980s, "[t]he suppression of hail in the United States alone offers a potential saving of roughly $500,000,000 per year." Dennis, *supra* note 47, at 228; *see also* Weather Act of 2009, *supra* note 49.
51. *See Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.
52. U.S. S. Select Comm. on Nat'l Water Resources, 86th Cong., Water Resources Activities in the U.S.: Evapo-Transpiration Reduction (Comm. Print 1960).
53. *DRI Receives Funding to Continue Cloud Seeding Program for 2011*, Desert Res. Inst. (Oct. 20, 2010), http://www.dri.edu/newsroom/news-releases/3404-dri-receives-funding-to-continue-cloud-seeding-program-for-2011-season.
54. *Id.*
55. *Id.*
56. *Id.*

2. Storm Control Through Weather Modification

Experiments have shown that weather modification activities may be useful to reduce the destructive impacts of severe storms, such as hurricanes or tornadoes.[57] In 1961, the National Oceanic and Atmospheric Administration ("NOAA"), along with the Department of Defense and the National Science Foundation seeded Hurricane Esther with silver iodide in an experiment called Project Stormfury, reducing its wind force by 10%.[58] Approximately eight years later, on August 18, 1969, NOAA once again attempted to weaken a hurricane's wind force by cloud seeding Hurricane Debbie with silver iodide five times during an eight-hour period.[59] As a result, winds decreased by 31% between the first seeding and five hours after the fifth seeding.[60] Nevertheless, the storm re-intensified the following day.[61] On August 20, 1969, once again NOAA seeded Hurricane Debbie, which resulted in a wind speed drop of 15%.[62] Notwithstanding this ability to weaken hurricanes, the federal government terminated Project Stormfury in 1982 "because NOAA and the Department of Defense could not maintain an operating relationship."[63]

Storm suppression through cloud seeding results not only in hurricanes' wind speed drop, but also in economic benefits. Annually, hurricanes cause substantial financial loss through physical damage and the high cost of precautionary measures.[64] For example, according to the National Climatic Data Center, damages from Hurricane Katrina in 2005 were estimated at approximately $105.8 billion in 2010 dollars.[65] Therefore, suppressing storms and diminishing the level of maximum sustained winds would seem to strongly reduce the detrimental characteristics of the hurricane event and, consequently, lower financial losses that result from hurricanes' damages.

Although weather modification activities seem to provide a wide range of benefits in different areas, such as storm suppression and freshwater increase, there is skepticism around what some believe could be a powerful technology used as a new kind of weapon.

C. Concerns About Weather Modification

Weather modification is a widely unknown and powerful technology and, as such, has been a cause for concern among those that speculate that it can have health and national security repercussions. Skeptics have voiced concerns regarding weather modification's use as a new kind of weapon. In the

57. Wood, *supra* note 46, at 370.
58. *See id.*
59. Ray J. Davis, *State Regulation of Weather Modification*, 12 Ariz. L. Rev. 35, 37 (1970) [hereinafter *State Regulation of Weather Modification*]; *see also* Wood, *supra* note 46, at 370.
60. *State Regulation of Weather Modification*, *supra* note 59, at 37.
61. *Id.* at 37–38.
62. *Id.* at 38.
63. Wood, *supra* note 46, at 388.
64. *See* Eric S. Blake et al., *The Deadliest, Costliest, and Most Intense United States Tropical Cyclones From 1851 to 2010 (And Other Frequently Requested Hurricane Facts)*, Nat'l Oceanic & Atmospheric Admin.: Nat'l Hurricane Ctr. (Aug. 2011), http://www.nhc.noaa.gov/pdf/nws-nhc-6.pdf.
65. *Id.* at 11.

1990s, the U.S. Air Force commissioned a report on weather modification, which concluded that "[o]ver the course of the next century, the weather will be our most powerful weapon. Weather modification can provide battle space dominance to a degree never before imagined."[66]

One potential use of weather modification as a weapon is an "unmanned stealth aircraft that could seed clouds above massing troops" in order to "produce localized flooding and create mud, which has been the bane of all of history's armies."[67] For example, from 1966 through 1972, the U.S. military began Project Popeye, a cloud seeding operation designed to flood supply routes used by the North Vietnamese into South Vietnam.[68] However, in 1977 the U.N. General Assembly, in the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques, formally banned using weather modification as a military tool.[69] President Carter ratified the Convention on December 13, 1979 and it entered into force for the United States on January 17, 1980.[70]

On the other hand, although opposing views exist regarding the danger of cloud seeding operations, some studies indicate, "silver iodide is toxic and can produce harm when used in sufficient quantities and concentrations."[71] Specifically, environmentalists have voiced concerns about the possible dangerous consequences of injecting silver iodide into clouds since the chemical may break down and add concentrations of silver to the environment.[72] According to research scientists at the U.S. Geological Survey in Menlo Park, California, "silver is a powerful environmental toxin."[73] Silver has the ability to kill microorganisms "indiscriminately and can wipe out the beneficial ones as well as the pathogenic ones."[74] Furthermore, the toxin has a direct effect on the reproduction of certain aquatic invertebrates and fish.[75]

Regarding health hazards to humans, the Environmental Protection Agency ("EPA") has classified silver as a nuisance chemical, or secondary contaminant, in drinking water.[76] The EPA states that in concentrations of 0.1 milligrams of substance per liter of water, silver ingestion can cause skin discoloration and a graying of the white part of the eye.[77]

The potential of using weather modification technology as a weapon and its health and environmental dangers adds to the urgency that the federal government should regulate and have centralized control over all weather modification activities in the United States. This way, the U.S. can reap the benefits of this technology while still controlling its use and minimizing any concern of danger.

II. Legal Development of Weather Modification in the United States

A. *Weather Modification's Legal Background*

As a result of the first scientifically controlled effort generally recognized as constituting weather modification in 1946, the federal government organized several projects aimed at more thorough research and investigation of weather modification.[78] Between 1947 and 1952, extensive government-funded tests demonstrated the possibility on a field scale of modifying supercooled clouds to both increase and retard precipitation.[79]

Consequently, legislative models started emerging during what is known as weather modification's "second phase."[80] The Advisory Committee on Weather Control was established, with a fixed duration of five years, by act of Congress on August 13, 1953.[81] The Advisory Committee's responsibilities dealt primarily with the "evaluation of public and private experiments in weather control for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate activities designed to control weather conditions."[82] Subsequent to the statutory termination of the Advisory Committee on Weather Control in 1958, Congress directed the National Science Foundation ("NSF") to investigate the field of weather modification and passed Public Law 85-510, which designated the NSF as the agency in charge of receiving reports on cloud seeding activities.[83] While there was no federal regulatory or operation program established, Congress provided appropriations

66. Simms, *supra* note 24, at 935.
67. *Id.*
68. *Id.*; *see also* Coble, *supra* note 25, at 4.
69. Article I of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques sets forth the basic commitment: "Each State Party to this Convention undertakes not to engage in military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State Party." Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques art. 1, *opened for signature* May 18, 1977, 31 U.S.T. 333.
70. *Id.*
71. *See* Ray J. Davis, *Black Clouds and Silver Iodide: Public Safety and Weather Modification Law*, 23 J. Weather Modification 63 (1991) [hereinafter *Black Clouds and Silver Iodide*]. *But see* Samantha Young, *Governments Turn to Cloud Seeding to Fight Drought*, U.S. News (Dec. 11, 2009), http://www.usnews.com/science/articles/2009/12/11/governments-turn-to-cloud-seeding-to-fight-drought (stating that a study published in 2009 by the Weather Modification Association in the United States revealed that no "environmentally harmful effects" from silver iodide were shown).
72. Simms, *supra* note 24, at 921.
73. Robin Marantz Henig, *Our Silver-Coated Future*, 29 OnEarth 1, Sept. 1, 2007.
74. *Id.*
75. *Id.*
76. EPA has established National Secondary Drinking Water Regulations that set non-mandatory water quality standards for fifteen secondary contaminants. EPA does not enforce these "secondary maximum contaminant levels." The standards established only act as guidelines to assist public water systems in managing their drinking water for aesthetic considerations, such as taste, color, and odor. *Secondary Drinking Water Standards: Guidance for Nuisance Chemicals*, U.S. Envtl. Protection Agency, https://www.epa.gov/dwstandardsregulations/secondary-drinking-water-standards-guidance-nuisance-chemicals#what-are-secondary (last visited Apr. 2, 2016).
77. *Id.*
78. *See* Corbridge & Moses, *supra* note 13, at 210.
79. *Id.*
80. Corbridge & Moses, *supra* note 13, at 210; *see also* Ray J. Davis, *Four Decades of American Weather Modification Law*, 19 J. Weather Modification 102, 103 (1987) [hereinafter *Four Decades of American Weather Modification Law*].
81. Jack C. Oppenheimer, *The Legal Aspects of Weather*, 1958 Ins. L.J. 314, 315 (1958).
82. Pub. L. No. 83-256, § 3, 67 Stat. 559, 559 (1953).
83. Corbridge & Moses, *supra* note 13, at 211; *see also Four Decades of American Weather Modification Law*, *supra* note 80, at 103.

for research[84] while the states took a leading role as weather modification regulators. States, especially those in arid settings, began to enact weather control regulations.[85]

The "golden years" of weather modification took place during the 1970s when governmental interest and legal development of weather modification technology reached their peak.[86] On December 18, 1971, Congress enacted 15 U.S.C. § 330 providing for the reporting of weather modification activities to the Secretary of Commerce, who was responsible for the maintenance and publication of such reports.[87] Currently, NOAA implements the Act.[88] This is the only act to date that is still in force regarding federal weather modification requirements.

The promise of the "golden years" dwindled later during the 1980s.[89] Governmental cloud seeding financial support withered mostly because of budget cuts in this particular field.[90] Congressional weather modification research and funding declined, as did the enactment of states' weather modification laws.[91]

Although cloud seeding regulation seemingly slowed down, weather modification activities have not ceased. Currently, the number of private and state-funded weather modification projects has jumped by nearly a third during the last decade and a half.[92] The numbers regarding cloud seeding operations continue to rise: sixty-one projects in nine states were reported in 2010, thirteen more than in 1998.[93] Nevertheless, the only type of federal control all these operations are submitted to is the requirements of 15 U.S.C. § 330. The broad and ambiguous requirements of the Act, which may take place even after the weather modification operation has culminated,[94] do not provide the type of regulation required to address the effects of weather modification activities in the United States.

B. Lack of Federal Weather Modification Regulation

Given the present failure of states to actively regulate weather modification activities, one might anticipate that legislators at the federal level would have filled this regulatory void given that this is an interstate activity. Nevertheless, up to the present, "Congress and federal agencies have been primarily concerned with investigating and coordinating weather modification, rather than with regulating it."[95]

1. Weather Modification Activities Federal Reporting Requirement

As previously mentioned, the only federal regulation of weather modification is 15 U.S.C. § 330, which imposes a mere reporting obligation of weather modification activities with a maximum $10,000 fine for those who knowingly and willfully violate this requirement.[96] The Act provides that all weather modification activities are subject to initial recording and submission of reports[97] to the NOAA.[98] However, the Secretary of Commerce may require that said reports be submitted to him before, during, or after any weather modification activity or attempt.[99] Moreover, after the Secretary has received initial notification of a planned weather modification activity, he may waive some of the subsequent reporting requirements.[100]

Activities of federal agencies and their contractors, employees, or agents, however, are exempted from the reporting requirements of the Act.[101] The Act applies only to an "individual, a corporation, company, association, firm, partnership, society, joint stock company, any State or local government or any agency thereof, or any other organization, whether commercial or nonprofit."[102]

Although this Act can be seen as an initial step towards federal regulation of weather modification, it falls short of providing the governmental machinery for coordination and regulation of weather modification activities. It provides no standards, requirements or guidelines for coordination and planning, or regulation and licensing of weather modification activities.[103]

2. Weather Modification Regulation on Federally Designated Wilderness Areas

Aside from 15 U.S.C. § 330, federal regulation of weather modification exists only on federally designated wilderness area.[104] The U.S. Forest Services ("USFS") and Bureau of

84. By the late 1970s, annual federal funding for cloud seeding projects reached $20 million. Simms, *supra* note 24, at 927.
85. *See Four Decades of American Weather Modification Law*, *supra* note 80, at 104.
86. *Id.*
87. 15 U.S.C. § 330 (2012); *see also* Peter E. Graf, *Weather Modification: The Need for a National Policy*, 3 Golden Gate U. L. Rev. 343, 356 (1973).
88. 15 C.F.R. § 908 (2016).
89. *Four Decades of American Weather Modification Law*, *supra* note 80, at 105.
90. "[T]he basic consideration during the present weather modification decade has been economic. Regulation costs money; de-regulation is the rage. Budgets are tight; weather modification lacks the political constituency to be protected from budget-makers' axes. The money tree has borne less fruit." *Id.*
91. *Id.*
92. *See* Simms, *supra* note 24, at 927.
93. Agric. Def. Coal., *A Summary of Weather Modification Activities Reported in 2010* (2010), http://www.agriculturedefensecoalition.org/sites/default/files/file/weather/450WV_2010_NOAA_Final_Listing_of_Weather_Modification_Programs_Spreadsheet_10WXMOD5.pdf.
94. 15 U.S.C. § 330(a) (2012).
95. Corbridge & Moses, *supra* note 13, at 219.
96. *See* 15 U.S.C. § 330(a), (d).
97. Weather modifiers must submit to NOAA information such as: (1) project or activity designation; (2) dates of project; (3) purpose of project or activity; (4) name, address, and phone number for the project sponsor and operator; (5) location and size of target and control areas; (6) a description of the weather modification apparatus, modification agents, and the techniques to be used; and (7) name, address, and phone number of the responsible individual from whom log books and records may be obtained. 15 C.F.R. § 908.4 (2016).
98. *See* 15 U.S.C. § 330(a).
99. *Id.*
100. "No person may engage, or attempt to engage, in any weather modification activity in the United States unless he submits to the Secretary such reports with respect thereto, in such form and containing such information, *as the Secretary may by rule prescribe*." *Id*. (emphasis added).
101. Graf, *supra* note 87, at 356; *see also* Wood, *supra* note 46, at 374.
102. 15 U.S.C. § 330(2).
103. *See* Graf, *supra* note 87, at 357–58.
104. Wilderness is defined by the Wilderness Act of 1964 as "[a]n area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." Furthermore, wilderness is defined as

Land Management ("BLM") have specific policies to regulate weather modification activities in wilderness area.[105]

According to USFS regulation, long-term weather modification programs "that produce, during any part of successive years, a repeated or prolonged change in the weather directly affecting wilderness areas," are not permitted.[106] However, "[s]hort-term weather modification activities that produce only occasional, incidental, temporary, or transitory changes in the weather with carryover ground effects that last only a few days beyond the actual cloud-seeding period may be permitted."[107] To carry out weather modification activities over wilderness areas administered by USFS, operators must satisfy certain criteria and obtain a permit.[108]

On the other hand, BLM policy for weather modification over wilderness largely mirrors that of USFS. State directors are required to gather the necessary information about the proposed activity and make recommendations to the Director of the BLM on any activity or application for weather modification operations.[109] The Director then determines whether to approve weather modification operations affecting wilderness.[110] As with USFS, applications for weather modification affecting BLM wilderness areas must meet certain criteria.[111]

C. Weather Modification State Regulation

The most recent information collected through the reporting requirements established in 15 U.S.C. § 330 revealed that there were sixty-one cloud seeding projects in nine states carried out in 2010 and thirty-two cloud seeding projects carried out in the same nine states in 2011. These weather modification projects are currently subject to the particular regulatory requirements established by each state legislature.[112] These state laws range widely in scope from laws that favor said activities by providing taxing authority for weather modification districts to laws that are so restrictive they practically constitute an effective ban on weather modification activities.[113] This has resulted in a patchwork of state regulation across the U.S. that ranges from very stringent to lax requirements.

1. Varied Weather Modification Regulation Across the States

A survey of all state statutes reveals that thirty-three states,[114] the District of Columbia, Puerto Rico, and the Virgin Islands have had or currently have weather modification regulation to some degree. The remaining seventeen states have opted to not adopt weather modification regulations for, what scholars believe to be, three main reasons. First, the uncertainties surrounding the consequences of a relatively new and powerful technology such as weather modification have led to some skepticism among states.[115] Second, there is a lack of federal government funds that can help with the implementation of weather modification programs in the states.[116] Lastly, states have banned "weather modification on the theory that rain falling prematurely is rain stolen from the location where it would otherwise naturally fall."[117] This "robbing Peter to pay Paul" theory, however, has been dispelled because clouds continually regenerate and release only a portion of their moisture when it rains, which means weather modification operations cannot eliminate all the moisture from a cloud and cannot "steal" rain from an area a cloud is ultimately traveling towards.[118]

The states that have enacted regulation regarding weather modification have done so in various and particular ways which have resulted in a broad difference in scope among the different acts. Some states require only reporting of weather modification activities, others require some form of licensing, but with no standards or criteria of competence, while other states like Oklahoma[119] are more stringent and require a showing of financial responsibility in case of liability, which might result from said activities.[120] The following two sub-

"[a]n area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable, (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation, (3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value." 16 U.S.C. § 1131 (2012).

105. *See* Western Water States Council, *supra* note 20, at vII.
106. U.S. Forest Serv., Forest Service Manual § 2323.45 (2007).
107. *Id.*
108. The USFS may approve wilderness area as a target area for weather modification operations when: (1) the weather modifier provides scientific evidence that the activities will not produce substantial, permanent changes; (2) the proposal includes no feature that will "visibly alter" or "impact the wilderness environment;" and (3) the proposal is not likely to "reduce the value of wilderness for recreation, scenic, scientific, educational, conservation, or historical use." U.S. Forest Serv., *supra* note 106.
109. *See* Bureau of Land Mgmt., BLM Manual § 8560.36 (1983).
110. *See id.*
111. The criteria that must be satisfied are: "(a) [t]he proponent can provide reasonable, scientifically supportable assurance that the activities will not produce permanent, substantial changes in natural conditions; [and] (b) [t]he proposal does not include any features that might reasonably be expected to produce conditions incompatible in appearance with the wilderness environment or reduce its value for recreation, scenic, scientific, education, conservation, or historical use." *Id.*; *cf.* U.S. Forest Serv., *supra* note 106.
112. *See* Graf, *supra* note 87, at 359–60.
113. *See* Dennis, *supra* note 47, at 242.
114. These states include Alaska, Arizona, California, Colorado, Florida, Texas, Pennsylvania, Oklahoma, Kansas, Wisconsin, North Dakota, Utah, New Mexico, Louisiana, Oregon, Idaho, Illinois, Indiana, Iowa, Maryland, Massachusetts, Michigan, Montana, Nebraska, Nevada, New Hampshire, Rhode Island, South Dakota, Tennessee, Virginia, Washington, West Virginia, and Wyoming.
115. "[T]he uncertainties of an infant science such as weather modification may lead to critical variations between anticipated and actual results." Corbridge & Moses, *supra* note 13, at 209.
116. *See* Coble, *supra* note 25, at 17–18.
117. Simms, *supra* note 24, at 927.
118. Amanda Little, *Weather on Demand: Making It Rain Is Now a Global Business*, Bloomberg Businessweek (Oct. 28, 2015), http://www.bloomberg.com/features/2015-cloud-seeding-india/.
119. The state of Oklahoma requires that "proof of financial responsibility shall be furnished by an applicant by his showing, to the satisfaction of the director, his ability to respond in damages for liability which might reasonably be attached to or result from his weather modification and control activities in connection with the operation for which he seeks a permit." 82 Okla. Stat. tit. 82, § 1087.14 (2015).
120. *See* Graf, *supra* note 87, at 359–60.

sections highlight the vast difference between state regulations concerning weather modification.

a. North Dakota

On one hand, states like North Dakota have enacted detailed regulatory weather modification statutes.[121] As part of North Dakota's weather modification efforts, it currently has a statewide operational cloud seeding program called North Dakota Cloud Modification Project.[122] In North Dakota, "no person may engage in weather modification activities without both a professional weather modification license . . . and a weather modification permit. . . ."[123] In determining whether to issue a license, North Dakota sets forth a series of rigorous requirements, such as a minimum of one year of field experience in the management and control of weather modification operations or research, proof of financial responsibility, and an explanation of whether a weather modification operational permit issued to the applicant in any jurisdiction has ever been suspended or revoked or whether there has been refusal to renew a permit by any jurisdiction.[124] After a license has been effectively issued, North Dakota retains authority over weather modification activities by having the power to revoke or suspend any license for different reasons, such as incompetency, dishonest practice, or failure to comply with any of the provisions or rules prescribed by the North Dakota legislature.[125]

b. Idaho

On the other hand, states with more relaxed weather modification statutes, such as the state of Idaho, concern licensing requirements that are essentially mere registration provisions which only require a cloud seeder to list their alleged qualifications, but no one has the responsibility to verify whether they are competent, honest, and solvent. For example, the weather modification statute of Idaho purports on its face only to require registration of producers of artificial rainfall with the state Department of Agriculture.[126] Registration only requires the "name of the person, association, or corporation, its residence, or principal place of business in the state of Idaho and the general nature of the business to be conducted."[127] However, the statute does not impose penalties on those who do not comply with it. Thus, if there are no consequences for noncompliance, the state's Department of Agriculture is in a disadvantaged position to enforce the required registration requirements. In fact, in 1978, Idaho's Department of Agriculture regarded "[i]tself as unable to enforce registration because the statute carries no penalties."[128]

Although states, like Idaho, have no robust weather modification regulation, countries around the world are currently extensively regulating weather modification technology. Unlike the United States, other countries' governments, such as China, have spent huge amounts of money to regulate this technology, apply the different techniques, and ultimately reap their benefits.

D. China's Weather Modification Activities and Regulation

According to the World Meteorological Organization, weather modification programs, primarily involving cloud seeding activities aimed at enhancing precipitation or mitigating hail fall, exist in more than approximately fifty-two countries.[129] One of these countries includes China, which has the most "extensive weather modification program in the world, with more than 35,000 people working in cloud seeding programs across the country."[130] The Chinese government has enacted regulations promoting weather modification cooperation between provinces and regions.[131] Also, the government funds a greatly expanded weather modification research and operations program at $100 million per year, in addition to training over 1,500 new weather modification scientists.[132] China's cloud seeding weapons include approximately 6,781 artillery guns and 4,110 rocket launchers.[133] In 2004, the Chinese government reported it eased drought by employing "[a]ircraft, rockets, artillery shells, meteorological balloons and mountain-top-based devices . . . to scatter silver iodide particles into gathering clouds to induce precipitation in the form of rain or snow over the city."[134]

One of the biggest cloud seeding operations in China took place in Beijing in 2008 months before the Summer Olympics took over the Chinese city.[135] In preparation for the Olympic games, Beijing officials set up cloud seeding stations where "peasants don military fatigues and helmets and squat behind anti-aircraft guns and rocket launchers blasting the sky with silver iodide, hoping to shock rain from the clouds."[136] Beijing officials planned to have these stations ready and, if rain threatened either the opening or closing ceremonies, they would "seed threatening clouds [using rocket launchers] outside the city . . . and cause them to release their rain before it reaches the capital."[137]

---

121. *See* N.D. Cent. Code § 61-04.1 (2015); *see also* N.D. Cent. Code § 89-07-02 (2014).
122. *The North Dakota Cloud Modification Project*, N.D. St. Gov't: St. Water Comm'n & Off. St. Engineer, http://www.swc.nd.gov/arb/ndcmp/ (last visited Sept. 23, 2016).
123. N.D. Cent. Code § 61-04.1-11 (2015).
124. N.D. Admin. Code §§ 89-07-02-07 to -14 (2014).
125. N.D. Cent. Code § 61-04.1-15 (2015).
126. Idaho Code Ann. §§ 22-3201 to -3202 (2015).
127. *Id.* § 22-3201.
128. *Weather Modification Interstate Legal Issues*, *supra* note 16, at 561–62.
129. Little, *supra* note 118.
130. Rocky Barker, *Modifying Weather: Cloud Seeding Has Some New Believers*, U.S. News (Nov. 19, 2009, 2:49 PM), http://www.usnews.com/science/articles/2009/11/19/modifying-weather-cloud-seeding-has-some-new-believers.
131. *See* Simms, *supra* note 24, at 923.
132. *Weather Modification and S. 517*, *supra* note 41.
133. Stephen Wade, *Rain Out: China Aims to Control Olympics Weather*, USA Today (Feb. 29, 2008), http://usatoday30.usatoday.com/weather/research/2008-02-29-china-weather_N.htm.
134. *Cloud Seeding Eases Drought*, China Internet Info. Ctr. (July 26, 2004), http://www.china.org.cn/english/China/102176.htm.
135. Wade, *supra* note 133.
136. *Id.*
137. *Id.*

Despite this arguable success in China's Olympic games preparation, the United States' federal government still has not resorted to effectively control weather modification in order to reap all the benefits that stem from this technology. There seems to be a paradox here where the federal government is not willing to spend funds to promote weather modification technologies and enact regulations, yet other countries are willing to spend huge amounts of funds to apply these techniques and reap their benefits.

III. Need for Weather Modification Regulation on a Federal Level

Weather modification activities are prone to interstate legal issues or adverse effects without any effective accountability by the federal government. Nevertheless, a federal interest exists if any weather modification activity in the United States could have effects beyond one state's border, or would affect federal lands or activities.[138] Thus, the federal government needs to take action and regulate weather modification across the United States in order to minimize the possibility of adverse effects or issues, addressed below, from cloud seeding activities and to avoid interstate legal issues.

Present capabilities in the science of weather modification suggest that the need for comprehensive regulation at a national level is imperative.[139] As global warming takes an exponential toll on fresh water supplies and weather patterns,[140] the science of weather modification, and the implied issues that result thereof, is effectively taking a dominant role in attempting to alleviate environmental effects that result from climate change.[141] Therefore, the federal government must resolve current issues and difficulties presented by weather modification in order to ensure its expansion while safeguarding weather modification operators and those who may be affected by the activities.

A. *Interstate Impact and Legal Issues*

The weather knows no territorial or political boundaries and, thus, its effects and impacts travel across states' borders resulting in multijurisdictional consequences. These issues could arise, for example, when an individual or government causes extra rain, which then floods a neighboring state's field.[142]

During the mid-1970s, a precipitation alteration project operated in Idaho and neighboring states gave rise to interstate legal issues.[143] Washington state's legislature was considering a bill to appropriate funds for drought relief cloud seeding activities.[144] Nevertheless, Idaho Attorney General Wayne Kidwell protested the bill and threatened to file a suit in the U.S. Supreme Court seeking an injunction to stop the cloud seeding.[145] Attorney General Kidwell's concern was based upon the belief that weather modification not only has an impact upon the target areas selected for cloud seeding, but can also have an adverse effect upon downwind areas such as the Idaho panhandle.[146] Fortunately, in this case, Idaho Governor John Evans opted for a different approach and proposed regional interstate coordination of cloud seeding efforts.[147]

Attorney General Kidwell voiced a common concern between adjoining states from where a weather modification operation is taking place.[148] Thus, weather modification should be federally regulated to minimize the possibility of adverse effects in downwind areas as well as in target areas. Furthermore, Congress should enact comprehensive regulation resolving or clearing liability issues and questions and multi-state impacts that arise from weather modification activities.

B. *Uniform Safety Standards*

As discussed above,[149] the use of silver iodide may present a health and environmental hazard "when used in sufficient quantities and concentrations."[150] A trial court judge in *Pennsylvania Natural Weather Ass'n v. Blue Ridge Weather Modification Ass'n*, noted that various seeding agents "are poisonous" and concluded that "possible harm can result from uncontrolled and unregulated weather modification activities."[151] Given the uncertain nature of this science there exist concerns over the long-term consequences of injecting silver iodide into clouds in order to manipulate the weather.[152]

Substantial risk upon "land, people, health safety, property, or the environment" has always been of sufficient importance to Congress as to call for legislative action.[153] Thus, Congress needs to step in and regulate weather modification activities nationwide and establish consistent and minimum standards of care in order to ensure or minimize any risk to public health, safety, and welfare that could result from unregulated cloud seeding operations.

C. *Lack of State Funding*

One of the obstacles to weather modification at the state level has been the financing and funding of weather modification activities.[154] "The States have small amounts of money and personnel to administer and enforce their regulations," and

138. *See* Wood, *supra* note 46, at 390.
139. *See* Corbridge & Moses, *supra* note 13, at 225.
140. *See* Alex Morales, *Global Warming Seen Taking Toll on Economy, Health, Crops*, Bloomberg, Nov. 4, 2013, http://www.bloomberg.com/news/articles/2013-11-04/global-warming-seen-taking-toll-on-economy-health-crops.
141. *See* Simms, *supra* note 24, at 918.
142. *See id.* at 933.
143. *See Weather Modification Interstate Legal Issues*, *supra* note 16, at 555.
144. *See id.* at 556.
145. *See id.*
146. *See id.*
147. *See id.*
148. *See* N.D. Atmospheric Res. Bd. v. Bd. of Nat. Res. & Conservation, 1992 Mont. Dist. LEXIS 60 (Mont. Dist. Ct. 1992) (upholding North Dakota's cloud seeding project despite allegations that it would have potential adverse effects in the state of Montana).
149. *See supra* Part I.
150. *See Black Clouds and Silver Iodide, supra* note 71, at 63.
151. Pa. Nat. Weather Ass'n v. Blue Ridge Weather Modification Ass'n, 44 Pa. D. & C.2d 749, 761 (Pa. C.P. 1968).
152. *See* Simms, *supra* note 24, at 921.
153. *Black Clouds and Silver Iodide, supra* note 71, at 64.
154. *See* Oppenheimer, *supra* note 81, at 317.

their weather modification activities are usually conducted as an incident to other conservation, water resources, or agricultural programs.[155] State officials have noted that the absence of explicit legal authority to the states renders improbable for states to appropriate general funds or levy taxes to finance weather modification activities.[156] Nevertheless, in the past, different states have shown interest in cooperating with the federal government and obtaining federal funding for the weather modification efforts in their respective states.[157] Thus, funds provided by the federal government acting in conjunction with the states would likely spark weather modification regulation.

As Congressman John Jacob Rhodes, Jr. stated in 1982, "the potential societal benefits of weather modification are too great for us to ignore or to pursue it in piecemeal fashion. We need a better sense of national strategy."[158] This is why there is a pressing need for federal action and national regulation of weather modification activities in order to minimize any of the adverse effects or issues, detailed above, that may arise from such operations, while still enjoying its benefits.

155. *Id.*
156. *Id.*
157. *See Weather Modification Law Developments*, *supra* note 16, at 418; *see also* Oppenheimer, *supra* note 81, at 317.
158. Stanley A. Changnon, Jr. & W. Henry Lambright, *The Rise and Fall of Weather Modification Policy*, 19 J. Weather Modification 1, 10 (1987).
159. U.S. Const. art. I, § 8, cl. 3.
160. *See* Christine A. Klein, *The Environmental Commerce Clause*, 27 Harv. Envtl. L. Rev. 1 (2003).
161. *Id.*

V. Conclusion

The confluence of factors including climate change and a practically inevitable freshwater crisis is a warning to political leaders in the United States to take action regarding weather modification regulation. The western part of the United States, specifically the state of California, and its territories, such as Puerto Rico, have already felt the effects of intensified and persistent droughts, and scientists point to "future dry spells" worsening as temperatures continue to rise.[211]

With such pressing concerns across the U.S., weather modification, particularly cloud seeding, is gaining momentum as it is being more frequently used as a technology to help stave off water scarcity issues. Nevertheless, stagnated and weak state regulations across the United States do not take into account the issues and effects that this technology may have across states' borders. Furthermore, there is no centralized governmental control of such a powerful technology, which has already been used in the past as a weapon in military affairs.

For such reasons, Congress needs to act and, by the powers vested in it, enact the NWMCA, which will establish comprehensive federal regulation of weather modification activities. Such a national plan, with a lead agency, and a strong coordinated federal-state partnership will provide the necessary tools for national regulation and control of weather modification operations, while reaping its benefits, such as freshwater augmentation and storm suppression. Given the critical environmental impacts of climate change felt in the United States, the time is ripe for Congress to act and enact the NWMCA.

211. Gillis, *supra* note 10.